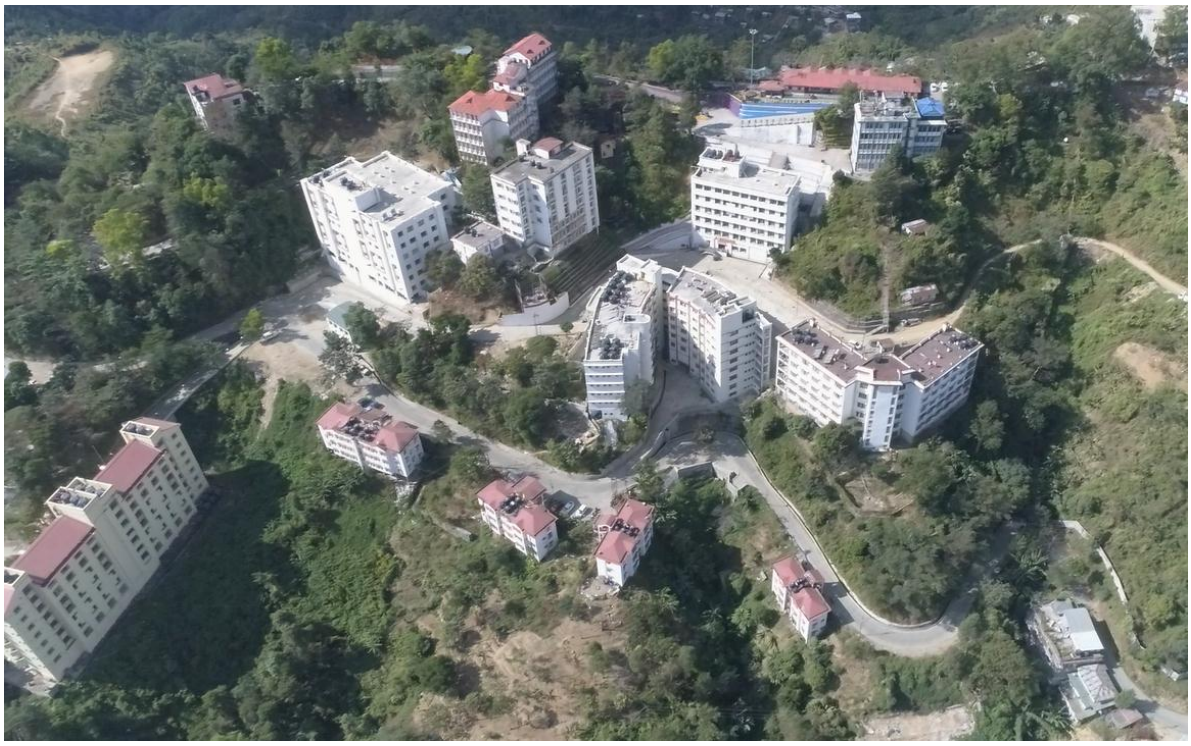
UP-GRADATION & DEVELOPMENT OF REGIONAL INSTITUTE OF PARAMEDICAL & NURSING SCIENCES,AIZAWL, MIZORAM

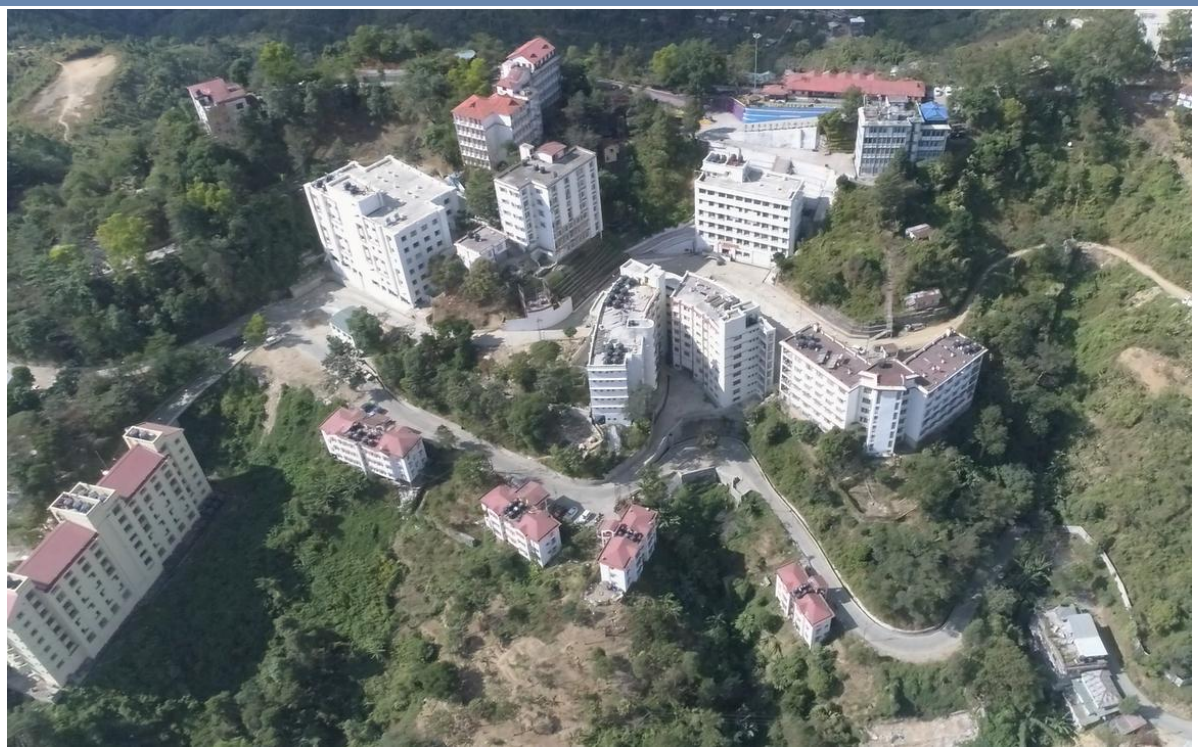


Tender No.- HLL/RIPANS-AIZAWL/2019

Vol 1: NIT & ITB
Vol 2: General Conditions of Contract
Vol 2A: Integrity Pact
Vol 3: Specific Conditions of Contract
Vol 4: Design Basis Report
Vol 5: Technical Specifications
Vol 6: Tender Drawings
Vol 7: Financial Bid

Vol.-1: NIT & ITB

UP-GRADATION AND DEVELOPMENT OF REGIONAL INSTITUTE OF PARAMEDICAL & NURSING SCIENCES,AIZAWL, MIZORAM



CLIENT
Regional Institute Of Paramedical & Nursing Sciences, Aizawl, Mizoram
(Ministry Of Health and Family Welfare, Govt. of India)

PROJECT CONSULTANT
HLL Lifecare Limited
(A Government of India Enterprise)

HLL Lifecare Ltd. (HLL)

(A Govt. of India Enterprise)

on behalf of

Regional Institute of Paramedical & Nursing Sciences, (RIPANS) Aizawl, Mizoram

Invites

e-Tender

For

Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram

on EPC Basis

Tender No. HLL /RIPANS-Aizawl/2019

Volume-1

Notice Inviting e-Tender

&

Instructions to Bidders

(September, 2019)

HLL Lifecare Limited
(A Government of India Enterprise)

B-14 A, SECTOR 62
NOIDA, UP 201 307
PH.: 0120 4071 500 FAX: 0120 4071 513

www.lifecarehll.com

PRESS NOTICE

Regional Institute of Paramedical & Nursing Sciences, (RIPANS) Aizawl, Mizoram

(Ministry of Health & Family Welfare, Government of India)

NOTICE INVITING e-TENDER

Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram

Tender No. HLL /RIPANS-Aizawl/2019

HLL Lifecare Ltd. (HLL), B-14-A, Sector-62, Noida-201307, on behalf of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram (Ministry of Health & Family Welfare, Govt. of India) for this Project, invites online bids on Design, Engineering, Procurement and Construction (EPC) basis through e-tendering from eligible contractors/firms in two bid system for the following work:-

Name and Description of work	Estimated cost	Completion period of Work	Last date to fill/ upload the bid through e-tendering	Bid Security amount
Design, Engineering, Procurement and Construction (EPC) of Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl	**Rs. 229.46 Crs**	**24 Months**	**16.10.2019 Upto 15:00 Hrs.**	**Rs.239.46 Lakhs**

The bid document shall be available online from 02.09.2019.

For submission & other tender details, please refer detailed NIT available on websites www.lifecarehll.com, e-Procurement System at NIC's (CPP Portal) https://etenders.gov.in/eprocure/app. Corrigendum/amendments etc., if any, will be notified on these websites only and separate advertisement will not be made for the same

HLL reserves the right to accept or reject any application without assigning any reason or incurring any liability whatsoever.

Vice President (ID)

Regional Institute of Paramedical & Nursing Sciences, (RIPANS) Aizawl, Mizoram

(Ministry of Health & Family Welfare, Government of India)

NOTICE INVITING e-TENDER

Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram

Tender No. HLL /RIPANS-Aizawl/2019

HLL Lifecare Ltd. (HLL), B-14-A, Sector-62, Noida-201307, on behalf of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram (Ministry of Health & Family Welfare, Govt. of India) for this Project, invites online bids on Design, Engineering, Procurement and Construction (EPC) basis through e-tendering from eligible contractors/firms in two bid system for the following work:-

Name and Description of work	Estimated cost	Completion period of Work	Date of availability of bid document online	Date & time of pre-bid meeting	Last date to fill/ upload the bid through e-tendering	Date of opening of bids	Bid Security amount (Rs.)
Design, Engineering, Procurement and Construction (EPC) of Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl	Rs.229.46 Crs	24 Months	02.09.2019	16.09.2019 at 11:00 Hrs.	16.10.2019 Upto 15:00 Hrs.	17.10.2019 at 15:00 Hrs.	Rs.239.46 Lakhs

* For MSME registered bidders, the tender documents will be free of cost and such bidders will be exempted from EMD.

For submission & other tender details, please refer detailed NIT available on websites www.lifecarehll.com, e-Procurement System at NIC's (CPP Portal) https://etenders.gov.in/eprocure/app. Corrigendum/amendments etc., if any, will be notified on these websites only and separate advertisement will not be made for the same.

The bidder would be required to register at https://etenders.gov.in/eprocure/app. This registration is free of cost.

The bidder is required to have Class III-B (Signing and Encryption) Digital Signature Certificate (DSC) from one of the authorized Certifying Authorities. The DSC should be valid atleast for a period of six months from the date of start of bidding. After submission of bid the contractor can re-submit revised bid any number of times but before the last time and date of submission of bid as notified. While submitting the revised bid, the contractor can revise the rate of one or more item(s) any number of times, but before the last time and date of submission of bids as notified.

The bidders are required to submit the under mentioned documents in the office of The Vice President (ID) M/s HLL Lifecare Ltd. (HLL), B-14A, Sector – 62, NOIDA (UP:

a) Original non-refundable Demand Draft / Pay order or Banker's Cheque of any Scheduled Bank drawn in favour of M/s HLL Lifecare Ltd. (HLL) Payable at New Delhi/ NOIDA for an amount of Rs.2,24,000/- (Rs. Two Lakh Twenty Four Thousand only) inclusive of GST as e-Tender Fee.

b) Original bid security in approved form.

c) Form A-Form of Bid and appendix, Form-E and Form-G as attached in Vol. I of Tender, in respect of above work before the last date and time. The documents to be uploaded online are listed at Annexure I of the NIT & ITB (Vol. 1).

The complete set of Tender Documents comprising Volumes 1, 2, 2 A, 3, 4, 5, 6 & 7 shall be made available, as per schedule above, on e-Procurement System at NIC's (CPP Portal) https://etenders.gov.in/eprocure/app.

HLL reserves the right to accept or reject any application without assigning any reason or incurring any liability whatsoever.

Prospective bidders are advised to regularly scan through website of HLL www.lifecarehll.com and e-Procurement System at NIC's (CPP Portal) https://etenders.gov.in/eprocure/app, as corrigendum/amendments etc., if any, will be notified on this portal only and separate advertisement will not be made for the same.

Vice President (ID)

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DISCLAIMER

This document has been prepared by HLL Lifecare Ltd. (HLL), (A Government of India Enterprise) on behalf of Regional Institute of Paramedical & Nursing Sciences, Aizawl (Ministry of Health & Family Welfare, Govt. of India) for the Project. The information is provided to prospective Bidders, who are interested to Bid for "*Design, Engineering, Procurement and Construction (EPC) of Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl*".

This document is neither an agreement, nor an offer or invitation to perform work of any kind to any party.

The purpose of this document is to provide interested parties with information to assist the preparation of their Bid. While due care has been taken in the preparation of the information contained herein, and believe it to be complete and accurate, neither any of their authorities or agencies nor any of their respective officers, employees, agents or advisors give any warranty or make any representations, expressed or implied as to the completeness or accuracy of the information contained in this document or any information which may be provided in association with it.

Further, HLL do not claim that the information is exhaustive. Interested parties are required to make their own inquiry/ survey and will be required to confirm, in writing, that they have done so and they did not rely solely on the information given herein.

HLL reserve the right not to proceed with the Project or to change the configuration of the Project, to alter the timetable reflected in this document or to change the process or procedure to be applied. It also reserves the right to decline to discuss the Project further with any interested party.

No reimbursement of cost of any type or on any account will be made to persons or entities submitting their Bid.

Definitions

1. **"Application"** shall mean the response submitted by interested parties.
2. **"Project"** shall mean "Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl".
3. **"Site"** shall mean the place where the works under the Project are to be carried out and **the** details of which are provided in this document.
4. **"BID/Tender"** shall mean documents issued by HLL to the prospective Bidder. The word "**Tender**" is synonymous with "**Bid**".
5. **"Bid Security/ Earnest Money"** shall mean the amount to be deposited by the Bidder with the Tender.
6. **"Bid Validity"** shall **mean** the period for which the Bids shall remain valid.
7. **"Bidder"** shall mean the individual, proprietary firm, firm in partnership, limited company, **private** or public or corporation participating in the tendering process pursuant to and in accordance with the terms of this document. The word "**Tenderer**" is synonymous with "**Bidder**".
8. **"Client/ Employer/ RIPANS"** shall mean Regional Institute of Paramedical & Nursing Sciences, Aizawl (Ministry of Health & Family Welfare, Govt. of India) or their nominee/ assignee.
9. **"HLL "** shall mean HLL Lifecare Ltd. (HLL), (A Government of India Enterprise) appointed as Project Consultant by Regional Institute of Paramedical & Nursing Sciences, Aizawl for "Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl" and acting for and on behalf of RIPANS.
10. **"Contract Agreement"** shall mean the agreement to be signed between the Successful Tenderer and the competent authority for and on behalf CLIENT /HLL and/or their authorized representative.
11. **"Contract Price"** shall mean the financial bid of the Successful Tenderer as accepted by the CLIENT/HLL.
12. **"Date of commencement of work"** shall mean the date of Start as specified in the Schedule "F" or the date of handing over of the site, whichever is later as indicated in the tender document.
13. **"Defects Liability Period"** means the period after completion of the Project during which the Client or his authorized representative / Engineer-in-charge/HLL that will notify to the Contractor any defect noticed in the work and the Contractor is liable for rectification of such defects. Proof of dispatch of letter notifying the defect/ intimating the representative of Contractor at site on the last date of Defect liability period will make the Contractor liable for rectify all such defects.
14. **"Engineer-in-Charge" (EIC)** means the Engineer Officer as mentioned in the schedule "F" hereunder, as authorized by HLL.
15. **"Evaluation Committee"** shall mean the committee for the evaluation of the bids as constituted by HLL.
16. **"Successful Tenderer"** shall mean the Tenderer declared technically and financially successful for the Project and with whom, the Contract Agreement shall be signed.
17. **"Letter of Award/ Letter of Acceptance"** shall mean the letter issued by the HLL to the Successful Tenderer inviting him to sign the Contract Agreement.

18. **Performance Guarantee"** shall mean the amount to be paid by the Successful Tenderer as per relevant clause mentioned elsewhere.
19. "**Similar Works**" shall mean the work as defined in eligibility criteria.
20. **"Scheduled banks"** mean **"Scheduled Commercial Banks**"
21. **"NIT"** means **Notice Inviting e-Tender.** The word "**Notice Inviting e-Tender**" is synonymous with "**Notice Inviting Bids**".
22. **"Tender/Bid Processing Fee**" shall mean the amount to be paid by the Bidders/Tenderers in consideration of cost of bid document.
23. **"ITB"** means **Instructions to Bidders**
24. **"YEAR"** means "Financial Year" unless stated otherwise.
25. **"GST"** shall mean Goods and Service Tax.

SECTION-I

NOTICE INVITING e-TENDER (Detailed NIT)

M/s HLL Lifecare Ltd. (HLL)
(A Government of India Enterprise)
As Project Consultant of
Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram

1.1. HLL Lifecare Ltd. (HLL), B-14-A, Sector-62, Noida-201307, on behalf of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram (Ministry of Health & Family Welfare, Govt. of India) for this Project, invites on-line bids on Design, Engineering, Procurement and Construction (EPC) basis from eligible bidders, in two bid system, through e-tendering.

1.2. The estimated cost of work is as given in Table - I. The Vice President (ID) M/s HLL Lifecare Ltd. (HLL), (A Government of India Enterprise), will deal with all the matters relating to invitation of tenders. Any clarification shall be sought from The Vice President (ID), HLL Lifecare Ltd, B-14A, Sector – 62, NOIDA (UP) -201307, on courier/fax no. : 0120-4071513. The NIT and other details are also available on the website of HLL www.lifecarehll.com/tenders/ and e-Procurement System at NIC's (CPP Portal) https://etenders.gov.in/eprocure/app.

TABLE – I

No.	Description	Details
1	Tender No.	HLL /RIPANS-Aizawl/2019
2	Name & Description of Work	Design, Engineering, Procurement and Construction (EPC) of Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl
3	Estimated cost (in Rs. in Crores)	229.46
4	Completion period of work (Months)	24
5	Bid Security (EMD) amount (in Rs. in Lakhs)	239.46
6	Tender/ Bid Processing Fee to HLL (DD/ Pay Order or Banker's Cheque)	Rs.2,24,000/- (Rs. Two Lakh Twenty Four Thousand only)-inclusive of GST.
7	Date of availability of Bid documents on line.	02nd September, 2019
8	Pre-Bid Meeting	16th September,2019 at 11am (IST)
9	Last date to fill/upload the e-tender through e-Tendering.	16th October, 2019 at 3 pm (IST)
10	Date & time for opening of Technical Bids	17th October,2019 at 3 pm (IST)
11	Date of opening of Financial Bids	Technically qualified bidders to be intimated at appropriate stage.

Note:

a. For MSME registered bidders, the tender documents will be free of cost and such bidders will be exempted from EMD.
b. The bidder would be required to register at e-Procurement System at NIC's (CPP Portal) https://etenders.gov.in/eprocure/app. This registration is free of cost.

1.3. Pre bid meeting will held in the office of The Vice President (ID), HLL Lifecare Ltd, B-14A, Sector – 62, NOIDA (UP) -201307. In case of change of venue the intimation will be published on at on the website of HLL www.lifecarehll.com/tenders/ and e-Procurement System at NIC's (CPP Portal) https://etenders.gov.in/eprocure/app.

Representatives (6 nos. maximum) of each prospective Bidder shall be allowed to participate on production of authority letter from the bidder. During the course of Pre-bid meeting, the bidders will be free to seek clarifications and make suggestions for consideration. The HLL shall endeavor to provide clarifications and such further information as it may, in its sole discretion, consider appropriate for facilitating a fair, transparent and competitive bidding process.

1.4. The intending bidder must read the terms and conditions of Notice Inviting e-tender and the Bid documents carefully. He should only submit his bid if he considers himself eligible and he is in possession of all the documents required. Intending bidder is eligible to submit the bid provided he has definite proof from the appropriate authority, which shall be to the satisfaction of the competent authority of the respective client(s), of having satisfactorily completed the works given in the Eligibility Criteria specified below:

Eligibility Criteria

The bidders should meet the following minimum eligibility criteria:

Bidders who fulfill the following requirement shall be eligible to apply.

Direct / indirect Joint Ventures (JV)/ Consortium/Special Purpose Vehicles of whatsoever kind are not accepted.

(a) Experience should be in the name of the bidding company and not in subsidiary/ associate company/ Group Company etc.

(b) Experience of having successfully completed works during the last 7 years ending the previous day to the last date of submission of tender. For this purpose, cost of work shall mean gross value of the completed work including cost of material supplied by the respective Client but excluding those supplied by the client free of cost:

Three similar completed works, each cost not less than the amount equal to
Rs. 91.78 Crs.

Or

Two similar completed works, each cost not less than the amount equal to
Rs.137.68 Crs.

Or

One similar completed work costing not less than the amount equal to
Rs. 183.57 Crs.

"Similar Work" shall mean construction of Non-Residential and Non- Industrial building Project(s) with minimum one work of at least Five Storey building including work of specialised E&M services of Sub-station & HVAC. For this purpose each basement, stilt constructed with the building shall be construed as a storey. Machine room and mumty shall not be counted as a storey.

Work of substation and HVAC, if executed under a separate contract by the applicant may also be considered for the purpose of assessing the technical competence only without adding its monetary value for determining the eligibility criteria.

The value of executed works shall be brought to current costing level by enhancing the actual executed value of work at simple interest rate of 7% per annum; calculated from the date of completion to previous day of last date of submission for bids.

Own works / work under the same management / own certification of the bidder shall not be considered.

(iii) **Foreign certificate**: In case the work experience is for the work (s) executed outside India, the bidders have to submit certificate(s) issued by the owner and affidavit to the correctness of the documents. However, the bidder will get the documents attested by the Indian Embassy/consulate/High commission in the respective country. For the purpose of evaluation of such bids, the conversion rate of respective currency into INR shall be the daily representative exchange rate published by the IMF as on 7 (Seven) working days prior to the Last date of submission of this bid including extension(s) given if any.

(c) **Turnover**: Average annual financial turnover on construction works should be at least **Rs 114.73** Crs. during the immediate last three consecutive financial years ending 31st March, 2018. The balance sheets, Statement of Profit & Loss Account and Notes to Accounts should be duly audited and certified by a Chartered Accountant with his seal / signatures and firm registration number. The year in which no turnover is shown, would also be considered for working out the average. The turnover should be of the Bidding Company and not for Group Company or subsidiary company etc. Turnover shall be duly certified by a Chartered Accountant with his seal / signatures and registration number.

The multiplication factor of 7% per annum simple interest is not applicable on the Annual financial turnover figures.

(d) **Profit / loss**: The bidder should not have incurred any loss (**profit after tax should be positive**) in more than two years during the available last five consecutive financial years ending 31st March, 2018. The balance sheets, Statement of Profit & Loss Account and Notes to Accounts should be duly audited and certified by a Chartered Accountant with his seal / signatures and firm registration number.

(e) **Solvency Certificate**: The bidder should have a Solvency of **Rs.91.78 Crs**. certified by his bankers for this work. Banker's certificates should be on letter head of the Bank, addressed to tendering authority.

(f) Should not have been blacklisted by any Central / State Government Department/Autonomous Body/PSU in last five years from the original last date of submission of the bid. The bidder shall submit duly notarized affidavit to this effect, as per prescribed format (Form "G").

1.5. **Completion Period** :

The total time allowed for carrying out the works will be 24 months from the date of start as defined in schedule 'F'.

1.6. The site for the work is available.

1.7. The bidder shall have In-house design capabilities to provide the required services as per the scope of work. In case, the in-house design capabilities are not available, then the bidder shall enter into an agreement with a design consultant who has requisite credentials as mentioned in the Specific Conditions of Contract. The bidder, within 7 days of award of work, shall submit details of such in house design capabilities or details of the design consultant proposed to be engaged by the bidder alongwith requisite credentials.

1.8. The bid documents consisting of Notice Inviting e-Tenders (NIT) & Instructions to Bidders (ITB), General Conditions of Contract, Pre-Contract Integrity Pact, Specific Conditions of Contract, Design Basis Report, Technical Specifications, Tender Drawings in PDF Format,

Financial Bid and other necessary documents (if any) are available online at e-tender portal https://etenders.gov.in/eprocure/app.

i. Tender drawings in the PDF format have been provided in Vol.-6 of the Tender documents. However set of drawings in Auto-Cad format, will be issued to only those bidders who get registered on the e-tender portal https://etenders.gov.in/eprocure/app and pay the tender fee/processing fee in the prescribed form as per Clause 1.12 (i.) The bidder shall submit the above documents in the office of the Vice President (ID) M/s HLL Lifecare Ltd. (HLL), B-14A, Sector – 62, NOIDA (UP) with a request letter for obtaining the above set of drawings in Auto-Cad format. On receipt of these documents inclusive of tender fee/processing fee, HLL shall provide the Auto-Cad copy of drawings in CD. Such bidders shall not be required to submit the tender fee/processing fee separately as a part of Technical Package Part- 1. A copy of receipt of tender fee/processing fee deposited as above shall be required to be uploaded.

ii. It is clarified that the set of drawings in PDF format provided as Vol.-6 Tender Drawings shall only be the part of tender documents. The set of drawings in Auto-Cad format issued shall be for reference only. The copyright of all these drawings under this tender shall remain with MoHFW/HLL .

1.9. Last date to fill/upload the e-tender through e-Tendering is as per Table-I at Clause 1.2 above.

1.10. The bidder is required to have Class III-B (Signing and Encryption) Digital Signature Certificate (DSC) from one of the authorized Certifying Authorities. The DSC should be valid atleast for a period of six months from the date of start of bidding. After submission of bid the contractor can re-submit revised bid any number of times but before the last time and date of submission of bid as notified. While submitting the revised bid, the contractor can revise the rate of one or more item(s) any number of times, but before the last time and date of submission of bids as notified.

1.11. The bidders are required to submit EMD and documents, as described in Section-II, Volume-1 and Checklist as per Annexure-I, to the office of The Vice President (ID), M/s HLL Lifecare Ltd. (HLL), B-14A, Sector – 62, NOIDA (UP) in respect of above works before date and time fixed for opening of bid either by speed post/ registered post or by hand, failing which the bid will be declared non-responsive. The Bid can only be submitted after uploading the prescribed scanned documents. All forms and formats are given in this document.

1.12. **E-Tender Fee and Earnest Money Deposit (EMD)**

i. **E-Tender Fee/ Processing Fee:** Interested Bidder who wishes to participate in the bid has to make payment, specified in Table –I at 1.2 above, towards the e-tender Fee/Processing Fee in the form of Demand Draft / Pay order or Banker's Cheque of any Scheduled Bank drawn in favour of "HLL Lifecare Limited" Payable at New Delhi / NOIDA and the relevant Demand Draft / Pay order or Banker's Cheque to be scanned and uploaded on the e-Tendering website before the due date and closing time of submission of bids as notified and original should be deposited in the office of The Vice President (ID), HLL Lifecare Limited, B-14A, Sector – 62, NOIDA (UP) - 201307 before the Date & time for submission of Bids. E-tender Fee / Processing Fee is non–refundable.

ii. **Earnest Money Deposit (EMD):** Bid shall be accompanied with Earnest money, as mentioned in Table –I above, in the form of demand draft of a scheduled bank issued in favour of "HLL Lifecare Limited" Payable at New Delhi/ NOIDA or fixed deposit receipt or Banker's cheque or Bank Guarantee in favour of "HLL Lifecare Limited" as

per Form B, having **validity for six months or more** from the last date of receipt of tenders or any extension thereof.

The earnest money amount in the form of demand draft or pay order or Banker's cheque or Bank Guarantee shall be scanned and uploaded to the e-Tendering website within the period of bids submissions and original should be deposited in the office of The Vice President (ID), HLL Lifecare Limited, B-14A, Sector – 62, NOIDA (UP) -201307 before the Date & Time for submission of Bids.

iii. Online bid documents submitted by intending bidders shall be opened only of those bidders, whose E-Tender Fee/ Processing Fee and EMD and other documents placed in the envelope are found to be in order.

1.13. The bid submitted shall become invalid and cost of e-Tender fee shall not be refunded if:

i. The bidder is found ineligible.

ii. The bidder does not upload all the documents (including Goods &Service Tax (GST) registration, PAN Card) as stipulated in the bid document.

iii. If any discrepancy is noticed between the documents as uploaded at the time of submission of bid and hard copies as submitted physically in the office of tender opening authority.

1.14.

a. The Technical Package Part-I, Part-II and Part-III and Financial Package as detailed in clause 2.3.6 of Section-II ITB shall be submitted online, and will be opened as per the schedule at Table-I above. Technical Package Part-II" of only those tenderer(s), whose Earnest money placed in the other envelope, is found to be in order, shall be opened.

b. The hard copies of the documents (in original) referred at Clause 2.3.6 of Section-II ITB are to be submitted in the office of The Vice President (ID), HLL Lifecare Limited, B-14A, Sector – 62, NOIDA (UP) -201307 before the Date & time for submission of Bids.

1.15. The Technical bid shall be opened first on due date and time as mentioned at Table-I above. The time and date of opening of Financial Bid of Bidders qualifying the Technical bid shall be communicated to them at a later date.

1.16. The Bidder, whose tender is accepted, will be required to furnish performance guarantee, of the amount and within the period, specified in Schedule F. This guarantee shall be in the form of Fixed Deposit Receipt (FDR) or Banker's Cheque or Demand Draft or Bank Guarantee of any scheduled commercial bank based in India, in favour of "HLL Lifecare Limited" as per Form C. **Performance Bank Guarantee to be valid up to sixty days beyond the stipulated date of completion or the extended period, thereof.**

The EPC-Contractor, shall furnish a Separate Performance Security (For Warranty period for MGPS for an amount equal to ten percent (10%) of the total value of the contract (total value of MGPS components), valid up to sixty (60) days after the date of completion of all contractual obligations by the EPC-Contractor, including the warranty obligations or the extended period, thereof.

1.17. In case the bidder fails to deposit the said performance guarantee within the period as indicated in schedule 'F', including the extended period if any, the earnest money deposited by the contractor shall be forfeited automatically without any notice to the bidder.

1.18. The Bidder whose bid is accepted will also be required to furnish either copy of applicable licenses / registration or proof of having made application for obtaining labour licenses, registration with EPFO, ESIC and BOCW, Welfare Board including Provident Fund Code No., if applicable and also ensure the compliance of aforesaid

provisions by the sub-agencies, if any engaged by the Contractor for the said work and Programme Chart (time and progress) within the period specified in Schedule 'F' of GCC.

1.19. **Performance Evaluation:** Performance Evaluation of the Bidders for eligibility shall be done by HLL. If required, the works executed by the bidders who otherwise qualify may **be got inspected by HLL/Client.**

1.20. Bidders are advised to inspect and examine the site and its surroundings and satisfy themselves before submitting their tenders as to the nature of the ground and sub-soil, the form and nature of the site, the means of access to the site, the accommodation they may require and in general shall themselves obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect their tender. A bidder shall be deemed to have full knowledge of the site whether he inspects it or not and no extra charges consequent on any misunderstanding or otherwise shall be allowed. The bidder shall be responsible for arranging and maintaining at its own cost all materials, tools & plants, water, electricity, access, facilities for workers and all other services required for executing the work unless otherwise specifically provided for in the contract documents. Submission of a tender by a bidder implies that he has read this notice and all other contract documents and has made himself aware of the scope and specifications of the work to be done and other conditions, factors etc. having a bearing on the execution of the work.

1.21. The Competent Authority for & on behalf of the HLL does not bind itself to accept the lowest or any other tender and reserves to itself the authority to reject any or all the tenders received without the assignment of any reason. All tenders in which any of the prescribed condition is not fulfilled or any condition including that of conditional rebate is put forth by the bidder shall be summarily rejected.

1.22. Canvassing, whether directly or indirectly, in connection with tenders is strictly prohibited and the tenders submitted by the contractors who resort to canvassing will be liable to rejection.

1.23. The Competent Authority for & on behalf of the Client/ HLL reserves to himself the right of accepting the whole or any part of the tender and the bidder shall be bound to perform the same at the rate quoted by him for the same.

1.24. The Bidder shall not be permitted to tender for works in case his near relative is Gazetted officer in the office of CLIENT/MoHFW or in the Managerial Cadres of HLL and is directly dealing with the Project. Any breach of this condition by the contractor would disqualify him from participation and consideration in the tender process.

1.25. No Engineer of Gazetted rank or other Gazetted officer employed in Engineering or Administrative duties in an Engineering Department of the Government of India / is allowed to work as a contractor for a period of one year after his retirement from Government service, without the prior permission of the Government of India in writing. This contract is liable to be cancelled if either the contractor or any of his employees is found any time to be such a person who had not obtained the permission of the Government of India as aforesaid before submission of the tender or engagement in the contractor's service.

1.26. The tender for the works shall remain open for acceptance for a period of 180 (ONE HUNDRED AND EIGHTY) days from the last date of submission of bid or any extension thereto. If any bidder withdraws his tender before the said period or issue of letter of acceptance, whichever is earlier, or makes any modifications in the terms and conditions of the tender which are not acceptable to the HLL, then the HLL shall, without prejudice to any other right or remedy, be at liberty to forfeit 100% of the said earnest money as aforesaid. Further the bidder shall not be allowed to participate in the re–tendering process of the work.

1.27. The scope of work envisages a number of specialized Civil/ Electrical/ Mechanical/IT/ Electronic Engineering services Medical Gas Piping System (MGPS) as required, etc. to be executed as integral part of this Contract. However, in case the Bidder does not have in house capacity for execution of such component(s) of work and intends to engage outside agency for execution, the bidder shall ensure that such specialized agencies in each case meets the eligibility criteria as follows:

i. For Specialized works viz. DG Sets, HVAC System, MGPS, Fire Fighting, Lift:

Experience of having successfully completed similar specialized works during last 7 years ending last day of month previous to the one in which applications are invited should be either of the following:

a. HVAC: One similar work having individual Chiller capacity not less than 100 TR **OR** Two similar works having individual Chiller capacity not less than 50 TR.

b. DG Set: One similar work having individual DG capacity not less than 750 KVA **OR** Two similar works having individual DG capacity not less than 500 KVA.

c. For Fire Fighting System: Experience of having successfully completed similar specialized works with atleast one no. of work involving supply & installation of firefighting system including sprinklers, fire pumps & wet riser etc. in a campus comprising of business/ institutional/ residential/ educational/assembly buildings as classified in NBC.

d. For Lifts works: For Lifts, associated agency shall be as per the approved makes

ii. For Specialized works viz. MGPS:

Experience of having successfully completed similar specialized works during last 7 years ending last day of month previous to the one in which applications are invited should be either of the following:

a. For MGPS: One work of complete MGPS system in minimum 100 bedded hospital or Two works of complete MGPS system in minimum 50 bedded hospital.

iii. For specialized works as mentioned below approval from Engineer-in-Charge shall be sought before commencement of work:-

a. Audio Visual System & Stage Lighting System

b. WTP, STP/ETP

c. LV works like Nurse Call System, BMS, Access Control System, LAN, IPABX, CCTV, Fire Alarm & Detection, Public Address, Information Display System etc.

d. Any other specialized works specified in Tender.

iv. For all other specialized works, for which the contractor intends to engage a specialized agency for execution of work, the contractor shall take approval of the Engineer-In-Charge before assignment of such agency.

1.28. Registration/ Licence: The bidder should have their registration for GST, PF, ESIC, Building Cess Registration etc., with the appropriate Authorities. In case the bidder is not registered for PF, ESIC, Building Cess Registration(except GST) etc., with the appropriate Authorities at the time of submission of bid, they will submit an undertaking that they will get themselves registered with the concerned authorities in case they are awarded the work.

1.29. The Bidder will indemnify CLIENT/ HLL, as the case may be, against all penal action that may be levied/effected by any concerned authority for default in any labour regulation/PF/ESI and other statutory requirements of the relevant Acts/Laws related to the work of the contractor and will bear the legal charges, if any, and will pay the legal

charges/dues directly to the concerned authority. An undertaking in this regard is required to be submitted by applicant alongwith their bid.

1.30. GST or any other tax applicable in respect of inputs procured by the contractor for this contract shall be payable by the Contractor and Client/HLL will not entertain any claim whatsoever in respect of the same. However, component of GST at time of supply of service (as provided in CGST Act) provided by the contract shall be varied if different from that applicable on the last date of receipt of tender including extension, if any, shall be paid or recovered.

1.31. This Notice Inviting e-Tender shall form a part of the contract document. The successful Bidder, on acceptance of his e-tender by the Competent Authority for & on behalf of the HLL / Client, shall, within 30 days from the stipulated date of start of the work, sign the contract consisting of the Notice Inviting Bids, all the documents including General Conditions of the Contract along with Sections thereto, Specific Conditions of Contract, Specifications, Bill of Quantities and drawings, if any, forming the e-tender as issued at the time of invitation of tender and acceptance thereof together with any correspondence leading thereto including amendments, corrigendum etc. if any.

1.32. Bid **document consists of :**

i. **Volume – 1 (Notice Inviting e-Tenders (NIT) & Instructions to Bidders (ITB))**
ii. **Volume – 2 (General Conditions of Contract)**
iii. **Volume – 2 A (Integrity Agreement)**
iv. **Volume - 3 (Specific Conditions of Contract)**
v. **Volume – 4 (Design Basis Report)**
vi. **Volume – 5 (Technical Specifications)**
vii. **Volume– 6 (Tender Drawings)**
viii. **Volume – 7 (Financial Bid)**
ix. **All amendments(s)/ corrigendum, if any.**

1.33. CLIENT / HLL reserves the right to accept or reject any or all the tenders without assigning any reason, No Bidder shall have any cause of action or claim against the CLIENT / HLL for rejection of his/ all e-tender (s).

For and on behalf of
Director,
Regional Institute of Paramedical & Nursing Sciences,
Aizawl, Mizoram

Vice President (ID)

SECTION-II

INSTRUCTIONS TO BIDDERS (ITB)

2 INTRODUCTION:

2.1 Brief Particulars of the Work

The scope of work includes architectural design, structural design, and design of all required services, obtaining mandatory approvals from local bodies/ authorities required for commencing the work, execution of work & services and handing over the assets after making them habitable in all aspects for Up-Gradation and Development of RIPANS, Aizawl, Mizoram. The work is to be executed on Design, Engineering, Procurement and Construction (EPC) basis. The details of scope of work are at Section III of the Document.

2.2 Eligibility Criteria & Disqualification:

The eligibility Criteria is as at Section I (Notice inviting e-Tender). It may be noted that even if a Bidder meets the eligibility criteria, the CLIENT/HLL may, at their discretion and at any stage during the selection process or execution of the Project, order disqualification of the contractor if the Contractor has been blacklisted by any Central/State Government Department/ Autonomous Body/ PSU even after bids have been opened and/or work awarded.

2.3 BID Documents :

2.3.1 Contents of BID Documents

BID Document shall consist of the documents listed in this document along with any schedules, addendum or corrigendum etc. issued by HLL for the purpose.

2.3.2 Pre-Bid Meeting

The purpose of the meeting will be to clarify issues and to answer questions on any matter that may arise at this stage. HLL shall conduct pre-Bid meeting(s) at the time and venue mentioned in Notice Inviting e-Tender to answer any queries / provide clarifications that the Bidders may have in connection with the Project and to give them relevant information regarding the same. Representatives (6 nos. maximum) of each prospective Bidder shall be allowed to participate on production of authority letter from the bidder. During the course of Pre-bid meeting, the bidders will be free to seek clarifications and make suggestions for consideration. The HLL shall endeavor to provide clarifications and such further information as it may, in its sole discretion, consider appropriate for facilitating a fair, transparent and competitive bidding process. Bidders are requested to bring authorization letter, letterhead and stamp/seal of the company at the time of pre – bid meeting. Only written queries shall be accepted from those present in the pre-bid meeting. No other queries shall be entertained or replied to. If prospective bidders / their authorized representatives wish to raise any queries, then they need to be present in the pre-bid meeting. HLL response (including an explanation on the query but without identifying the source of the inquiry) will be uploaded on the website of HLL www.lifecarehll.com/tenders/ and https://etenders.gov.in/eprocure/app.

2.3.3 Clarifications

A prospective Bidder requiring any clarification with regards to the BID document may notify Vice President (ID), HLL Lifecare Limited, B-14-A, Sector-62, Noida -201307in writing at the mailing address indicated in Notice Inviting Bid or e-mail at idnoida@hllhites.com. Vice President (ID),HLL Lifecare Limited, B-14-A, Sector-62, Noida -201307 will respond any request for clarification which is received within

seven days from the date of availability of Tender document on-line .HLL's responses (including an explanation on the query but without identifying the source of the inquiry) upload on the website of HLL www.lifecarehll.com and https://etenders.gov.in/eprocure/app. Only written communication/clarification shall be considered as valid

2.3.4 **Amendment to BID Document**

i. At any time prior to the deadline for the submission of Bids, HLL may for any reason, whether at its own initiative or in response to a clarification or query raised by prospective Bidders, modify the BID document by an amendment(s)/ addendum(s)/corrigendum(s).

ii. The said amendments in the form of the addendum/corrigendum will be made available on website of HLL www.lifecarehll.com and https://etenders.gov.in/eprocure/app at least three (3) days prior to the last date of the original or extended deadline for the submission of the bids. The uploading of the said amendment(s)/ addendum(s)/corrigendum(s) shall be binding of the bidders. The Bidders are advised to regularly visit above mentioned websiteto ensure that they are aware of the amendment(s)/ addendum(s)/corrigendum(s). The amendment(s)/ addendum (s)/ corrigendum(s) issued will form part of the BID documents.

iii. In order to provide prospective Bidders reasonable time for preparing their Bids after taking into accounts such amendments, addendum(s)/corrigendum(s) the, HLL may, at its discretion, extend the deadline for the submission of Bids.

2.3.5 **Preparation of Bid:**

a) Bidder's responsibility:

i. The Bidder is solely responsible for the details of his Bid and the preparation of Bids.

ii. The Bidder is expected to examine carefully all the contents of BID document as mentioned in Notice Inviting e-Tender including instructions, conditions, forms, terms, etc. and take them fully into account before submitting his offer. Bids, which do not satisfy all the requirements, as detailed in these documents, are liable to be rejected as being non - responsive.

iii. The Bidder shall be deemed to have inspected the Site and its surroundings and taken into account all relevant factors pertaining to the Site, while preparing and submitting the Bid.

b) Project Inspection and Site Visit

Any Site information including the site survey, soil investigation report etc., given in this Bid Document is for guidance only. The Bidder is advised to visit and examine the Site of works and its surroundings at his/their cost and get/ obtain at his/their own responsibility, any information that may consider necessary including conducting site survey, soil investigations, availability of electricity, water and drainage, as applicable, for preparing the Bid.

The Bidder is further advised to ascertain site conditions, location of buildings, surroundings, climate, availability of power, water and other utilities for construction, access to site, handling and storage of materials, applicable laws and regulations, and any other matter considered relevant by them.

CLIENT/HLL shall not be liable for such costs, regardless the outcome of the selection process.

c) Documents Comprising the Bid

Bidders shall submit their Bids online. The hard copies of the documents as explained in Clause 2.3.6 are to be submitted separately. These are to be submitted in two packages 'Technical Package' (Hard Copy & Online) and 'Financial Package' (Online Only). The contents of the Technical and Financial packages are as mentioned hereinafter i.e. Clause 2.3.6.

d) Alternative Proposal by bidders:

Bidders shall submit offers that comply with the requirement of the Tender. Alternative Proposal(s) will not be considered.

e) Method of Application:

i. If the bidder is an individual, the application shall be signed by him above his/her full type written name and current address.

ii. If the bidder is a proprietary firm; the application shall be signed by the proprietor above his/her full type written name and the full name of his firm with its current address.

iii. If the bidder is a firm in partnership, the application shall be signed by all the partners of the firm above their full type written names and current addresses or alternatively by a partner holding power of attorney for the firm. In the later case a certified copy of the Power of Attorney should accompany the application. In both the cases a certified copy of the partnership deed and current address of all the partners of the firm should accompany the application.

iv. If the bidder is a Limited company or a corporation, the bid shall be signed by a duly authorized person holding Power of Attorney for signing the application and certified copy of such power of attorney shall also be furnished. The bidder should also furnish a copy of memorandum of articles of association duly attested by a Public Notary.

f) Bid documentation

i. All information called for in the enclosed forms should be furnished against the relevant columns in the forms. If for any reason, information is furnished on a separate sheet, this fact should be mentioned against the relevant column. Even, if no information is to be provided in a column, a 'Nil' or 'no such case' entry should be made in that column. If any particulars/query is not applicable in case of the bidder, it should be stated as 'Not applicable'. The bidders are cautioned that not giving complete information called for in the application forms or not giving it in clear terms or making any change in the prescribed forms (or) deliberately suppressing the information may result in the bid being summarily disqualified. Bid made by telegram or telex and those received late will not be entertained.

ii. The bid should be type written. The bidder should sign each page of application, forms and documents before scanning & uploading.

iii. Over writing should be avoided. Corrections if any should be made by neatly crossing out, initialling, dating and rewriting. Pages of the eligibility criteria document are numbered. Additional Sheets if any added by the Bidder should also be numbered by him. They should be submitted as a package with signed letter of transmittal.

iv. References, information and certificate from the respective clients certifying technical knowledge or capability of the bidder etc. should be signed by an officer not below the rank of Executive Engineer or equivalent.

v. The bidder may furnish any additional information, which he thinks is necessary to establish his capabilities to successfully complete envisaged work. He is, however advised not to furnish superfluous information. No information shall be entertained after submission of eligibility criteria document unless it is called for by the HLL.

vi. If private works are shown in support of eligibility, certified copy of the tax deducted at source certificate (TDS) shall be submitted along with the experience certificate and the TDS amount shall tally with the actual amount of work done.

2.3.6 **Contents of Packages(Bid Submission):**

The tender/ bid shall be submitted in two package i.e. Technical Package & Financial Package.

2.3.6.1 **Technical Package:**

The technical package, clearly labeled as "**TECHNICAL PACKAGE**", is to be submitted in three parts.

A. Technical Package, Part-1: e-Tender Fee / Processing Fee & EMD.

This part shall consist of following:-

However, MSME bidders are exempted from paying the e-Tender Fee/bid processing fee to HLL. MSME bidders shall have to furnish a proof of MSME registration and other valid documents, as applicable.

I. Original Non – Refundable e-Tender Fee / Processing Fee (Hard copy in original and scanned copy online) as per Table-I in form of Demand Draft / Pay order or Banker's Cheque of any Scheduled Bank drawn in favour of "HLL Lifecare Limited" Payable at New Delhi / NOIDA should be deposited along with physical submission of Technical bid, in the office of The Vice President (ID), HLL Lifecare Limited, B-14A, Sector – 62, NOIDA (UP) -201307 before the Date & time for submission of Bids. The scanned copy of the original relevant Demand Draft / Pay order or Banker's Cheque to be uploaded on the e-Tendering website before the due date and closing time of submission of bids as notified. e-Tender Fee / Processing Fee is non – refundable. Any physical submission not accompanied by the requisite e-Tender Fee / Processing Fee will be rejected.

II. Bid Security/EMD, in original. (Hard copy in original and scanned copy online)

a. The Bidder shall enclose EMD with his Bid for an amount, as mentioned in Notice Inviting e-Tender.

b. The EMD will be in the form of Demand draft / Banker's Cheque / Bank Guarantee of a scheduled bank issued in in favour of "HLL Lifecare Limited" payable at New Delhi / NOIDA or fixed deposit receipt or Banker's cheque or Bank Guarantee in favour of "HLL Lifecare Limited" as per Form B, having validity for six months or more from the last date of receipt of tenders or any extension thereof. The Bank guarantees should be irrevocable and operative for a period of six months or more from the last date of receipt of tenders or any extension thereof.

c. Bids not accompanied by EMD, shall be treated as non-responsive, and will be summarily rejected by HLL.

d. The Bid securities of unsuccessful Bidders shall be discharged/ returned by HLL not later than 30 days after the expiration of the period of Bid Validity.

e. The Bid Security shall be forfeited if a bidder withdraws his bid during the period of bid validity or in the case of the successful bidder, if he fails to submit the necessary performance security or fails to enter into the Contract within time limit specified in Schedule 'F' of General Conditions of Contract.

f. The Bid Security Bank Guarantee of the successful bidder shall be returned after receipt of Performance Bank Guarantee as Security Deposit as per Clause 1A of General Conditions of Contract (Volume-2).

g. EMD (Form B) in original as per the required forms should be submitted in the envelope and marked clearly as **Envelope No: 1 "EMD".**

h. MSME Bidders are exempted from EMD. MSME bidders shall have to furnish a proof of MSME registration and other valid documents, as applicable.

B. Technical Package, Part-2: Should be submitted in original with scanned copy of documents to be uploaded online (Hardcopy and Scanned copy online)

a. Form A: Form of bid along with Appendix to be typed on the letterhead and duly signed and stamped by authorized person.

b. Form E: Format for Power of Attorney for signing of proposal. In case bid is signed by Managing Director/Partner/Proprietor himself, Power of Attorney is not required. It is mandatory to mention on letterhead that the bid is duly signed and stamped by Managing Director / Partner / Proprietor.

c. Indemnity/ Undertaking/ Affidavits as per requirements (Form-F, H)

d. Form G: Original Affidavit as per format at Form 'G'

e. Form 'T-1' (Financial Information) – Annual Audited Financial Statements for the last five years (Audited balance sheets and Statement of Profit & Loss Account along with notes to accounts duly signed by Chartered Accountant shall be attached with this form for last five financial years i.e. 2013-14, 2014-15, 2015-16, 2016-17 & 2017 -18)

f. Form T1 – B: Self Attested Bank Solvency Certificate from a Nationalised bank or Scheduled Bank as per format at "Form T1-B".

g. Form "T-5" (TDS Details for Private Sector Projects for the works executed in India)

The above listed documents in original are to be submitted in the envelope and marked clearly as **Envelope No: 2 "Technical Package".**

Envelope No. 1 and Envelope No. 2 should be kept in one single sealed envelope super-scribed with Name of the bidder and Name of the e-tender should be submitted to following address:

The Vice President (ID)
HLL Lifecare Limited,
B-14A, Sector – 62, NOIDA (UP) -201307

C. Technical Package, Part-3: shall be submitted <u>online only</u> duly digitally signed & stamped by authorized signatory and comprise the following:

a. Form "T-2 (List of all works successfully completed during the last seven years)

b. Form "T-3" (Performance Report of Similar Works)

c. Form "T-4" (Structure and Organization)

d. Form "T-6" (GST Registration Details)

e. Copies of GST Registration or undertaking / EPF Registration/ PAN Number

f. Integrity Pact and Agreement (Vol-2A):

"The Integrity pact annexed shall be part and parcel of this document, and has to be signed by bidder(s) at the pre-tendering stage itself, as a pre-bid obligation and should be submitted alongwith the Financial and Technical Bids. All the bidders bound are bound to comply with the Integrity Pact clauses. Bids submitted without signing Integrity Pact will be ab initio rejected without assigning reason."

The Integrity Pact & Agreement duly signed by the person authorized to sign the bid on behalf of the bidder. (As per Performa given in GCC, Vol-2 A).

g. All pages of the entire Corrigendum/ addendum (if any)/ pre bid clarifications (if any) signed by the authorized person of the bidder(s).

h. All TDS Certificates of Private Sector Projects for the works executed in India.

i. Any other document as specified in the bid document.

2.3.6.2 **Financial Package**

The financial package **(VOLUME *7* –FINANCIAL BID)** should be submitted **ONLINE** only. Physical submission of financial bid will not be accepted and e-tender shall be rejected. The quoted rates should include all costs associated with the Project including any out of pocket / mobilization expenses. Quoted rates shall include all prevailing taxes including Goods and Services Tax, Building and other Construction Workers welfare Cess and any other applicable statutory taxes, levies till the last stipulated date for the receipt of tender including extensions if any. In case Government levies/modifies any tax subsequently, the same will be adjusted plus/minus as the case may be.

The Bidder must ensure to fill up rate against each item of financial bid. If any cell is left blank then value of that cell shall be treated as "0" (ZERO). In event no rate has been quoted for any item (s), it will be presumed that the contractor has included the cost of this/these items(s) in other items and rate for such item(s) will be considered as zero and work will be required to be executed accordingly.

2.3.6.3 The complete Bid shall be without alterations, overwriting, interlineations or erasures except those to accord with instructions issued by HLL, or as necessary to correct errors made by the Bidder. All amendments/ corrections shall be initialed by the person or persons signing the Bid.

2.3.*7* **Language of Bid**

The Bid and all related correspondence and documents relating to the Project shall be in English language only.

2.3.8 **Currency of Bid**

Bid prices shall be quoted in Indian Rupees only. The amount mentioned elsewhere in the bid document will also deemed to be in Indian Rupees unless otherwise mentioned.

2.3.9 **Extension of Bid Validity**

Prior to the expiry of the original Bid Validity Period, HLL may, at its discretion, request Bidders to extend the Bid Validity Period for a specified additional period and also correspondingly extend the period of validity of Bid Security submitted in the form a Bank Guarantee.

2.3.10 **Format and Signing of Bid**

a. Bid documents (Technical package and Financial package) shall be digital signed by a person duly authorized to sign the Bid documents. The Bidder shall also submit a Power of Attorney in original authorizing the person signing the documents.

b. Entries to be filled in by the Bidder shall be typed or written in indelible ink.

c. All witnesses and sureties shall be persons of status and probity and their full names, occupations and addresses shall be written below their signatures.

2.3.11 **Sealing and Marking of Bids**

a. The Bid shall be submitted along with documents and mode of submission mentioned at Clause 2.3.6 mentioned above at Section-II (ITB) and also mentioned in the Checklist at Annexure - I in Volume 1 of the document.

Please note that the price should not be indicated in any of the documents enclosed in Technical package. Non-compliance shall entail rejection of the Bid.

2.3.12 **Submission of Bids**

a. The last date for submission of completed Bids is given in Notice Inviting e-Tender. HLL may, at their discretion, extend this date, in which case all rights and obligations of the CLIENT/ HLL and the Bidder shall thereafter be subjected to the new deadline as extended. If such nominated date for submission of Bid is subsequently declared as a public holiday, the next official working day shall be deemed as the date for submission of Bid.

b. Required documents which are required to be submitted in original as per mode defined in Checklist at Annexure I, appended to this document shall be submitted by hand or through registered post or courier service at the address mentioned above. CLIENT/ HLL shall not take any cognizance and shall not be responsible for delay/loss in transit or non-submission of said documents in time.

2.3.13 **Modifications/ Substitution/ Withdrawal of Bids**

a. No modification or substitution of the submitted Bid shall be allowed after last date of submission of bids.

b. A Bidder may withdraw its submitted Bid, provided that written notice of the withdrawal is received by The Vice President (ID), HLL Lifecare Limited, before the last date for submission of Bids.

c. Only a single copy of the withdrawal notice shall be prepared and each page of the notice shall be signed and stamped by the authorized signatory. The notice shall be duly marked "WITHDRAWAL". This withdrawal notice will be opened at the time of opening of bid and not earlier. The signature of GPA holder will be verified and withdrawal shall be considered only in case both are same.

2.3.14 **Late Bids**

Any Bid received at the address mentioned above after the deadline prescribed for submission of Bids in Notice Inviting e-Tender/extended date as the case may be, herein will not be considered and will be returned unopened to the Bidder.

2.3.15 **Power of Attorney:**

Bidders shall submit, along with Technical Package, a Power of Attorney, on a stamp paper of appropriate value, in favour of the person signing the Bid documents authorizing him to sign the Bid documents, make corrections/ modifications thereto and interacting with CLIENT / HLL and act as the contact person. The format for the power of attorney shall be as per form E of Bid Document Volume-1. In case bids are signed by Managing Director/Partner/Proprietor himself, Power of Attorney is not required.

In the event of tender being submitted by a firm, it must be signed separately by each partner thereof or in the event of the absence of any partner, it must be signed on his behalf by a person holding a Power of Attorney authorizing him to do so, such power of attorney to be produced with the tender, and it must disclose that the firm is duly registered under the Indian Partnership Act 1932.

In the event of tender being submitted by a Limited company or a corporation, it must be signed by a duly authorized person holding power of attorney for signing the application and certified copy of such power of attorney shall also be furnished. The bidder should also furnish a copy of memorandum of articles of association duly attested by a Public Notary.

2.4 Bid Opening and Evaluation:

2.4.1 Bid opening

i. The Bids will be opened in the presence of prospective Bidders or their authorized representatives who may choose to attend on date & time as mentioned in Notice Inviting e-Tender. However, the bidders can view the bid opening process online by logging on to the e-tender portal from anywhere.

ii. If such nominated date for opening of Bid is subsequently declared as a public holiday, the next official working day shall be deemed as the date of opening of the Bid.

iii. Bids for which an acceptable notice of withdrawal has been submitted shall not be opened.

iv. Bids which have not complied with one or more of the foregoing instructions may not be considered.

v. On opening of the e-Bid, it will be checked if they contain Technical & Financial Bids and e-Tender Processing Fees paid, EMD/ Bid Security as detailed above.

vi. Technical Package – Hardcopy (Envelope No. 1) of the Bids will be opened first. These will be checked for completeness and confirmation of submission of the requisite EMD/Bid Security. Thereafter Technical Package – Hardcopy (Envelope No. 2) will be opened. If the documents do not meet the requirements of the e-Tender, a note will be recorded.

vii. The Bidders name, the presence or absence of the requisite Bid Security and any other details as HLL or their authorized representative, may consider appropriate will be announced at the time of Bid opening.

viii. Technical evaluation shall be as per Section IV, Evaluation Process.

ix. Financial Package of all bidders whose bids are found responsive after Technical evaluation will be opened at a later date.

2.4.2 Determination of Responsiveness

i. Prior to the detailed evaluation of Bids, Client/HLL will determine whether each Bid is responsive to the requirements of the tender.

ii. For the purpose of this clause, a responsive Bid is one which:

a. have digital signature.

b. is accompanied by the Power(s) of Attorney, if required

c. contains all the information as requested in the Bid Document

d. contains information in formats same/similar as those specified in this Bid Document

e. mentions the validity period of the bid

f. is accompanied by the Bid Security/ EMD,

g. Conforms to all the terms, conditions and specifications of Tender without material deviation or reservation. "Deviation" may include exceptions and exclusions. A material deviation or reservation is one which affects, in any substantial way, the scope, quality, performance or administration of the works

to be undertaken by the Bidder under the Contract, or which limits in any substantial way, CLIENT /HLL 's rights or the Bidder's obligations under the Contract as provided for in Bid and/or is of an essential condition, the rectification of which would affect unfairly the competitive position of other Bidders presenting substantially responsive Bids at reasonable price.

iii. If a Bid is not substantially responsive to the requirements of Bid, it will be rejected by Client/HLL . The decision of the Client/HLL in this regard shall be final and binding. The financial Packages of non-responsive Bidders shall not be opened.

2.4.3 **Evaluation of Bids**

i. Client/HLL would examine and evaluate responsive Bids, as per the criteria set out in this document at Section IV Evaluation Process

ii. Client/HLL reserves the right to reject any Bid if:

a. At any time, a material misrepresentation is made or uncovered;

or

b. The Bidder does not respond within the stipulated time to requests for supplemental information/ clarifications required and sought by HLL for the evaluation of the Bid;

or

c. It is found that the information provided is not true or incorrect or facts/ material for the evaluation have been suppressed.

iii. The Client/HLL reserves the right, without being liable for any damages or obligation to inform the bidder to :

a. Amend the scope and value of contract.

b. Reject any or all the applications without assigning any reason.

2.4.4 **Clarification of Bids**

i. Evaluation of technical Bids submitted by Bidders shall be undertaken based on details submitted therein only. Bidder shall not be allowed to submit on their own, additional information or material subsequent to the date of submission and such material / information, if submitted, will be disregarded. It is therefore essential that all details are submitted by the Bidder comprehensively, accurately and specifically in their technical Bid, avoiding vague answers. However, Evaluation Committee, if it so desires, reserves the right to seek any clarification from the Bidders on the information provided in the bid.

2.4.5 **Process to be Confidential**

i. Except the public opening of the Bids, information relating to the examination, clarification, evaluation and comparison of Bids and recommendations concerning the award of Contract shall not be disclosed to Bidders or other persons not officially concerned with such process.

ii. Any effort by a Bidder to influence CLIENT /HLL Evaluation Committee in the process of examination, clarification, evaluation and comparison of Bids and in decisions concerning award of Contract, shall result in the rejection of their Bid.

2.5 Award of Contract

i. Award Criteria

HLL will declare the Bidder ranked L1 as Successful Bidder considering the total bid comprising of Part-A & Part-B as mentioned in the NIT. HLL reserves the right to

proceed and award the work for Part-A & Part-B together or Part–A & Part-B separately and issue Letter of Award (LOA) on these basis as per the procedure mentioned in the Bid Document and terms and conditions set out in this Bid document.

In case, the HLL award the work under Part-A initially and Part-B separately at a subsequent date, then the Part-B of the contract shall be executed through a supplementary agreement with Client at appropriate stage.

ii. Notification of Award

a. Prior to the expiry of the period of Bid Validity, Client/HLL will issue the Letter of Award to the Successful Bidder, notifying him of being declared successful and the intent to sign the Contract Agreement with him. This letter (hereinafter and in the Conditions of Contract called 'the Letter of Award') shall mention the amount which HLL , will pay to the Contractor in consideration of the completion and guarantee of the work to be performed by them, as prescribed therein (hereinafter and in the conditions of Contract called 'the Contract Price'). No correspondence will be entertained by Client/ HLL from the unsuccessful Bidders.

b. The Letter of Award shall constitute a part of the Contract.

iii. Signing of Agreement

a. HLL shall prepare the Contract Agreement in the Proforma (Form D) included in this document, duly incorporating all the terms of agreement between the two parties within thirty days from the date of issue of the Letter of Award the Successful Bidder will be required to execute the Contract Agreement.

b. Prior to the signing of the Contract Agreement, the Successful Bidder shall submit Performance Guarantee.

c. The contractor whose bid is accepted will also be required to furnish either copy of applicable licenses/registrations or proof of applying for obtaining labour licenses, registration with EPFO, ESIC and BOCW Welfare Board and Programme Chart (Time and Progress) within the period specified in schedule “F” given in Volume –2, GCC.

d. The Contract Agreement shall be duly signed by the Client/HLL and the Contractor through their authorized signatories.

e. In case the Successful Bidder does not sign the Contract Agreement, Client/HLL reserves the right to cancel the selection process, forfeit any Bid Security and/or Performance Guarantee, as the case may be, submitted by the Successful Bidder and either re-Bid or proceed in any manner that it may deem fit.

iv. Refund of Earnest Money/ Bid Security

a. The Earnest Money/ Bid Security will be refunded to the unsuccessful bidders on finalization of the award or on rejection of a bid or at the expiry of the validity period of the tender (unless extended by the bidder), whichever is earlier. Earnest Money/ Bid Security Deposit submitted by contractors except the first and second lowest bidders may be returned within a week from the date of opening of the price bids.

b. Earnest Money/ Bid Security will be refunded without waiting for any application or request from unsuccessful bidders.

c. Details of Demand Draft/ Banker’s Cheque received as Earnest Money/ Bid Security with the tender shall be entered in the tender register, and these need not be deposited in the bank except for the successful bidder.

*****

SECTION-III

SCOPE OF WORK

3. Bids are invited for following scope of work:

3.1. The scope of work relates to Up-gradation & development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram. The work is to be executed on Design, Engineering, Procurement & Construction (EPC) basis. Following major buildings/ blocks are to be constructed with associated infrastructure along with other utilities & services required for smooth functioning of RIPANS taking into consideration all statutory regulations:

- Institute Complex
  - Academic Building Block –IV
  - Guest House
  - General Hostel Block
  - Indoor Sports Complex and Auditorium
- Hospital Complex
  - 100 Bedded Hospital
  - Resident Doctor's Quarters
  - Medical Superintendent Quarter
  - Staff / Nurse Quarters

In the present tender the scope of work relates to construction for required facilities as stated above with all services, road, pavements, pathways, parking, external lighting and other allied works. The Medical Gas Piping System (MGPS) is in the scope of work as per requirement.

3.2. Land: - The RIPANS is located in Zemabawk on the slope of a hill in out skirts of Aizawl which is capital of Mizoram. The total area of campus is around 13.20 Acres. The surrounding districts are Kolasib, Champhai, Mamit, Serchhip and Lunglei. The stretch of land is rolling hill with valleys and it is around 10 Kms from city Aizawl and 39 Kms from Airport and 10 kms from existing Civil Hospital. The site falls under the jurisdiction of Aizawl Municipal Corporation (AMC), Aizawl. The connectivity to the site is augmented via NH 54 road.

3.3. The design approach intends to undertake all proposed construction in a phased manner to enable development of the proposed infrastructure. The site is a hilly terrain sloping mainly from West to East direction. There are water channels flowing across the site.

3.4. RIPANS is an running and existing Institution with following buildings and allied infrastructure:

A. <u>Academic:</u>

i. Academic Building Block - I
ii. Academic Building Block -II
iii. Academic Building Block -III
iv. Library & Examination Hall

B. <u>Hostels:</u>

i. Girls Hostel with Hostel warden Qtr.
ii. Boys Hostel with Warden Quarters
iii. Boys Hostel
iv. Additional Girls Hostel
v. Additional Boys Hostel
vi. Assam Type Additional Boys Hostel

C. Administrative Block

D. Residences & Staff Quarters

i. Director Quarter
ii. Type – I (6 Units)
iii. Type – II (6 Units)
iv. Type – III (6 Units)
v. Type – IV (6 Units)

E. Miscellaneous and other buildings:- such as Canteens, Workshops etc.

3.5. Special care for existing building & Infrastructure:

Construction operations in a RIPANS institute which has to be kept running need special attention and careful planning. As RIPANS is an existing and running institution, the existing operations cannot be stopped or hampered in any way due to the construction activities. The bidders are expected to study the site conditions thoroughly to understand the requirements of the functioning RIPANS Institute.

There may be some services crossing the construction area of the proposed Buildings/ Block. The scope of work includes dismantling of services falling in the construction area and supporting/shifting & making functional existing services/sewerage and water supply lines etc.

All necessary steps and arrangements to be taken care of for safety and precaution of the existing Institute buildings and infrastructure during construction without any damage to the existing building during execution of foundations works or super structure construction activities and other infrastructure/services activities. No extra payment will be made for the above conditions. Any rectification/re-construction required to be done by the Contractor at his own cost. Accordingly, necessary safety arrangements should be taken up well in advance to safeguard against land sliding during construction activities.

3.6. The bidder shall be provided with a Master Plan of the complex, Concept Plans of the proposed buildings in the complex, Technical specifications and other details forming the part of bid documents. The successful bidder shall prepare their detailed designs based on these drawings and documents and in conformity with the local Bye-laws. Any modification in the master plan and concept plans, required to meet the conformance to the local bye laws, shall be done with the approval of HLL.

3.7. The work is to be executed on Design, Engineering, Procurement & Construction (EPC) basis which shall include all activities for designing, supply, execution, testing & commissioning including obtaining all required statutory approvals during different stages/phases with respect to all the buildings, services and utilities complete as per requirements and directions of Engineer-In Charge. It shall include but not limited to the following:

(i) Conducting site surveys and soil investigations as per requirements.

(ii) Preparation of Architectural & Structural Designs, Detailed Designs of Services, external development, roads and pavements, retaining walls, landscaping, horticulture, signage's etc. complete as per requirements in line with the Master Plan & Concept Designs as well as the Design Basis Report (DBR) made available

in the bid document. It shall include modifications, if any, required in the master plan and concept plans to meet the conformance to the local bye laws and the same, shall be done with the approval of HLL.

(iii) Design of all MEP services other Services their integration and installation and commissioning.

(iv) Obtaining mandatory approvals from local bodies/ statutory authorities, as required, for commencement of construction of work.

(v) Obtaining proof checking of structural designs from IIT / NIT /Govt. Institute as approved by HLL.

(vi) Execution of work with construction of various buildings and services. This shall include supply of all required materials, construction, installation, testing and commissioning for operationalization of all buildings and services in phases. This shall also include shifting of all existing trees, services and utilities including removal of debris and foundations of the existing building /structures.

(vii) Supervision of works with required quality assurance

(viii) Obtaining all required statutory approvals during different stages/ phases and after completion of the project.

(ix) Obtaining Green Building Rating as per GRIHA-3 Star Certification.

(x) Any other services and utilities as per requirements and direction of Engineer-In-Charge for completion of the project.

3.8. Statutory Approvals:

i. The Contractor shall obtain all necessary approvals including pre-construction from Municipal and other local bodies including Municipal bodies, Water supply agencies concerned, Electric Supply and inspectorate. Agencies concerned, Police and Security Agencies, Chief Controller of Explosives, Fire Department, Civil Aviation, EIA, Air Force Department, in accordance to prevailing rules, Building Bye-Laws, tree replantation etc., as the case may be with related to/ required for Construction/ Completion, as per requirements. All expenditure on this account will be borne by the contractor. These approvals shall include obtaining approval of all the competent authorities and other statutory bodies like Ministry of Environment and forests, State Pollution Control Board, civil aviation, railways and local development bodies etc. as applicable necessary according to the local Acts, Laws, Regulations, etc. and make any changes desired by such authorities at no extra cost..

ii. Obtaining approval of the Architectural drawings from relevant local statutory body & obtain Commencement Certificate from local bodies leading to commencement of construction of the project if required.

iii. Obtaining NOCs (No Objection Certificates) from Fire Department, Lift Inspector, Storm water drainage & sewerage department, Municipal Corporation / Local Bodies, Civil Aviation, completion and / or occupancy certificates etc. as required.

iv. Obtaining approval of electrical drawings from Central / State Electrical Inspectorate, as applicable if required.

v. Any other approval required from the appropriate Statutory Authorities/ Local Bodies.

vi. Compliance as per GRIHA norms and obtaining approval and certification for minimum 3 Star, Green Building Rating for specific buildings/blocks from GRIHA Council etc.

CLIENT/ HLL may, at the written request of the Contractor, assist him in obtaining the approvals from relevant authorities. However any such request by the Contractor shall not bind the CLIENT/ HLL in any manner. The original documents of approval shall be submitted to the HLL /Client.

3.9. Green Building Rating approvals as per GRIHA

The scope of work shall also include the cost of all such activities. HLL aims at getting GRIHA rating of 3 Star for the Building for rating for the following buildings in the Complex.

i. Hospital Block

ii. Academic Block

The contractor shall register and obtain the required GRIHA certification from the designated authority and shall be required to provide all relevant documents, other inputs and take the appropriate measures etc. during execution of work and thereafter obtain required GRIHA 3 Star rating, to enable CLIENT/HLL in achieving this objective.

SECTION IV-

EVALUATION PROCESS

4. Evaluation Process:

The Bids will be evaluated in the following stages:

i. Stage 1-Preliminary & Technical Evaluation

ii. Stage2-Financial Evaluation

E-tender will be evaluated at each and every stage of evaluation process. The Bids will be evaluated in the following stages:

4.1. Stage 1: Preliminary &Technical Evaluation

4.1.1. Preliminary Evaluation

In Preliminary Stage, e-Tender Fee / Processing Fee & EMD will be checked first. Envelope No. 1 containing hardcopies of EMD will be opened of only those bidders who have submitted bids online on https://etenders.gov.in/eprocure/app. e-Tender Fee / Processing Fee and EMD will be checked for veracity of Amount and Form as required by e-tender terms and conditions. If e-Tender Fee / Processing Fee and / or EMD submitted by any bidder is not as per e-tender terms and conditions, his bid will be rejected and will not be considered for further stages of evaluation.

4.1.2. Technical Evaluation

a. Technical Bid

Envelope No. 2 containing hardcopies of technical documents in original as mentioned earlier in section – II will be opened of only those bidders who have qualified in the Preliminary Stage.

b. Technical Bid – Eligibility Criteria

Bidders qualifying in Stage 1(4.1.1 & 4.1.2 a.) will be considered for further evaluation and the Technical Bids shall be evaluated as per eligibility criteria detailed in Clause 1.4 and bidder's eligibility for the work shall be determined.If bidder is not meeting with the minimum eligibility criteria as detailed in Clause 1.4, his bid will be rejected and will not be considered for further stages of evaluation.

c. Technical Evaluation - Performance of the Contractor

The bidders qualifying the eligibility criteria (Clause 1.4.1) will be evaluated by evaluation methodology set out below. Only in case of those bids achieving the minimum qualifying marks, the financial bids will be opened.

(a)	Financial strength (Form 'T-1`' & 'T-1 B')	Maximum 20 marks
(b)	Experience in similar nature of work during last seven years (Form 'T-2')	Maximum 20 marks
(c)	Performance on works (Form 'T-3') – Time over run	Maximum 20 marks
(d)	Performance on works (Form 'T-3') – Quality	Maximum 40 marks
	Total	**100 marks**

To become eligible for short listing, the bidder must secure at least 50% marks in each attribute {(a), (b), (c) & (d)} and 60% marks in aggregate.

Client/HLL will carry out technical assessment of submitted technical proposals to determine that the Tenderer has a full comprehension of the work of the contract. In case the Tenderer's technical submittal is found non-complaint with the requirements

of the project the same is liable to be rejected. This process is to assure that only technically acceptable proposals are considered for the work.

Client/HLL , however, reserve the rights to restrict the list of such qualifiedbidders to any number deemed suitable by it.

i. The financial Bid of only those Bidders who are technically qualified shall be opened.

ii. The financial Bids of Bidders whose technical Bids are found unacceptable shall be not be opened

iii. HLL shall notify all the technically qualified Bidders of their technical qualification indicating the date, time and venue for opening of financial Bids.

4.2. Stage 2: Financial Bid Evaluation

The evaluation of financial proposals by Client/HLL will take into account, in addition to the tender amounts, the following factors:

a. Arithmetical errors corrected by Client/HLL

b. Such other factors of administrative nature as Client/HLL may consider having a potentially significant impact on contract execution, price and payments, including the effect of items or rates that are unbalanced or unrealistically priced.

The financial proposal shall be processed as under:

i. Evaluation Committee shall open the financial Bid of the technically qualified Bidders in the presence of the Bidders/their authorized representative, who choose to attend, at the scheduled date and time.

ii. On opening the financial Bids, the Evaluation Committee shall read out the financial Bid to all the Bidders and record the same.

iii. If a bidder quotes Nil rates against each item in the tender shall be treated as invalid and will not be considered as lowest tenderer.

iv. All the financial Bids shall then be ranked according to the financial Bid in increasing order with the Bidder quoting the least amount ranked L1, Bidder quoting next higher figure as L2 and so on.

v. If two more bidders quote same lowest price, such lowest bidders can be asked to submit sealed revised offer and the revised offer should not be higher than their original quoted price. The lowest offer can be decided on the basis of revised offer. If the revised offer is again found to be equal, then the lowest bid of these bidders shall be decided by draw in presence of authorised representative of bidders.

vi. L1 will be declared as Successful Bidder and his offer will be processed further.

4.3. Letter of Award:

The Successful Bidder would be notified in writing by Client/HLL by issuing the Letter of Award (LOA) in favour of the Lowest (L1) Bidder. Client/HLL will declare the Bidder ranked L1 as Successful Bidder considering the total bid as mentioned in the NIT. Client/HLL reserves the right to proceed and award the work and issue Letter of Award (LOA) on the basis as per the procedure mentioned in the Bid Document and terms and conditions set out in this Bid document.

FORM – "A"

FORM OF BID

From
(BIDDER)

To

Vice President (ID)
HLL Lifecare Limited
B-14-A, Sector-62,
Noida -201307
For and on behalf of
Director,
Regional Institute of Paramedical & Nursing Sciences,
Aizawl, Mizoram

Name of Work: Design, Engineering, Procurement and Construction (EPC) of Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram.

Sir,

Having visited the Site, ascertained the Site conditions and examined the General Conditions of Contract as well as Specific Conditions of Contract, Notice Inviting Bids, Instructions to Bidders etc. and addenda for the above project, we the undersigned, are pleased to submit our technical and financial Bid along with relevant documents.

1. We acknowledge that the Appendix forms an integral part of the Bid.
2. While preparing this Bid, we have gathered our own information and conducted our own inquiry/survey to our satisfaction and we did not rely solely on the information provided in the Bid Documents. We shall not hold CLIENT /HLL responsible on any account in this regard.
3. We hereby certify that all the statements made and information supplied in the enclosed forms and accompanying statements are true and correct.
4. We have furnished all information and details necessary for eligibility and have no further pertinent information to supply.
5. We submit the requisite certified solvency certificate and authorize Vice President (ID), HLL Lifecare Limited, Noida to approach the Bank issuing the solvency certificate to confirm the correctness thereof. I/We also authorize Vice President (ID), HLL Lifecare Limited, Noida to approach individuals, employers, firms and corporation to verify our competence, work experience, and general reputation.
6. We undertake, if our Bid is accepted, to commence the works within the stipulated time and to complete the whole of the works comprised in the Contract within the stipulated time calculated from the start date
7. If our Bid is accepted, we will furnish a bank guarantee as Performance Guarantee for the due performance of the Contract. The amount and form of such guarantee or bond will be in accordance with as given in the General Conditions of the Contract.
8. We are aware that in the event of delay in execution of the Project, beyond the agreed timelines due to reasons attributable to us, liquidated damages shall be recovered from us.
9. Our Bid is valid for your acceptance for a period of ONE HUNDRED AND EIGHTY DAYS from the last date of submission of the Bid as per the Bid Documents or any extension thereto.
10. We agree to the General Conditions of Contract and Specific Conditions of Contract and the terms and conditions mentioned in the Bid Documents.

11. We declare that the submission of this Bid confirms that no agent, middleman or any intermediary has been, or will be engaged to provide any services, or any other item of work related to the award of this Contract. We further confirm and declare that no agency commission or any payment, which may be construed as an agency, commission has been, or will be, paid and that the Bid price does not include any such amount. We acknowledge the right of CLIENT /HLL , if it finds anything to the contrary, to declare our Bid to be non-compliant and if the Contract has been awarded to declare the Contract null and void.
12. We understand that you are not bound to accept the lowest or any Bid you may receive.
13. If our Bid is accepted, we understand that we are to be held solely responsible for the due performance of the Contract.
14. We submit the certificates in support of our suitability, technical knowledge and capability for having successfully completed the works.
15. We enclose;
    a. All documents as per the checklist
    b. Bank guarantee for Rs _____ (Rupees _____ only) issued by _____ (name of the bank) valid until _____ towards EMD.

Note : i. The Appendix forms part of the Bid

ii. Bidders are required to fill up all the blank spaces in this form of Bid and Appendix.

Dated this……day of……**2019**

Signature ……

Name……..…… in the capacity of ……..

duly authorized to sign Bids for and on behalf of……..……

Address ……..……..

Witness – Signature …….

Name ……..

Address ……

****

Certificate

It is certified that the information given by us towards meeting the requirement of the eligibility to bid are correct. It is also certified that I/We shall be liable to be debarred, disqualified/ cancellation of enlistment in case any information furnished by me/us is found to be incorrect.

Date Seal of bidder&

Signature(s)
of bidder(s)

****

Form A Appendix

APPENDIX TO THE FORM OF BID

i.	(a) Amount of Performance Guarantee to be deposited by financially successful bidder	5 percent of the total contract price
	(b) Amount of Security Deposit	As per Clause 1 A of GCC.
Ii	Date for commencement of work	As per Schedule "F"
Iii	Time for completion	24 Months from the issue of letter of award
iv.	Amount of compensation in case of extension of completion date due to delays by the Contractor	As per Clause 2 of GCC
v.	Defects Liability Period from the date of issue of "Taking Over Certificate"	The defect liability period for the blocks/buildings and services completed in a phased manner, shall commence from such completion and shall be upto 12 months after the overall completion of project.
vi.	(a) Period of validity of Performance Guarantee	As per of GCC
	(b) Period of validity of Security Deposit	As per of GCC

Signature

(Authorized Signatory)

Date ……..…… Name …….

Place …….. ……. Address …….

FORM 'T-1'

FINANCIAL INFORMATION

1. **Financial Analysis**-Details to be furnished duly supported by figures in balance sheet, statement of Profit & Loss account along with notes to accounts for the last five years duly certified by the Chartered Accountant mentioning the firm registration number issued by ICAI along with the full address.

   i) **Gross Annual Turnover on construction works** for last three consecutive financial years ending 31.03.2018.

Financial Year	Annual Turn Over in Indian Rupees (or equivalent to Indian Rupees) as per Audited Balance Sheet
2015-16	Rs.
2016-17	Rs.
2017-18	Rs.
Average Annual Turnover over the past three years	Rs.

   ii) **Balance Sheet & Statement of Profit & Loss** for last five consecutive financial years ending 31.03.2018

Financial Information in Rs. Equivalent	2013-14	2014-15	2015-16	2016-17	2017-18
1. Total Assets					
2. Current Assets					
3. Total Liabilities					
4. Current Liabilities					
5. Profit before Tax					
6. Profit after Tax					
7. Net Worth					
8. Bank solvency amount as mentioned in the bank solvency certificate (form "T-1B"					

Note:

1. In case of bidders with Foreign Origin (Outside India), the financial years shall be as applicable for the respective countries i.e. 2013, 2014, 2015, 2016 and 2017.
2. Net Worth shall mean the sum of subscribed and paid up equity and reserves from which shall be deducted the sum of revaluation reserves, miscellaneous expenditure not written off and reserves not available for distribution to equity shareholders.

Signature of Chartered
Accountant with Seal
FRN Number

Signature of Bidder.

FORM 'T-1 B'

FORM OF BANKERS' CERTIFICATE FROM A SCHEDULED BANK (SOLVENCY CERTIFICATE)

This is to certify that to the best of our knowledge and information that M/s./Shri …… having marginally noted address, a customer of our bank are/is respectable and can be treated as good for any engagement upto a limit of Rs. ……..(Rupees……).

This certificate is issued without any guarantee or responsibility on the bank or any of the officers.

(Signature)
For the Bank

NOTE (1) Bankers certificates should be on letter head of the Bank, addressed to tendering authority.

(2) In case of partnership firm, certificate should include names of all partners as recorded with the bank.

FORM 'T-2'

DETAILS OF ELIGIBLE SIMILAR NATURE OF WORKS COMPLETED IN LAST SEVEN YEARS ENDING PREVIOUS DAY OF LAST DATE OF SUBMISSION OF BID

Name of the Bidder…….

S. No.	Details	
1.	Name of work / project and location	
2.	Owner/Client or sponsoring organization	
3.	Type of work (with respect to the eligibility criteria of this bid)	
4.	Work Components[Please tick (√) in relevant box]	
a	RCC Framed Structure	
b	Finishing Works	
c	Water Supply and sanitary installation works	
d	External development and Drainage	
e	Electrical installations	
f	Firefighting Works	
g	LV Works	
h	Lifts	
i	HVAC Works	
5.	No. of basements	
6.	No. of storeys	
7.	Height of building	
8.	Cost of work on completion in Rs. Crores	
9.	Date of commencement as per contract	
10.	Stipulated date of completion	
11.	Actual date of completion	
12.	Date and No. of completion certificate	
13.	Ref. & Page No. of documentary proof of the detail missing in completion certificate	
14.	*Litigation/ arbitration cases pending / in progress with details	
15.	Name and Address (Postal & E-mail) / telephone number of officer to whom reference may be made	
16.	Whether the work was done on back to back basis	

Certified that the above list of works is complete and no work has been left out and that the information given is correct to my / our knowledge and belief.

SIGNATURE OF BIDDER(S)
WITH STAMP

*indicate gross amount claimed and amount awarded by the Arbitrator.

Note: -Copy of work Orders and Completion Certificates of the above works should also be submitted.

FORM 'T-3

PERFORMANCE REPORT OF WORKS REFERRED TO IN FORM-T-2

1.	Name of work / Project & Location		
2.	Agreement No.		
3.	Whether the work is carried out in Engineering, Procurement & Construction (EPC)/Turnkey basis		Yes/ No
4.	Name of Contractor		
5.	Estimated Cost		
6.	Tendered Cost		
7.	Cost of Completed Work		
8.	Date of Start		
9.	Date of completion		
	i)	Stipulated Date of Completion (as mentioned in work order)	
	ii)	Actual Date of Completion	
10.	i)	Whether case of levy of compensation for delay has been decided or not	Yes/ No
	ii)	If decided, amount of compensation levied for delayed completion, if any.	
11.	Work Components[Please tick (√) in relevant box]		
a)	RCC Framed Structure		
b)	Finishing Works		
c)	Water Supply and sanitary installation works		
d)	External development and Drainage		
e)	Electrical installations		
f)	Firefighting Works		
g)	LV Works		
h)	Lifts		
i)	HVAC Works		
12.	No. of basements		
13.	No. of storeys		
14.	Height of building		
15.	Performance Report		
	1) Quality of Work		Outstanding /Very Good/Good/Poor
	2) Financial Soundness		Outstanding /Very Good/Good/Poor
	3) Technical Proficiency		Outstanding /Very Good/Good/Poor
	4) Resourcefulness		Outstanding /Very Good/Good/Poor
	5) General Behaviour		Outstanding /Very Good/Good/Poor

Dated : _____ Executive Engineer or Equivalent

FORM 'T-4'

STRUCTURE & ORGANIZATION

1.	Name & Address of the bidder		
2.	Telephone No. /Email id /Telex No./Fax No.		
3.	Legal status of the bidder (Attach copies of original document defining the legal status).		
	a)	An Individual	
	b)	A proprietary firm	
	c)	A firm in partnership	
	d)	A limited company or Corporation	
4.	Particulars of registration with various Government bodies (attach attested photo-copy).		
	ORGANIZATION/PLACE OF REGISTRATION		REGISTRATION No.
	1.		
	2.		
	3.		
5.	Names and Titles of Directors & Officers with designation to be concerned with this work.		
6.	Designation of individuals authorized to act for the organization.		
7.	Has the bidder or any constituent partner in case of partnership firm, ever abandoned the awarded work before its completion? If so, give name of the project and reasons for abandonment.		
8.	Has the bidder or any constituent partner in case of partnership firm/ limited company/ joint venture, ever been convicted by the court of law? If so, give details.		
9.	In which field of Civil Engineering Construction, the bidder has specialization and interest?		
10.	Any other information considered necessary but not included above.		

Signature of bidder(s) with stamp

Form –"T-5"

TDS DETAILS FOR PRIVATE SECTOR PROJECTS FOR THE WORKS EXECUTED IN INDIA

Sl. No.	Description	Details
1.	Name of work	
2.	Name of Clients	
3.	Project cost in crores	
4.	No. and date of completion certificate	
5.	Cost of the work on completion in crores	
6.	Payments received as per TDS in Crores	
7.	TDS Corresponding to the payments	
8.	Year wise TDS as per form-26AS/Form 16A relating to the work.	

Note:

1. Value of work done will be considered commensurate with value of TDS certificates.
2. In case of multiple contracts undertaken from a client, reconciliation for the TDS pertaining to the work mentioned above need to be segregated and reconciled with From-26AS.
3. This form need to be supported with form-26AS taken in HTML format or Form -16A.

Signature of Chartered
Accountant with Seal
FRN No.

Signature of Bidder.

Form-"T-6"

GST Registration Details

Sr. NO.	Description	Details
1.	Entity Name	
2.	Address (As per registration with GST)	
3.	City	
4.	Postal code	
5.	Region/State (complete state name)	
6.	Permanent account number	
7.	GSTN/ARN/UID/Provisional with ID No. (Copy of acknowledgement required)	
8.	Type of business (As per registration with GST)	
9.	Service accounting code/HSN Code	
10.	Contract Person	
11.	Phone Number and Mobile Number	
12.	Email –ID	
13.	Compliance Rating (If updated by GSTN)	

Signature of bidder(s) with stamp

Form 'T- 7'

CRITERIA FOR EVALUATION OF THE PERFORMANCE OF BIDDERS/ CONTRACTORS FOR PRE-ELIGIBILITY

	ATTRIBUTES	**EVALUATION**
(a)	**Financial Strength (20 Marks)**	60% marks for minimum eligibility criteria
	Average Annual Turnover (16 Marks)	100% marks for twice the minimum eligibility criteria or more
	Solvency Certificate (4 Marks)	In between (i) & (ii) – on pro rata basis
(b)	**Experience of similar class of works (20 marks)**	60% marks for minimum eligibility criteria
		100% marks for twice the minimum eligibility criteria or more
		In between (i) & (ii) – on pro rata basis

(c)	**Performance on works (Time over run) (20 Marks)**						
	Parameter	Calculation for Point	Score				Maximum Points
	If TOR=		1.0	2.0	3.0	>3.50	20
	(i) Without Levy of compensation		20	15	10	10	
	(ii) With Levy of compensation		20	5	0	-5	
	(Iii) Levy of compensation not decided		20	10	0	0	
	TOR = AT/ ST, where AT = Actual Time; ST = Stipulated Time						
	Note: - Marks for value in between the stages indicated above is to be determined by straight line variation method.						

(d)	**Performance of Works (Quality) (40 Marks)**	Performance	Marks
		Outstanding	40
		Very Good	30
		Good	20
		Poor	0

	Bidders qualifying the initial criteria as set out in para 1.4 will be evaluated for following criteria by scoring method on the basis of details furnished by them.	
a	Financial strength (Form 'T-1' & 'T-1 B') –	Maximum 20 marks
b	Experience in similar nature of work during last five years (Form 'T-2')	Maximum 20 marks
c	Performance on works (Form 'T-3') – Time over run	Maximum 20 marks
d	Performance on works (Form 'T-3') – Quality	Maximum 40 marks
	Total -	100 marks
To become eligible for short listing, the bidder must secure at least 50% marks in each attribute and minimum 60% marks in aggregate.		

Form-B

FORM OF EARNEST MONEY DEPOSIT (BANK GUARANTEE BOND)

WHEREAS, Bidder..... (Name of Bidder) (herein after called "the Bidder") has submitted his bid dated ..... (date) for **Design, Engineering, Procurement and Construction (EPC) of Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram.** (Name of work) (herein after called "the bidder")

KNOW ALL PEOPLE by these presents that we ..... (Name of bank) having our registered office at ..... (herein after called "the Bank") are bound unto **Vice President (ID), HLL Lifecare Limited(HLL), NOIDA- 201307**in the sum of Rs. ..... (Rs. in words .....) for which payment well and truly to be made to the said **Vice President (ID), HLL Lifecare Limited(HLL), NOIDA- 201307,** the Bank binds itself, his successors and assigns by these presents.

SEALED with the Common Seal of the said Bank this .....day of ..... 2.... THE CONDITIONS of this obligation are:

(1) If after bid opening ……. of bid; the Bidder withdraws, his bid during the period of validity of bid (including extended validity of bid) specified in the Form of Bid;

(2) If the Bidder having been notified of the acceptance of his bid by HLL .

(a) fails or refuses to execute the Form of Agreement in accordance with the Instructions to Bidder, if required;

OR

(b) fails or refuses to furnish the Performance Guarantee, in accordance with the provisions of bid document and Instructions to Bidder,

We undertake to pay to the **Vice President (ID), HLL Lifecare Limited(HLL), NOIDA- 201307** either up to the above amount or part thereof upon receipt of his first written demand, without the **Vice President (ID), HLL Lifecare Limited(HLL), NOIDA- 201307**having to substantiates his demand, provided that in his demand **the Vice President (ID), HLL Lifecare Limited(HLL), NOIDA-201307**will note that the amount claimed by him is due to him owing to the occurrence of one or any of the above conditions, specifying the occurred condition or conditions.

This Guarantee will remain in force up to and including the date (*) after the deadline for submission of bid as such deadline is stated in the Instructions to Bidder or as it may be extended by the **Vice President (ID), HLL Lifecare Limited(HLL), NOIDA- 201307,** notice of which extension(s) to the Bank is hereby waived. Any demand in respect of this Guarantee should reach the Bank not later than the above date.

DATE ..... **SIGNATURE OF THE BANK**
WITNESS ..... **SEAL**
(SIGNATURE, NAME AND ADDRESS)

(*) Date to be worked out on the basis of validity period of _____months from the last date of uploading the bid.

Form-C

FORM OF PERFORMANCE GUARANTEE BANK GUARANTEE

(On a stamp paper of appropriate value from any Nationalised Bank or Scheduled Bank)

To,
Vice President (ID)
HLL Lifecare Limited
B-14-A, Sector-62, Noida -201307
For and on behalf of Director,
Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram

Dear Sir,

In consideration of the CLIENT (Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram) for Design, Engineering, Procurement and Construction (EPC) of Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram which expression shall include his successor and assignees represented by his Project Consultant, M/s HLL Lifecare Limited, B-14-A, Sector-62, Noida -201307, (herein after called HLL) having awarded to----------having its Registered Office at ---------- (hereinafter referred to as "the said Contractor (s)", which expression shall include his successor and assignees) for the work of Design, Engineering, Procurement and Construction (EPC) of Up-gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram, INDIA a Contract No. ----------in terms interalia, of the and the General Conditions of Contract and upon the condition of the Contractor's furnishing Security for the performance of the Contractor's obligations and discharge of the Contractor's liability under and in connection with the said Contract up to a sum of Rs.----------Rupees ----------) amounting to 5% percent of the total Contract value.

1. We,_____(hereinafter called `The Bank' which expression shall include its successors and assignees) hereby jointly and severally undertake to guarantee the payment to the HLL in rupees forthwith on demand in writing and without protest or demur or any and all moneys payable by the Contractor to the HLL in respect of or in connection with the said Contract inclusive of all the HLL 'S losses and damages and costs, (inclusive between attorney and client) charges and expenses and other moneys payable in respect of the above as specified in any notice of demand made by the HLL to the Bank with reference to this guarantee up to an aggregate limit of Rs----------(Rupees ----------).

2. We_____ Bank Ltd. further agree that the HLL shall be sole judge of and as to whether the said Contractor has committed any breach or breaches of any of the terms and conditions of the said Contract and the extent of loss, damage, cost, charges and expenses caused to or suffered by or that may be caused to or suffered by the HLL on account thereof and the decision of the HLL that the said Contractor has committed such breach or breaches and as to the amount or amounts of loss, damage, costs, charges and expenses caused to or suffered by the HLL from time to time shall be final and binding on us.

3. The HLL shall be at liberty without reference to the Bank and without affecting the full liability of the Bank hereunder to take any other Security in respect of the Contractor's obligations and liabilities hereunder or to vary the Contract or the work to be done

there under vis-a-vis the Contractor or to grant time or indulgence to the Contractor or to reduce or to increase or otherwise vary the prices of the total Contract value or to release or to forbear from enforcement of all or any of the Security and/or any other Security(ies) now or hereafter held by The HLL and no such dealing(s) reduction(s) increase(s) or other indulgence(s) or arrangements with the Contractor or release or forbearance whatsoever shall absolve the bank of the full liability to the HLL hereunder or prejudice the rights of the HLL against the bank.

4. This guarantee shall not be determined or affected by the liquidation or winding up, dissolution, or change of constitution or insolvency of the Contractor but shall in all respects and for all purposes be binding and operative until payment of all monies payable to the HLL in terms thereof.

5. The bank hereby waives all rights at any time inconsistent with the terms of this guarantee and the obligations of the Bank in terms hereof shall not be anywise affected or suspended by reason of any dispute or disputes having been raised by the Contractor stopping or preventing or purporting to stop or prevent any payment by the Bank to the HLL - in terms hereof.

6. The amount stated in any notice of demand addressed by the HLL to the Bank as liable to be paid to the HLL by the Contractor or as suffered or incurred by the HLL on account of any losses or damages or costs, charges and/or expenses shall be conclusive evidence of the amount so liable to be paid to the HLL or suffered or incurred by the HLL as the case may be and shall be payable by the Bank to The HLL in terms hereof.

7. This guarantee shall be a continuing guarantee and shall remain valid and irrevocable for all claims of the HLL and liabilities of the Contractor arising up to and until midnight of

8. This guarantee is valid till ----------(date to be mentioned) (Sixty days beyond the stipulated date of completion or the extended period, thereof)

9. This guarantee shall be in addition to any other guarantee or Security whatsoever that the HLL may now or at any time anywise may have in relation to the Contractor's obligations/or liabilities under and/or in connection with the said Contract, and the HLL shall have full authority to have recourse to or enforce this Security in preference to any other guarantee or Security which the HLL may have or obtain and no forbearance on the part of the HLL in enforcing or requiring enforcement of any other Security shall have the effect of releasing the Bank from its full liability hereunder.

10. It shall not be necessary for the HLL to proceed against the said Contractor before proceeding against the Bank and the Guarantee herein contained shall be enforceable against the Bank notwithstanding that any Security which The HLL may have obtained or obtain from the Contractor shall at the time when proceedings are taken against the said bank hereunder be outstanding or unrealised.

11. We, the said Bank undertake not to revoke this guarantee during its currency except with the consent of the HLL in writing and agree that any change in the constitution of the said Contractor or the said bank shall not discharge our liability hereunder.

12. We_____ the said Bank further that we shall pay forthwith the amount stated in the notice of demand notwithstanding any dispute/difference pending between the parties before the arbitrator and/or that any dispute is being referred to arbitration.

13. Notwithstanding anything contained herein above, our liability under this guarantee shall be restricted to Rs.---------- (Rupees ---------- ----------) and this guarantee shall remain in force till ---------- - and unless a claim is made on us within 6 months from that date, that is before---------

---------- all the claims under this guarantee shall be forfeited and we shall be relieved of and discharged from our liabilities there under.

Notwithstanding anything contained herein above:

(a) Our liability under this Bank Guarantee shall not exceed Rs. ----------(Rupees ----------)

(b) This Bank Guarantee shall be valid up to ----------

(c) We are liable to pay the guaranteed amount or any part thereof under this Bank Guarantee only and only if you serve upon us a written claim or demand on or before ----------at (bank address)otherwise, all your rights under this guarantee shall be forfeited and bank shall be relieved and discharged from all the liabilities there under irrespective of whether or not the original bank guarantee returned to us or not

Dated_____day of_____2019

For and on behalf of Bank.

Issued under seal :

Form D

FORM OF AGREEMENT

This agreement is made at ---------- on the ---- day of --------- 2019 between CLIENT/HLL " which expression shall, unless repugnant to the context or meaning thereof be deemed to mean and include its successors, legal representatives and assigns) of the **First Part.**

M/s ---------- a Company incorporated under the Companies Act 1956 having Head Office at ----------, (hereinafter called the "Contractor" which expression unless repugnant to the context shall mean and include its successors-in-interest assigns etc.) of the **Second Part.**

Whereas CLIENT/HLL is desirous that certain works should be executed, **for Design, Engineering, Procurement and Construction (EPC) of Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram** hereinafter called the "The Project" and has accepted a Tender submitted by the contractor for the execution and completion of such works as well as guarantee of such works and the remedying of defects therein.

NOW THIS AGREEMENT WITHNESSTH as follows:

1. In this agreement words and expression shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.
2. The following documents shall be deemed to form and be read and constructed as part of this agreement Viz.
   i) Volume – 1- (NIT & ITB)
   ii) Volume- 2 - General Conditions of Contract (GCC)
   iii) Volume- 2A – Integrity Agreement
   iv) Volume – 3 – Specific Conditions of Contract (SCC)
   v) Volume – 4 – Design Basis Report (DBR)
   vi) Volume – 5 - Technical Specifications
   vii) Volume – 6 - (Tender Drawings)
   viii) Amendments & other documents (To be specifically added)
   ix) Letter of Award (LOA) No. _____ dated _____.
3. In consideration of the payment to be made by HLL to the Contractor as hereinafter mentioned, the Contractor hereby covenants with HLL to execute and complete the Project - **Design, Engineering, Procurement and Construction (EPC) of Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram.**by **24 (Twenty Four) Calendar months** from the date of commencement and remedy and defects therein in conformity in all respects with the provisions of the Contract.
4. Whereas HLL has accepted bid/ negotiated Bid for the above mentioned work for an amount of Rs. _____ (Rupees _____Only). The above bid/ negotiated bid amount is inclusive of all prevailing taxes including Goods and Services Tax, Building and other Construction Workers welfare Cess and any other applicable statutory taxes, levies as per terms & conditions of Bid document.

   HLL hereby covenants to pay the Contractor in consideration of the execution and completion of the project and remedying of defects therein for contract price of Part-A

– Building & Services of Rs. _____ (Rupees _____Only),

Above being the sum stated in the letter of Award (LOA) subject to such additions there to or deductions there from as may be made under the provisions of the Contract at the times and in the manner prescribed by the Contract.

5. OBLIGATION OF THE CONTRACTOR

The Contractor shall ensure full compliance with tax laws of India with regard to this Contract and shall be solely responsible for the same.

IN WITHNESS OF WHEREOF the parties hereto have caused their respective common seals to be hereunto affixed / (or have hereunto set their respective hands and seals) the day and year first above written.

For and on behalf of the Contractor	For on behalf of Director, Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram
Signature of the authorized official	Signature of the authorized official
Name of the Contractor Stamp / Seal of the Contractor	Name of the official Stamp / Seal
SIGNED, SEALED AND DELIVERED By the said	By the Said
on behalf of the Contractor:	on behalf of the HLL
in the presence of: Witness_____ Name _____ Address_____	in the presence of: Witness_____ Name _____ Address_____

Form E

FORMAT FOR POWER OF ATTORNEY FOR SIGNING OF PROPOSAL (Authorized Signatory)

Know all men by these presents, we …… (Name of the Tenderer and address of their registered office) do hereby constitute, appoint and authorize Mr / Ms……(name and residential address of Power of Attorney holder) who is presently employed with us and holding the position of ……..…… as our attorney, to do in our name and on our behalf, all such acts, deeds and things necessary in connection with or incidental to our Bid for the Project and submission of all documents and providing information / responses to _____ _____, representing us in all matters before _____ _____, and generally dealing with _____ _____ in all matters in connection with our proposal for the said Project.

We hereby agree to ratify all acts, deeds and things lawfully done by our said attorney pursuant to this Power of Attorney and that all acts, deeds and things done by our aforesaid attorney shall and shall always be deemed to have been done by us.

FORM - F

UNDERTAKING (FOR SPECIALIZED AGENCY)
(On a Rs 100/- non judicial stamp paper duly notarized)

We do hereby undertake to engage a specialised agency after approval of HLL for undertaking the execution of specialized works whose minimum qualification shall be as under:

a. For Specialized works viz. DG Sets, HVAC System, Fire Fighting, Lift, MGPS, as required:

Experience of having successfully completed similar specialized works during last 7 years ending last day of month previous to the one in which applications are invited should be either of the following:

i. HVAC: One similar work having individual Chiller capacity not less than 100 TR OR Two similar works having individual Chiller capacity not less than 50 TR.

ii. DG Set: One similar work having individual DG capacity not less than 750 KVA OR Two similar works having individual DG capacity not less than 500 KVA.

iii. For Fire Fighting System: Experience of having successfully completed similar specialized works with atleast one no. of work involving supply & installation of firefighting system including sprinklers, fire pumps & wet riser etc. in a campus comprising of business/ institutional/ residential/ educational/assembly buildings as classified in NBC.

iv. For Lifts Works: For Lifts associated agency shall be as per the approved makes

v. For MGPS: One work of complete MGPS system in minimum 100 bedded hospital or Two works of complete MGPS system in minimum 50 bedded hospital.

b. For specialized works as mentioned below approval from Engineer-in-Charge shall be sought before commencement of work:

i. Audio Visual System & Stage Lighting System

ii. WTP. STP/ETP

iii. LV works like Nurse Call System, BMS, Access Control System, LAN, IPABX, CCTV, Fire Alarm & Detection, Public Address, Information Display System etc.

iv. Any other specialized works specified in Tender.

c. For all other specialized works, for which the contractor intend to engage a specialized agency for execution of work, the contractor shall take approval of the Engineer-In-Charge before assignment of such agency.

(Authorized Signatory of Bidder)

Form G

AFFIDAVIT

(On a Rs 100/- non judicial stamp paper duly notarized)

1. I, the undersigned, do hereby certify that all the statements made in the required attachments are true and correct.
2. The undersigned also herby certifies the our firm M/s _____ have neither abandoned any contract awarded to us nor such works have been rescinded, during the last five years prior to the date of this application.
3. The undersigned also herby confirmed M/s _____ have not been blacklisted/debarred/penalized by any government agency or public sector undertaking or judicial authority/arbitration body.
4. The undersigned hereby authorize (s) and request (s) any bank, person, form or corporation to furnish pertinent information deemed necessary and requested by the Department to verify this statement or regarding my (our) competence and general reputation.
5. The undersigned understands and agrees that further qualifying information may be requested, and agrees to furnish any such information at the request of the Client.
6. The undersigned undertake that 'I/We have not altered/ modified the financial bid attached in the https://etenders.gov.in/eprocure/app portal. If it is found during the tender stage or later that the BOQ is modified by us, the client/ HLL shall have the right to reject our bid'.

_____

Signed by an Authorised Officer of the Bidder

Form-"H"

UNDERTAKING

(On a Rs 100/- non judicial stamp paper duly notarized)

We do hereby indemnify CLIENT/HLL , against all penal action that may be levied/ effected by any concerned authority for default in any labour regulation/PF/ESI and other statutory requirements of the relevant Acts/Laws related to the work of the contractor and will bear the legal charges, if any, and will pay the legal charges/dues directly to the concerned authority.

_____

Signed by an Authorised Officer of the Firm

Form-"I"

FORMAT OF BANK GUARANTEE FOR MOBILISATION ADVANCE

BANK GUARANTEE NO: **ISSUE DATE:**

The Vice President (ID),
M/S. HLL Lifecare Ltd. (HLL)
(A Government Of India Enterprise)
B-14A, Sector-62,
Noida-201307, (Uttar Pradesh).

Project Consultant of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram

Dear Sirs,

Mobilization Advance Guarantee No.

Amount of Guarantee Rs._____

Guarantee cover from:

Last Date of Lodgment for Claim: _____

In consideration of the M/S. HLL Lifecare Ltd (HLL), as Project Consultant of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram (hereinafter called "HLL ") which expression shall unless repugnant to be subject or context include its successors and permitted assigns) having agreed under the terms and conditions of HLL LOA No. _____ Design, Engineering, Procurement and Construction (EPC) of Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram on EPC Basis Entered into between HLL Lifecare Ltd and _____ having its Registered Office at _____, (herein after called "the said contractor') to make mobilization advance lump-sum advance to the tune of Rs._____ (Rupees _____)subject to submission of the Bank Guarantee for equal amount from any Schedule B. We _____, and having its registered office at _____ & a branch office inter alia at _____ (Hereinafter called as Bank) Do hereby undertake and agree to pay to the HLL to the extent of Rs._____ (Rupees _____) on demand stating that the amount claimed by the HLL is due and payable by the contractor for the reasons of non-refund and non- recovery of the amount with simple interest at the rate of 10% p .a. thereon and to unconditionally pay the amount claimed by the HLL under this guarantee on such demand without any demur to the extent aforesaid.

We, _____, agree that HLL shall be the sole judge as to whether the said contractor has failed/neglect in performing any of the terms and conditions of the said contract and the decision the HLL in this behalf shall be final and binding on us, in terms hereof.

We _____further agree that the guarantee herein contained shall remain in full force and effect up to _____ and any claim received after the said date shall in no case bind the bank.

HLL shall have the fullest liberty without affecting in any way the liability of the Bank under this guarantee or indemnify from time to time vary any of the terms and condition of the said contract or to extend the time of performance by the said contractor or to postpone any time and from time to time any of the powers exercisable by it against to the said contractor and either to enforce or to forbear from enforcing any of the terms and conditions governing the said contract or securities available to HLL and the said Bank shall not be released from its liability under these presents.

Notwithstanding anything contained herein the liability of the said Bank under this guarantee is restricted to Rs._____/- (Rupees _____ only) and this Guarantee shall come into force from the date hereof and shall remain in full force and effect till _____ unless the written demand or claim under this guarantee is made by HLL with us on or before _____ all rights of HLL under this guarantee shall cease to have any effect and we shall be relieved and discharged from our liabilities hereunder.

We _____ lastly undertake not to revoke this guarantee during its currency except with the previous consent of HLL in writing and agree that any change in the constitution of the said contractor or the said Bank shall not discharge our liability hereunder.

N0TWITHSTANDING anything contained hereinabove:

1. Our liability under the Bank Guarantee shall not exceed Rs._____ (Rupees _____)
2. This Bank Guarantee shall be valid up _____
3. We are liable to pay the Guarantee amount or any part thereof under this guarantee only and if you serve upon a written claim or demand at _____ on or before _____ _____.

Annexure -1 - Checklist

CHECK LIST OF DOCUMENTS TO BE SUBMITTED WITH THE BID

TECHNICAL PACKAGE – Hardcopy and Online

Sl. No.	Name of Document	Mode of submission
1	Non –refundable payment of Rs.2,24,000/- (Rs. Two Lakh Twenty Four Thousand only) as e-Tender Fee / Processing Fee, in favour of "HLL Lifecare Limited"	**Original**
2.	Bid Security / EMD (Form B) in favour of "HLL Lifecare Limited "payable at Noida / Delhi	**In Original in Envelope no. 1 & submit Scanned Copy Online**
3.	Form of bid and Appendix (Form A) for the bid	**In Original in Envelope no. 2 & submit Scanned Copy Online**
4.	Power of Attorney (Form E) in favour of the person signing the Bid	
5.	Undertaking for engaging specialized agencies (Form F)	
6.	Affidavit by Bidder (Form G) duly notarized on non-judicial of appropriate value-stamp paper	
7.	Affidavit/ Indemnity / Undertaking (Form H)	
8.	Form "T-1" (Financial Information)	
9.	Form "T-1-B" (Solvency Certificate as per Clause 1.4)	
10.	Form "T-5" (TDS details for Private Sector Projects for the works executed in India)	
TECHNICAL PACKAGE – Online		
1.	Form "T-2" (Details of Eligible Similar Works completed)	**Online**
2.	Form "T-3" (Performance Report of Works referred to in Form T-2)	
3.	Form "T-4" (Structure and Organization)	
4.	Form "T-6" (GST Registration Details)	
5.	Copies of GST Registration or undertaking / EPF Registration/ PAN Number	
6.	Integrity Pact & Agreement duly signed by the authorized signatory on behalf of the bidder (as per proforma given in GCC Vol-2 A)	
7.	All pages of the entire Corrigendum/ addendum (if any)/ pre bid clarifications (if any) signed by the authorised person of the bidder/bidder.	
8.	All TDS Certificates of Private Sector Projects for the works executed in India.	
9.	Any other document as specified in the bid document.	
Note:- All the uploaded documents should be in readable, printable & legible form.		

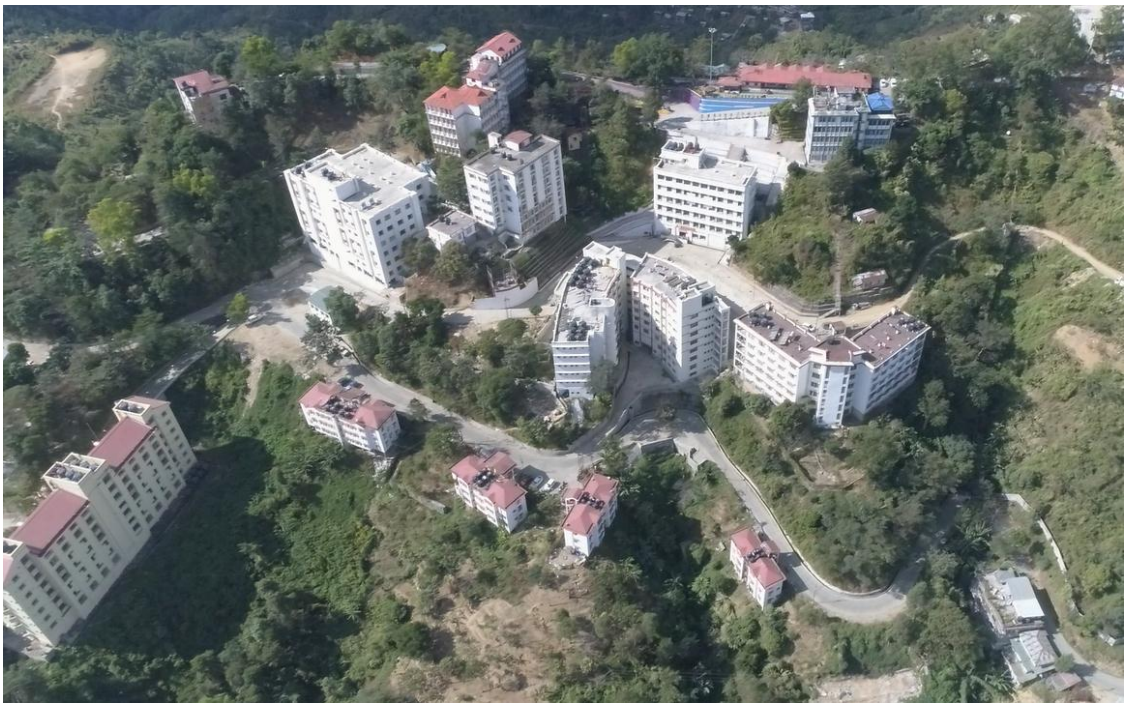
FINANCIAL PACKAGE: Online

S. No	Name of Document	Mode of submission
1.	Digitally signed bid / Price Bid (Financial Bids – Volume-7)	Online

END OF VOLUME – 1

Vol.-2: General Conditions of Contract

UP-GRADATION AND DEVELOPMENT OF REGIONAL INSTITUTE OF PARAMEDICAL & NURSING SCIENCES,AIZAWL, MIZORAM



CLIENT
Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram
(Ministry Of Health and Family Welfare, Govt. of India)

PROJECT CONSULTANT
HLL Lifecare Limited
(A Government of India Enterprise)

HLL Lifecare Ltd. (HLL)

(A Govt. of India Enterprise)

on behalf of

Regional Institute of Paramedical & Nursing Sciences, (RIPANS) Aizawl, Mizoram

Invites

e-Tender

For

Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram

on EPC Basis

Tender No. HLL /RIPANS-Aizawl/2019

Volume-2

General Conditions of Contract (GCC)

(September, 2019)

HLL Lifecare Limited
(A Government of India Enterprise)

B-14 A, SECTOR 62
NOIDA, UP 201 307
PH.: 0120 4071 500 FAX: 0120 4071 513

www.lifecarehll.com

Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram on EPC Basis

INDEX

INTEGRITY PACT

To,

……
……
……

Sub: Tender No. HLL /RIPANS-Aizawl/2019 for the work of Design, Engineering, Procurement and Construction (EPC) including Operation & Maintenance Works of Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram.

Dear Sir,

It is here by declared that the CLIENT/HLL are committed to follow the principle of transparency, equity and competitiveness in public procurement.

The subject Notice Inviting Tender (NIT) is an invitation to offer made on the condition that the Bidder will sign the integrity Agreement, which is an integral part of tender/bid documents, failing which the tenderer/bidder will stand disqualified from the tendering process and the bid of the bidder would be summarily rejected.

This declaration shall form part and parcel of the Integrity Agreement and signing of the same shall be deemed as acceptance and signing of the Integrity Agreement on behalf of the CLIENT/HLL.

Yours faithfully

Engineer-in-Charge

INTEGRITY PACT

To,

…….

(Designated authority of CLIENT/HLL)

Sub:

Dear Sir,

I/We acknowledge that the CLIENT/HLL is committed to follow the principles thereof as enumerated in the Integrity Agreement enclosed with the tender/bid document.

I/We agree that the Notice Inviting Tender (NIT) is an invitation to offer made on the condition that I/We will sign the enclosed integrity Agreement, which is an integral part of tender documents, failing which I/We will stand disqualified from the tendering process. I/We acknowledge that the making of the bid shall be regarded as an unconditional and absolute acceptance of this condition of the NIT.

I/We confirm acceptance and compliance with the Integrity Agreement in letter and spirit and further agree that execution of the said Integrity Agreement shall be separate and distinct from the main contract, which will come into existence when tender/bid is finally accepted by the CLIENT/HLL. I/We acknowledge and accept the duration of the Integrity Agreement, which shall be in the line with Clause 12 of the enclosed Integrity Agreement.

I/We acknowledge that in the event of my/our failure to sign and accept the Integrity Agreement, while submitting the tender/bid, the CLIENT/HLL shall have unqualified, absolute and unfettered right to disqualify the tenderer/bidder and reject the tender/bid is accordance with terms and conditions of the tender/bid.

Yours faithfully

(Duly authorized signatory of the Bidder)

PRE-CONTRACT INTEGRITY PACT

This Pre-Contract Integrity Pact (herein after called the Integrity Pact) is made on _____ day of the month of _____

Between

HLL Lifecare Ltd. A Government of India Enterprise with registered office at HLL Bhavan, Poojappura, Thiruvananthapuram 695 012, Kerala, India. (Hereinafter called "HLL", which expression shall mean and include, unless the context otherwise requires, his successors in office and assigns) of the First Party.

And

M/s _____ with office at ……represented by Shri _____ , Chief Executive Officer (hereinafter called the "BIDDER/Seller"/Contractor which expression shall mean and include, unless the context otherwise requires, his successors and permitted assigns) of the Second Party.

Preamble

[Both HLL and BIDDER referred above are jointly referred to as the Parties]

HLL intends to award, under laid down organizational procedures, Purchase orders / contract/s against Tender /Work Order /Purchase Order No. …….. HLL desires full compliance with all relevant laws and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder/s and Contractor/s.

NOW, THEREFORE,

To avoid all forms of corruption by following a system that is fair, transparent and free from any influence/prejudiced dealings prior to, during and subsequent to the currency of the contract to be entered into with a view to:-

1. Enable HLL to obtain the desired materials/ stores/equipment/ work/ project done at a competitive price in conformity with the defined specifications by avoiding the high cost and the distortionary impact of corruption on public procurement; and
2. Enable the BIDDER to abstain from bribing or indulging in any corrupt practice in order to secure the contract by providing assurance to them that their competitors will also abstain from bribing and other corrupt practices and HLL will commit to prevent corruption, in any form, by its officials by following transparent procedures.

The parties hereto hereby agree to enter into this Integrity Pact and agree as follows:

Clause.1. Commitments of HLL

1.1 HLL undertakes that HLL and/or its Associates (i.e. employees, agents, consultants, advisors, etc.) will not demand, take a promise for or accept, directly or through intermediaries, any bribe, consideration, gift, reward, favour or any material or immaterial benefit or any other advantage from the BIDDER, either for themselves or for any person, organization or third party related to the contract in exchange for an advantage in the bidding process, bid evaluation, contracting or implementation process related to the contract.

1.2 HLL will, during the tender process / pre-contract stage, treat all BIDDERs with equity and reason, and will provide to all BIDDERs the same information and will not provide any such information or additional information, which is confidential in any manner, to any particular BIDDER which could afford an advantage to that particular BIDDER in comparison to other BIDDERs in relation to tendering process or during the contract execution.

1.3 All the officials of HLL will report to Chief Vigilance Officer of HLL (CVO), any attempted or completed breaches of the above commitments as well as any substantial suspicion of such a breach.

1.4 HLL will exclude from the process all known prejudiced persons and persons who would be known to have a connection or nexus with the prospective bidder.

1.5 If the BIDDER reports to HLL with full and verifiable facts any misconduct on the part of HLL 's Associates (i.e. employees, agents, consultants, advisors, etc.) and the same is prima facie found to be correct by HLL , necessary disciplinary proceedings, or any other action as deemed fit, including criminal proceedings may be initiated by HLL . Further, such an Associate may be debarred from further dealings related to the contract process. In such a case, while an enquiry is being conducted by HLL the proceedings under the contract would not be stalled.

Clause 2. Commitments of BIDDERs/ CONTRACTORs

2. The BIDDER commits itself to take all measures necessary to prevent corrupt practices, unfair means and illegal activities during any stage of its bid or during any pre-contract or post-contract stage in order to secure the contract or in furtherance to secure it and in particular commit itself to the following:-

2.1 The BIDDER will not offer, directly or indirectly (i.e. employees, agents, consultants, advisors, etc.) any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of HLL , connected directly or indirectly with the bidding process, or to any person, organization or third party related to the contract in exchange for any advantage in the bidding, evaluation, contracting and implementation of the contract.

2.2 The BIDDER further undertakes that it has not given, offered or promised to give, directly or indirectly any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of HLL or otherwise in procuring the contract or forbearing to do or having done any act in relation to obtaining or execution of the contract or any other contract with HLL for showing or forbearing to show favour or disfavor to any person in relation to the contract or any other contract with HLL.

2.3 The BIDDER will not engage in collusion, price fixing, cartelization, etc. with other counterparty(s).

2.4 The Bidder (s) will not pass to any third party any confidential information entrusted to it, unless duly authorized by HLL.

2.5 The Bidder (s) will promote and observe ethical practices within its Organization and its affiliates.

2.6 BIDDER shall disclose the name and address of agents and representatives and Indian BIDDERS shall disclose their foreign principals or associates.

2.7 The Bidder (s) will not make any false or misleading allegations against HLL or its Associates.

2.8 BIDDERs shall disclose the payments to be made by them to agents/brokers or any other intermediary, in connection with this bid/contract.

2.9 The BIDDER further confirms and declares to HLL that the BIDDER is the original manufacture/integrator/authorized government sponsored export entity of the defense stores and has not engaged any individual or firm or company whether Indian or foreign to intercede, facilitate or in any way to recommend to HLL or any of its functionaries, whether officially or unofficially to award the contract to the BIDDER, nor

has any amount been paid, promised or intended to be paid to any such individual, firm or company in respect of any such intercession, facilitation or recommendation.

2.10 The BIDDER while presenting the bid or during pre-contract negotiations or before signing the contract, shall disclose any payments he has made, is committed to or intends to make to officials of HLL or their family members, agents, brokers or any other intermediaries in connection with the contract and the details of services agreed upon for such payments.

2.11 The BIDDER will not accept any advantage in exchange for any corrupt practice, unfair means and illegal activities.

2.12 The BIDDER commits to refrain from giving any complaint directly or through any other manner without supporting it with full and verifiable facts.

2.13 If the BIDDER or any employee of the BIDDER or any person acting on behalf of the BIDDER, either directly or indirectly, is a relative of any of the officers of HLL, or alternatively, if any relative of an officer of HLL has financial interest/stake in the BIDDER's firm, the same shall be disclosed by the BIDDER at the time of filing of tender.

The term 'relative' for this purpose would be as defined in Section 2(77) of the Companies Act 2013

2.14 The BIDDER shall not lend to or borrow any money from or enter into any monetary dealings or transactions, directly or indirectly, with any employee of HLL .

2.15 The BIDDER will not collude with other parties interested in the contract to impair the transparency, fairness and progress of the bidding process, bid evaluation, contracting and implementation of the contract, and will not enter into any undisclosed agreement or understanding with other Bidders, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.

2.16 The BIDDER will not commit any offence under the relevant Indian Penal Code, 1860 or Prevention of Corruption Act, 1988; further the Bidder(s)/ Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the HLL as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically. The BIDDER also undertakes to exercise due and adequate care lest any such information is divulged.

2.17 The BIDDER will not instigate third persons to commit offences outlined above or be an accessory to such offences.

2.18 The Bidder(s)/Contractors(s) of foreign origin shall disclose the name and address of the Agents/representatives in India, if any. Similarly the Bidder(s)/Contractors(s) of Indian Nationality shall furnish the name and address of the foreign Principal(s), if any.

Clause.3. Previous contravention and Disqualification from tender process and exclusion from future contracts

3.1 The BIDDER declares that no previous contravention occurred in the last three years immediately before signing of this Integrity Pact, with any other company in any country in respect of any corrupt practices envisaged hereunder or with any Public Sector Enterprise in India or any Government Department in India that could justify BIDDER's exclusion from the tender process

3.2 The BIDDER agrees that if it makes incorrect statement on this subject, BIDDER can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

If BIDDER before award or during execution has committed a contravention through a violation of Clause 2, above or in any other form such as to put his reliability or credibility in question, HLL is entitled to disqualify the BIDDER from the tender process.

Clause.4. Equal treatment of all Bidders/Contractors / Subcontractors

4.1 The Bidder(s)/ Contractor(s) undertake(s) to demand from his Subcontractors a commitment in conformity with this integrity Pact.

4.2 HLL will enter into agreements with identical conditions as this one with all Bidders and Contractors.

4.3 HLL will disqualify from the tender process all bidders who do not sign this Pact or violate its provisions.

Clause.5. Consequences of Violation / Breach

5.1 Any breach of the aforesaid provision by the BIDDER or any one employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER) shall entitle HLL to take all or any one of the following action, wherever required:-

i. To immediately call off the pre-contract negotiations without assigning any reason or giving any compensation to the BIDDER. However, the proceedings with the other BIDDER(s) would continue.

ii. If BIDDER commits violation of Integrity Pact Policy during bidding process, he shall be liable to compensate HLL by way of liquidated damages amounting to a sum equivalent to 5% to the value of the offer or the amount equivalent to Earnest Money Deposit/Bid Security, whichever is higher.

iii. In case of violation of the Integrity Pact after award of the contract, HLLwill be entitled to terminate the contract. HLL shall also be entitled to recover from the contractor liquidated damages equivalent to 10% of the contract value or the amount equivalent to security deposit/ performance guarantee, whichever is higher.

iv. To immediately cancel the contract, if already signed, without giving any compensation to the BIDDER.

v. To recover all sums already paid by HLL, and in case of an Indian BIDDER with interest thereon at 2% higher than the prevailing Prime Lending Rate of State Bank of India, while in case of a BIDDER from a country other than India with interest thereon at 2% higher than the LIBOR. If any outstanding payment is due to the BIDDER from HLL in connection with any other contract for any other stores, such outstanding payment could also be utilized to recover the aforesaid amount.

vi. To encash the advance bank guarantee and performance guarantee /warranty bond, if furnished by the BIDDER, in order to recover the payments already made by HLL, along with interest.

vii. To cancel all or any other contract with the BIDDER. The BIDDER shall be liable to pay compensation for any loss or damage to HLL resulting from such cancellation/recession and HLL shall be entitled to deduct the amount so payable from the money(s) due to the BIDDER.

viii. To debar the BIDDER from participating in future bidding processes of HLL for a minimum period of five (5) years, which may be further extended at the discretion of HLL or until Independent External Monitors is satisfied that the Bidder (s) will not commit any future violation.

ix. To recover all sums paid in violation of this Pact by BIDDER(s) to any middleman or agent or broker with a view to securing the contract.

x. In cases where irrevocable Letters of credit have been received in respect of any contract signed by HLL with the BIDDER, the same shall not be opened.

xi. Forfeiture of performance guarantee in case of a decision by HLL to forfeit the same without assigning any reason for imposing sanction for violation of the pact.

5.2 HLL will be entitled to all or any of the actions mentioned in para 5.1(i) to (x) of this pact also on the commission by the BIDDER or any one employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER), of an offence as defined in Chapter IX of the Indian Penal Code, 1860 or Prevention of Corruption Act, 1988 or any other statute enacted for prevention of corruption.

5.3 The decision of HLL to the effect that a breach of the provisions of this Pact has been committed by the BIDDER shall be final and conclusive on the BIDDER. However, the BIDDER can approach the Independent External Monitor(s) appointed for the purposes of this Pact.

Clause.6. Fall Clause

The BIDDER undertakes that it has not supplied/is not supplying similar product/systems or subsystems OR providing similar services at a price / charge lower than that offered in the present bid in respect of any other Ministry/Department of the Government of India or PSU and if it is found any stage that similar product/systems or sub systems was supplied by the BIDDER to any to the Ministry/Department of the Government of India or a PSU at a lower price, then that very price, with due allowance for elapsed time will be applicable to the present case and the difference in the cost would be refunded by the BIDDER to HLL , if the contract has already been concluded.

Clause.7. Independent External Monitor(s)

7.1 HLL has appointed Shri M.J. Joseph ICAS (Retd.) Ex-Controller General of Accounts (Secretary Rank) as Independent External Monitor(s) (hereinafter referred to as IEM(s)) for this Pact in consultation with the Central Vigilance Commission. Contact details of IEM is as below:

Shri M.J. Joseph ICAS (Retd.)
Ex-Controller General of Accounts (Secretary Rank)
Email: iemhll@lifecarehll.com

7.2 The responsibility of the IEM(s) shall be to review independently and objectively, whether and to what extent the parties comply with the obligations under this Pact.

7.3 The IEM(s) shall not be subject to instructions by the representatives of the parties and perform their functions neutrally and independently.

7.4 Both the parties accept that the IEM(s) have the right to access all the documents relating to the project/ procurement, including minutes of meetings.

7.5 As soon as the IEM(s) notices, or has reason to believe, a violation of this pact, he will so inform the CVO.

7.6 The BIDDER(S) accepts that the IEM(s) have the right to access without restriction to all project documentation of HLL including that provided by the BIDDER. The BIDDER will also grant the IEM(s), upon his request and demonstration of a valid interest, unrestricted and unconditional access to his project documentation. The same is applicable to subcontractors engaged by the BIDDER. The IEM(s) shall be under contractual obligation to treat the information and documents of the BIDDER/ Subcontractor(s) with confidentiality.

7.7 HLL will provide to the IEM(s) sufficient information about all meetings among the parties related to the Project provided such meeting could have an impact on the contractual relation between the parties. The parties will offer to the IEM(s) option to participate in such meetings.

7.8 The IEM(s) will submit a written report to the CVO of HLL within 8 to 10 weeks from the date of reference or intimation to him by HLL /BIDDER and, should consent arise, submit proposals for correcting problematic situations.

Clause.8.Criminal charges against violating Bidder(s)/ Contractor(s)/ Subcontractor(s)

If HLL obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if HLL has substantive suspicion in this regard, HLL will inform the same to the Chief Vigilance Officer, HLL

Clause.9. Facilitation of Investigation

In case of any allegation of violation of any provisions of this Pact or payment of commission, HLL or its agencies shall be entitled to examine all the documents, including the Books of Accounts of the BIDDER and the BIDDER shall provide necessary information and documents in English and shall extend all possible help for the purpose of such examination.

Clause.10. Law and Place of Jurisdiction

Both the Parties agree that this Pact is subject to Indian Law. The place of performance and hence this Pact shall be subject to Delhi Jurisdiction.

Clause.11. Other legal Actions

The actions stipulated in the Integrity Pact are without prejudice to any other legal action that may follow in accordance with the provisions of the extant law in force relating to any civil or criminal proceedings.

Clause.12. Validity and Duration of the Agreement

This Pact begins when both parties have legally signed it. It expires for the Contractor/Successful bidder 12 months after the last payment under the contract or the complete execution of the contract to the satisfaction of the both HLL and the BIDDER /Seller, including warranty/ Defect Liability Period, whichever is later, and for all other Bidders/unsuccessful bidders 6 months after the contract has been awarded.

If any claim is made / lodged during this time, the same shall be binding and continue to be valid despite the lapse of this pact as specified above, unless it is discharged / determined by Chairman and Managing Director of HLL .

Clause.13. Other provisions

13.1 Changes and supplements as well as termination notices need to be made in writing. Both the Parties declare that no side agreements have been made to this Integrity Pact.

13.2 If the Contractor is a partnership or a consortium, this agreement must be signed by all partners or consortium members.

13.3 Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intentions

IN WITNESS THEREOF the parties have signed and executed this pact at the place and date first above mentioned in the presents of following witnesses:

HLL Lifecare Ltd.	**Bidder**
_____	_____
Witness	Witness
1……..	1……
2……	2……..

Section -1

CONDITIONS OF CONTRACT

A. Definitions

1. The **Contract** means the documents forming the tender and acceptance thereof and the formal agreement executed between the competent authority of HLL as Project Consultant of Regional Institute of Paramedical & Nursing Sciences, Aizawl (Ministry of Health & Family Welfare, Govt. of India), as indicated in **Schedule 'F'**, and the **Contractor**, together with the documents referred to therein including these conditions, the specifications, designs, drawings and instructions issued from time to time by the Engineer-in-charge and all these documents taken together, shall be deemed to form one contract and shall be complementary to one another.

2. In the contract the following expressions shall, unless the context otherwise requires, have the meanings, thereby respectively assigned to them:-

i) The expressions "**Work(s)"** shall, unless there be something either in the subject or context repugnant to such construction, be construed and taken to mean the works by or by virtue of the contract contracted to be executed whether temporary or permanent, and whether original, altered, substituted or additional. The work shall also mean the work including survey, investigation, design, both permanent and temporary, or services to be carried out, designed, constructed, manufactured, fabricated, delivered to Site, erected, installed, completed, tested, commissioned, (including Integrated Testing and Commissioning) and remedying of any defects, and/ or supplied in accordance with the Contract and include Plant, Goods and Materials and their accessories and other necessary items/activities to complete the project/work.

ii) The **"Site"** shall mean the land, places on, into or or where work is to be executed under the contract or any adjacent land, path or street or where work is to be executed under the contract or any adjacent land, path or street which may be temporally allotted or used for the purpose of carrying out the contract.

iii) The **"Contractor"** shall mean the individual, firm or company, whether incorporated or not, undertaking the works and shall include the legal personal representative of such individual or the persons composing such firm or company, or the successors of such firm or company and the permitted assignees of such individual, firm or company.

iv) The "**Government or Government of India (GoI)"** shall mean the President of India represented by officials of Ministry of Health & Family Welfare, Govt. of India.

v) **"Client/ Employer/ RIPANS"** shall mean Regional Institute of Paramedical & Nursing Sciences, Aizawl (Ministry of Health & Family Welfare, Govt. of India) or their nominee/ assignee.

vi) **"The Consultant/ Project Consultant"** shall mean Consultant appointed by the Client for implementation of the project i.e. HLL Lifecare Limited (HLL).

vii) **"HLL"** shall mean HLL Lifecare Limited (HLL), a Company incorporated under the Companies Act 1956 with Registered Office at HLL Bhavan, Poojappura Thiruvananthapuram - 695 012, Kerala, India and also having its regional office at HLL Lifecare Limited, B-14-A, Sector-62, Noida-201307, (U.P).

viii) **"Accepting Authority"** shall mean the authority mentioned in schedule 'F'

ix) **"Department**" means RIPANS or his authorised representative who invites tender on behalf of President of India and shall include their legal representatives, nominees, employees and permitted agencies who invite tenders on behalf of RIPANS.

x) **"Engineer in Charge"** (EIC) means the Engineer Officer as mentioned in the schedule "F" hereunder, as authorized by HLL/RIPANS.

xi) **"Expected risk(s)"**are risks due to riots(other than those on account of the contractor's employees), war (whether declared or not) invasion, act of foreign enemies, hostilities, civil war, rebellion revolution, insurrection, military or usurped power, any act of Client, damage from aircraft, acts of God, such as earthquake, lightening and unprecedented floods, and other causes over which the contractor has no control and accepted as such by the Accepting Authority or causes solely due to use or occupation by Client of the part of the works in respect of which a certificate of completion has been issued or a cause solely due to Client's faulty design of work.

xii) **"Market rate"** shall be the rate as decided by Engineer-in-charge on the basis of the cost of materials and labour at the site where the work is to be executed plus the percentage mentioned in Schedule 'F' to cover, all overheads and profits.

Provided that no extra overheads and profits shall be payable on the part(s) of work assigned to other agency(s) by the contractor as per terms of contract.

xiii) **"Schedule(s)"** referred to in these conditions shall mean the relevant schedule(s) annexed to the tender papers or the standard Schedule of Rates of the Government mentioned in Schedule 'F' hereunder, with the amendments thereto issued upto the date of receipt of the tender.

xiv) **"Tendered Value"/ "Contract Price"** means the value of the entire work as stipulated in the letter of award.

xv) **"Date of commencement of work":** The date of commencement of work shall be the date of start as specified in schedule 'F' or the first date of handing over of the site, whichever is later, in accordance with the phasing, if any, as indicated in the tender document

xvi) **GST** shall mean Goods and Service Tax- Central, State and Inter State.

xvii) **"Design Data"** means all specifications, plans, drawings, details, graphs, sketches, models, levels, setting-out dimensions, calculations duly checked by the Contractor and other documents relating to the design of the Works prepared or to be prepared by or on behalf of the Contractor.

3. Scope and Performance

i) Where the context so requires, words imparting the singular only also include the plural and vice versa. Any reference to masculine gender shall whenever required include feminine gender and vice versa.

ii) Headings and Marginal notes to these General Conditions of Contract shall not be deemed to form part thereof or be taken into consideration in the interpretation or construction thereof or of the contract.

iii) The contractor shall be furnished, free of cost one certified copy of the contract documents, together with all drawings as may be forming part of the tender documents. None of these documents shall be used for any purpose other than that of this contract.

4. Works to be carried out

The work to be carried out under the Contract shall, except as otherwise provided in these conditions, include all Details Designs, Engineering & Procurement with required labourers, materials, tools, plants, equipment and transport which may be required in preparation of and for and in the full and entire execution and completion of the works. The descriptions given in the Schedule of Quantities shall, unless otherwise stated, be held to include wastage on materials, carriage and cartage, carrying and return of empties, hoisting,

setting, fitting and fixing in position and all other labours necessary in and for the full and entire execution and completion of the work as aforesaid in accordance with good practice and recognized principles.

5. Sufficiency of Tender

The Contractor shall be deemed to have satisfied himself before tendering as to the correctness and sufficiency of his tender for the works and of the rates and prices quoted in the Schedule of Quantities, which rates and prices shall, except as otherwise provided, cover all his obligations under the Contract and all matters and things necessary for the proper completion and maintenance of the works.

6. Laws and Language

In this contract unless the context otherwise require, following shall be applicable:

6.1. Laws

i) references to any legislation or any provision thereof, administrative orders of the State or Central Government or their regulatory bodies/authorities, or the orders/ruling of any competent Court of Law in India shall include amendment or re-enactment or consolidation of such legislation or any provision thereof so far as such amendment or re-enactment or consolidation applies or is capable of applying to any transaction entered into hereunder;

ii) references to laws of India or Indian law or regulation having the force of law shall include the laws, acts, ordinances, rules, regulations, bye laws or notifications which have the force of law in the territory of India and as from time to time may be amended, modified, supplemented, extended or re-enacted.

iii) terms and expressions not herein defined shall have the meanings assigned to them in the "Indian General Clauses Act, 1897" or the Indian Contract Act or the Indian Sale of Goods Act or any other applicable Indian Law, as the case may be.

iv) "Jurisdiction of Courts" Where recourse to a court is made by either party in respect of any matter under the contract, the court of competent jurisdiction at New Delhi, shall have the exclusive jurisdiction to try all disputes between the parties.

6.2. Language

i) "Language" of the contract shall be English and in case of bilingual contract, English version shall prevail over other language.

ii) references to a "person" and words denoting a natural person shall be construed as a reference to any individual, firm, company, corporation, society, trust, government, state or agency of a state or any association or partnership (whether or not having separate legal personality) of two or more of the above and shall include successors and assigns;

iii) the table of contents, headings or sub-headings in this Contract are for convenience of reference only and shall not be used in, and shall not affect, the construction or interpretation of this Contract;

iv) the words "include" and "including" are to be construed without limitationand shall be deemed to be followed by "without limitation" or "but not limited to" whether or not they are followed by such phrases;

v) words indicating one gender include all genders;

vi) words indicating the singular also include the plural and words indicating the plural also include the singular, and

vii) "written" or "in writing" means hand-written, type written, printed or electronically made and resulting in a permanent record falling within the meaning of 'document' as per the Indian Evidence Act, 1872.

7. Interpretation

7.1. In this Contract, unless the context otherwise requires,

i) references to "development" include, unless the context otherwise requires, construction, renovation, refurbishing, augmentation, up gradation and other activities incidental thereto, and "develop" shall be construed accordingly;

ii) any reference to any period of time shall mean a reference to that according to Indian Standard Time (IST);

iii) references to any date, period or Project Milestone shall mean and include such date, period or Project Milestone as may be extended pursuant to this Contract;

iv) any reference to any period commencing "from" a specified day or date and "till" or "until' a specified day or date shall include both such days or dates; provided that if the last day of any period computed under this Contract is a gazetted/general holiday, then the period shall run until the end of the next working day;

v) "lakh/lac" means a hundred thousand (100,000) and "crore" means ten million (10,000,000);

vi) "indebtedness" shall construed so as to include any obligation (whether incurred as principal or surety) for the payment or repayment of money, whether present or future, actual or contingent;

vii) references to the "winding-up", "dissolution", "insolvency", or "reorganisation" of a company or corporation shall be construed so as to include any equivalent or analogous proceedings under the law of the jurisdiction in which such company or corporation is incorporated or any jurisdiction in which such company or corporation carries on business including the seeking of liquidation, winding-up, reorganisation, dissolution, arrangement, protection or relief of debtors;

viii) save and except as otherwise provided in this Contract, any reference, at any time, to any contract, deed, instrument, licence or document of any description shall be construed as reference to that contract, deed, instrument, licence or other document as amended varied, supplemented, modified or suspended at the time of such reference; provided that this Clause shall not operate so as to increase liabilities or obligations of the Employer hereunder or pursuant hereto in any manner whatsoever;

ix) any contract, consent, approval, authorisation, notice, communication, information or report required under or pursuant to this Contract from or by any Party or the Employer's Engineer shall be valid and effective only if it is in writing under the hand of a duly authorised representative of such Party or the Employer's Engineer, as the case may be, in this behalf and not otherwise;

x) the Schedules and Recitals to this Contract form an integral part of this Contract and will be in full force and effect as though they were expressly set out in the body of this Contract;

xi) references to Recitals, Articles, Clauses, Sub-clauses or Schedules in this Contract shall mean references to Recitals, Articles, Clauses, Sub-clauses and Schedules of or to this Contract, and references to a Paragraph shall, subject to any contrary indication, be construed as a reference to a Paragraph of this Contract or of the Schedule in which such reference appears;

xii) the damages payable by either Party to the other of them, as set forth in this Contract, whether on per diem basis or otherwise, are mutually agreed genuine pre-estimated loss and without any proof of actual damage likely to be suffered and incurred by the Party entitled to receive the same and are not by way of penalty (the "Damages"); and

7.2. Unless expressly provided otherwise in this Contract, any Documentation required to be provided or furnished by the Contractor to the Employer/Engineer shall be provided free of cost and in three copies, and if the Employer/Engineer is required to return any such Documentation with its comments and/or approval, it shall be entitled to retain two copies thereof.

7.3. The rule of construction, if any, that a contract should be interpreted against the parties responsible for the drafting and preparation thereof, shall not apply.

8. Measurements and arithmetic conventions

Unless and otherwise specified in Specifications/Standards as applicable and BIS Codes/Specifications, all measurements and calculations shall be in the metric system and calculations done to 2 (two) decimal places, with the third digit of 5 (five) or above being rounded-up and below 5 (five) being rounded-down.

9. Employer's use of Contractor's Documents

The Contractor shall be deemed (by signing the Contract) to give to the Employer a non-terminable transferable non-exclusive royalty-free licence to copy, use and communicate the Contractor's Documents, including making and using modifications of them. This licence shall:

i) apply throughout the actual or intended working life (whichever is longer) of the relevant parts of the Works,

ii) entitle any person in proper possession of the relevant part of the Works to copy, use and communicate the Contractor's Documents for the purposes of completing, operating, maintaining, altering, adjusting, repairing and demolishing the Works, and

iii) in the case of Contractor's Documents which are in the form of computer programs and other software, permit their use on any computer on the Site and other places as envisaged by the Contract, including replacements of any computers supplied by the Contractor.

10. Contractor's use of Employer's Document

As between the Parties, the Employer shall retain the copyright and other intellectual property rights in the Employer's Requirements and other documents made by (or on behalf of) the Employer. The Contractor may, at his cost, copy, use, and obtain communication of these documents for the purposes of the Contract.

They shall not, without the Employer's consent, be copied, used or communicated to a third party by the Contractor, except as necessary for the purposes of the Contract.

11. Compliance with Statutes, Regulations and Laws

The Contractor shall familiarise themselves and conform in all aspects with:

i) the provisions, their legal interpretation in respect of any enactment and relevant judicial/administrative/quasi-judicial orders in India, as is and/or may become, applicable from time to time, related to or having impact on any aspect affecting the works

ii) the regulations or bye-laws of any local body and utilities.

iii) the Contractor shall be bound to give all notices required by statute, regulations or by-laws, as aforesaid and to pay all fees and bills payable in respect thereof. The Contractor will arrange necessary clearances and approvals before the Work is taken up.

Ignorance of Rules, Regulations and Bylaws shall not constitute a basis for any claim at any stage of work.

The Contractor shall indemnify the Employer against all penalties and liabilities of every kind of breach of any such enactment, laws, regulations, bye-laws or rules.

B. Discrepancies and Adjustment of errors

The several documents forming the contract are to be taken as mutually explanatory of one another, detailed drawings being followed in preference to small scale drawings and figured dimensions in preference to scale and specific conditions in preference to general conditions.

i. In the case of discrepancy between the various documents, the following order of preference shall be observed: –

a. Master Plan, Concept designs &Tender Drawings along with Design Basis Report (DBR).

b. Specific Conditions of Contract.

c. General Conditions of Contract, NIT, ITB.

d. Technical Specifications.

e. CPWD Specifications.

f. Indian Standard Specifications of BIS

g. National Building Code, 2016 & ECBC.

h. Sound engineering practices and as per directions of the Engineer-in-Charge.

ii. If there are varying or conflicting provisions made in any one document forming Part of the contract, Engineer-in- Charge shall be deciding authority with regard to the intention of the document and his decision shall be final and binding on the Contractor.

Any error in description, quantity or rate in schedule of quantities or any omission therefrom shall not vitiate the contract or release the contractor from the execution of the whole or any part of the works comprised therein according to drawings and specifications or from any of his obligation under the contract.

C. Signing of Contract

The successful bidder/contractor, on acceptance of his tender by the Accepting Authority, shall execute/sign the Contract Agreement, within the period specified in schedule 'F', consisting of:-

i. The notice inviting tender, all the documents including drawings, amendments, corrigendum etc, if any, forming the tender as issued at the time of invitation of tender and acceptance thereof together with any correspondence leading thereto.

ii. General Conditions of Contract consisting of:

a. Various standard clauses with corrections upto the date stipulated in Schedule 'F' along with annexure thereto.

b. Safety Code.

c. Rules for the protection of health, sanitary arrangements for workers employed by the Client or its contractors, which are applicable for the workers employed by the Contractor for this Project.

d. Contractor's Labour Regulations, to be followed by the Contractor for this Project.

e. List of Acts and omissions for which fines can be imposed.

iii. No payment for the work done will be made

a. Unless contract agreement is signed by the contractor.

b. Till the copy of applicable labour licenses, registration with EPFO, ESIC and BOCW Welfare Board is submitted by the contractor.

CLAUSES OF CONTRACT

CLAUSE 1 PERFORMANCE GUARANTEE

i. The contractor shall submit an irrevocable Performance Guarantee of 5% (Five percent) of the tendered amount in addition to other deposits mentioned elsewhere in the contract for his proper performance of the contract agreement, (not withstanding and/or without prejudice to any other provisions in the contract) within period specified in Schedule 'F' from the date of issue of letter of acceptance. This period can be further extended by the Engineer-in-Charge up to a maximum period as specified in schedule 'F' on written request of the contractor stating the reason for delays in procuring the Performance Guarantee, to the satisfaction of the Engineer-in-Charge. This guarantee shall be in the form of Cash (in case guarantee amount is less than Rs. 10,000/-) or Deposit at Call receipt of any scheduled bank/Banker's Cheque of any scheduled bank/Demand Draft of any scheduled bank/Pay Order of any scheduled bank (in case guarantee amount is less than Rs. 1,00,000/-) or Government Securities or Fixed Deposit Receipts or Guarantee Bonds of any Scheduled Bank or the State Bank of India in accordance with the form annexed hereto. In case a fixed deposit receipt of any Bank is furnished by the contractor to the Government as part of the performance guarantee and the Bank is unable to make payment against the said fixed deposit receipt, the loss caused thereby shall fall on the contractor and the contractor shall forthwith on demand furnish additional security to the Government to make good the deficit.

ii. The Performance Guarantee shall be initially valid up to the stipulated date of completion plus minimum 6 months beyond that and the same shall be submitted by the agency on prescribed format (Form-C as per NIT &ITB(Vol.1)). In case the time for completion of work gets enlarged, the contractor shall get the validity of Performance Guarantee extended to cover such enlarged time for completion of work. After recording of the completion certificate for the work by the competent authority, the performance guarantee shall be returned to the contractor, without any interest.

iii. The Engineer-in-Charge shall not make a claim under the performance guarantee except for amounts to which the Client is entitled under the contract (not withstanding and/or without prejudice to any other provisions in the contract agreement) in the event of:

a) Failure by the contractor to extend the validity of the Performance Guarantee as described herein above, in which event the Engineer-in-Charge may claim the full amount of the Performance Guarantee.

b) Failure by the contractor to pay Client any amount due, either as agreed by the contractor or determined under any of the Clauses/Conditions of the agreement, within 30 days of the service of notice to this effect by Engineer-in-Charge.

iv. In the event of the contract being determined or rescinded under provision of any of the Clause/Condition of the agreement, the performance guarantee shall stand forfeited in full and shall be absolutely at the disposal of the Client.

v. On substantial Completion of any work which has been completed to such an extent that the intended purpose of the work is met and ready to use, then a provisional Completion certificate shall be recorded by the Engineer-in-Charge. The provisional certificate shall have appended with a list of outstanding balance item of work that need to be completed in accordance with the provisions of the contract.

This provisional completion certificate shall be recorded by the concerned Engineer- in-charge. After recording of the Provisional Completion Certificate for the work by the competent authority, the 80 % of performance guarantee shall be returned to the contractor,

without any interest. The balance 20% of performance guarantee shall be returned to the contractor without any interest after fulfillment of all the relevant conditions & obligations of the Contract.

CLAUSE 1 A RECOVERY OF SECURITY DEPOSIT

The person/persons whose tender(s) may be accepted (hereinafter called the contractor) shall permit the Client at the time of making any payment to him for work done under the contract to deduct a sum at the rate of 2.5% of the gross amount of each running and final bill till the sum deducted will amount to security deposit of 2.5% of the tendered value of the work. Such deductions will be made and held by Client by way of Security Deposit unless he/they has/have deposited the amount of Security at the rate mentioned above in cash or in the form of Government Securities or fixed deposit receipts. In case a fixed deposit receipt of any Bank is furnished by the contractor to the Client as part of the security deposit and the Bank is unable to make payment against the said fixed deposit receipt, the loss caused thereby shall fall on the contractor and the contractor shall forthwith on demand furnish additional security to the Client to make good the deficit.

All compensations or the other sums of money payable by the contractor under the terms of this contract may be deducted from, or paid by the sale of a sufficient part of his security deposit or from the interest arising there from, or from any sums which may be due to or may become due to the contractor by Client on any account whatsoever and in the event of his Security Deposit being reduced by reason of any such deductions or sale as aforesaid, the contractor shall within 10 days make good in cash or fixed deposit receipt tendered by the State Bank of India or by Scheduled Banks or Government Securities (if deposited for more than 12 months) endorsed in favour of the Engineer-in-Charge, any sum or sums which may have been deducted from, or raised by sale of his security deposit or any part thereof. The security deposit shall be collected from the running bills and the final bill of the contractor at the rates mentioned above.

The security deposit as deducted above can be released against bank guarantee issued by a scheduled bank, on its accumulations to a minimum of Rs. 5 lac subject to the condition that amount of such bank guarantee, except last one, shall not be less than Rs. 5 lac. Provided further that the validity of bank guarantee including the one given against the earnest money shall be in conformity with provisions contained in clause 17 which shall be extended from time to time depending upon extension of contract granted under provisions of clause 2 and clause 5.

Note-1: Government papers tendered as security will be taken at 5% (five per cent) below its market price or at its face value, whichever is less. The market price of Government paper would be ascertained by the Divisional Officer at the time of collection of interest and the amount of interest to the extent of deficiency in value of the Government paper will be withheld if necessary.

Note-2: Government Securities will include all forms of Securities mentioned in Rule No. 274 of the G.F. Rules except fidelity bond. This will be subject to the observance of the condition mentioned under the rule against each form of security.

Note-3: Note 1 & 2 above shall be applicable for both clause 1 and 1A

CLAUSE 2 COMPENSATION FOR DELAY

If the contractor fails to maintain the required progress in terms of clause 5 or to complete the work and clear the site on or before the contract or justified extended date of completion as per clause 5 (excluding any extension under Clause 5.5) as well as any extension granted under clauses 12 and 15, he shall, without prejudice to any other right or remedy available under the law to the HLL on account of such breach, pay as compensation the amount calculated at the rates stipulated below as the authority specified in schedule 'F' may decide on the amount of tendered

value of the work for every completed day/month (as determined) that the progress remains below that specified in Clause 5 or that the work remains incomplete.

(i)	Compensation for delay of work	With maximum rate @ 1% (one percent) month of delay to be computed on per day basis based on quantum of damage suffered due to stated delay on the part of Contractor

Provided always that the total amount of compensation for delay to be paid under this Condition shall not exceed 10% of the accepted Tendered Value of work or of the accepted Tendered Value of the sectional part of the work as mentioned in schedule 'F' for which a separate period of completion is originally given.

In case no compensation has been decided by the authority in Schedule 'F' during the progress of work, this shall be no waiver of right to levy compensation by the said authority if the work remains incomplete on final justified extended date of completion. If the Engineer in Charge decides to give further extension of time allowing performance of work beyond the justified extended date, the contractor shall be liable to pay compensation for such extended period. If any variation in amount of contract takes place during such extended period beyond justified extended date and the contractor becomes entitled to additional time under clause 12, the net period for such variation shall be accounted for while deciding the period for levy of compensation. However, during such further extended period beyond the justified extended period, if any delay occurs by events under sub clause 5.2, the contractor shall be liable to pay compensation for such delay.

Provided that compensation during the progress of work before the justified extended date of completion for delay under this clause shall be for non-achievement of sectional completion or part handing over of work on stipulated/justified extended date for such part work or if delay affects any other works/services. This is without prejudice to right of action by the Engineer in Charge under clause 3 for delay in performance and claim of compensation under that clause.

In case action under clause 2 has not been finalized and the work has been determined under clause 3, the right of action under this clause shall remain post determination of contract but levy of compensation shall be for days the progress is behind the schedule on date of determination, as assessed by the authority in Schedule F, after due consideration of justified extension. The compensation for delay, if not decided before the determination of contract, shall be decided after of determination of contract.

The amount of compensation may be adjusted or set-off against any sum payable to the Contractor under this or any other contract with the HLL/Client. In case, the contractor does not achieve a particular milestone mentioned in schedule F, or the re-scheduled milestone(s) in terms of Clause 5.4, the amount shown against that milestone shall be withheld, to be adjusted against the compensation levied as above. With-holding of this amount on failure to achieve a milestone, shall be automatic without any notice to the contractor. However, if the contractor catches up with the progress of work on the subsequent milestone(s), the withheld amount shall be released. In case the contractor fails to make up for the delay in subsequent milestone(s), amount mentioned against each milestone missed subsequently also shall be withheld. However, no interest, whatsoever, shall be payable on such withheld amount.

CLAUSE 3 WHEN CONTRACT CAN BE DETERMINED

Subject to other provisions contained in this clause, the Engineer-in-Charge may, without prejudice to his any other rights or remedy against the contractor in respect of any delay, inferior workmanship, any claims for damages and/or any other provisions of this contract or otherwise, and whether the date of completion has or has not elapsed, by notice in writing absolutely determine the contract in any of the following cases:

(i) If the contractor having been given by the Engineer-in-Charge a notice in writing to rectify, reconstruct or replace any defective work or that the work is being performed in an inefficient or otherwise improper or un-workman like manner shall omit to comply with the requirement of such notice for a period of seven days thereafter.

(ii) If the contractor has, without reasonable cause, suspended the progress of the work or has failed to proceed with the work with due diligence and continues to do so after a notice in writing of seven days from the Engineer-in-Charge.

(iii) If the contractor fails to complete the work or section of work with individual date of completion on or before the stipulated or justified extended date, on or before such date of completion; and the Engineer in Charge without any prejudice to any other right or remedy under any other provision in the contract has given further reasonable time in a notice given in writing in that behalf as either mutually agreed or in absence of such mutual agreement by his own assessment making such time essence of contract and in the opinion of Engineer-in-Charge the contractor will be unable to complete the same or does not complete the same within the period specified.

(iv) If the contractor persistently neglects to carry out his obligations under the contract and/or commits default in complying with any of the terms and conditions of the contract and does not remedy it or take effective steps to remedy it within 7 days after a notice in writing is given to him in that behalf by the Engineer-in-Charge.

(v) If the contractor shall offer or give or agree to give to any person in Government service or to any other person on his behalf any gift or consideration of any kind as an inducement or reward for doing or forbearing to do or for having done or forborne to do any act in relation to the obtaining or execution of this or any other contract for Client/HLL .

(vi) If the contractor shall enter into a contract with Client/HLL in connection with which commission has been paid or agreed to be paid by him or to his knowledge, unless the particulars of any such commission and the terms of payment thereof have been previously disclosed in writing to the Engineer-in-Charge.

(vii) If the contractor shall obtain a contract with Client/HLL as a result of wrong tendering or other non-bonafide methods of competitive tendering or commits breach of integrity pact.

(viii) If the contractor being an individual, or if a firm, any partner thereof shall at any time be adjudged insolvent or have a receiving order or order for administration of his estate made against him or shall take any proceedings for liquidation or composition (other than a voluntary liquidation for the purpose of amalgamation or reconstruction) under any Insolvency Act for the time being in force or make any conveyance or assignment of his effects or composition or arrangement for the benefit of his creditors or purport so to do, or if any application be made under any Insolvency Act for the time being in force for the sequestration of his estate or if a trust deed be executed by him for benefit of his creditors.

(ix) If the contractor being a company shall pass a resolution or the court shall make an order that the company shall be wound up or if a receiver or a manager on behalf of a creditor shall be appointed or if circumstances shall arise which entitle the court or the creditor to appoint a receiver or a manager or which entitle the court to make a winding up order.

(x) If the contractor shall suffer an execution being levied on his goods and allow it to be continued for a period of 21 days.

(xi) If the contractor assigns (excluding part(s) of work assigned to other agency(s) by the contractor as per terms of contract), transfers, sublets (engagement of labour on a piece-work basis or of labour with materials not to be incorporated in the work, shall not be deemed to be subletting) or otherwise parts with or attempts to assign, transfer, sublet or

otherwise parts with the entire works or any portion thereof without the prior written approval of the Engineer -in-Charge.

When the contractor has made himself liable for action under any of the cases aforesaid, the Engineer-in-Charge on behalf of the Client/ HLL shall have powers:

(a) To determine the contract as aforesaid so far as performance of work by the Contractor is concerned (of which determination notice in writing to the contractor under the hand of the Engineer-in-Charge shall be conclusive evidence). Upon such determination, the Earnest Money Deposit, Security Deposit already recovered and Performance Guarantee under the contract shall be liable to be forfeited and shall be absolutely at the disposal of the Client/HLL.

(b) After giving notice to the contractor to measure up the work of the contractor and to take such whole, or the balance or part thereof, as shall be un-executed out of his hands and to give it to another contractor to complete the work. The contractor, whose contract is determined as above, shall not be allowed to participate in the tendering process for the balance work.

In the event of above courses being adopted by the Engineer-in-Charge, the contractor shall have no claim to compensation for any loss sustained by him by reasons of his having purchased or procured any materials or entered into any engagements or made any advances on account or with a view to the execution of the work or the performance of the contract. And in case action is taken under any of the provision aforesaid, the contractor shall not be entitled to recover or be paid any sum for any work thereof or actually performed under this contract unless and until the Engineer-in-Charge has certified in writing the performance of such work and the value payable in respect thereof and he shall only be entitled to be paid the value so certified.

CLAUSE 3A

In case, the work cannot be started due to reasons not within the control of the contractor within 1/8th of the stipulated time for completion of work or one month whichever is higher, either party may close the contract by giving notice to the other party stating the reasons. In such eventuality, the Performance Guarantee of the contractor shall be refunded within 30 days.

Neither party shall claim any compensation for such eventuality. This clause is not applicable for any breach of the contract by either party.

CLAUSE 4 CONTRACTOR LIABLE TO PAY COMPENSATION EVEN IF ACTION NOT TAKEN UNDER CLAUSE 3

In any case in which any of the powers conferred upon the Engineer-in-Charge by Clause-3 thereof, shall have become exercisable and the same are not exercised, the non-exercise thereof shall not constitute a waiver of any of the conditions hereof and such powers shall notwithstanding be exercisable in the event of any future case of default by the contractor and the liability of the contractor for compensation shall remain unaffected. In the event of the Engineer-in-Charge putting in force all or any of the power vested in him under the preceding clause he may, if he so desires after giving a notice in writing to the contractor, take possession of (or at the sole discretion of the Engineer-in-Charge which shall be final and binding on the contractor) use as on hire (the amount of the hire money being also in the final determination of the Engineer-in-Charge) all or any tools, plant, materials and stores, in or upon the works, or the site thereof belonging to the contractor, or procured by the contractor and intended to be used for the execution of the work/or any part thereof, paying or allowing for the same in account at the contract rates, or, in the case of these not being applicable, at current market rates to be certified by the Engineer-in-Charge, whose certificate thereof shall be final, and binding on the contractor, clerk of the works, foreman or other authorized agent to remove such tools, plant, materials, or stores

from the premises (within a time to be specified in such notice) in the event of the contractor failing to comply with any such requisition, the Engineer-in-Charge may remove them at the contractor's expense or sell them by auction or private sale on account of the contractor and his risk in all respects and the certificate of the Engineer-in-Charge as to the expenses of any such removal and the amount of the proceeds and expenses of any such sale shall be final and conclusive against the contractor.

CLAUSE 5 TIME AND EXTENSION FOR DELAY

The time allowed for execution of the Works as specified in the Schedule 'F' or the extended time in accordance with these conditions shall be the essence of the Contract. The execution of the work shall commence from such time period as mentioned in schedule 'F' or from the date of handing over of the site, notified by the Engineer-in-Charge, whichever is later. If the Contractor commits default in commencing the execution of the work as aforesaid, the performance guarantee shall be forfeited by the Engineer in Charge and shall be absolutely at the disposal of the Client/HLL without prejudice to any other right or remedy available in law.

5.1 As soon as possible but within Thirty days of award of work and in consideration of Schedule of handing over of site as specified in the Schedule 'F'

(i) The Contractor shall submit a Time and Progress Chart for each mile stone. The Engineer-in-Charge may within 30 days thereafter, if required modify, and communicate the program approved to the contractor failing which the program submitted by the contractor shall be deemed to be approved by the Engineer-in-Charge. The work programme shall include all required details w.r.t. designs, drawings and documents to be made available by the Contractor. The Chart shall be prepared in direct relation to the time stated in the Contract documents for completion of the works. It shall indicate the forecast of the dates of commencement and completion of various trades of sections of the work and may be amended as necessary by agreement between the Engineer-in-Charge and the Contractor within the limitations of time imposed in the Contract documents.

(ii) In case of non-submission of construction programme by the contractor the program approved by the Engineer-in-Charge shall be deemed to be final.

(iii) The approval by the Engineer-in-Charge of such programme shall not relieve the contractor of any of the obligations under the contract.

(iv) The contractor shall submit the Time and Progress Chart and progress report using the mutually agreed software or in other format decided by Engineer-in-Charge for the work done during previous month to the Engineer-in-charge on or before 5th day of each month failing which a recovery Rs. 5000/- shall be made on per week or part basis in case of delay in submission of the monthly progress report.

5.2 If the work(s) be delayed by:-

i. force majeure, or

ii. abnormally bad weather, or

iii. serious loss or damage by fire, or

iv. civil commotion, local commotion of workmen, strike or lockout, affecting any of the trades employed on the work, or

v. delay on the part of other contractors or tradesmen engaged by Engineer-in-Charge in executing work not forming part of the Contract, or

vi. any other cause like above which, in the reasoned opinion of the Engineer-in-Charge is beyond the Contractor's control.

then upon the happening of any such event causing delay, the Contractor shall immediately give notice thereof in writing to the Engineer-in-Charge for entry in the physical hindrance

register but shall nevertheless use constantly his best endeavours to prevent or make good the delay and shall do all that may be reasonably required to the satisfaction of the Engineer-in-Charge to proceed with the works.

The contractor shall have no claim of damages for extension of time granted or rescheduling of milestone/s for events listed in sub clause 5.2.

5.3 In case the work is hindered by any reasons, in the opinion of the contractor, by the Department or for someone for whose action the Department is responsible, the contractor may immediately give notice thereof in writing to the Engineer-in-Charge in the same manner as prescribed under sub Clause 5.2 seeking extension of time or rescheduling of milestone/s. The authority as indicated in Schedule 'F' shall, if justified, give a fair and reasonable extension of time and reschedule the mile stones for completion of work after due consideration of the same within 30 days of receipt of such request. In event of non-application by the contractor for extension of time E-in-C after affording opportunity to the contractor may give, supported with a programme, a fair and reasonable extension within a reasonable period of occurrence of the event.

Such extension of time or rescheduling of milestone/s shall be without prejudice to any other right or remedy of the parties in contract or in law; provided further that for concurrent delays under this sub clause and sub clause 5.2 to the extent the delay is covered under sub clause 5.2 the contractor shall be entitled to only extension of time and no damages.

5.4 Request for rescheduling of Mile stones or extension of time, to be eligible for consideration, shall be made by the Contractor in writing within fourteen days of the happening of the event causing delay on the prescribed forms i.e. Form of application by the contractor for seeking rescheduling of milestones (Appendix-XVI) or Form of application by the contractor for seeking extension of time (Appendix –XVII) respectively to the authority as indicated in Schedule 'F'. The Contractor shall indicate in such a request the period by which rescheduling of milestone/s or extension of time is desired.

With every request for rescheduling of milestones, or if at any time the actual progress of work falls behind the approved programme by more than 10% of the stipulated period of completion of contract, the contractor shall produce a revised programme along with all required designs, drawings and documents pending and are to be made available by the contractor without causing any delay in execution of the work. It shall also include decisions required from Client/HLL to complete the contract. A recovery @ Rs. 5,000/- per day shall be made on per day basis in case of delay in submission of the revised programme.

5.4.1 In any such case the authority as indicated in Schedule 'F' may give a fair and reasonable extension of time for completion of work or reschedule the mile stones. Such extension or rescheduling of the milestones shall be communicated to the Contractor by the authority as indicated in Schedule 'F' in writing, within 30 days of the date of receipt of such request from the Contractor in prescribed form. In event of non-application by the contractor for extension of time Engineer–in-Charge after affording opportunity to the contractor may give, supported with a programme (as specified under 5.4 above), a fair and reasonable extension within a reasonable period of occurrence of the event.

5.5 In case the work is delayed by any reasons, in the opinion of the Engineer-in-Charge, by the contractor for reasons beyond the events mentioned in clause 5.2 or clause 5.3 or clause 5.4 and beyond the justified extended date; without prejudice to right to take action under Clause 3, the Engineer-in-Charge may grant extension of time required for completion of work without rescheduling of milestones. The contractor shall be liable for levy of compensation for delay for such extension of time.

CLAUSE 6 COMPUTERIZED MEASUREMENT BOOK

Engineer-in-Charge shall, except as otherwise provided, ascertain and determine by measurement the value of work done in accordance with the contract.

All measurements as per the stage payments, mentioned in the tender documents, having financial value shall be entered by the contractor and compiled in the shape of the Computerized Measurement Book having pages of A-4 size as per the format of the department so that a complete record is obtained of all the stages of works performed under the contract.

All such measurements recorded by the contractor or his authorized representative from time to time, during the progress of the work, shall be got checked by the contractor from the Engineer-in-Charge or his authorized representative as per interval or program fixed in consultation with Engineer-in-Charge or his authorized representative. After the necessary corrections made by the Engineer-in-Charge, the measurement sheets shall be returned to the contractor for incorporating the corrections and for resubmission to the Engineer-in- Charge for the dated signatures by the Engineer-in- Charge and the contractor or their representatives in token of their acceptance.

Whenever bill is due for payment, the contractor would initially submit draft computerized measurement sheets and these measurements would be got checked/test checked from the Engineer-in-Charge and/or his authorized representative. The contractor will, thereafter, incorporate such changes as may be done during these checks/test checks in his draft computerized measurements, and submit to the department a computerized measurement book, duly bound, and with its pages machine numbered. The Engineer-in- Charge and/or his authorized representative would thereafter check this MB, and record the necessary certificates for their checks/ test checks.

The final, fair, computerized measurement book given by the contractor, duly bound, with its pages machine numbered, should be 100% correct, and no cutting or over-writing in the measurements would thereafter be allowed. If at all any error is noticed, the contractor shall have to submit a fresh computerized MB with its pages duly machine numbered and bound, after getting the earlier MB cancelled by the Client/HLL. Thereafter, the MB shall be taken in the HLL records, and allotted a number as per the Register of Computerized MBs. This should be done before the corresponding bill is submitted to the Engineer-In-Charge for payment. The contractor shall submit two spare copies of such computerized MB's for the purpose of reference and record by the various officers of the Client/HLL.

The contractor shall also submit to the Engineer-In-Charge separately his computerized Abstract of Cost and the bill based on these measurements, duly bound, and its pages machine numbered along with two spare copies of the "bill. Thereafter, this bill will be processed by the Engineer-In-Charge and allotted a number as per the computerized record in the same way as done for the measurement book meant for measurements.

The contractor shall, without extra charge, provide all assistance with every appliance, labour and other things necessary for checking of measurements/by the Engineer-in- Charge or his representative.

Except where any general or detailed description of the work expressly shows to the contrary, measurements shall be taken in accordance with the procedure set forth in the contract notwithstanding any provision in the relevant Standard Method of measurement or any general or local custom.

The contractor shall give not less than seven days' notice to the Engineer-in-Charge or his authorized representative in charge of the work before covering up or otherwise placing beyond the reach of checking and/or test checking the measurement of any work in order that the same may be checked and/or test checked and correct dimensions thereof be taken before the same is covered up or placed beyond the reach of checking and/or test checking measurement and shall not cover up and place beyond reach of measurement any work without consent in writing of the Engineer-in-Charge or his authorized representative in charge of the work who shall within the

aforesaid period of seven days inspect the work, and if any work shall be covered up or placed beyond the reach of checking and/or test checking measurements without such notice having been given or the Engineer-in- Charge's consent being obtained in writing the same shall be uncovered at the Contractor's expense, or in default thereof no payment or allowance shall be made for such work or the materials with which the same was executed.

Engineer-in-Charge or his authorized representative may cause either themselves or through another officer of the department to check the measurements recorded by contractor and all provisions stipulated herein above shall be applicable to such checking of measurements or levels.

It is also a term of this contract that checking and/or test checking the measurements of any item of work in the measurement book and/or its payment in the interim, on account of final bill shall not be considered as conclusive evidence as to the sufficiency of any work or material to which it relates nor shall it relieve the contractor from liabilities from any over measurement or defects noticed till completion of the defects liability period.

CLAUSE 7 PAYMENT ON INTERMEDIATE CERTIFICATE TO BE REGARDED AS ADVANCES

The running account bills shall be submitted by the contractor for the work executed on the basis of such recorded measurements on the format of the Client/HLL in triplicate on or before the date of every month fixed for the same by the Engineer-in-Charge. The contractor shall not be entitled to be paid any such interim payment if the gross work done together with net payment/ adjustment of advances for material collected, if any, since the last such payment is less than the amount specified in Schedule 'F', in which case the interim bill shall be prepared on the appointed date of the month after the requisite progress is achieved. Engineer-in-Charge shall arrange to have the bill verified by taking or causing to be taken, where necessary, the requisite measurements of the work. In the event of the failure of the contractor to submit the bills, no claims whatsoever due to delays on payment including that of interest shall be payable to the contractor. Payment on account of amount admissible shall be made by the Engineer-in-Charge certifying the sum to which the contractor is considered entitled by way of interim payment at such rates as decided by the Engineer-in-Charge. The amount admissible shall be paid within thirty working days after the day of presentation of the bill by the Contractor to the Engineer-in-Charge together with the account of the material issued by the department, or dismantled materials, if any. In the case of works outside the headquarters of the Engineer- in-Charge, the period of thirty working days will be extended to forty five working days.

All such interim payments shall be regarded as payment by way of advances against final payment only and shall not preclude the requiring of bad, unsound and imperfect or unskilled work to be rejected, removed, taken away and reconstructed or re-erected. Any certificate given by the Engineer-in-Charge relating to the work done or materials delivered forming part of such payment, may be modified or corrected by any subsequent such certificate(s) or by the final certificate and shall not by itself be conclusive evidence that any work or materials to which it relates is/are in accordance with the contract and specifications. Any such interim payment, or any part thereof shall not in any respect conclude, determine or affect in any way powers of the Engineer-in-Charge under the contract or any of such payments be treated as final settlement and adjustment of accounts or in any way vary or affect the contract.

Pending consideration of extension of date of completion, interim payments shall continue to be made as herein provided without prejudice to the right of the department to take action under the terms of this contract for delay in the completion of work, if the extension of date of completion is not granted by the competent authority.

In case main contractor fails to make the payment to the contractor associated by him within15 days of receipt of each running account payment, then on the written complaint of contractor associated for such minor component, Engineer in charge of minor component shall serve the show

cause to the main contractor and if reply of main contractor either not received or found unsatisfactory, he may make the payment directly to the contractor associated for minor component as per the terms and conditions of the agreement drawn between main contractor and associate contractor fixed by him. Such payment made to the associate contractor shall be recovered by Engineer-in-charge of major or minor component from the next RA/ final bill due to main contractor as the case may be.

The Engineer-in-Charge in his sole discretion on the basis of a certificate from his authorized representative in-charge of the work at site to the effect that the work has been completed up to the level in question make interim advance payments without detailed measurements for work done working out at 75% of the assessed value. The advance payments so allowed shall be adjusted in the subsequent interim bill by taking detailed measurements thereof.

CLAUSE 7A

No running account bill shall be paid for the work till the applicable labour licenses, registration with EPFO, ESIC and BOCW Welfare Board, whatever applicable, are submitted by the contractor to the Engineer-in-charge.

The Contractor shall also ensure the compliance of EPF & MP Act, 1952 by the sub-contractors, if any, engaged by contractor for above said work.

The contractor shall submit affidavit to indemnify and save harmless the Client / HLL and against all actions, suits, proceedings, losses, costs, damages, charges, claims and demands of every nature and description brought or recovered against the Client/HLL by reasons of any act or omission of the Contractor, his agents or employees in connection with complying the provisions of the Employees Provident Fund & Miscellaneous Provisions Act, 1952 as amended from time to time. All sums payable by way of compensation/ penalty/ damages/ interest on the outstanding amounts payable by the contractor shall be considered as reasonable and be payable by the contractor to the Client/HLL immediately and if the contractor does not pay the amount immediately the same will be deducted from security deposit or earnest money or any other amount available with the Client/HLL or any money payable to the Contractor by the Client/HLL.

Contractor should submit a Compliance Certificate as per the proforma (Appendix-XIX) mentioned in every bill as per the provisions of the EPF and ESI Act as amended from time to time.

Clause 7B Opening of Separate Bank Account for the Project:

The Contractor shall maintain a separate account with a Scheduled Bank for the purpose of receiving all the payments under the Contract and for Utilization of payments received from the Client/HLL for the disbursement to sub-contractors, sub-vendors, PRW's suppliers etc. for this contract. The Contractor shall maintain separate books of account for all payments under this contract and the Engineer-in-Charge shall access to it at all times.

For tracking of utilization of funds received from the Client/HLL, the contractor shall submit a monthly statement by 7th of every month to the Engineer-in-Charge certifying the transactions pertaining to the above account along with Purpose of such transactions.

In case the Contractor wants to withdraw funds from the above bank account for any purpose other than the Contract, he shall be required to submit an undertaking to the Engineer-in-Charge certifying that all due statutory payments, labour payments and payments to all his sub-contractors/ vendors have been disbursed by him corresponding to the total payment received under the contract.

CLAUSE 8 COMPLETION CERTIFICATE AND COMPLETION PLANS

Within ten days of the completion of the work, the contractor shall give notice of such completion to the Engineer-in-Charge and within thirty days of the receipt of such notice, the Engineer-in-Charge shall inspect the work and if there is no defect in the work, shall furnish the contractor with a final certificate of completion, otherwise a provisional certificate of physical completion indicating defects (a) to be rectified by the contractor and/or (b) for which payment will be made at reduced rates, shall be issued. But no final certificate of completion shall be issued, nor shall the work be considered to be complete until the contractor shall have removed from the premises on which the work shall be executed all scaffolding, surplus materials, rubbish and all huts and sanitary arrangements required for his/their work people on the site in connection with the execution of the works as shall have been erected or constructed by the contractor(s) and cleaned off the dirt from all wood work, doors, windows, walls, floor or other parts of the building, in, upon, or about which the work is to be executed or of which he may have had possession for the purpose of the execution; thereof, and not until the work shall have been measured by the Engineer-in-Charge. If the contractor shall fail to comply with the requirements of this Clause as to removal of scaffolding, surplus materials and rubbish and all huts and sanitary arrangements as aforesaid and cleaning off dirt on or before the date fixed for the completion of work, the Engineer-in-Charge may at the expense of the contractor remove such scaffolding, surplus materials and rubbish etc., and dispose of the same as he thinks fit and clean off such dirt as aforesaid, and the contractor shall have no claim in respect of scaffolding or surplus materials as aforesaid except for any sum actually realized by the sale thereof.

CLAUSE 8A COMPLETION DOCUMENTS TO BE SUBMITTED BY THE CONTRACTOR

The contractor shall submit all required designs, drawings including completion plans for internal and external civil, electrical, mechanical and other services, details and documents, manuals etc, as per requirements for all components of works within thirty days of the completion of the work. In case, the contractor fails to submit the same as aforesaid, he shall be liable to pay a sum of 0.10 % (Zero point One Percent) of accepted Tendered Value and in this respect the decision of the Engineer-in-Charge shall be final and binding on the contractor.

CLAUSE 9 PAYMENT OF FINAL BILL

The final bill shall be submitted by the contractor, along with all supporting documents, in the same manner as specified in interim bills within three months of physical completion of the work or within one month of the date of the final certificate of completion furnished by the Engineer-in-Charge whichever is earlier. No further claims shall be made by the contractor after submission of the final bill and these shall be deemed to have been waived and extinguished. Payments of those items of the bill in respect of which there is no dispute and of items in dispute, for quantities and rates as approved by Engineer-in-Charge, will, as far as possible be made within 6 months period, period being reckoned from the date of receipt of the bill by the Engineer-in-Charge or his authorized Engineer, complete with all supporting documents, account of materials issued by the Department and dismantled materials.

CLAUSE 9A PAYMENT OF CONTRACTOR'S BILLS TO BANKS

Payments due to the contractor may, if so desired by him, be made to his bank, registered financial, co-operative or thrift societies or recognized financial institutions instead of direct to him provided that the contractor furnishes to the Engineer-in-Charge (1) an authorization in the form of a legally valid document such as a power of attorney conferring authority on the bank; registered financial, co-operative or thrift societies or recognized financial institutions to receive payments and (2) his own acceptance of the correctness of the amount made out as being due to him by Client/HLL or his signature on the bill or other claim preferred against Client/HLL before settlement by the Engineer-in-Charge of the account or claim by payment to the bank, registered

financial, co-operative or thrift societies or recognized financial institutions. While the receipt given by such banks; registered financial, co-operative or thrift societies or recognized financial institutions shall constitute a full and sufficient discharge for the payment, the contractor shall whenever possible present his bills duly receipted and discharged through his bank, registered financial, co-operative or thrift societies or recognized financial institutions.

Nothing herein contained shall operate to create in favour of the bank; registered financial, co-operative or thrift societies or recognized financial institutions any rights or equities vis- a-vis the Client/HLL.

CLAUSE 10A MATERIALS TO BE PROVIDED BY THE CONTRACTOR

The contractor shall, at his own expense, provide all materials, required for the works. The contractor shall, at his own expense and without delay, supply to the Engineer-in- Charge samples of materials to be used on the work and shall get these approved in advance. All such materials to be provided by the Contractor shall be in conformity with the specifications laid down or referred to in the contract. The contractor shall, if requested by the Engineer-in-Charge furnish proof, to the satisfaction of the Engineer-in-Charge that the materials so comply. The Engineer-in-Charge shall within thirty days of supply of samples or within such further period as he may require intimate to the Contractor in writing whether samples are approved by him or not. If samples are not approved, the Contractor shall forthwith arrange to supply to the Engineer-in-Charge for his approval, fresh samples complying with the specifications laid down in the contract. When materials are required to be tested in accordance with specifications, approval of the Engineer-in-Charge shall be issued after the test results are received.

The Contractor shall at his risk and cost submit the samples of materials to be tested or analyzed and shall not make use of or incorporate in the work any materials represented by the samples until the required tests or analysis have been made and materials finally accepted by the Engineer-in-Charge. The Contractor shall not be eligible for any claim or compensation either arising out of any delay in the work or due to any corrective measures required to be taken on account of and as a result of testing of materials.

The contractor shall, at his risk and cost, make all arrangements and shall provide all facilities as the Engineer-in-Charge may require for collecting, and preparing the required number of samples for such tests at such time and to such place or places as may be directed by the Engineer-in-Charge and bear all charges and cost of testing unless specifically provided for otherwise elsewhere in the contract or specifications. The Engineer- in-Charge or his authorized representative shall at all times have access to the works and to all workshops and places where work is being prepared or from where materials manufactured articles or machinery are being obtained for the works and the contractor shall afford every facility and every assistance in obtaining the right to such access.

The Engineer-in-Charge shall have full powers to require the removal from the premises of all materials which in his opinion are not in accordance with the specifications and in case of default, the Engineer-in-Charge shall be at liberty to employ at the expense of the contractor, other persons to remove the same without being answerable or accountable for any loss or damage that may happen or arise to such materials. The Engineer-in-Charge shall also have full powers to require other proper materials to be substituted thereof and in case of default, the Engineer-in-Charge may cause the same to be supplied and all costs which may attend such removal and substitution shall be borne by the Contractor.

The contractor shall, at his own expense, provide a material testing lab at the site for conducting routine field tests. The lab shall be equipped at least with the testing equipment as specified in schedule F.

CLAUSE 10B

(i) SECURED ADVANCE ON NON-PERISHABLE MATERIAL

The contractor, on signing an indenture in the form in Appendix-XX by the Engineer-in-Charge, shall be entitled to be paid during the progress of the execution of the work up to 75% of the assessed value of any materials which are in the opinion of the Engineer-in-Charge non-perishable, non-fragile and non-combustible and are in accordance with the contract and which have been brought on the site in connection therewith and are adequately stored and/or protected against damage by weather or other causes but which have not at the time of advance been incorporated in the works. When materials on account of which an advance has been made under this sub-clause are incorporated in the work, the amount of such advance shall be recovered/ deducted from the next payment made under any of the clause or clauses of this contract.

Such secured advance shall also be payable on other items of perishable nature, fragile and combustible with the approval of the Engineer-in-Charge provided the contractor provides a comprehensive insurance cover for the full cost of such materials. The decision of the Engineer- in-Charge shall be final and binding on the contractor in this matter. No secured advance, shall however, be paid on high-risk materials such as ordinary glass, sand, petrol, diesel etc.

(ii) MOBILISATION ADVANCE

Mobilization advance not exceeding 10% of the tendered value may be given, if requested by the contractor in writing within two months of the order to commence the work. Such advance shall be in two or more installments to be determined by the Engineer-in-Charge at his sole discretion. The first installment of such advance shall be released by the Engineer-in-charge to the contractor on a request made by the contractor to the Engineer- in-Charge in this behalf. The second and subsequent installments shall be released by the Engineer- in- Charge only after the contractor furnishes a proof of the satisfactory utilization of the earlier installment to the entire satisfaction of the Engineer-in-Charge.

Before any installment of advance is released, the contractor shall execute a Bank guarantee Bond from scheduled Bank for the amount equal to 110% of the amount of advance valid for the Contract Period. This (Bank Guarantee from Scheduled Bank for the amount equal to 110% of the balance amount of advance) shall be kept renewed from time to time to cover the balance amount and likely period of complete recovery, together with interest. The total number of bank guarantees, which shall be submitted by the contractor, shall be restricted to six numbers only.

Provided always that provision of Clause 10 B (ii) shall be applicable only when so provided in 'Schedule F'.

(iii) Interest & Recovery

The mobilization advance and plant and machinery advance in (ii) above bear simple interest at the rate of 10 percent per annum and shall be calculated from the date of payment to the date of recovery, both days inclusive, on the outstanding amount of advance. Recovery of such sums advanced shall be made by the deduction from the contractors bills commencing after first ten percent of the gross value of the work is executed and paid, on pro-rata percentage basis to the gross value of the work billed beyond 10% in such a way that the entire advance is recovered by the time eighty percent of the gross value of the contract is executed and paid, together with interest due on the entire outstanding amount up to the date of recovery of the installment.

If the circumstances are considered reasonable by the Engineer- in-Charge, the period mentioned in (ii) for request by the contractor in writing for grant of mobilization advance and plant and equipment advance may be extended at the discretion of the Engineer-in-Charge.

CLAUSE 10C, 10CA, 10CC ESCALATIONS

No escalation shall be applicable on this contract. The Price quoted by contractor shall be firm and fixed for entire contract period as well as extended period for completion of the works.

CLAUSE 10 D DISMANTLED MATERIAL GOVT. PROPERTY

The contractor shall treat all materials obtained during dismantling of a structure, excavation of the site for a work, etc. as Government/ Client/ HLL's property and such materials shall be disposed off to the best advantage of Government/ Client/ HLL according to the instructions in writing issued by the Engineer-in-Charge. However, nothing extra shall be payable to the contractor in this regard.

CLAUSE 11 WORK TO BE EXECUTED IN ACCORDANCE WITH SPECIFICATIONS, DRAWINGS, ORDERS ETC.

The contractor shall execute the whole and every part of the work in the most substantial and workmanlike manner both as regards materials and otherwise in every respect in strict accordance with the specifications. The contractor shall also conform exactly, fully and faithfully to the design, drawings and instructions in writing in respect of the work signed by the Engineer-in-Charge and the contractor shall be furnished free of charge one copy of the contract documents. Any other specifications, including latest standard specifications of Central Public Works Department (CPWD) or in any Bureau of Indian Standard or any other, published standard or codes, Schedule of Rates and/or any other printed publication referred to elsewhere in the contract, designs, drawings and instructions as referred to in contract document, but not included in the contract document, are a part of contract documents.

The contractor shall comply with the provisions of the contract and with the care and diligence execute and maintain the works and provide all labour and materials, tools and plants including for measurements and supervision of all works, structural plans and other things of temporary or permanent nature required for such execution and maintenance in so far as the necessity for providing these, is specified or is reasonably inferred from the contract. The Contractor shall take full responsibility for adequacy, suitability and safety of all the works and methods of construction.

CLAUSE 12 DEVIATIONS/ VARIATIONS EXTENT AND PRICING

The Engineer-in-Charge shall have power (i) to make alteration in, omissions from, additions to, or substitutions for the original specifications, drawings, designs and instructions that may appear to him to be necessary or advisable during the progress of the work, and (ii) to omit a part of the works in case of non-availability of a portion of the site or for any other reasons and the contractor shall be bound to carry out the works in accordance with any instructions given to him in writing signed by the Engineer-in-Charge and such alterations, omissions, additions or substitutions shall form part of the contract as if originally provided therein and any altered, additional or substituted work which the contractor may be directed to do in the manner specified above as part of the works, shall be carried out by the contractor on the same conditions in all respects including price on which he agreed to do the main work except as hereunder provided.

12.1

The time for completion of the works shall, in the event of any deviations resulting in additional cost over the tendered value sum being ordered, be extended, if requested by the contractor, as follows:

(i) In the proportion which the additional cost of the altered, additional or substituted work, bears to the original tendered value plus

(ii) 25% of the time calculated in (i) above or such further additional time as may be considered reasonable by the Engineer-in-Charge.

12.2 Extra and Substituted Items

In case of any change in approved drawings given by the Client/HLL and forming part of the Contract, if there are any deviation in the items the contractor may within fifteen days of receipt of order from Engineer in Charge claim the rates, supported by proper analysis for the items the Engineer-in- Charge shall within prescribed time limit of receipt of the claims supported by analysis, after giving consideration to the analysis of the rates submitted by the contractor, determine the rates on the basis of the market rates of both of extra items or original and substituted items as the case may be (as per invoice, vouchers from the manufacturers or suppliers submitted by the agency and duly verified by Engineer in Charge or his representative and the contractor shall be paid in accordance with the rates so determined.

CLAUSE 13 FORECLOSURE OF CONTRACT DUE TO ABANDONMENT OR REDUCTION IN SCOPE OF WORK

If at any time after acceptance of the tender or during the progress of work, the purpose or object for which the work is being done changes due to any supervening cause and as a result of which the work has to be abandoned or reduced in scope the Engineer-in-Charge shall give notice in writing to that effect to the contractor stating the decision as well as the cause for such decision and the contractor shall act accordingly in the matter. The contractor shall have no claim to any payment of compensation or otherwise whatsoever, on account of any profit or advantage which he might have derived from the execution of the works in full but which he did not derive in consequence of the foreclosure of the whole or part of the works.

The contractor shall be paid at contract rates, full amount for works executed at site and, in addition, a reasonable amount as certified by the Engineer-in-Charge for the items hereunder mentioned which could not be utilized on the work to the full extent in view of the foreclosure;

(i) Any expenditure incurred on preliminary site work, e.g. temporary access roads, temporary labour huts, staff quarters and site office; storage accommodation and water storage tanks.

(ii) Client/HLL shall have the option to take over contractor's materials or any part thereof either brought to site or of which the contractor is legally bound to accept delivery from suppliers (for incorporation in or incidental to the work) provided, however Client/HLL shall be bound to take over the materials or such portions thereof as the contractor does not desire to retain. For materials taken over or to be taken over by Client/HLL, cost of such materials as detailed by Engineer-in- Charge shall be paid. The cost shall, however, take into account purchase price, cost of transportation and deterioration or damage which may have been caused to materials whilst in the custody of the contractor.

(iii) Reasonable compensation for transfer of T & P from site to contractor's permanent stores or to his other works, whichever is less. If T & P are not transported to either of the said places, no cost of transportation shall be payable.

(iv) Reasonable compensation for repatriation of contractor's site staff and imported labour to the extent necessary.

The contractor shall, if required by the Engineer- in-Charge, furnish to him, books of account, wage books, time sheets and other relevant documents and evidence as may be necessary to enable him to certify the reasonable amount payable under this condition.

The reasonable amount of items on (i), (iii) and (iv) above shall not be in excess of 2% of the cost of the work remaining incomplete on the date of closure, i.e. total stipulated cost of the work as per accepted tender less the cost of work actually executed under the contract and less the cost of contractor's materials at site taken over by the Client/HLL as per item (ii) above. Provided always that against any payments due to the contractor on this account or otherwise, the Engineer-in-Charge shall be entitled to recover or be credited with any outstanding balances due from the contractor for advance paid in respect of any tool, plants and materials and any other sums which at the date of termination were recoverable by the Client/HLL from the contractor under the terms of the contract.

In the event of action being taken under Clause 13 to reduce the scope of work, the contractor may furnish fresh Performance Guarantee on the same conditions, in the same manner and at the same rate for the balance tendered amount and initially valid up to the extended date of completion or stipulated date of completion if no extension has been granted plus 60 days beyond that. Wherever such a fresh Performance Guarantee is furnished by the contractor the Engineer-in-Charge may return the previous Performance Guarantee.

CLAUSE 14 PRE- CONSTRUCTION ACTIVITIES

The data supplied by the Client/HLL, if any, are for General Guidance only. The contractor shall be responsible for carrying out pre- construction activities for construction of work as defined in the tender documents. The contractor shall also carry out site investigations to verify site details / Data at his own cost.

CLAUSE 15 SUSPENSION OF WORK

(i) The contractor shall, on receipt of the order in writing of the Engineer-in-Charge, (whose decision shall be final and binding on the contractor) suspend the progress of the works or any part thereof for such time and in such manner as the Engineer-in-Charge may consider necessary so as not to cause any damage or injury to the work already done or endanger the safety thereof for any of the following reasons:

(a) on account of any default on the part of the contractor or;

(b) for proper execution of the works or part thereof for reasons other than the default of the contractor; or

(c) for safety of the works or part thereof.

The contractor shall, during such suspension, properly protect and secure the works to the extent necessary and carry out the instructions given in that behalf by the Engineer- in-Charge.

(ii) If the suspension is ordered for reasons (b) and (c) in sub-para (i) above:

(a) the contractor shall be entitled to an extension of time equal to the period of every such suspension PLUS 25%, for completion of the item or group of items of work for which a separate period of completion is specified in the contract and of which the suspended work forms a part, and;

(b) If the total period of all such suspensions in respect of an item or group of items or work for which a separate period of completion is specified in the contract exceeds thirty days, the contractor shall, in addition, be entitled to such compensation as the Engineer-in-Charge may consider reasonable in respect of salaries and/or wages paid by the contractor to his employees and labour at site, remaining idle during the period of suspension, adding thereto 2% to cover indirect expenses of the contractor provided the contractor submits his claim supported by details to the Engineer-in-Charge within fifteen days of the expiry of the period of 30 days.

(iii) If the works or part thereof is suspended on the orders of the Engineer-in-Charge for more than three months at a time, except when suspension is ordered for reason (a) in sub-para (i) above, the contractor may after receipt of such order serve a written notice on the Engineer-in-Charge requiring permission within fifteen days from receipt by the Engineer-in-Charge of the said notice, to proceed with the work or part thereof in regard to which progress has been suspended and if such permission is not granted within that time, the contractor, if he intends to treat the suspension, where it affects only a part of the works as an omission of such part by Client/HLL or where it affects whole of the works, as an abandonment of the works by Client/HLL , shall within ten days of expiry of such period of 15 days give notice in writing of his intention to the Engineer-in-Charge. In the event of the contractor treating the suspension as an abandonment of the contract by Client/HLL , he shall have no claim to payment of any compensation on account of any profit or advantage which he might have derived from the execution of the work in full but which he could not derive in consequence of the abandonment. He shall, however, be entitled to such compensation, as the Engineer-in-Charge may consider reasonable, in respect of salaries and/or wages paid by him to his employees and labour at site, remaining idle in consequence adding to the total thereof 2% to cover indirect expenses of the contractor provided the contractor submits his claim supported by details to the Engineer-in-Charge within 30 days of the expiry of the period of 3 months.

CLAUSE 16 ACTION IN CASE WORK NOT DONE AS PER SPECIFICATIONS

All works under or in course of execution or executed in pursuance of the contract, shall at all times be open and accessible to the inspection and supervision of the Engineer-in- charge, his authorized subordinates in charge of the work and all the superior officers, officer of the Quality Assurance Unit of the Department or any organization engaged by the Department for Quality Assurance and of the Chief Technical Examiner's Office, and the contractor shall, at all times, during the usual working hours and at all other times at which reasonable notice of the visit of during the usual working hours and at all other times at which reasonable notice of the visit of such officers has been given to the contractor, either himself be present to receive orders and instructions or have a responsible agent duly accredited in writing, present for that purpose. Orders given to the Contractor's agent shall be considered to have the same force as if they had been given to the contractor himself.

If it shall appear to the Engineer-in-charge or his authorized subordinates in-charge of the work or to the Officer in charge of Quality Assurance or his subordinate officers or the officers of the organization engaged by the Department for Quality Assurance or to the Chief Technical Examiner or his subordinate officers, that any work has been executed with unsound, imperfect, or unskillful workmanship, or with materials or articles provided by him for the execution of the work which are unsound or of a quality inferior to that contracted or otherwise not in accordance with the contract, the contractor shall, on demand in writing which shall be made within twelve months (six months in the case of work costing Rs. 10 Lac and below except road work) of the completion of the work from the Engineer-in-Charge specifying the work, materials or articles complained of notwithstanding that the same may have been passed, certified and paid for forthwith rectify, or remove and reconstruct the work so specified in whole or in part, as the case may require or as the case may be, remove the materials or articles so specified and provide other proper and suitable materials or articles at his own charge and cost. In the event of the failing to do so within a period specified by the Engineer-in- Charge in his demand aforesaid, then the contractor shall be liable to pay compensation at the same rate as under clause 2 of the contract (for non-completion of the work in time) for this default.

In such case the Engineer-in-Charge may not accept the item of work at the rates applicable under the contract but may accept such items at reduced rates as the authority specified in schedule 'F' may consider reasonable during the preparation of on account bills or final bill if the item is so acceptable without detriment to the safety and utility of the

item and the structure or he may reject the work outright without any payment and/or get it and other connected and incidental items rectified, or removed and re-executed at the risk and cost of the contractor. Decision of the Engineer-in-Charge to be conveyed in writing in respect of the same will be final and binding on the contractor.

CLAUSE 17 CONTRACTORS LIABLE FOR DAMAGES, DEFECTS DURING DEFECT LIABILITY PERIOD

If the contractor or his working people or servants shall break, deface, injure or destroy any part of building in which they may be working, or any building, road, road kerb, fence, enclosure, water pipe, cables, drains, electric or telephone post or wires, trees, grass or grassland, or cultivated ground contiguous to the premises on which the work or any part is being executed, or if any damage shall happen to the work while in progress, from any cause whatever or if any defect, shrinkage or other faults appear in the work within twelve months after a certificate final or otherwise of its completion shall have been given by the Engineer in- Charge as aforesaid arising out of defect or improper materials or workmanship the contractor shall upon receipt of a notice in writing on that behalf make the same good at his own expense or in default the Engineer-in-Charge cause the same to be made good by other workmen and deduct the expense from any sums that may be due or at any time thereafter may become due to the contractor, or from his security deposit or the proceeds of sale thereof or of a sufficient portion thereof. The security deposit of the contractor shall not be refunded before the expiry of twelve months after the issue of the certificate final or otherwise, of completion of work, or till the final bill has been prepared and passed whichever is later. Provided that in the case of road work, if in the opinion of the Engineer-in-Charge, half of the security deposit is sufficient, to meet all liabilities of the contractor under this contract, half of the security deposit will be refundable after twelve months and the remaining half after twelve months of the issue of the said certificate of completion or till the final bill has been prepared and passed whichever is later.

If the contractor or his working people or servants shall break, deface, injure or destroy any part of building in which they may be working, or any building, road, road kerb, fence, enclosure, water pipe, cables, drains, electric or telephone post or wires, trees, grass or grassland, or cultivated ground contiguous to the premises on which the work or any part is being executed, or if any damage shall happen to the work while in progress, from any cause whatever or if any defect, shrinkage or other faults appear in the work within twelve months (six months in the case of work costing Rs. Ten lacs and below except road work) after a certificate final or otherwise of its completion shall have been given by the Engineer-in-Charge as aforesaid arising out of defect or improper materials or workmanship the contractor shall upon receipt of a notice in writing on that behalf make the same good at his own expense or in default the Engineer-in-Charge cause the same to be made good by other workmen and deduct the expense from any sums that may be due or at any time thereafter may become due to the contractor, or from his security deposit or the proceeds of sale thereof or of a sufficient portion thereof. The security deposit of the contractor shall not be refunded before the expiry of twelve months (six months in the case of work costing Rs. Ten lacs and below except road work) after the issue of the certificate final or otherwise, of completion of work, or till the final bill has been prepared and passed whichever is later.

CLAUSE 18A RECOVERY OF COMPENSATION PAID TO WORKMEN

In every case in which by virtue of the provisions sub-section (1) of Section 12, of the Workmen's Compensation Act, 1923, Client/HLL is obliged to pay compensation to a workman employed by the contractor, in execution of the works, Client/HLL will recover from the contractor, the amount of the compensation so paid; and, without prejudice to the rights of the Client/HLL under sub-section (2) of Section 12, of the said Act, Client/HLL shall be at liberty to recover such amount or any part thereof by deducting it from the security deposit or from any sum due by Client/HLL

to the contractor whether under this contract or otherwise. Client/HLL shall not be bound to contest any claim made against it under sub-section (1) of Section 12, of the said Act, except on the written request of the contractor and upon his giving to Client/ HLL full security for all costs for which Client/HLL might become liable in consequence of contesting such claim.

CLAUSE 18B ENSURING PAYMENT AND AMENITIES TO WORKERS IF CONTRACTOR FAILS

In every case in which by virtue of the provisions of the Contract Labour (Regulation and Abolition) Act, 1970, and of the Contract Labour (Regulation and Abolition) Central Rules, 1971, Client/HLL is obliged to pay any amounts of wages to a workman employed by the contractor in execution of the works, or to incur any expenditure in providing welfare and health amenities required to be provided under the above said Act and the rules under Clause 19H or under the Contractor's Labour Regulations, or under the Rules framed by Government / HLL from time to time for the protection of health and sanitary arrangements for workers employed by Contractors, Client/HLL will recover from the contractor, the amount of wages so paid or the amount of expenditure so incurred; and without prejudice to the rights of the Client/HLL under sub-section(2) of Section 20, and sub-section (4) of Section 21, of the Contract Labour (Regulation and Abolition) Act, 1970, Client/HLL shall be at liberty to recover such amount or any part thereof by deducting it from the security deposit or from any sum due by Client/HLL to the contractor whether under this contract or otherwise Client/HLL shall not be bound to contest any claim made against it under sub-section (1) of Section 20, sub-section (4) of Section 21, of the said Act, except on the written request of the contractor and upon his giving to the Client/HLL full security for all costs for which Client/HLL might become liable in contesting such claim.

CLAUSE 19 LABOUR LAWS TO BE COMPLIED BY THE CONTRACTOR

The contractor shall obtain a valid licence under the Contract Labour (R&A) Act, 1970, and the Contract Labour (Regulation and Abolition) Central Rules, 1971, before the commencement of the work, and continue to have a valid license until the completion of the work. The contractor shall also comply with provisions of the Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979.The contractor shall also abide by the provisions of the Child Labour (Prohibition and Regulation) Act, 1986.

The contractor shall also comply with the provisions of the building and other Construction Workers (Regulation of Employment & Conditions of Service) Act, 1996 and the building and other Construction Workers Welfare Cess Act, 1996.

The contractor shall also comply with provisions of the Inter-State migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979.

Any failure to fulfill these requirements shall attract the penal provisions of this contract arising out of the resultant non-execution of the work.

CLAUSE 19A

No labour below the age of fourteen years shall be employed on the work.

CLAUSE 19 B PAYMENT OF WAGES

Payment of wages:

(i) The contractor shall pay to labour employed by him either directly or through sub-contractors, wages not less than fair wages as defined in the CPWD Contractor's Labour Regulations or as per the provisions of the Contract Labour (Regulation and Abolition) Act,

1970 and the contract Labour (Regulation and Abolition) Central Rules, 1971, wherever applicable.

(ii) The contractor shall, notwithstanding the provisions of any contract to the contrary, cause to be paid fair wage to labour indirectly engaged on the work, including any labour engaged by his sub-contractors in connection with the said work, as if the labour had been immediately employed by him.

(iii) In respect of all labour directly or indirectly employed in the works for performance of the contractor's part of this contract, the contractor shall comply with or cause to be complied with the Central Public Works Department contractor's Labour Regulations made by Government from time to time in regard to payment of wages, wage period, deductions from wages recovery of wages not paid and deductions unauthorizedly made, maintenance of wage books or wage slips, publication of scale of wages and other terms of employment, inspection and submission of periodical returns and all other matters of the like nature or as per the provisions of the Contract Labour (Regulation and Abolition) Act, 1970, and the Contract Labour (Regulation and Abolition) Central Rules, 1971, wherever applicable.

(iv) (a) The Engineer-in-Charge concerned shall have the right to deduct from the moneys due to the contractor any sum required or estimated to be required for making good the loss suffered by a worker or workers by reason of non-fulfillment of the conditions of the contract for the benefit of the workers, non-payment of wages or of deductions made from his or their wages which are not justified by their terms of the contract or non-observance of the Regulations.

(b) Under the provision of Minimum Wages (Central) Rules, 1950, the contractor is bound to allow to the labours directly or indirectly employed in the works one day rest for 6 days continuous work and pay wages at the same rate as for duty. In the event of default, the Engineer-in-Charge shall have the right to deduct the sum or sums not paid on account of wages for weekly holidays to any labours and pay the same to the persons entitled thereto from any money due to the contractor by the Engineer-in-Charge concerned.

In the case of Union Territory of Delhi, however, as the all-inclusive minimum daily wages fixed under Notification of the Delhi Administration No. F.12(162)MWO / DAB/43884-91, dated 31-12-1979 as amended from time to time are inclusive of wages for the weekly day of rest, the question of extra payment for weekly holiday would not arise.

(v) The contractor shall comply with the provisions of the Payment of Wages Act, 1936, Minimum Wages Act, 1948, Employees Liability Act, 1938, Workmen's Compensation Act, 1923, Industrial Disputes Act, 1947, Maternity Benefits Act, 1961, and the Contractor's Labour (Regulation and Abolition) Act 1970, or the modifications thereof or any other laws relating thereto and the rules made thereunder from time to time.

(vi) The contractor shall indemnify and keep indemnified Client/HLL against payments to be made under and for the observance of the laws aforesaid and the Contractor's Labour Regulations without prejudice to his right to claim indemnity from his sub-contractors.

(vii) The laws aforesaid shall be deemed to be a part of this contract and any breach thereof shall be deemed to be a breach of this contract.

(viii) Whatever is the minimum wage for the time being, or if the wage payable is higher than such wage, such wage shall be paid by the contractor to the workmen directly without the intervention of Jamadar and that Jamadar shall not be entitled to deduct or recover any amount from the minimum wage payable to the workmen as and by way of commission or otherwise.

(ix) The contractor shall ensure that no amount by way of commission or otherwise is deducted or recovered by the Jamadar from the wage of workmen.

CLAUSE 19C

In respect of all labour directly or indirectly employed in the work for the performance of the contractor's part of this contract, the contractor shall at his own expense arrange for the safety provisions as per Safety Code framed from time to time and shall at his own expense provide for all facilities in connection therewith. In case the contractor fails to make arrangement and provide necessary facilities as aforesaid, he shall be liable to pay a penalty of Rs.200/- for each default and in addition, the Engineer-in- Charge shall be at liberty to make arrangement and provide facilities as aforesaid and recover the costs incurred in that behalf from the contractor.

CLAUSE 19 D

The contractor shall submit by the 4th and 19th of every month, to the Engineer-in-Charge, a true statement showing in respect of the second half of the preceding month and the first half of the current month respectively:-

(1) the number of labourers employed by him on the work,

(2) their working hours,

(3) the wages paid to them,

(4) the accidents that occurred during the said fortnight showing the circumstances under which they happened and the extent of damage and injury caused by them, and

(5) the number of female workers who have been allowed maternity benefit according to Clause 19F and the amount paid to them.

Failing which the contractor shall be liable to pay to HLL/Client, a sum of Rs.200/- for each default or materially incorrect statement. The decision of the Engineer in charge shall be final in deducting from any bill due to the contractor; the amount levied as fine and shall be binding on the contractor.

CLAUSE 19E

In respect of all labour directly or indirectly employed in the works for the performance of the contractor's part of this contract, the contractor shall comply with or cause to be complied with all the rules framed by HLL/Client from time to time for the protection of health and sanitary arrangements for workers employed by the Client/HLL and its contractors.

CLAUSE 19 F

Leave and pay during leave shall be regulated as follows:-

1. Leave:

   (i) in the case of delivery - maternity leave not exceeding 8 weeks, 4 weeks up to and including the day of delivery and 4 weeks following that day,

   (ii) in the case of miscarriage - upto 3 weeks from the date of miscarriage.

2. Pay :

   (i) in the case of delivery - leave pay during maternity leave will be at the rate of the women's average daily earnings, calculated on total wages earned on the days when full time work was done during a period of three months immediately preceding the date on which she gives notice that she expects to be confined or at the rate of Rupee one only a day whichever is greater.

(ii) in the case of miscarriage - leave pay at the rate of average daily earning calculated on the total wages earned on the days when full time work was done during a period of three months immediately preceding the date of such miscarriage.

3. Conditions for the grant of Maternity Leave:

No maternity leave benefit shall be admissible to a woman unless she has been employed for a total period of not less than six months immediately preceding the date on which she proceeds on leave.

4. The contractor shall maintain a register of Maternity (Benefit) in the Prescribed Form as shown in Appendix -I and II, and the same shall be kept at the place of work.

CLAUSE 19 G

In the event of the contractor(s) committing a default or breach of any of the provisions of the Contractor's Labour Regulations and Model Rules for the protection of health and sanitary arrangements for the workers as amended from time to time or furnishing any information or submitting or filing any statement under the provisions of the above Regulations and' Rules which is materially incorrect, he/they shall, without prejudice to any other liability, pay to the Client/HLL a sum–not exceeding Rs.200/- for every default, breach or furnishing, making, submitting, filing such materially incorrect statements and in the event of the contractor(s) defaulting continuously in this respect, the penalty may be enhanced to Rs.200/- per day for each day of default subject to a maximum of 5 per cent of the estimated cost of the work put to tender. The decision of the Engineer-in-Charge shall be final and binding on the parties.

Should it appear to the Engineer-in-Charge that the contractor(s) is/are not properly observing and complying with the provisions of the Contractor's Labour Regulations and Model Rules and the provisions of the Contract Labour (Regulation and Abolition) Act 1970, and the Contract Labour (R& A) Central Rules 1971, for the protection of health and sanitary arrangements for work-people employed by the contractor(s) (hereinafter referred as "the said Rules") the Engineer-in-Charge shall have power to give notice in writing to the contractor(s) requiring that the said Rules be complied with and the amenities prescribed therein be provided to the work-people within a reasonable time to be specified in the notice. If the contractor(s) shall fail within the period specified in the notice to comply with and/observe the said Rules and to provide the amenities to the work-people as aforesaid, the Engineer-in-Charge shall have the power to provide the amenities hereinbefore mentioned at the cost of the contractor(s). The contractor(s) shall erect, make and maintain at his/their own expense and to approved standards all necessary huts and sanitary arrangements required for his/their work-people on the site in connection with the execution of the works, and if the same shall not have been erected or constructed, according to approved standards, the Engineer-in-Charge shall have power to give notice in writing to the contractor(s) requiring that the said huts and sanitary arrangements be remodeled and/or reconstructed according to approved standards, and if the contractor(s) shall fail to remodel or reconstruct such huts and sanitary arrangements according to approved standards within the period specified in the notice, the Engineer-in-Charge shall have the power to remodel or reconstruct such huts and sanitary arrangements according to approved standards at the cost of the contractor(s).

CLAUSE 19H

The contractor(s) shall at his/their own cost provide his/their labour with a sufficient number of huts (hereinafter referred to as the camp) of the following specifications on a suitable plot of land to be approved by the Engineer-in-Charge.

(i) (a) The minimum height of each hut at the eaves level shall be 2.10m (7 ft.) and the floor area to be provided will be at the rate of 2.7 sq.m. (30 sq.ft.)for each member of the worker's family staying with the labourer.

(b) The contractor(s) shall in addition construct suitable cooking places having a minimum area of 1.80m x 1.50m (6'x5') adjacent to the hut for each family.

(c) The contractor(s) shall also construct temporary latrines and urinals for the use of the labourers each on the scale of not less than four per each one hundred of the total strength, separate latrines and urinals being provided for women.

(d) The contractor(s) shall construct sufficient number of bathing and washing places, one unit for every 25 persons residing in the camp. These bathing and washing places shall be suitably screened.

(ii) (a) All the huts shall have walls of sun-dried or burnt-bricks laid in mud mortar or other suitable local materials as may be approved by the Engineer-in-Charge. In case of sun-dried bricks, the walls should be plastered with mud gobri on both sides. The floor may be kutcha but plastered with mud gobri and shall be at least 15 cm (6") above the surrounding ground. The roofs shall be laid with thatch or any other materials as may be approved by the Engineer-in-Charge and the contractor shall ensure that throughout the period of their occupation, the roofs remain water-tight.

(b) The contractor(s) shall provide each hut with proper ventilation.

(c) All doors, windows, and ventilators shall be provided with suitable leaves for security purposes.

(d) There shall be kept an open space of at least 7.2m (8 yards) between the rows of huts which may be reduced to 6m (20 ft.) according to the availability of site with the approval of the Engineer-in-Charge. Back to back construction will be allowed.

(iii) Water Supply - The contractor(s) shall provide adequate supply of water for the use of labourers. The provisions shall not be less than two gallons of pure and wholesome water per head per day for drinking purposes and three gallons of clean water per head per day for bathing and washing purposes. Where piped water supply is available, supply shall be at stand posts and where the supply is from wells or river, tanks which may be of metal or masonry, shall be provided. The contractor(s) shall also at his/ their own cost make arrangements for laying pipe lines for water supply to his/ their labour camp from the existing mains wherever available, and shall pay all fees and charges therefore.

(iv) The site selected for the camp shall be high ground, removed from jungle.

(v) Disposal of Excreta - The contractor(s) shall make necessary arrangements for the disposal of excreta from the latrines by trenching or incineration which shall be according to the requirements laid down by the Local Health Authorities. If trenching or incineration is not allowed, the contractor(s) shall make arrangements for the removal of the excreta through the Municipal Committee/authority and inform it about the number of labourers employed so that arrangements may be made by such Committee/authority for the removal of the excreta. All charges on this account shall be borne by the contractor and paid direct by him to the Municipality/authority. The contractor shall provide one sweeper for every eight seats in case of dry system.

(vi) Drainage - The contractor(s) shall provide efficient arrangements for draining away sullage water so as to keep the camp neat and tidy.

(vii) The contractor(s) shall make necessary arrangements for keeping the camp area sufficiently lighted to avoid accidents to the workers.

(viii) Sanitation - The contractor(s) shall make arrangements for conservancy and sanitation in the labour camps according to the rules of the Local Public Health and Medical Authorities.

CLAUSE 19I

The Engineer-in-Charge may require the contractor to dismiss or remove from the site of the work any person or persons in the contractors' employ upon the work who may be incompetent or misconduct himself and the contractor shall forthwith comply with such requirements. In respect of maintenance/repair or renovation works etc. where the labour have an easy access to the individual houses, the contractor shall issue identity cards to the labourers, whether temporary or permanent and he shall be responsible for any untoward action on the part of such labour. The Engineer-in-Charge will display a list of contractors working in the colony/Blocks on the notice board in the colony and also at the service centre, to apprise the residents about the same.

CLAUSE 19J

It shall be the responsibility of the contractor to see that the building under construction is not occupied by anybody unauthorizedly during construction, and is handed over to the Engineer-in-Charge with vacant possession of complete building. If such building though completed is occupied illegally, then the Engineer-in-Charge shall have the option to refuse to accept the said building/buildings in that position. Any delay in acceptance on this account will be treated as the delay in completion and for such delay, a levy upto 5% of tendered value of work may be imposed by the Engineer-in-Charge whose decision shall be final both with regard to the justification and quantum and be binding on the contractor.

However, the Engineer- in- charge, through a notice, may require the contractor to remove the illegal occupation any time on or before construction and delivery.

CLAUSE 19K EMPLOYMENT OF SKILLED/SEMI SKILLED WORKERS

The contractor shall, at all stages of work, deploy skilled/semi-skilled tradesmen who are qualified and possess certificate in particular trade from CPWD Training Institute/ Industrial Training Institute/National Institute of construction Management and Research (NICMAR)/ National Academy of Construction, CIDC, National Skill Development Corporation certified training institute or any similar reputed and recognized Institute managed/ certified by State/Central Government. The number of such qualified tradesmen shall not be less than 20% of total skilled/semi-skilled workers required in each trade at any stage of work. The contractor shall submit number of man days required in respect of each trade, its scheduling and the list of qualified tradesmen along with requisite certificate from recognized Institute to Engineer in charge for approval. Notwithstanding such approval, if the tradesmen are found to have inadequate skill to execute the work of respective trade, the contractor shall substitute such tradesmen within two days of written notice from Engineer- in-Charge. Failure on the part of contractor to obtain approval of Engineer-in-Charge or failure to deploy qualified tradesmen will attract a compensation to be paid by contractor at the rate of Rs. 100 per such tradesman per day. Decision of Engineer in Charge as to whether particular tradesman possesses requisite skill and amount of compensation in case of default shall be final and binding.

CLAUSE 19L CONTRIBUTION TO EPF and ESI

The ESI and EPF contributions on the part of the Client/ HLL in respect of this Contract shall be paid by the Contractor and nothing shall be reimbursed by the Client/ HLL.

CLAUSE 20 MINIMUM WAGES ACT TO BE COMPLIED WITH

The contractor shall comply with all the provisions of the Minimum Wages Act, 1948, and Contract Labour (Regulation and Abolition) Act, 1970, amended from time to time and rules framed thereunder and other labour laws affecting contract labour that may be brought into force from time to time.

CLAUSE 21 WORK NOT TO BE SUBLET. ACTION IN CASE OF INSOLVENCY

The contract shall not be assigned or sublet without the written approval of the Engineer-in - Charge. And if the contractor shall assign or sublet his contract, or attempt to do so, or become insolvent or commence any insolvency proceedings or make any composition with his creditors or attempt to do so, or if any bribe, gratuity, gift, loan, perquisite, reward or advantage pecuniary or otherwise, shall either directly or indirectly, be given, promised or offered by the contractor, or any of his servants or agent to any public officer or person in the employ of Client/HLL in any way relating to his office or employment, or if any such officer or person shall become in any way directly or indirectly interested in the contract, the Engineer-in-Charge on behalf of the Client shall have power to adopt the course specified in Clause 3 hereof in the interest of Client/HLL and in the event of such course being adopted, the consequences specified in the said Clause 3 shall ensue.

CLAUSE 22

Any amount payable by way of compensation under any of these conditions shall be considered as reasonable compensation to be applied to the use of Client/HLL without reference to the actual loss or damage sustained and whether or not any damage shall have been sustained.

CLAUSE 23 CHANGES IN FIRM'S CONSTITUTION TO BE INTIMATED

Where the contractor is a partnership firm, the previous approval in writing of the Engineer- in-Charge shall be obtained before any change is made in the constitution of the firm. Where the contractor is an individual or a Hindu undivided family business concern, such approval as aforesaid shall likewise be obtained before the contractor enters into any partnership agreement where under the partnership firm would have the right to carry out the works hereby undertaken by the contractor. If previous approval as aforesaid is not obtained, the contract shall be deemed to have been assigned in contravention of Clause 21 hereof and the same action may be taken, and the same consequences shall ensue as provided in the said Clause 21.

CLAUSE 24 LIFE CYCLE COST

The contractor shall have obligation to rectify construction defects minimum up to 5 (five) years from the date of completion of work. The defects have to be rectified within a reasonable time not exceeding three months after issue of notice by Client/HLL.

CLAUSE 25 SETTLEMENTS OF DISPUTES & ARBITRATION

Except where otherwise provided in the contract, all disputes and claims relating to the meaning of the specifications, designs, drawings and instructions here-in-before mentioned and as to the quality of workmanship or materials used in the work or as to any other question, claim, right, matter or thing whatsoever in any way arising out of or relating to the contract, designs, drawings, specifications, estimates, instructions, orders or these conditions or otherwise concerning the work or the execution or failure to execute the same whether arising during the progress of the work or

after the cancellation, termination, completion or abandonment thereof shall be dealt with as mentioned here-in-after.

i. If the Contractor considers any work demanded of him to be outside the requirements of the contract, or disputes any drawings, record or decision given in writing by the Engineer-in-Charge or if the Engineer-in-Charge considers any act or decision of the contractor on any matter in connection with or arising out of the contract or carrying out of the work to be unacceptable and is disputed, such party shall promptly within 15 days of arising of the disputes request the Vice President, HLL, NOIDA in writing for written instructions or decision. Thereupon, the Vice President, HLL, NOIDA shall give to the opposing party two weeks for a written response, and give its decisions within a period of 60 days extendable by 30 days, by the consent of both the parities from the date of receipt of reference.

ii. If Vice President, HLL, NOIDA fails to give his instructions or decision in writing within the aforesaid period or if the contractor is dissatisfied with the instructions or decision of the Vice President, HLL, NOIDA, the contractor may, within 15 days of the receipt of Vice President, HLL, NOIDA' decision, appeal to the Director, HLL, who shall afford an opportunity to the contractor to be heard, if the later so desires, and to offer evidence in support of his appeal. The Director, HLL shall give his decision within 30 days of receipt of contractor's appeal. If the contractor is dissatisfied with this decision, the contractor shall within a period of 30 days from receipt of the decision, give notice to the Director, RIPANS, Aizwal for appointment of Sole Arbitrator. The said notice for appointment of a Sole Arbitrator on the prescribed proforma as per Appendix-XV shall be under intimation to the other party.

   It is a term of contract that each party invoking arbitration must exhaust the aforesaid mechanism of settlement of disputes prior to invoking arbitration.

iii. The Director, RIPANS, Aizwal shall in such a case appoint Sole Arbitrator, within 30 days from the receipt of such a request (on prescribed proforma) and refer such disputes to arbitration.

iv. It is a term of this contract that the party invoking arbitration shall give a list of disputes with amounts claimed in respect of each such dispute along with the notice for appointment of arbitrator and giving reference to the decision by the Director, HLL. The arbitration shall be conducted in accordance with the provisions of the Arbitration and Conciliation Act, 1996 (26 of 1996) as amended by the Amendment Act, 2015 or any statutory modifications or re-enactment thereof and the rules made there under and for the time being in force shall apply to the arbitration proceeding under this clause.

   It is also a terms of contract that the Sole Arbitrator shall be a Graduate Engineer with experience in handling public works engineering contract at a level not lower than the Chief Engineer (Joint Secretary to Govt. of India) or Graduate Engineer retired from any government service from a position not below the level of Joint Secretary to the Government of India or equivalent level from the CPSU's and having experience in the field of arbitration in construction contracts.

   The parties, before or at the time of appointment of the Sole Arbitrator may agree in writing for fast track arbitration as per the Arbitration and Conciliation Act, 1996 (26 of 1996) as amended in 2015.

   Subject to provision in the Arbitration and Conciliation Act, 1996 (26 of 1996) as amended in 2015 whereby the counter claims if any can be directly filed before the arbitrator without any requirement of reference by the appointing authority, the arbitrator shall adjudicate on only such disputes as are referred to him by the appointing authority and give separate award against each dispute and claim referred to him and in all cases where the total amount of the claims by any party exceeds Rs.1,00,000/-, the arbitrator shall give reasons for the award.

It is also term of contract that if any fees are payable to the arbitrator, these shall be paid as per the rates specified in the Fourth Schedule of the Arbitration and Conciliation Act, 1996 as amended by the Amendment Act, 2015 or as per guidelines issued by the competent authority.

The place of arbitration shall be Delhi / NOIDA. The venue of the arbitration shall be such place as may be fixed by the Sole Arbitrator in consultation with both the parties. Failing any such agreement, then the Sole Arbitrator shall decide the venue.

CLAUSE 26 CONTRACTORS(S) TO INDEMNIFY GOVT. AGAINST PATENT RIGHTS

The contractor(s) shall fully indemnify and keep indemnified the Client/HLL against any action, claim or proceeding relating to infringement or use of any patent or design or any alleged patent or design rights and shall pay any royalties which may be payable in respect of any article or part thereof included in the contract. In the event of any claims made under or action brought against Client/HLL in respect of any such matters as aforesaid, the contractor shall be immediately notified thereof and the contractor shall be at liberty, at his own expense, to settle any dispute or to conduct any litigation that may arise therefrom, provided that the contractor shall not be liable to indemnify the Client/HLL if the infringement of the patent or design or any alleged patent or design right is the direct result of an order passed by the Engineer-in-Charge in this behalf.

CLAUSE 27 WITHHOLDING AND LIEN IN RESPECT OF SUM DUE FROM CONTRACTOR

(i) Whenever any claim or claims for payment of a sum of money arises out of or under the contract or against the contractor, the Engineer-in-Charge or the HLL shall be entitled to withhold and also have a lien to retain such sum or sums in whole or in part from the security, if any deposited by the contractor and for the purpose aforesaid, the Engineer-in-Charge or the Client/HLL shall be entitled to withhold the security deposit, if any, furnished as the case may be and also have a lien over the same pending finalisation or adjudication of any such claim. In the event of the security being insufficient to cover the claimed amount or amounts or if no security has been taken from the contractor, the Engineer-in-Charge or the Client/HLL shall be entitled to withhold and have a lien to retain to the extent of such claimed amount or amounts referred to above, from any sum or sums found payable or which may at any time thereafter become payable to the contractor under the same contract or any other contract with the Engineer-in-Charge of the Client/HLL or any contracting person through the Engineer- in-Charge pending finalization of adjudication of any such claim.

It is an agreed term of the contract that the sum of money or moneys so withheld or retained under the lien referred to above by the Engineer-in-Charge or Client/HLL will be kept withheld or retained as such by the Engineer-in-Charge or Client/HLL till the claim arising out of or under the contract is determined by the arbitrator(if the contract is governed by the arbitration clause) by the competent court, as the case may be and that the contractor will have no claim for interest or damages whatsoever on any account in respect of such withholding or retention under the lien referred to above and duly notified as such to the contractor. For the purpose of this clause, where the contractor is a partnership firm or a limited company, the Engineer-in-Charge or the Client/HLL shall be entitled to withhold and also have a lien to retain towards such claimed amount or amounts in whole or in part from any sum found payable to any partner/limited company as the case may be, whether in his individual capacity or otherwise.

(ii) CLIENT / HLL shall have the right to cause an audit and technical examination of the works and the final bills of the contractor including all supporting vouchers, abstract, etc., to be made after payment of the final bill and if as a result of such audit and technical examination any sum is found to have been overpaid in respect of any work done by the

contractor under the contract or any work claimed to have been done by him under the contract and found not to have been executed, the contractor shall be liable to refund the amount of over-payment and it shall be lawful for CLIENT / HLL to recover the same from him in the manner prescribed in sub-clause (i) of this clause or in any other manner legally permissible; and if it is found that the contractor was paid less than what was due to him under the contract in respect of any work executed by him under it, the amount of such under payment shall be duly paid by CLIENT / HLL to the contractor, without any interest thereon whatsoever.

Provided that the CLIENT / HLL shall not be entitled to recover any sum overpaid, nor the contractor shall be entitled to payment of any sum paid short where such payment has been agreed upon between the Engineer- in- charge on the one hand and the contractor on the other under any term of the contract permitting payment for work after assessment by the Engineer- in- charge.

CLAUSE 28 LIEN IN RESPECT OF CLAIMS IN OTHER CONTRACTS

Any sum of money due and payable to the contractor (including the security deposit returnable to him) under the contract may be withheld or retained by way of lien by the Engineer-in-Charge or the Client/HLL or any other contracting person or persons through Engineer-in-Charge against any claim of the Engineer-in-Charge or Client/HLL or such other person or persons in respect of payment of a sum of money arising out of or under any other contract made by the contractor with the Engineer- in-Charge or the Client/HLL or with such other person or persons.

It is an agreed term of the contract that the sum of money so withheld or retained under this clause by the Engineer-in-Charge or the Client/HLL will be kept withheld or retained as such by the Engineer-in-Charge or the Client/HLL or till his claim arising out of the same contract or any other contract is either mutually settled or determined by the arbitration clause or by the competent court, as the case may be and that the contractor shall have no claim for interest or damages whatsoever on this account or on any other ground in respect of any sum of money withheld or retained under this clause and duly notified as such to the contractor.

CLAUSE 29 EMPLOYMENT OF COAL MINING OR CONTROLLED AREA LABOUR NOT PERMISSIBLE

The contractor shall not employ coal mining or controlled area labour falling under any category whatsoever on or in connection with the work or recruit labour from area within a radius of 32 km (20 miles) of the controlled area. Subject as above the contractor shall employ imported labour only i.e., deposit imported labour or labour imported by contractors from area, from which import is permitted.

Where ceiling price for imported labour has been fixed by State or Regional Labour Committees not more than that ceiling price shall be paid to the labour by the contractor.

The contractor shall immediately remove any labourer who may be pointed out by the Engineer in-Charge as being a coal mining or controlled area labourer. Failure to do so shall render the contractor liable to pay to Government a sum calculated at the rate of Rs.10/- per day per labourer. The certificate of the Engineer-in-Charge about the number of coal mining or controlled area labourer and the number of days for which they worked shall be final and binding upon all parties to this contract.

It is declared and agreed between the parties that the aforesaid stipulation in this clause is one in which the public are interested within the meaning of the exception in Section 74 of Indian Contract Act, 1872.

Explanation: - Controlled Area means the following areas:

Districts of Dhanbad, Hazaribagh, Jamtara - a Sub-Division under Santhal Pargana Commissionery, Districts of Bankuara, Birbhum, Burdwan, District of Bilaspur.

Any other area which may be declared a Controlled Area by or with the approval of the Central Government.

CLAUSE 30 UNFILTERED WATER SUPPLY

The contractor(s) shall make his/their own arrangements for water required for the work and nothing extra will be paid for the same. This will be subject to the following conditions.

(i) That the water used by the contractor(s) shall be fit for construction purposes to the satisfaction of the Engineer-in-Charge.

(ii) The Engineer-in-Charge shall make alternative arrangements for supply of water at the risk and cost of contractor(s) if the arrangements made by the contractor(s) for procurement of water are in the opinion of the Engineer-in- Charge, unsatisfactory.

CLAUSE 31 ALTERNATE WATER ARRANGEMENTS

The contractor shall be allowed to construct temporary wells in Government land for taking water for construction purposes only after he has got permission of the Engineer-in- Charge in writing. No charges shall be recovered from the contractor on this account, but the contractor shall be required to provide necessary safety arrangements to avoid any accidents or damage to adjacent buildings, roads and service lines. He shall be responsible for any accidents or damage caused due to construction and subsequent maintenance of the wells and shall restore the ground to its original condition after the wells are dismantled on completion of the work

CLAUSE 32 EMPLOYMENT OF TECHNICAL STAFF AND EMPLOYEES

Contractors Superintendence, Supervision, Technical Staff & Employees

(i) The contractor shall provide all necessary superintendence during execution of the work and all along thereafter as may be necessary for proper fulfilling of the obligations under the contract.

The contractor shall immediately after receiving letter of acceptance of the tender and before actual commencement of the work, intimate in writing to the Engineer-in-Charge, the name(s), qualifications, experience, age, address(s) and other particulars along with certificates, of the principal technical representative to be in charge of the work and other technical representative(s) who will be supervising the work. Minimum requirement of such technical representative(s) and their qualifications and experience shall not below than specified in Schedule 'F'. The Engineer-in-Charge shall within 3 days of receipt of such communication intimate in writing his approval or otherwise of such a representative(s) to the contractor. Any such approval may at any time be withdrawn and in case of such withdrawal, the contractor shall appoint another such representative(s) according to the provisions of this clause. Decision of the tender accepting authority shall be final and binding on the contractor in this respect. Such a principal technical representative and other technical representative(s) shall be appointed by the contractor soon after receipt of the approval from Engineer-in-charge and shall be available at site before start of work.

All the provisions applicable to the principal technical representative under the Clause will also be applicable to other technical representative(s) The principal technical representative and other technical representative(s) shall be present at the site of work for supervision at all times when any construction activity is in progress and also present himself/themselves, as required, to the Engineer-in-Charge and/or his designated

representative to take instructions. Instructions given to the principal technical representative or other technical representative(s) shall be deemed to have the same force as if these have been given to the contractor. The principal technical representative and other technical representative(s) shall be actually available at site fully during all stages of execution of work, during recording/checking/test checking of measurements of works and whenever so required by the Engineer-in-Charge and shall also note down instructions conveyed by the Engineer-in- Charge or his designated representative(s) in the site order book and shall affix his/their signature in token of noting down the instructions and in token of acceptance of measurements/ checked measurements/test checked measurements. The representative(s) shall not look after any other work. Substitutes, duly approved by Engineer-in-Charge of the work in similar manner as aforesaid shall be provided in event of absence of any of the representative(s) by more than two days.

If the Engineer-in-Charge, whose decision in this respect is final and binding on the contractor, is convinced that no such technical representative(s) is/are effectively appointed or is/are effectively attending or fulfilling the provision of this clause, a recovery (non-refundable) shall be effected from the contractor as specified in Schedule 'F' and the decision of the Engineer-in-Charge as recorded in the site order book and measurement recorded checked/test checked in Measurement Books shall be final and binding on the contractor. Further if the contractor fails to appoint suitable Principal technical representative and/or other technical representative(s) and if such appointed persons are not effectively present or are absent by more than two days without duly approved substitute or do not discharge their responsibilities satisfactorily, the Engineer-in-Charge shall have full powers to suspend the execution of the work until such date as suitable other technical representative(s) is/are appointed and the contractor shall be held responsible for the delay so caused to the work. The contractor shall submit a certificate of employment of the technical representative(s) along with every on account bill/ final bill and shall produce evidence if at any time so required by the Engineer-in-Charge. The contractor shall submit a certificate of employment of the technical representative(s) (in the form of copy of Form-16 or CPF deduction issued to the Engineers employed by him) along with every on account bill/final bill and shall produce evidence if at any time so required by the Engineer-in-Charge.

(ii) The contractor shall provide and employ on the site only such technical assistants as are skilled and experienced in their respective fields and such foremen and supervisory staff as are competent to give proper supervision to the work.

The contractor shall provide and employ skilled, semiskilled and unskilled labour as is necessary for proper and timely execution of the work.

The Engineer-in-Charge shall be at liberty to object to and require the contractor to remove from the works any person who in his opinion misconducts himself, or is incompetent or negligent in the performance of his duties or whose employment is otherwise considered by the Engineer-in-Charge to be undesirable. Such person shall not be employed again at works site without the written permission of the Engineer-in-Charge and the persons so removed shall be replaced as soon as possible by competent substitutes.

CLAUSE 33 LEVY/TAXES PAYABLE BY CONTRACTOR

(i) GST, Building and other Construction Workers Welfare Cess or any other tax, levy or Cess in respect of input for or output by this contract shall be payable by the contractor and Government / HLL shall not entertain any claim whatsoever in this respect except as provided under clause 34.

(ii) The contractor shall deposit royalty and obtain necessary permit for supply of the red bajri, stone, kankar, etc. from local authorities.

(iii) If pursuant to or under any law, notification or order any royalty, cess or the like becomes payable by the Government of India and does not any time become payable by the contractor to the State Government, Local authorities in respect of any material used by the contractor in the works, then in such a case, it shall be lawful to the Government of India and it will have the right and be entitled to recover the amount paid in the circumstances as aforesaid from dues of the contractor.

CLAUSE 34 CONDITIONS FOR REIMBURSEMENT OF LEVY/TAXES IF LEVIED AFTER RECEIPT OF TENDERS

(i) All tendered rates shall be inclusive of any tax, levy or cess applicable on last stipulated date of receipt of tender including extension if any. No adjustment i.e. increase or decrease shall be made for any variation in the rate of GST, Building and Other Construction Workers Welfare Cess or any tax, levy or cess applicable on inputs.

However, effect of variation in rates of GST or Building and Other Construction Workers Welfare Cess or imposition or repeal of any other tax, levy or cess applicable on output of the works contract shall be adjusted on either side, increase or decrease.

Provided further that for Building and Other Construction Workers Welfare Cess or any tax (other than GST), levy or cess varied or imposed after the last date of receipt of tender including extension if any, any increase shall be reimbursed to the contractor only if the contractor necessarily and properly pays such increased amount of taxes/levies/cess.

Provided further that such increase including GST shall not be made in the extended period of contract for which the contractor alone is responsible for delay as determined by authority for extension of time under Clause 5 in Schedule F.

(ii) The contractor shall keep necessary books of accounts and other documents for the purpose of this condition as may be necessary and shall allow inspection of the same by the Engineer-in-Charge and shall also furnish such other information document as the Engineer-in-Charge may require from time to time.

(iii) The contractor shall, within a period of 30 days of the imposition of any such further tax or levy or cess, give a written notice thereof to the Engineer-in-charge that the same is given pursuant to this condition, together with all necessary information relating thereto.

CLAUSE 35 TERMINATION OF CONTRACT ON DEATH OF CONTRACTOR

Without prejudice to any of the rights or remedies under this contract, if the contractor dies, the authority indicated in schedule "F" on behalf of the HLL shall have the option of terminating the contract without compensation to the contractor.

CLAUSE 36 IF RELATIVE WORKING IN OFFICE OF CLIENT/ DEPARTMENT THEN THE CONTRACTOR NOT ALLOWED TO TENDER

The contractor shall not be permitted to tender for works in the MoHFW/ HLL /RIPANS in which his near relative is posted as Divisional Accountant or equivalent or as an officer in any capacity between the grades of the General Manager/ Chief Engineer and Site Engineer (both inclusive). He shall also intimate the names of persons who are working with him in any capacity or are subsequently employed by him and who are near relatives to any Gazetted Officer in the in the Ministry of Health & Family Welfare. Any breach of this condition by the contractor would render him liable to be removed from the approved list of contractors of Client/HLL . If

however the contractor is registered in any other department, he shall be debarred from tendering in the Client/HLL in future for any breach of this condition.

NOTE: By the term "near relatives" is meant wife, husband, parents and grandparents, children and grandchildren, brothers and sisters, uncles, aunts and cousins and their corresponding in-laws.

CLAUSE 37 NO GAZETTED ENGINEER TO WORK AS CONTRACTOR WITHIN ONE YEAR OF RETIREMENT

No engineer of gazetted rank or other gazetted officer employed in engineering or administrative duties in an engineering department of the Government of India shall work as a contractor or employee of a contractor for a period of one year after his retirement from government service without the previous permission of Government of India in writing. This contract is liable to be cancelled if either the contractor or any of his employees is found at any time to be such a person who had not obtained the permission of Government of India as aforesaid, before submission of the tender or engagement in the contractor's service, as the case may be.

CLAUSE 38 THEORETICAL CONSUMPTION OF MATERIALS

(i) After completion of the work and also at any intermediate stage in the event of Non reconciliation of materials procured, theoretical quantity of materials used in the work shall be calculated on the basis and method given hereunder:-

(a) Quantity of cement & bitumen shall be calculated on the basis of quantity of cement & bitumen required for different items of work as shown in the Schedule of Rates mentioned in Schedule 'F'. In case any item is executed for which standard constants for the consumption of cement or bitumen are not available in the above mentioned schedule/ statement or cannot be derived from the same shall be calculated on the basis of standard formula to be laid down by the Engineer-in-Charge.

(b) Theoretical quantity of steel reinforcement or structural steel sections shall be taken as the quantity required as per design or as authorized by Engineer-in-Charge, including authorized lappages, chairs etc. plus 3% wastage due to cutting into pieces, such theoretical quantity being determined and compared with the actual procurement each diameter wise, section wise and category wise separately.

(c) Theoretical quantity of G.I. & C.I. or other pipes, conduits, wires and cables, pig lead and G.I. /M.S. sheets shall be taken as quantity actually required and measured plus 5% for wastage due to cutting into pieces (except in the case of G.I./M.S. sheets it shall be 10%), such determination & comparison being made diameter wise & category wise.

(d) For any other material as per actual requirements.

Over the theoretical quantities of materials so computed a variation shall be allowed as specified in Schedule 'F'. For non-scheduled items, the decision of the Engineer-in-Charge regarding theoretical quantities of materials which should have been actually used, shall be final and binding on the contractor.

(ii) The said action under this clause is without prejudice to the right of the Client/HLL to take action against the contractor under any other conditions of contract for not doing the work according to the prescribed specifications.

CLAUSE 39 COMPENSATION DURING WARLIKE SITUATIONS

The work (whether fully constructed or not) and all materials, machines, tools and plants, scaffolding, temporary buildings and other things connected therewith shall be at the risk of the contractor until the work has been delivered to the Engineer-in-Charge and a certificate from him

to that effect obtained. In the event of the work or any materials properly brought to the site for incorporation in the work being damaged or destroyed in consequence of hostilities or warlike operation, the contractor shall when ordered (in writing) by the Engineer-in-Charge to remove any debris from the site, collect and properly stack or remove in store all serviceable materials salvaged from the damaged work and shall be paid at the contract rates in accordance with the provision of this agreement for the work of clearing the site of debris, stacking or removal of serviceable material and for reconstruction of all works ordered by the Engineer-in-Charge, such payments being in addition to compensation upto the value of the work originally executed before being damaged or destroyed and not paid for. In case of works damaged or destroyed but not already measured and paid for, the compensation shall be assessed by the Engineer- in-charge or his authorized representative. The contractor shall be paid for the damages/destruction suffered and for restoring the material at the rate based on analysis of rates tendered for in accordance with the provision of the contract. The certificate of the Engineer-in-Charge regarding the quality and quantity of materials and the purpose for which they were collected shall be final and binding on all parties to this contract.

Provided always that no compensation shall be payable for any loss in consequence of hostilities or warlike operations (a) unless the contractor had taken all such precautions against air raid as are deemed necessary by the A.R.P. Officers or the Engineer-in-Charge (b) for any material etc. not on the site of the work or for any tools, plant, machinery, scaffolding, temporary building and other things not intended for the work.

In the event of the contractor having to carry out reconstruction as aforesaid, he shall be allowed such extension of time for its completion as is considered reasonable by the Engineer- in- charge.

CLAUSE 40 APPRENTICES ACT PROVISIONS TO BE COMPLIED WITH

The contractor shall comply with the provisions of the Apprentices Act, 1961 and the rules and orders issued thereunder from time to time. If he fails to do so, his failure will be a breach of the contract and the Client may, in his discretion, cancel the contract. The contractor shall also be liable for any pecuniary liability arising on account of any violation by him of the provisions of the said Act.

CLAUSE 41 RELEASE OF SECURITY DEPOSIT AFTER LABOUR CLEARANCE

Deposit of the work shall not be refunded till the contractor produces a clearance deposit after labour certificate from the Labour Officer. As soon as the work is virtually complete the contractor clearance shall apply for the clearance certificate to the Labour Officer under intimation to the Engineer-in-Charge. The Engineer-in-Charge, on receipt of the said communication, shall write to the Labour Officer to intimate if any complaint is pending against the contractor in respect of the work. If no complaint is pending, on record till after 3 months after completion of the work and/or no communication is received from the Labour Officer to this effect till six months after the date of completion, it will be deemed to have received the clearance certificate and the Security Deposit will be released if otherwise due.

CLAUSE 42:- INSURANCE

42.1 Without limiting the Contractor's obligations and responsibilities stated elsewhere in the Contract, the Contractor shall at his own cost arrange, secure and maintain insurance in the name of the HLL and the contractor with an insurance company selected by the contractor and acceptable to the HLL ,in such a manner that the HLL and the contractor are covered for all time during the period of contract i.e. the time period allowed for completion of work, extended period and the defect liability period. The insurance shall be effected in accordance with terms approved by the HLL and the contractor shall submit the insurance

policies to the Engineer-In-Charge within one week of signing of the agreement along with the receipt of premium. The contractor shall timely pay and submit the receipts of payment of premiums for extensions of policies, if any. The insurance shall cover the following: -

a) Contractor's All Risks Insurance

The contractor shall insure the work for a sum equivalent to the Contract valuetogether with materials and Plant for incorporation therein, to the full replacement cost and it being understood that such insurance shall provide for compensation to be payable to rectify the loss or damage incurred,and,an additional sum of 15 (%) per-cent of such replacement cost to cover any additional costs of and incidental to the rectification of loss or damage including professional fees and the cost of demolishing and removing any part of the Works and of removing debris of whatsoever nature, and it being understood that such insurance shall provide for compensation to be payable to rectify the loss or damage incurred or such additional sums as specified and the interests of the HLL against ALL RISKS claims, proceedings, loss or damages, costs, charges and expenses from whatsoever cause arising out of or in consequence of the execution and maintenance of the work for which the contractor is responsible under the contract.

b) Workman Compensation & Employers Liability Insurance.

This insurance shall be effected for all the contractor's employees engaged in the performance of the contract. The HLL shall not be liable in respect of any damages or compensation payable at law in respect of or in consequence of any accident or injury to any workman or any other person in the employment of the contractor and the contractor shall indemnify and keep indemnified the HLL against all such damages and compensation and against all claims, demands, proceedings, costs, charges and expenses, whatsoever in respect or in relation thereof.

c) Third Party Insurance.

The contractor shall be responsible for making good to the satisfaction of the Engineer-in-Charge any loss or any damage to all structures and properties belonging to the HLL or being executed or procured or being procured by the HLL or of the other agencies within the premises of all work of the HLL if such loss or damage is due to fault and or the negligence or willful acts or omissions and commissions of the contractor, his employees, agents, representatives.

The contractor shall take sufficient care in moving his plants, equipment and materials from one place to another so that they do not cause any damage to any person or to the property of the HLL or any third party including overhead and underground cables and in the event of any damage resulting to the property of the HLL or to a third party during the movement of the aforesaid plant, equipment or materials, the cost of such damages including eventual loss of production, operation or services in any plant or establishment as estimated by the HLL or ascertained or demanded by the third party, shall be borne by the contractor.

Before commencing the execution of the work, the contractor, shall insure and indemnify and keep the HLL harmless of all claims, against the contractor's liability for any materials or physical damage, loss or injury which may occur to any property, including that of the HLL or to any person including any employee of HLL, or arising out of the execution of the work or in the carrying out of the contract, otherwise than due to the matters referred to in the provision to (a) above. Such insurance shall be effected for an amount sufficient to cover such risks. The terms shall include a provision whereby, in the event of any claim in respect of which the contractor, would be entitled to receive indemnify under the policy being brought or made against the HLL , the insurer willfully indemnify HLL against such claims and any costs, charges and expenses in respect thereof.

d) The Contractor shall also at times indemnify the HLL against all claims, damages or compensation under the provisions of Payment or Wages Act, 1936, Minimum Wages Act, 1948, Employer's Liability Act, 1938, the Workman's Compensation Act, 1947, Industrial Disputes Act, 1947 and Maternity Benefit Act, 1961, or any modification thereof or any other law relating thereof and rules made there under from time to time.

e) The Contractor shall also at his own cost carry and maintain any and all other insurance(s) which he may be required for the Contractor's Equipment and other things brought onto the Site by the Contractor, for a sum sufficient to provide for their replacement at the Site

f) The Contractor shall also at his own cost carry and maintain any and all other insurance(s) which he may be required to take out under any law or regulation from time to time. He shall also carry and maintain any other insurance, which may be required by the Engineer-in-Charge.

g) **Cross liabilities:** -The insurance policy shall include a cross liability clause such that the insurance shall apply to the contractor and to the HLL as separate insured.

42.1.1 The Contractor shall prove to the Engineer-in-charge from time to time he has taken out all the insurance policies referred to above and has paid the necessary premiums for keeping the policies alive till expiry of the Defects Liability Period.

42.2 Evidence and Terms of Insurance

The Contractor shall provide evidence to the as soon as practicable after the respective insurance have been taken out but in any case prior to the start of work at the Site that insurance required under the Contract have been effected and shall, within 30 days of the Commencement Date, provide the insurance policies to the HLL . When providing such evidence and such policies to the HLL , the Contractor shall notify to the Engineer in Charge also. Such insurance policies shall be consistent with the general terms agreed prior to the issue of the Letter of Acceptance. The Contractor shall effect all insurance for which he is responsible with insurers and in terms approved by the Engineer-In-Charge.

42.3 Adequacy and cancellation of Insurance

a) The Contractor shall notify the insurers of changes in the nature, extent or programme for the execution of the Works and ensure the continuity and adequacy of the insurance at all times in accordance with the terms of the Contract and shall, when required, produce to the Engineer-in-Charge the insurance policies in force and the receipts for payment of the current premiums.

b) The aforesaid insurance policies shall provide that they shall not be cancelled till the Engineer-in-charge has agreed for cancellation.

42.4 Remedy on the contractor's failure to insure

If the contractor shall fail to effect and keep in force the insurance referred to above or any other insurance which he/they may be required to effect under the terms of the contract then and in any such case Engineer-in-charge may without being bound to, effect and keep in force any such insurance and pay such premium or premiums, as may be necessary for that purpose and from time to time deduct the amount so paid by the Engineer-in-charge from any moneys due or which may become due to the contractor or recover the same as a debt due from the contractor.

42.5 Compliance with Policy Conditions

In the event that the Contractor fails to comply with conditions imposed by the insurance policies effected pursuant to the Contract, the Contractor indemnify the HLL against all losses and claims arising from such failure.

Appendix 'XV-A'

ESTABLISHING SITE LABORATORY AND TESTING OF MATERIALS

Equipments for conducting necessary tests including mandatory tests (as per CPWD Specifications) shall be provided and installed at site in the well-furnished site laboratory by the Contractor at his own cost. The following laboratory equipment should be in general or as and when required be set up at site laboratory: -

Sl. No.	Equipment	Numbers
1.	100MT compression testing machine, electrical-cum-manually operated)	1
2.	Slump cone, steel plate, tamping rod, steel scale, scoop	10
3.	Vicat Apparatus with Desk pot	3
4.	Megger & earth resistance tester	3
5.	Pumps and pressure gauges for hydraulic testing of pressure pipes	2
6.	Weighing scale platform type 100 Kg capacity	2
7.	Graduated glass measuring cylinder	As per requirement
8.	Sets of sieves of 450mm internal dia for coarse aggregate [100mm, 80mm, 40mm; 2mm; 12.5mm,10mm; 4.75mm complete with lid and pan]	3
9.	Sets of sieves of 20mm internal dia for fine aggregate[4.75mm; 2.36mm; 1.18mm; 600 microns; 300 microns & 150 micron, with lid and pan]	3
10.	Sieve Brushes and sieve shaker capable of 20mm and 300mm dia sieves, manually operated with timing switch assembly	5
11.	Cube moulds size 70mmx70mmx70mm	30
12.	Cube moulds size 150mmx150mmx150mm	12
13.	Ultrasonic Test Equipment (For concrete)	3
14.	Hot air oven temp. Range 50°C to 300°C- sensitivity 1 degree	3
15.	Electronic balance 600gx0.1g., 10kg and 50 kg	4
16.	Physical balance weight up to 5 kg	4
17.	Digital thermometer up to 150oc	4
18.	Air Content of concrete testing machine	3
19.	Measuring jars 100ml, 20ml, 500ml	5 Nos each size

20.	Gauging trowels 100mm & 20mm with woodenhandle	12
21.	Spatula 100mm & 20mm with long blade wooden handle	12
22.	Vernier calipers 12" & 6" size	6 each
23.	Digital PH meter least count 0.01mm	6 each
24.	Digital Micrometer least count. 0.01mm	6 each
25.	Digital paint thickness meter for steel 500 micronsRange	3
26.	GI tray 600x450x50mm, 450x300x40mm,300x250x40mm	3 Nos each
27.	Electric Motor mixer 0.25 cum capacity	4
28.	Rebound hammer test digital rebound hammer	4
29.	Screw gauge 0.1mm-10mm, least count 0.05	6
30.	Water testing kit	3
31.	Motorized sieve shaker	3
32.	Pruning Rods 2 Kg weight length 40 cm and ramming face 25 mm2	4
33.	Extra Bottom plates for 15 cm cube mould	30
34.	Standard Vibration Table for gauging the cubes	2
35.	Pocket concrete penetrometer 0 to 50kg/ sq.cm	2
36.	Concrete temperature measuring thermometer with Brass protection sheath 0- 100 degree centigrade	4
37.	Mortar Cube vibrator	2
38.	Dial type spring balance preferable with zero correction knob capacity 100 kgs. reading to ½ kg.	2
39.	Counter scale capacity 1 kg and 10 kg	2
40.	Iron Weight of 5 kg, 2 kg, 1 kg, 500 gm, 20 gm, 100 gm	2each
41.	Brass Weight of 50 gm, 2 gm, 10 gm, 5 gm, 2 gm, 1 gm	2each
42.	Measuring cylinder TPX or Poly propylene capacity 100 ml, 500 ml, 250 ml, 100 ml	2each
43.	Pyrex, corning or Borosil beakers with cover capacity 500 ml, 20 ml, 50 ml	3 each
44.	Wash Bottles capacity 500 ml	12
45.	Thermometers 1-100 degree centigrade / max. and Min/ Dry and wet with table	6
46.	Set of box spanner ratchet	3
47.	Hammer 1lb& 2lb	3 each
48.	Distance metre (of 100 metre)	2
49.	Hacksaw with 6 blades	3

50.	Measuring tape (5 metre)	4
51.	Depth gauge 2 cm	6
52.	Shovels& Spade	6
53.	Steel plates 5 mm thick 75x75 cm	6
54.	Plastic or G.I. Buckets 15 ltr, 10 ltr, 5 ltr	3each
55.	Wheel Barrow	12
56.	Floor Brushes, hair dusters, scrappers, wire brush, paint brushes, shutter steel plat oil, kerosene with stove etc.	12each
57.	Any other equipment for site tests as outlined in BIS and other relevant codes/specifications and as directed by the Engineer-in-charge.	-

Appendix 'XV-B'

SUGGESTIVE LIST OF PLANT AND EQUIPMENT AT SITE

Sl. No.	Equipment	Numbers
1.	Builders hoist	4
2.	Centralized concrete batch mix plant of minimum capacity 30 cum per hour (fully automatic with computerised control)	As per requirement
3.	Excavator cum loader (JCB 3D model or equivalent).	4
4.	Compressor machine minimum 20 CFM with rock Breaker.	4
5.	DG set of minimum capacity 62.5 KVA.	3
6.	Mini batching plant (6 cum./hr.).	2
7.	Transit mixers.	As per requirement
8.	Concrete pump	4
9.	Needle Vibrators.	10
10.	Screed leveler.	5
11.	Plate Vibrator	10
12.	Automatic Ring making machine(Reinforcement)	8
13.	Dumper/Tipper	8
14.	Reinforcement bending machine.	8
15.	Reinforcement cutting machine.	8
16.	Power driven earth rammer (Soil compactor).	4
17.	Total station.	2
18.	Water tanker (Minimum capacity of 5000 liters)	4
19.	Welding machine 400 Ampere	5
20.	Screener for coarse sand and fine sand	5
21.	Centrifugal mono block water pump minimum capacity 2 HP	5
22.	Road roller 8 to 10 tons	1
23.	Vibratory roller	1
24.	Drilling machine	5 Nos.
25.	Shuttering with necessary props	50000 sq.mt.
26.	Double steel scaffolding and staging materials	20000 sq.mt.
27.	Air compressor	3Nos.

28.	Floor grinding/polishing machines	5Nos.
29.	Granite cutting machine	4 Nos.
30.	Ceramic tile cutting machine	10 Nos.
31.	Granite polishing machine	4Nos.
32.	Granite hand polishing machine	4 Nos.
33.	Mobile tower crane	6 Nos.
34.	Desktop Computers (All in one),	6 Nos.
35.	Laptop / IPAD for recording measurements at site.	4 Nos
36.	Inspection Vehicle for coordination with various agencies and delivery of samples for Third Party Labs.	2 Nos.
37.	Mobile Phones (with camera) for communication and instant photos	8 Nos.
38.	Good quality Camera for taking photographs and video recording of major activities for record purpose and for quality assurance.	2 Nos.
39.	Any other machinery required for completion of the work as per decision of Engineer-in-charge.	As per Actual requirement

Note: 1.The above list is only indicative and not exhaustive. The Bidder may be required to deploy more T&P as per requirement of work and as and when directed by Engineer-in-Charge.

2. All the above plants & equipments are to be deployed as and when required or directed by Engineer-in-Charge.

APPENDIX – XVI

(Refer Clause 5.4)

FORM OF APPLICATION BY THE CONTRACTOR FOR SEEKING RESCHEDULING OF MILESTONES

1. Name of contractor

2. Name of work as given in the agreement

3. Agreement no

4. Estimated amount put tender

5. Date of commencement of work as per agreement

6. Period allowed for completion of work as per agreement

7. Date of completion stipulated in agreement

8. Rescheduling of milestones done previously

Milestone No. Already Rescheduled	Letter no. and date	Rescheduling of Milestones Done	
		Original Date	Rescheduled Date
(a) 1st Milestone			
(b) 2nd Milestone			

Rescheduling of Milestone applied for

Milestone No. For which Rescheduling is Applied	Original/ Rescheduled Date	Details And Period of Hindrances	Comments of Engineer-in-charge or his authorized representative	Proposed Rescheduled Date of
A) Ist Milestone				
B) 2nd Milestone				

Submitted to the Engineer-in-charge or his authorized representative

Signature of Contractor

Dated

Appendix-XVI-A

(Refer Clause 5)

Form of application by the Contractor for seeking Extension of Time

1. Name of contractor
2. Name of work as given in the agreement
3. Agreement no
4. Estimated amount put tender
5. Date of commencement of work as per agreement
6. Period allowed for completion of work as per agreement
7. Date of completion stipulated in agreement
8. Period for which extension of time if has been given by authority in schedule 'F' previously

	Letter No. And date	Extension granted	
		Months	Days
(a) 1st extension			
(b) 2nd extension			
(c) 3rd extension			
(d) 4th extension			
(e) Total extension previously given			

9. Reasons for which extension have been previously given (copies of the previous applications should be attached)
10. Period for which extension if applied for
11. Hindrances on account of which extension is applied for with dates on which hindrances occurred and the period for which these are likely to last (for cause under clause 5.2/ and 5.3)

Submitted to the authority indicated in schedule F with copy to the Engineer –in –charge.

Signature of contractor

Dated

Appendix-XVII
Notice for appointment of Arbitrator
[Refer clause 25]

To

The

……

Dear Sir,

In terms of clause 25 of the agreement, particulars of which are given below, I/we hereby give notice to you to appoint an arbitrator for settlement of disputes mentioned below:

1. Name of applicant
2. Whether applicant is Individual/Prop. Firm/Partnership Firm/Ltd. Co.
3. Full address of the applicant
4. Name of the work and contract number in which arbitration sought
5 Name of the Division which entered into contract
6. Contract amount in the work
7. Date of contract
8. Date of contract Date of initiation of work
9. Stipulated date of completion of work
10. Actual date of completion of work (if completed)
11. Total number of claims made
12. Total amount claimed
13. Date of intimation of final bill (if work is completed)
14. Date of payment of final bill (if work is completed)
15. Amount of final bill (if work is completed)
16. Date of request made to Reviewing Authority for decision
17. Date of receipt of Reviewing Authority's decision
18. Date of appeal to you
19. Date of receipt of your decision.

Specimen signatures of the applicant

(Only the person/authority who signed the contract should sign)

I/We certify that the information given above is true to the best of my/our knowledge. I/We enclose following documents.

1. Statement of claims with amount of claims.
2.
3.
4.

Yours faithfully,

Copy in duplicate to:

1. The Engineer –in-charge

Appendix XVIII

Undertaking by the Contractor to have complied with the provisions of Contract Labour (Regulation & Abolition) Act & Rules, EPF and ESI Obligations.

(To be submitted alongwith each RA/ Final Bill)
(Clause 7)

I …… S/o Sh. …….
Authorized representative of M/s …….. do hereby declare and undertake as under:

1. That in the capacity of independent Contractor for M/s HLL Lifecare Ltd. at ……., Contractor engaged by me on behalf of RIPANS for the above said work, if any, have complied with the provisions of Contract Labour (Regulation & Abolition) Act, 1970 by holding a valid license under the Act and Rules thereto. I have paid the wages for the month of …… .
   These wages are not less than the minimum rates applicable to all the employees and no other dues are payable to any employee.
2. That I and the sub-contractor engaged by me for the above said work, if any , have covered all the eligible employees under Employees Provident Funds and Miscellaneous Provisions Act, 1952 and the Employees State Insurance Act, 1948 and deposited the Contributions for the months up to ……. And as such no amount towards EPF/ESI contributions, whatsoever is payable, is pending.
3. I, further declare and undertake that in case any liablity pertaining to my employees or towards employees of the sub-contractor engaged by me for the above said work, if any, arises in future, I shall be fully responsible for all consequences. In case, any Liability is discharged by Client/HLL Lifecare Ltd. due to my/ my sub-contractor's lapse. I undertake to reimburse the same or Client/HLL Lifecare Ltd. is authorized to deduct the same from my dues at this Project or at any other Project.

Authorized Signatory

(Name & Seal of Company)

Date:_____

Witness:

1. _____
2. _____

Appendix-XX

INDENTURE FOR SECURED ADVANCES (Clause 10 B)

THIS INDENTURE made the…… day of ……..20……. BETWEEN …… (hereinafter called the Contractor which expression shall where the context so admits or implies be deemed to include his executors administrators and assigns) of the one part and the HLL Lifecare Limited (hereinafter called the HLL which expression shall where the context so admits or implies be deemed to include his successors in office and assigns) of the other part.

WHEREAS by an agreement dated…… (hereinafter called the said agreement) the Contractor has agreed AND WHEREAS the Contractor has applied to the HLL that he may be allowed advances on the security of materials absolutely belonging to him and brought by him to the site of the works the subject of the said agreement for use in the construction of such of the works as he has undertaken to execute at rates fixed for the finished work (inclusive of the cost of materials and labour and other charges) AND WHEREAS the President has agreed to advance to the Contractor the sum of Rupees …… on the security of materials the quantities and other particulars of which are detailed in Accounts of Secured Advances attached to the Running Account Bill for the said works signed by the Contractor on ……and the HLL has reserved to himself the option of making any further advance or advances on the security of other materials brought by the Contractor to the site of the said works. Now THIS INDENTURE WITNESSETH that in pursuance of the said agreement and in consideration of the sum of Rupees ……on or before the execution of these presents paid to the Contractor by the HLL (the receipt whereof the Contractor doth hereby acknowledge) and of such further advances (if any) as may be made to him as aforesaid the Contractor doth hereby covenant and agree with the HLL and declare as follows: -

(1) That the said sum of Rupees ……..so advanced by the HLL to the Contractor as aforesaid and all or any further sum or sums advanced as aforesaid shall be employed by the Contractor in or towards expediting the execution of the said works and for no other purpose whatsoever.

(2) That the materials detailed in the said Account of Secured Advances which have been offered to and accepted by the HLL as security are absolutely the Contractor's own property and free from encumbrances of any kind and the contractor will not make any application for or receive a further advance on the security of materials which are not absolutely his own property and free from encumbrances of any kind and the Contractor indemnifies the HLL against all claims to any materials in respect of which an advance has been made to him as aforesaid.

(3) That the materials detailed in the said Account of Secured Advances and all other materials on the security of which any further advance or advances may hereafter be made as aforesaid (hereinafter called the said materials) shall be used by the Contractor solely in the execution of the said works in accordance with the directions of the Engineer-In-Charge and in the term of the said agreement.

(4) That the Contractor shall make at his own cost all necessary and adequate arrangements for the proper watch, safe custody and protection against all risks of the said materials and that until used in construction as aforesaid the said materials shall remain at the site of the said works in the Contractor's custody and on his own responsibility and shall at all times be open to inspection by the Engineer-In-Charge or any officer authorised by him. In the event of the said materials or any part thereof being stolen, destroyed or damaged or becoming deteriorated in a greater degree than is due to reasonable use and wear thereof the Contractor will forthwith replace the same with other materials of like quality or repair and make good the same as required by the Engineer-In-Charge.

(5) That the said materials shall not on any account be removed from the site of the said works except with the written permission of the Engineer-In-Charge or an officer authorised by him on that behalf.

(6) That the advances shall be repayable in full when or before the Contractor receives payment from the HLL of the price payable to him for the said works under the terms and provisions of the said agreement. Provided that if any intermediate payments are made to the Contractor on account of work done than on the occasion of each such payment the HLL will be at liberty to make a recovery from the Contractor's bill for such payment by deducting there from the value of the said materials then actually used in the construction and in respect of which recovery has not been made previously, the value for this purpose being determined in respect of each description of materials at the rates at which the amounts of the advances made under these presents were calculated.

(7) That if the Contractor shall at any time make any default in the performance or observance in any respect of any of the terms and provisions of the said agreement or of these presents the total amount of the advance or advances that may still be owing to the HLL shall immediately on the happening of such default be repayable by the Contractor to the HLL together with interest thereon at twelve per cent per annum from the date or respective dates of such advance or advances to the date of repayment and with all costs charges, damages and expenses incurred by the HLL in or for the recovery thereof or the enforcement of this security or otherwise by reason of the default of the Contractor and the Contractor hereby covenants and agrees with the HLL to repay and pay the same respectively to him accordingly.

(8) That the Contractor hereby charges all the said materials with the repayment to the HLL of the said sum of Rupees ……and any further sum or sums advanced as aforesaid and all costs charges, damages and expenses payable under these presents PROVIDED ALWAYS and it is hereby agreed and declared that notwithstanding anything in the said agreement and without prejudice to the powers contained therein if and whenever the covenant for payment and repayment herein before contained shall become enforceable and the money owing shall not be paid in accordance therewith the HLL may at any time thereafter adopt all or any of the following courses as he may deem best :-

(a) Seize and utilize the said materials or any part thereof in the completion of the said works on behalf of the Contractor in accordance with the provisions in that behalf contained in the said agreement debiting the Contractor with the actual cost of effecting such completion and the amount due in respect of advances under these presents and crediting the Contractor with the value of work done as if he had carried it out in accordance with the said agreement and at the rates thereby provided. If the balance is against the Contractor he is to pay same to the HLL on demand.

(b) Remove and sell by public auction the seized materials or any part thereof and out of the moneys arising from the sale retain all the sums aforesaid repayable orpayable to the HLL under these presents and pay over the surplus (if any) to the Contractor.

(c) Deduct all or any part of the moneys owing out of the security deposit or any sum due to the Contractor under the said agreement.

(9) That except in the event of such default on the part of the Contractor as aforesaid interest on the said advance shall not be payable.

(10) That in the event of any conflict between the provisions of these presents and the said agreement the provisions of these presents shall prevail and in the event of any dispute or difference arising over the construction or effect of these presents the settlement of which has not been herein before expressly provided for the same shall be finally resolved as per provisions of clause 25 of the contract.

In witness whereof the said ……and ……by the order and under the direction of the HLL have hereunto set their respective hands the day and year first above written.

Signed, sealed and delivered by……..

the said contractor in the presence of

Signature ……

Witness Name …… ……..

Address ……..

Signed by……..

by the order and direction of the HLL

in the presence of

Signature ……

Witness Name …… ……..

Address ……..

SECTION-3

SAFETY CODE

1. Suitable scaffolds should be provided for workmen for all works that cannot safely be done from the ground, or from solid construction except such short period work as can be done safely from ladders. When a ladder is used an extra Mazdoor shall be engaged for holding the ladder and if the ladder is used for carrying materials as well suitable footholds and hand-hold shall be provided on the ladder and the ladder shall be given an inclination not steeper than ¼ to 1 (1/4 horizontal and 1 vertical).

2. Scaffolding of staging more than 3.6 m (12 ft.) above the ground or floor, swung or suspended from an overhead support or erected with stationary support shall have a guard rail properly attached or bolted, braced and otherwise secured atleast 90 cm (3 ft.) high above the floor or platform of such scaffolding or staging and extending along the entire length of the outside and ends thereof with only such opening as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.

3. Working Platforms, gangways and stairways should be so constructed that they should not sag unduly or unequally, and if the height of the platform or the gangway or the stairway is more than 3.6 m (12 ft.) above ground level or floor level, they should be closely boarded, should have adequate width and should be suitably fastened as described in (2) above.

4. Every opening in the floor of a building or in a working platform shall be provided with suitable means to prevent the fall of person or materials by providing suitable fencing or railing whose minimum height shall be 90 cm (3 ft.).

5. Safe means of access shall be provided to all working platforms and other working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m (30 ft) in length while the width between side rails in rung ladder shall in no case be less than 29 cm. (11 ½") for ladder upto and including 3 metre (10 ft.) in length. For longer ladders this width should be increased atleast ¼" for each additional 30 cm.(1 foot) of length. Uniform step spacing of not more than 30 cm shall be kept. Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the sites or work shall be so stacked or placed as to cause danger or inconvenience to any person or the public. The contractor shall provide all necessary fencing and lights to protect the public from accident and shall be bound to bear the expenses of defence of every suit, action or other proceedings at law that may be brought by any person for injury sustained owing to neglect of the above precautions and to pay any damages and cost which maybe awarded in any such suit, action or proceedings to any such person or which may, with the consent of the contractor, be paid to compensate any claim by any such person.

6. (a) Excavation and trenching- All trenches 1.2 m (4 ft,) or more in depth, shall at all times be supplied with at least one ladder for each 30 metre (100 ft) in length or fraction thereof. Ladder shall extend from bottom of the trench to at least 90 cm. (3 ft) above the surface of the ground. The sides of the trenches, which are 1.5 m (5 ft) or more in depth shall be stepped back to give suitable slope or securely held by timber bracing, so as to avoid the danger of sides collapsing. The excavated material shall not be placed within 1.5 m (5 ft) of the edges of the trench or half of the depth of the trench whichever is more. Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be done.

6. (b) Safety Measures for digging bore holes:-

   (i) If the bore well is successful, it should be safely capped to avoid caving and collapse of the bore well. The failed and the abandoned ones should be completely refilled to avoid caving and collapse;

   (ii) During drilling, Sign boards should be erected near the site with the address of the drilling contractor and the Engineer in-charge of the work;

   (iii) Suitable-fencing should be erected around the well during the drilling and after the installation of the rig on the point of drilling, flags shall be put 50m all-round the point of drilling to avoid entry of people;

(iv) After drilling the bore well, a cement platform (0.50m x 0.50m to 1.20m) 0.60m above ground level and 0.60m below ground level should be constructed around the well casing;

(v) After the completion of the bore well, the contractor should cap the bore well properly by welding steel plate, cover the bore well with the drilled wet soil and fix thorny shrubs over the soil. This should be done even while repairing the pump;

(vi) After the bore well is drilled the entire site should be brought to the ground level.

7. Demolition. - Before any demolition work is commenced and also during the progress of the work,

i) All roads and open areas adjacent to the work site shall either be closed or suitably protected.

ii) No electric cable or apparatus which is liable to be a source of danger or a cable or apparatus used by the operator shall remain electrically charged.

iii) All practical steps shall be taken to prevent danger to persons employed from risk of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.

8. All necessary personal safety equipment as considered adequate by the Engineer-in-Charge should be kept available for the use of the person employed on the site and maintained in a condition suitable for immediate use, and the contractor should take adequate steps to ensure proper use of equipment by those concerned. The following safety equipment shall invariably be provided.

i) Workers employed on mixing asphaltic materials, cement and lime mortars shall be provided with protective footwear and protective goggles.

ii) Those engaged in whitewashing and mixing or stacking of cement bags or any material, which is injurious to the eyes, shall be provided with protective goggles.

iii) Those engaged in welding works shall be provided with welder's protective eye shields.

iv) Stonebreakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.

v) When workers are employed in sewers and manholes, which are in active use, the contractors shall ensure that the manhole covers are opened and ventilated atleast for an hour before the workers are allowed to get into manholes and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to the public. In addition , the contractor shall ensure that the following safety measures are adhered to:-

a) Entry for workers into the line shall not be allowed except under supervision of the Engineer in Charge or any other higher officer.

b) At least 5 to 6 manholes upstream and downstream should be kept open for atleast 2 to 3 hours before any man is allowed to enter into the manhole for working inside.

c) Before entry presence of toxic gases should be tested by inserting wet lead acetate paper, which changes colour in the presence of such gases and gives indication of their presence.

d) Presence of oxygen should be verified by lowering a detector lamp into the manhole. In case, no oxygen is found inside the sewer line, worker should be send only with oxygen kit.

e) Safety belt with rope should be provided to the workers. While working inside the manhole such rope should be handled by two men standing outside to enable him to be pulled out during emergency.

f) The area should be barricaded or cordoned off by suitable means to avoid mishaps of any kind. Proper warning signs should be displayed for the safety of the public whenever for the cleaning works is undertaken during night or day.

g) No smoking or open flames shall be allowed near the blocked manhole being cleaned.

h) The malba obtained on account of cleaning of blocked manholes and sewer lines should be immediately removed to avoid accidents on account of slippery nature of the malba.

i) Workers should not be allowed to work inside the manhole continuously. He should be given rest intermittently. The Engineer-in-Charge may decide the time upto which worker may be allowed to work continuously inside the manhole.

j) Gas masks with Oxygen cylinder should be kept at site for use in emergency.

k) Air blowers should be used for flow of fresh air through the manholes. Whenever called for, portable air blowers are recommended for ventilating the manholes. The motors for these, shall be vapour proof and of totally enclosed type. Non-sparking gas engines also could be used but they should be placed at least 2 metres away from the opening and on the leeward side, protected from wind so that they will not be the source of friction on any inflammable gas that might be present.

l) The workers engaged for cleaning the manholes/sewers should be properly trained before allowing working in the manhole.

m) The worker shall be provided with Gumboots or non-sparking shoes bump helmets and gloves non-sparking tools and safety lights and gas masks and portable air-blowers (when necessary). They must be supplied with barrier cream for anointing the limits before working inside the sewer lines.

n) Workmen descending a manhole shall try each ladder stop or rung carefully before putting his full weight on it to guard against insecure fastening due to corrosion of the rung fixed to manhole well.

o) If a man has received a physical injury, he should be brought out of the sewer immediately and adequate medical aid should be provided to him.

p) The extent to which these precautions are to be taken depend on individual situation but the decision of the Engineer-in-Charge regarding the steps to be taken in this regard in an individual case will be final.

vi) The contractor shall not employ men and women below the age of 18 years on the work of painting with products containing lead in any form. Whenever men above the age of 18 years are employed on the work of lead painting, the following precautions should be taken: -

a) No paint containing lead or lead products shall be used except in the form of paste or readymade paint.

b) Suitable face masks should be supplied for use by the workers when paint is applied in the form of spray or a surface having lead paint is dry rubbed and scrapped.

c) Overalls shall be supplied by the contractors to the workmen and adequate facilities shall be provided to enable the working painters to wash during and on the cessation of work.

9. The Contractor shall not employ women and men below the age of 18 years on the work of painting with product containing lead in any form. Whenever men above the age of 18 are employed on the work of lead painting, the following principles must be observed for such use:

i) White lead, sulphate of lead or product containing these pigments, shall not be used in painting operation except in the form of pastes or paint ready for use.

ii) Measures shall be taken, wherever required in order to prevent danger arising from the application of paint in the form of spray.

iii) Measures shall be taken, wherever practicable to prevent danger arising out of from dust caused by dry rubbing down and scrapping.

iv) Adequate facilities shall be provided to enable working painters to wash during and on cessation of work

v) Overall shall be worn by working painters during the whole of working period.

vi) Suitable arrangement shall be made to prevent clothing put off during working hours being spoiled by painting materials.

vii) Cases of lead poisoning and suspected lead poisoning shall be notified and shall be subsequently verified by medical man appointed by the competent authority of Department.

viii) Department may require, when necessary, medical examination of workers.

ix) Instructions with regard to special hygienic precautions, to be taken in the painting trade, shall be distributed to working painters.

10. When the work is done near any place where there is risk of drowning, all necessary equipment should be provided & kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision, should be made for prompt first aid treatment of all injuries likely to be obtained during the course of the work.

11. Use of hoisting machines and tackle including their attachments, anchorage and supports shall conform to the following standards or conditions: -

    (i) (a) These shall be of good mechanical construction, sound materials and adequate strength and free from patent defects and shall be kept repaired and in good working order.

    (b) Every rope used in hoisting or lowering materials or as means of suspension shall be of durable quality and adequate strength, and free from patent defects.

    (ii) Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years should be in charge of any hoisting machine including any scaffolding winch or give signals to operator.

    (iii) In case of every hoisting machine and of every chain ring hook, shackle swivel and pulley blocks used in hoisting or as means of suspension the safe working load shall be ascertained by adequate means. Every hoisting machine and all gear referred to above shall be plainly marked with the safe working load. In case of hoisting machine having a variable safe working load each safe working load and the condition under which it is applicable shall be clearly indicated. No part of any machine or any gear, referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing.

    (iv) In case of departmental machines, the safe working load shall be notified by the Electrical Engineer-in-Charge. As regard contractor's machines the contractors shall notify the safe working load of the machines to the Engineer-in-Charge whenever he brings any machinery to the site of work and get it verified by the Electrical Engineer concerned.

12. Motors, gearing, transmission, electric wiring and other dangerous parts of hoisting appliances should be provided with efficient safeguards. Hoisting appliances should be provided with such means as will reduce to the minimum the risk of accidental descent of the load. Adequate precautions should be taken to reduce to the minimum the risk of any part of a suspended load becoming accidentally displaced. When workers are employed on electrical installations, which are already energized, insulating mats, wearing apparel, such as gloves, sleeves and boots, as may be necessary, should be provided. The worker should not wear any rings, watches and carry keys or other materials, which are good conductors of electricity.

13. All scaffolds ladders and other safety devices mentioned or described herein shall be maintained in safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use. Adequate washing facilities should be provided at or near places of work.

14. These safety provisions should be brought to the notice of all concerned by display on a notice board at a prominent place at work spot. The person responsible for compliance of the safety code shall be named therein by the contractor.

15. To ensure effective enforcement of the rules and regulations relating to safety precautions the arrangements made by the contractor shall be open to inspection by Labour Officer or the Engineer-in-Charge or their representatives.

16. Notwithstanding the above clauses from (1) to (15) there is nothing in these to exempt the contractor from the operations of any other Act or Rule in force in the Republic of India.

SECTION -4

RULES FOR THE PROTECTION OF HEALTH AND SANITARY ARRANGEMENTS FOR WORKERS EMPLOYED BY CONTRACTORS

1. APPLICATION

These rules shall apply to all buildings and construction works in charge of the Client in which twenty or more workers are ordinarily employed or are proposed to be employed in any day during the period during which the contract work is in progress.

2. DEFINITION

Work place means a place where twenty or more workers are ordinarily employed in connection with construction work, on any day during the period, during which the contract work is in progress.

3. FIRST-AID FACILITIES

i) At every work place there shall be provided and maintained, so as to be easily accessible during working hours, first aid boxes at the rate of not less than one box for 150-contract labour or part thereof ordinarily employed.

ii) The first-aid box shall be distinctly marked with a red cross on white back ground and shall contain the following equipment: -

a) For work places in which the number of contract labour employed does not exceed 50- Each first-aid box shall contain the following equipment: -

1. 6 small sterilised dressings.
2. 3 medium size sterilised dressings.
3. 3 large size sterilised dressings.
4. 3 large sterilised burn dressings.
5. 1 (30 ml.) bottle containing a two percent alcoholic solution of iodine
6. 1 (30ml) bottle containing salvolatile having the dose and mode of administration indicated on the label.
7. 1 snakebite lancet.
8. 1 (30gms.) bottle of potassium permanganate crystals.
9. 1 pair scissors.
10. 1 copy of the first-aid leaflet issued by the Director General, Factory Advice Service and Labour Institute, Government of India or his Client.
11. 1 Bottle containing 100 tablets (each of 5 gms.) of aspirin.
12. Ointment for burns.
13. A bottle of suitable surgical antiseptic solution

b) For workplaces in which the number of contract labour exceeds 50- Each first–aid- box shall contain the following equipment.

1. 12 small sterilized dressing.
2. 6 medium size sterilised dressings.
3. 6 large size sterilised dressings.
4. 6 large size sterilised burn dressings.
5. 6 (15-gms.) packets sterilised cotton wool.
6. 1 (60 ml.) bottle containing two percent alcoholic solution iodine.
7. 1 (60-ml.) bottle containing salvolatile having the dose and mode of administration indicated on the label.
8. 1 roll of adhesive plaster.

9. 1 snake bite lancet.
10. 1 (30 gms.) bottle of potassium permanganate crystals.
11. 1 pair of scissors.
12. 1 copy of the first-aid leaflet issued by the Director General Factory Advice Service and Labour Institute/ Government of India or Client of India.
13. A bottle containing 100 tablets (each of 5 gms.) of aspirin.
14. Ointment for burns.
15. A bottle of suitable surgical antiseptic solution.

iii) Adequate arrangements shall be made for immediate procurement of the equipment when necessary.

iv) Nothing except the prescribed contents shall be kept in the First-aid box.

v) The first-aid box shall be kept in charge of a responsible person who shall always be readily available during the working hours at the work place.

vi) A person in charge of the first-aid box shall be a person trained in First-Aid treatment, at the work places where the number of contract labour employed is 150 or more.

vii) In work places where the number of contract labour employed is 500 or more and hospital facilities are not available within easy distance from the works, First-aid posts shall be established and run by a trained compounder. The compounder shall be on duty and shall be available at all hours when the workers are at work.

viii) Where work places are situated in places, which are not towns or cities, a suitable motor transport shall be kept readily available to carry injured person or person suddenly taken ill to the nearest hospital.

4. DRINKING WATER

i) In every work place, there shall be provided and maintained, at suitable places, easily accessible to labour, a sufficient supply of cold water fit for drinking.

ii) Where drinking water is obtained from an intermittent public water supply, each work place shall be provided with storage where such drinking water shall be stored.

iii) Every water supply or storage shall be at a distance of not less than 50 feet from any latrine drain or other source of pollution. Where water has to be drawn from an existing well, which is within such proximity of latrine, drain or any other source of pollution, the well shall be properly chlorinated before water is drawn from it or for drinking. All such wells shall be entirely closed in and be provided with a trap door, which shall be dust and waterproof.

iv) A reliable pump shall be fitted to each covered well, the trap door shall be kept locked and opened only for cleaning or inspection which shall be done at least once a month.

5. WASHING FACILITIES

i) In every work place adequate and suitable facilities for washing shall be provided and maintained for the use of contract labour employed therein.

ii) Separate and adequate cleaning facilities shall be provided for the use of male and female workers.

iii) Such facilities shall be conveniently accessible and shall be kept in clean and hygienic condition.

6. LATRINES AND URINALS

i) Latrines shall be provided in every work place on the following scale namely:-

a) Where female are employed there shall be at least one latrine for every 25 females.

b) Where males are employed, there shall be at least one latrine for every 25 males.

Provided that where the number of males or females exceeds 100, it shall be sufficient if there is one latrine for 25 males or females as the case may be upto the first 100, and one for every 50 thereafter.

ii) Every latrine shall be under cover and so partitioned off as to secure privacy, and shall have a proper door and fastenings.

iii) Construction of latrines: The inside walls shall be constructed of masonry or some suitable heat-resisting nonabsorbent materials and shall be cement washed inside and outside at least once a year. Latrines shall not be of a standard lower than bore-hole system.

iv) a) Where workers of both sexes are employed, there shall be displayed outside each block of latrine and urinal, a notice in the language understood by the majority of the workers "For Men only" or "For Women only" as the case may be.

b) The notice shall also bear the figure of a man or a woman, as the case may be.

v) There shall be at least one urinal for upto 50 number of male workers and one for upto 50 number of female workers employed at a time, provided that where the number of male or female workers, as the case may be, exceeds 500, it shall be sufficient if there is one urinal for every 50 males or females, upto the first 500 and one for every 100 or part thereafter.

vi) a) The latrines and urinals shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times.

b) Latrines and urinals other than those connected with a flush sewage system shall comply with the requirements of the Public Health Authorities.

vii) Water shall be provided by means of tap or otherwise so as to be conveniently accessible in or near the latrines and urinals.

viii) Disposal of excreta: - Unless otherwise arranged for by the local sanitary authority, arrangements for proper disposal of excreta by incineration at the work place shall be made by means of a suitable incinerator. Alternately excreta may be disposed off by putting a layer of night soil at the bottom of a pucca tank prepared for the purpose and covering it with a 15 cm. layer of waste or refuse and then covering it with a layer of earth for a fortnight (When it will turn to manure).

ix) The contractor shall at his own expense, carry out all instructions issued to him by the Engineer-in-Charge to effect proper disposal of night soil and other conservancy work in respect of the contractor's workmen or employees on the site. The contractor shall be responsible for payment of any charges, which may be levied by Municipal or Cantonment Authority for execution of such on his behalf.

7. PROVISION OF SHELTER DURING REST

At every place there shall be provided, free of cost, four suitable sheds, two for meals and the other two for rest separately for the use of men and women labour. The height of each shelter shall not be less than 3 metres (10 ft.) from the floor level to the lowest part of the roof. These shall be kept clean and the space provided shall be on the basis of 0.6 sq. m. (6 sft.) per head.

Provided that the Engineer-in-Charge may permit subject to his satisfaction, a portion of the building under construction or other alternative accommodation to be used for the purpose.

8. CRECHES

i) At every work place, at which 20 or more women worker are ordinarily employed, there shall be provided two rooms of reasonable dimensions for the use of their children under the age of six years. One room shall be used as a playroom for the children and the other as their bedroom. The rooms shall be constructed with specifications as per clause 19 H (ii) a, b & c.

ii) The rooms shall be provided with suitable and sufficient openings for light and ventilation. There shall be adequate provision of sweepers to keep the places clean.

iii) The contractor shall supply adequate number of toys and games in the playroom and sufficient number of cots and beddings in the bedroom.

iv) The contractor shall provide one ayah to look after the children in the crèche when the number of women workers does not exceed 50 and two when the number of women workers exceeds 50.

v) The use of the rooms earmarked as crèches shall be restricted to children, their attendants and mothers of the children.

9. CANTEENS

i) In every work place where the work regarding the employment of contract labour is likely to continue for six months and where in contract labour numbering one hundred or more are ordinarily employed, an adequate canteen shall be provided by the contractor for the use of such contract labour.

ii) The contractor shall maintain the canteen in an efficient manner.

iii) The canteen shall consist of atleast a dining hall, kitchen, storeroom, pantry and washing places, separately for workers and utensils.

iv) The canteen shall be sufficiently lighted at all times when any person has access to it.

v) The floor shall be made of smooth and impervious materials and inside walls shall be lime-washed or colour washed atleast once in each year. Provided that the inside walls of the kitchen shall be lime-washed every 4 months.

vi) The premises of the canteen shall be maintained in a clean and sanitary condition.

vii) Wastewater shall be carried away in suitable covered drains and shall not be allowed to accumulate so as to cause a nuisance.

viii) Suitable arrangements shall be made for the collection and disposal of garbage.

ix) The dining hall shall accommodate at a time 30 percent of the contract labour working at a time.

x) The floor area of the dining hall, excluding the area occupied by the service counter and any furniture, except tables and chairs, shall not be less than one square metre (10 sft.) per diner to be accommodated as prescribed in sub-Rule 9.

xi)

a) A portion of the dining hall and service counter shall be partitioned off and reserved for women workers in proportion to their number.

b) Washing places for women shall be separate and screened to secure privacy.

xii) Sufficient tables' stools, chair or benches shall be available for the number of diners to be accommodated as prescribed in sub-Rule 9.

xiii) a)

1. There shall be provided and maintained, sufficient utensils, crockery, furniture and any other equipment's, necessary for the efficient running of the canteen.
2. The furniture utensils and other equipment shall be maintained in a clean and hygienic condition.

b)

1. Suitable clean clothes for the employees serving in the canteen shall be provided and maintained.
2. A service counter, if provided, shall have top of smooth and impervious material.
3. Suitable facilities including an adequate supply of hot water shall be provided for the cleaning of utensils and equipment's.

xiv) The foodstuffs and other items to be served in the canteen shall be in conformity with the normal habits of the contract labour.

xv) The charges for foodstuffs, beverages and any other items served in the canteen shall be based on 'No profit, No loss' and shall be conspicuously displayed in the canteen.

xvi) In arriving at the price of food stuffs, and other articles served in the canteen, the following items shall not be taken into consideration as expenditure namely: -

a) The rent of land and building.

b) The depreciation and maintenance charge for the building and equipment's provided for the canteen.

c) The cost of purchase, repairs and replacement of equipment's including furniture, crockery, cutlery and utensils.

d) The water charges and other charges incurred for lighting and ventilation.

e) The interest and amounts spent on the provision and maintenance of equipment's provided for the canteen.

xvii) The accounts pertaining to the canteen shall be audited once every 12 months by registered accountants and auditors.

10. ANTI-MALARIAL PRECAUTIONS

The contractor shall at his own expense, conform to all anti-malarial instructions given to him by the Engineer-in-Charge including the filling-up of any borrow pits which may have been dug by him.

11. The above rules shall be incorporated in the contracts and in notices inviting tenders and shall form an integral part of the contracts.

12. AMENDMENTS

Department may, from time to time, add to or amend these rules and issue directions it may consider necessary for the purpose of removing any difficulty, which may arise in the administration thereof.

SECTION-5

CONTRACTOR'S LABOUR REGULATIONS TO BE FOLLOWED IN THIS PROJECT

1. SHORT TITLE

These regulations may be called the Contractors Labour Regulations and shall be followed by the Contractor for this Project.

2. DEFINITIONS

i) **Workman** means, any person employed by Department or its contractor directly or indirectly, through a subcontractor, with or without the knowledge of the Department, to do any skilled, semiskilled or unskilled, manual, supervisory, technical or clerical work, for hire or reward, whether the terms of employment are expressed or implied, but does not include any person: -

a) Who is employed mainly in a managerial or administrative capacity; or,

b) Who, being employed in a supervisory capacity draws wages exceeding five hundred rupees per mensem or exercises either by the nature of the duties attached to the office or by reason of powers vested in him, functions mainly of managerial nature; or,

c) Who is an out worker, that is to say, person to whom any article or materials are given out by or on behalf of the principal employers to be made up cleaned, washed, altered, ornamental finished, repaired adopted or otherwise processed for sale for the purpose of the trade or business of the principal employers and the process is to be carried out either in the home of the out worker or in some other premises, not being premises under the control and management of the principal employer.

No person below the of 14 years shall be employed to act as a workman

ii) **Fair Wages** means wages whether for time or piecework fixed and notified under the provision of the Minimum Wages Act from time to time.

iii) **Contractors** shall include every person who undertakes to produce a given result other than a mere supply of goods or articles of manufacture through contract labour or who supplies contract labour for any work and includes a subcontractor.

iv) **Wages** shall have the same meaning as defined in the Payment of Wages Act.

3.

i) Normally working hours of an adult employee should not exceed 9 hours a day. The working day shall be so arranged that inclusive of interval for rest, if any, it shall not spread over more than 12 hours on any day.

ii) When an adult worker is made to work for more than 9 hours on any day or for more than 48 hours in any week he shall be paid over time for the extra hours put in by him at double the ordinary rate of wages.

iii) a) Every worker shall be given a weekly holiday normally on a Sunday, in accordance with the provisions of Minimum Wages (Central) Rules 1960, as amended from time to time, irrespective of whether such worker is governed by the Minimum Wages Act or not.

b) Where the minimum wages prescribed by the Government, under the Minimum Wages Act, are not inclusive of the wages for the weekly day of rest, the worker shall be entitled to rest day wages, at the rate applicable to the next preceding day, provided he has worked under the same contractor for a continuous period of not less than 6 days.

c) Where a contractor is permitted by the Engineer-in-Charge to allow a worker to work on a normal weekly holiday, he shall grant a substituted holiday to him for the whole day, on one of the five days, immediately before or after the normal weekly holiday, and pay wages to such worker for the work performed on the normal weekly holiday at the overtime rate.

4. DISPLAY OF NOTICE REGARDING WAGES ETC.

The contractor shall, before he commences his work on contract, display and correctly maintain and continue to display and correctly maintain, in a clear and legible condition in conspicuous places on the

work, notices in English and in local Indian languages spoken by the majority of the workers, giving the minimum rates of the wages fixed under Minimum Wages Act, the actual wages being paid, the hours of work for which such wage are earned, wages periods, dates of payments of wages and other relevant information as per Appendix 'lll'.

5. PAYMENT OF WAGES.

i) The contractor shall fix wage periods in respect of which wages shall be payable.

ii) No wage period shall exceed one month.

iii) The wages of every person employed as contract labour in an establishment or by a contractor, where less than one thousand such persons are employed, shall be paid before the expiry of seventh day and in other cases before the expiry of tenth day after the last day of the wage period in respect of which the wages are payable.

iv) Where the employment of any worker is terminated by or on behalf of the contractor the wages earned by him shall be paid before the expiry of the second working day from the date on which his employment is terminated.

v) All payment of wages shall be made on a working day at the work premises and during the working time and on a date notified in advance and in case the work is completed before the expiry of the wage period, final payment shall be made within 48 hours of the last working day.

vi) Wages due to every worker shall be paid to him direct or to other person authorised by him in this behalf.

vii) All wages shall be paid in current coin or currency or in both.

viii) Wages shall be paid without any deductions of any kind except those specified by the Central Government by general or special order in this behalf or permissible under the Payment of Wages Act 1956.

ix) A notice showing the wages period and the place and time of disbursement of wages shall be displayed at the place of work and a copy sent by the contractor to the Engineer-in-Charge under acknowledgement.

x) It shall be the duty of the contractor to ensure the disbursement of wages in presence of authorised representative of the Engineer-in-Charge who will be required to be present at the place and time of the disbursement of wages by the contractor to workmen.

xi) The contractor shall obtain from the junior engineer or any other authorised representative of the Engineer-in-Charge, as the case may be, a certificate under his signature at the end of the entries in the "Register of Wages" or the "Wage-cum-Muster Roll", as the case may be, in the following form: -

"Certified that the amount shown in the column No……has been paid to the workman concerned in my presence on……..…..at……"

6. FINES AND DEDUCTIONS WHICH MAY BE MADE FROM WAGES

(i) The wages of a worker shall be paid to him without any deduction of any kind except the following: -

(a) Fines

(b) Deductions for absence from duty i.e. from the place or the places where by the terms of his employment he is required to work. The amount of deduction shall be in proportion to the period for which he was absent.

(c) Deductions for damage to or loss of goods expressly entrusted to the employed person for custody, or for loss of money or any other deductions which he is required to account, where such damage or loss is directly attributable to his neglect or default.

(d) Deduction for recovery of advances or for adjustment of overpayment of wages, advances granted shall be entered in a register.

(e) Any other deduction, which the Central Government may from time to time, allows.

(ii) No fines should be imposed on any worker save in respect of such acts and omissions on his part as have been approved of by the Chief Labour Commissioner.

Note:- An approved list of Acts and Omission for which fines can be imposed is enclosed at Appendix-1.

(iii) No fine shall be imposed on a worker and no deduction for damage or loss shall be made from his wages until the worker has been given an opportunity of showing cause against such fines or deductions.

(iv) The total amount of fine, which may be imposed, in any one-wage period, on a worker, shall not exceed an amount equal to three paise in a rupee of the total wages, payable to him in respect of that wage period.

(v) No fine imposed on any worker shall be recovered from him by instalment, or after the expiry of sixty days from the date on which it was imposed.

(vi) Every fine shall be deemed to have been imposed on the day of the act or omission in respect of which it was imposed.

7. LABOUR RECORDS

(i) The contractor shall maintain a **Register of Persons employed** on work on contract in Form XIII of the CL (R&A) Central Rules 1971 (Appendix IV)

(ii) The contractor shall maintain a **Muster Roll** register in respect of all workmen employed by him on the work under Contract in Form XVI of the CL (R&A) Rules 1971 (Appendix V)

(iii) The contractor shall maintain a **Wage Register** in respect of all workmen employed by him on the work under contract in Form XVII of the CL (R&A) Rules 1971 (Appendix VI)

(iv) Register of accident – The contractor shall maintain a register of accidents in such form as may be convenient at the work place but the same shall include the following particulars:

a) Full Particulars of the labourers who met with accident.
b) Rate of wages.
c) sex
d) Age
e) Nature of accident and cause of accident
f) Time and date of accident
g) Date and time when admitted in hospital
h) Date of discharge from the hospital
i) Period of treatment and result of treatment
j) Percentage of loss of earning capacity and disability as assessed by Medical Officer.
k) Claim required to be paid under Workmen's Compensation Act.
l) Date of payment of compensation
m) Amount paid with details of the person to whom the same was paid
n) Authority by whom the compensation was assessed
o) Remarks.

(v) The contractor shall maintain a **Register of Fines** in the Form XII of the CL (R&A) Rules 1971 (Appendix XI)

The contractor shall display in a good condition and in a conspicuous place of work the approved list of acts and omission for which fines can be imposed (Appendix X)

(vi) The contractor shall maintain a **Register of deductions for damage or loss** in Form XX of the CL (R&A) Rules 1971 (Appendix XII).

(vii) The contractor shall maintain a **Register of Advances** in Form XXIII of the CL (R&A) Rules 1971 (Appendix-XIII).

(viii) The contractor shall maintain a **Register of Overtime** in Form XXIII of the CL (R&A) Rules 1971 (Appendix-XIV).

8. ATTENDANCE CARD-CUM WAGE SLIP

(i) The contractor shall issue an **Attendance card cum wage slip** to each workman employed by him in the specimen form at (Appendix-VII).

(ii) The card shall be valid for each wage period.

(iii) The contractor shall mark the attendance of each workman on the card twice each day, once at the commencement of the day and again after the rest interval, before he actually starts work.

(iv) The card shall remain in possession of the worker during the wage period under reference.

(v) The contractor shall complete the wage slip portion on the reverse of the card at least a day prior to the disbursement of wages in respect of the wage period under reference.

(vi) The contractor shall obtain the signature or thumb impression of the worker on the wage slip at the time of disbursement of wages and retain the card with him.

9. EMPLOYMENT CARD

The contractor shall issue an **Employment Card** in the Form XIV of CL (R&A) Central Rules 1971 to each worker within three days of the employment of the worker (Appendix-VIII).

10. SERVICE CERTIFICATE

On termination of employment for any reason whatsoever the contractor shall issue to the workman whose services have been terminated, a Service Certificate in the Form XV of the CL (R&A) Central Rules 1971 (Appendix-IX).

11. PRESERVATION OF LABOUR RECORDS

All records required to be maintained under Regulations Nos. 6 &7 shall be preserved in original for a period of three years from the date of last entries made in them and shall be made available for inspection by the Engineer-in-Charge or Labour Officer or any other officers authorised by the Department this behalf.

12. POWER OF LABOUR OFFICER TO MAKE INVESTIGATIONS OR ENQUIRY

The labour officer or any person authorised by the Central Government on their behalf shall have power to make enquiries with a view to ascertaining and enforcing due and proper observance of Fair Wage Clauses and provisions of these Regulations. He shall investigate into any complaint regarding the default made by the contractor or subcontractor in regard to such provision.

13. REPORT OF LABOUR OFFICER

The Labour Officer or other persons authorised as aforesaid shall submit a report of result of his investigation or enquiry to the Engineer in charge concerned indicating the extent, if any, to which the default has been committed with a note that necessary deductions from the contractor's bill be made and the wages and other dues be paid to the labourers concerned. In case an appeal is made by the contractor under Clause 13 of these regulations, actual payment to labourers will be made by the Engineer in charge after the Client / HLL has given his decision on such appeal.

i) Engineer in charge shall arrange payments to the labour concerned within 45 days from the receipt of the report form or the Client / HLL as the case may be the Labour Officer

14. APPEAL AGAINST THE DECISION OF LABOUR OFFICER

Any person aggrieved by the decision and recommendations of the Labour Officer or other person so authorised may appeal against such decision to the Client / HLL concerned within 30 days from the date of decision, forwarding simultaneously a copy of his appeal to the Executive Engineer concerned but subject to such appeal, the decision of the officer shall be final and binding upon the contractor.

15. PROHIBITION REGARDING REPRESENTATION THROUGH LAWYER

i) A workman shall be entitled to be represented in any investigation or enquiry under these regulations by: -

a) An officer of a registered trade union of which he is a member.

b) An officer of a federation of trade unions to which the trade union referred to in Clause (a) is affiliated.

c) Where the employer is not a member of any registered trade union, by an officer of a registered trade union, connected with the industry in which the worker is employed or by any other workman employed in the industry in which the worker is employed.

ii) An employer shall be entitled to be represented in any investigation or enquiry under these regulations by:-

a) An officer of an association of employers of which he is a member.

b) An officer of a federation of associations of employers to which association referred to in Clause (a) is affiliated.

c) Where the employer is not a member of any association of employers, by an officer of association of employer connected with the industry, in which the employer is engaged or by any other employer, engaged in the industry in which the employer is engaged.

iii) No party shall be entitled to be represented by a legal practitioner in any investigation inquiry under these regulations.

16. INSPECTION OF BOOKS AND SLIPS

The contractor shall allow inspection of all the prescribed labour records to any of his workers or to his agent at a convenient time and place after due notice is received or to the Labour Officer or any other person, authorised by the Central Government on his behalf.

17. SUBMISSION OF RETURNS

The contractor shall submit periodical returns as may be specified from time to time.

18. AMENDMENTS

The Central Government/HLL may from time to time add to or amend the regulations and on any question as to the application/interpretation or effect of those regulations the decision of the EIC concerned shall be final.

Appendix 'I'

REGISTER OF MATERNITY BENEFITS (Clause 19F)

Name and address of the contractor_____

Name and Location of the work_____

Name of the Employee	Father's/ husband's name	Nature of Employment	Period of actual confinement	Date on which notice of confinement given
1	2	3	4	5

Date on which maternity leave commenced and ended				
Date of Delivery/ Miscarriage	In case of delivery		In case of miscarriage	
	Commenced	Ended	Commenced	Ended
6	7	8	9	10

Leave pay paid to the employee				Remarks
In case of delivery		In case of miscarriage		
Rate of leave pay	Amount paid	Rate of leave pay	Amount paid	
11	12	13	14	15

Appendix 'II'

SPECIMEN FORM OF THE REGISTER, REGARDING MATERNITY BENEFIT ADMISSIBLE TO THE CONTRACTOR'S LABOUR

Name and address of the contractor_____

Name and location of the work_____

1. Name of the woman and her husband's name.
2. Designation
3. Date of appointment.
4. Date with months and years in which she is employed.
5. Date of discharge / dismissal, if any.
6. Date of production of certificates in respect of pregnancy.
7. Date on which the woman informs about the expected delivery.
8. Date of delivery / miscarriage / death.
9. Date of production of certificates in respect of delivery / miscarriage.
10. Date with the amount of maternity/ death benefit paid in advance of expected delivery.
11. Date with amount of subsequent payment of maternity benefit.
12. Name of the person nominated by the woman to receive the payment of the maternity benefit after her death.
13. If the woman dies, the date of death, the name of the person to whom maternity benefit amount was paid, the month thereof and the date of payment.
14. Signature of the contractor authenticating entries in the register.
15. Remarks column for the use of inspecting officer.

Appendix 'III'

LABOUR BOARD

Name of work:_____

Name of Contractor:_____

Address of Contractor:_____

Name and address of Construction divn./unit _____

Name of CLIENT Labour Officer :_____

Address of CLIENT Labour Officer:_____

Name of Labour Enforcement Officer:_____

Address of Labour Enforcement Officer:_____

Sl.No	Category	Minimum wage Fixed	Actual wage paid	Number Present	Remarks

Weekly holiday_____

Wage period _____

Date of payment of Wages_____

Working hours_____

Rest interval_____

Appendix 'IV'

Form-XIII (See Rule 75)
Register of Workmen Employed by Contractor

Name and address of contractor_____

Name and address of establishment under which contract is carried on_____

Nature and location of Work_____

Name and address of Principal Employer_____

Sl. No.	Name and surname of Workman	Age and Sex	Father's/ Husband's Name	Nature of employment / designation.	Permanent home address of the workman (Village and Tehsil, Taluka and District)	Local Address	Date of commencement of employment	Signature or thumb impression of the workman	Date of Termination of employment.	Reasons For terminations.	Remarks
1	2	3	4	5	6	7	8	9	10	11	12

Appendix 'V'

Form-XVI (See Rule 78(2)(a)

Muster Roll

Name and address of the contractor_____

Name and address of establishment under which contract is carried on_____

Nature and location of work_____

Name and address of Principal Employer_____

For the month of fortnight_____

Sl. No.	Name of workman	Sex	Father's/ Husband's Name	Dates					Remarks
1	2	3	4	5					6
				1	2	3	4	5	

Appendix 'VI'

Form –XVII (See Rule 78(2)(a))

Register of Wages

Name and address of the contractor_____

Name and address of establishment under which contract is carried on_____

Nature and location of work_____

Name and address of Principal Employer_____

Wages period_____ Monthly/fortnightly

Sl.No.	Name of workman	Serial No.in the register of workman	Designation Nature of work done	No. of days worked	Units of work done	Daily rate of wages/piece rate	Basic Wages
1	2	3	4	5	6	7	8

Dearness allowances	Overtime	Other cash payments(Indicate nature)	Total	Deductions if any, (indicate nature)	Nett amount paid	Signature or thumb impression of the workman	Initial of contractor or his representative
9	10	11	12	13	14	15	16

Appendix'VII'
(Observe)

Wage Card No._____

Wage Card

Name and address of the contractor_____ Date of issue_____

Name and location of work_____ Designation_____

Name of Workman_____ Month/fortnight----------

Rate of Wages_____

DATE																														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Morning																															
Evening																															
Initial																															

Rate_____ Amount_____

Received from_____ the sum of Rs. _____on account of my wages.

Signature

The wage card is valid for one month from the date of issue

Appendix 'VII'
(Reverse)

Form-XIX
(See rule 78(2)(b))

Wages Slip

Name and address of the contractor_____

Name and Father's/Husband's name of workman_____

Nature and location of work_____

For the Week/Fortnight/Month ending_____

1. No. of days worked _____

2. No. of units worked in case of piece rate workers_____

3. Rate of daily wages/piece rate_____

4. Amount of overtime wages_____

5. Gross wages payable_____

6. Deduction, if any_____

7. Net amount of wages paid_____

Initials of the Contractors or his representative

Appendix 'VIII'

Form-XIV
(See rule 76)

Employment Card

Name and address of the contractor_____

Name and address of establishment under which contract is carried on_____

Nature of work and location of work_____

Name and address of Principal Employer_____

1. Name of Workman_____

2. Sl No. in the register of workman employed_____

3. Nature of employment/designation_____

4. Wage rate (with particulars of unit in case of piece work)_____

5. Wages period_____

6. Tenure of employment_____

7. Remarks_____

Signature of contractor

Appendix 'IX'

Form-XV (See Rule 77)

Service Certificate

Name and address of the contractor_____

Nature and location of work_____

Name and Address of workman_____

Age or date of birth_____

Identification marks_____

Father's/Husband's name_____

Name and address of establishment in under which contract is carried on_____

Name and address of Principal Employer_____

Sl.No.	Total period for which employed		Nature of work done	Rate of Wages (with particulars of unit in case of piece work)	Remarks
	From	To			
1	2	3	4	5	6

Signature

Appendix 'X'

LIST OF ACTS AND OMISSIONS FOR WHICH FINES CAN BE IMPOSED

In accordance with rule 7 (v) of the Contractor's Labour Regulations to be displayed prominently at the site of work both in English and local Language.

1. Willful insubordination or disobedience, whether along or in combination with other.
2. Theft fraud or dishonestly in connection with the contractors beside a business or property of Department.
3. Taking or giving bribes or any illegal gratifications.
4. Habitual late attendance.
5. Drunkenness fighting, riotous or disorderly or indifferent behaviour.
6. Habitual negligence.
7. Smoking near or around the area where combustible or other materials are locked.
8. Habitual indiscipline.
9. Causing damage to work in the progress or to property of the Department or of the contractor.
10. Sleeping on duty.
11. Malingering or slowing down work.
12. Giving of false information regarding name, age, father's name etc.
13. Habitual loss of wage cards supplied by the employers.
14. Unauthorized use of employer's property of manufacturing or making of unauthorized particles at the work place.
15. Bad workmanship in construction and maintenance by skilled workers which is not approved by the Department and for which the contractors are compelled to undertake rectification.
16. Making false complaints and/or misleading statements.
17. Engaging on trade within the premises of the establishments.
18. Any unauthorized divulgence of business affairs of the employees.
19. Collection or canvassing for the collection of any money within the premises of an establishment unless authorized by the employer.
20. Holding meeting inside the premises without previous sanction of the employers.
21. Threatening or intimidating any workman or employer during the working hours within the premises.

Appendix 'XI'

Form-XII (See Rule 78(2)(d))

Register of Fines

Name and address of the contractor_____

Name and address of establishment in under which contract is carried on_____

Nature and location of work_____

Name and address of Principal Employer_____

Sl.No.	Name of workman	Father's/Husband's name	Designation/nature of employment	Act/Omission For which fine imposed	Date of Offence
1	2	3	4	5	6

Whether workman Showed cause against fine	Name of person in whose presence employees explanation was heard	Wage period and wages payable	Amount of fine imposed	Date on which fine realized	Remarks.
7	8	9	10	11	12

Appendix 'XII'

Form-XX (See Rule 78(2)(d))

Register of Deduction for Damage or Loss

Name and address of the contractor_____

Name and address of establishment in under which contract is carried on_____

Nature and location of work_____

Name and address of Principal Employer_____

Sl.No.	Name of workman	Father's/Husband's name	Designation/nature of employment	Particulars of damage or loss	Date of damage or loss
1	2	3	4	5	6

Whether workman showed cause against fine	Name of person in whose presence employees explanation was heard	Amount of deduction imposed	No. of installments	Date of recovery		Remarks
				First installment	Last installment	
7	8	9	10	11	12	13

Appendix 'XIII'

Register of Advances

Name and address of the contractor_____

Name and address of establishment in under which contract is carriedon_____

Nature and location of work_____

Name and address of Principal Employer_____

Sl. No.	Name of workman	Father's/Husband's name	Designation nature of employment	Wage period and wages payable	Date and Amount of Advance given	Purpose(s) for which Advance made	Number of Installments by which advance to be repaid	Date and amount of each installments repaid	Date on which last Installments was repaid	Remarks
1	2	3	4	5	6	7	8	9	10	11

Appendix 'XIV'

Form-XXIII (See Rule 78(2)(e))

Register of Overtime

Name and address of the contractor_____

Name and address of establishment in under which contract is carried on _____

Nature and location of work_____

Name and address of Principal Employer _____

Sl.No.	Name of workman	Father's/husband's name	Sex	Designation /nature of employment	Date on which Overtime worked	Total overtime worked or production in case of piece rated	Normal rate of wages	Overtime rate of wages	Overtime earnings	Rate on which overtime wages paid	Remarks
1	2	3	4	5	6	7	8	9	10	11	12

SECTION -6

PROFORMA OF SCHEDULES

(Operative Schedules)

SCHEDULE 'A'			
	Schedule of quantities (BOQ)		Attached as Volume –7, Financial Bid.
SCHEDULE 'B'			
	Schedule of materials to be issued to the contractor		**NIL**
SCHEDULE 'C'			
	Tools and plants to be hired to the contractor		**NIL**
SCHEDULE 'D'			
	Extra schedule for specific requirements/ document for the work, if any.		**NIL**
SCHEDULE 'E'			
	Name of work : :	Design, Engineering, Procurement and Construction (EPC) including Operation & Maintenance of Up-gradation & Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram.	
	Estimated cost of work:	**Design, Engineering, Procurement and Construction (EPC):Rs. 229.46 Crs**	
	Earnest money:	**Rs. 239.46 Lakh**	
Clause: 1	Performance Guarantee:	**5% of Tendered Value**	
Clause: 1A	Security Deposit:	**2.5 % of Tendered Value**	
SCHEDULE 'F'			
	GENERAL RULES & DIRECTIONS		
	Officer inviting bid	The Vice President (ID), HLL Lifecare Limited For and on behalf of the Director, Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram.	
	Maximum percentage for quantity of items of work to be executed beyond which the rates are to be determined in accordance with Clause 12.2.& 12.3		Under class 12 below
	DEFINITIONS		
1	Authority executing the agreement on behalf of the Client	Officer nominated by Client/HLL	

2(vi)	Engineer-in-Charge	Officer nominated by Client/HLL
2(ix)	Percentage on cost of materials and labour to cover all Overheads and profits.	15%
2(xi)	Standard Schedule of Rates	
	(i) Civil work	i) Delhi Schedule of Rates 2018 with amendments up to the date of submission of bid.
	(ii) Electrical & Mechanical works	ii) Delhi Schedule of Rate 2018- (E&M) with amendments up to the date of submission of bid.
	(iii) Horticulture work	iii) Horticulture Schedule of Rate 2018- with amendments up to the date of submission of bid.
2(xii)	Department	Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram
	CLAUSES OF CONTRACT	
Clause 1	(i) Time allowed for submission of Performance Guarantee from the date of issue of letter of acceptance or proof of applying thereof from the date of issue of letter of acceptance	**15 days**
	(ii) Time allowed for submission of Programme Chart (Time & Progress), applicable labour licences, registration with EPFO, ESIC & BOCW Welfare Board or proof of applying thereof from the date of issue of letter of acceptance	**30 days**
	(iii)Maximum allowable extension for submission of Performance Guarantee, with late fee @ 0.1% per day of Performance Guarantee amount beyond the period as provided in (i) above.	**15 days**
Clause 2	Authority for fixing compensation under Clause 2.	The Director, RIPANS
Clause 5	Number of days from the date of issue of letter of acceptance for reckoning date of Start	The date of start shall be reckoned from 15 Days after the date of issue of Letter of Award
	Authority to decide shifting of date of start in case of delay in handing over of site.	The Vice President, HLL Lifecare Limited
	Mile stone(s) will be as per table given below	

Mile Stone No	Description of Milestone (Physical)	Time allowed in days (from date of start)	**Amount to be with- held in case of non - achievement of milestone. (Rs. in Lakhs)**

1	Completion of Structures upto level 01 of:-		
	a. 100 Bedded Hospital i/c services block	8 months	Rs. 74 lakhs
	b. Academic Building Block –IV	8 months	Rs. 54 lakhs
	c. Guest House	8 months	Rs. 4 lakhs
	d. General Hostel Block	8 months	Rs. 30 lakhs
	e. Staff / Nurse Quarters	8 months	Rs. 10 lakhs
	f. Resident Doctor's Quarters	8 months	Rs. 22 lakhs
2	Completion of Structures of:		
	a. 100 Bedded Hospital i/c services block	16 months	Rs. 78 lakhs
	b. Academic Building Block –IV	16 months	Rs. 61 lakhs
	c. Guest House	16 months	Rs. 4 lakhs
	d. General Hostel Block	16 months	Rs. 34 lakhs
	e. Indoor Sports Complex and Auditorium	16 months	Rs. 52 lakhs
	f. Staff / Nurse Quarters	16 months	Rs. 12 lakhs
	g. Resident Doctor's Quarters	16 months	Rs. 24 lakhs
	h. Medical Superintendent Quarter	16 months	Rs. 3 lakhs
3	Completion of Finishing and Services (excluding fitting & fixtures) of:		
	a. 100 Bedded Hospital i/c services block	22 months	Rs. 211 lakhs
	b. Academic Building Block –IV	22 months	Rs. 115 lakhs
	c. Guest House	22 months	Rs. 9 lakhs
	d. General Hostel Block	22 months	Rs. 69 lakhs
	e. Indoor Sports Complex and Auditorium	22 months	Rs. 80 lakhs
	f. Staff / Nurse Quarters	22 months	Rs. 25 lakhs

	g. Resident Doctor's Quarters	22 months	Rs. 43 lakhs
	h. Medical Superintendent Quarter	22 months	Rs. 3 lakhs
4	Completion i/c testing and commissioning of:		
	i. 100 Bedded Hospital i/c services block	23 months	Rs. 11 lakhs
	j. Academic Building Block –IV		
	k. Guest House		
	l. General Hostel Block		
	m. Indoor Sports Complex and Auditorium		
	n. Staff / Nurse Quarters		
	o. Resident Doctor's Quarters		
	p. Medical Superintendent Quarter		
5	External services i.e.:- Roadwork, Retaining Walls, parking, pathways, external drainage, gates, external development including electrical services, signages etc.	23 months	Rs. 60 lakhs
6	Final finishing including painting and handing over	24 months	Rs. 59.30 lakhs
	Note:-Total withheld amount not to exceed 5% of the tendered cost as per terms of Contract.		

Clause 5.4	Authority for deciding Extension of Time and rescheduling of Milestones	The Vice President , HLL Lifecare Limited
Clause 7	Gross work to be done together with net payment /adjustment of advances for material collected, if any, since the last such payment for being eligible to interim payment.	**Rs. 4.00 Crores**
Clause 7A	Whether clause 7A shall be applicable	**Yes**
(i)	No Running Account Bill shall be paid for the work till the applicable labour licenses, registration with EPFO, ESIC and BOCW Welfare Board, whatever applicable as submitted by the Bidder to the Engineer-in Charge. Each bill shall be accompanied by Appendix-A	
Clause	List of testing equipment to be provided	As per Appendix - D at page 178 CPWD

10A	by the contractor at site laboratory.	Specification 2009 Volume-I, and, List attached as Appendix-XV-A and XV-B
	Secured Advance:- Whether Clause 10 B (i) shall be applicable	**Yes**
Clause 10B	Mobilization Advance	
	Whether Clause 10 B (ii) shall be applicable	**Yes**
Clause 11	Specifications to be followed for execution of work	CPWD Specifications 2009 (Vol.-I & II)
		CPWD Specifications 2018 (Horticulture & Landscaping)
		Electrical work: 1. CPWD General Specification for Electrical Works Part I Internal - 2013. 2. CPWD General Specification for Electrical Works Part IV Substation - 2013. 3. CPWD General Specification for Electrical Works Part VII DG Sets - 2013. 4. CPWD General Specification for Electrical Works Part VIII Gas Based Fire Extinguishing System - 2013. 5. General Specification for Heating Ventilation & Air-Conditioning (HVAC) Works-2017. 6. General Specification for Electrical Works (Part III Lifts & Escalators)-2003
	All above specifications shall be applicable with corrections slips up to the last date of submission/ uploading of bid and, Technical Specifications (Volume 5) of the tender documents.	
Clause 16	Competent Authority for deciding reduced rates	The Vice President, HLL Lifecare Limited

Clause 32 **Minimum Requirement of Technical Representative(s) and monthly recovery Rate**

S. No	Requirement of Technical Staff		Minimum Experience (Years)	Designation of Technical Staff	Rate of recovery if provision of clause 32 not fulfilled
	Qualification	Strength			
1.	Graduate (Civil) Engineer	1 No	20 (and having experience of one similar nature of work)	Project Manager	Rs.100000/- per Month

2.	Post Graduate (Structural Engineer)	1 No	12 (and having experience of one similar nature of work)	Deputy Project Manager	Rs.70000/- per Month
3.	Graduate (Civil) Engineer	1 Nos.	12 (and having experience of one similar nature of work)	Deputy Project Manager	Rs. 70,000/- per Month
4.	Electrical /Mechanical Graduate Engineer	1 No	-do-	Deputy Project Manager	Rs. 70,000/- per Month
5.	Biomedical Engineer (Graduate Or Diploma Engineer)	1 No	5 or 10 Respectively	Project / Site Engineer	Rs. 50,000/- per Month
6.	Civil Engineer (Graduate Or Diploma Engineer)	4 No	5 or 10 Respectively	Project / Site Engineer	Rs. 50,000/- per Month per person
7.	Electrical /Mechanical Graduate Engineer or Diploma Engineer	2 No	5 or 10 respectively	Project / Site Engineer	Rs. 50,000/- per Month per person
8.	Graduate Engineer (Civil & Electrical/ Mechanical)	2No	8	Quality Engineer	Rs. 60,000/- per Month per person
9.	Diploma Engineer	1 No	8	Surveyor	Rs. 40,000/- per Month per person
10.	Architect	1 No	5	Architect	Rs. 40,000/- per Month per person
11.	Civil Graduate Engineer	2 Nos	6	Project Planning/ Billing Engineer	Rs. 45,000/- per Month per person
12.	Electrical/ Mechanical Graduate Engineer	1 No	6	Project Planning/ Billing Engineer	Rs. 45,000/- per Month per person
13.	Civil Diploma Engineer	2 Nos	3	Supervisors	Rs. 30,000/- per Month per person
14.	Electrical /Mechanical Graduate Engineer or Diploma Engineer	2 Nos	3	Supervisors	Rs. 30,000/- per Month per person
15.	Safety Engineer Degree /Diploma in Safety Management/ Industrial Safety.	1 No	10	Safety Engineer.	Rs. 70,000/- per Month per person

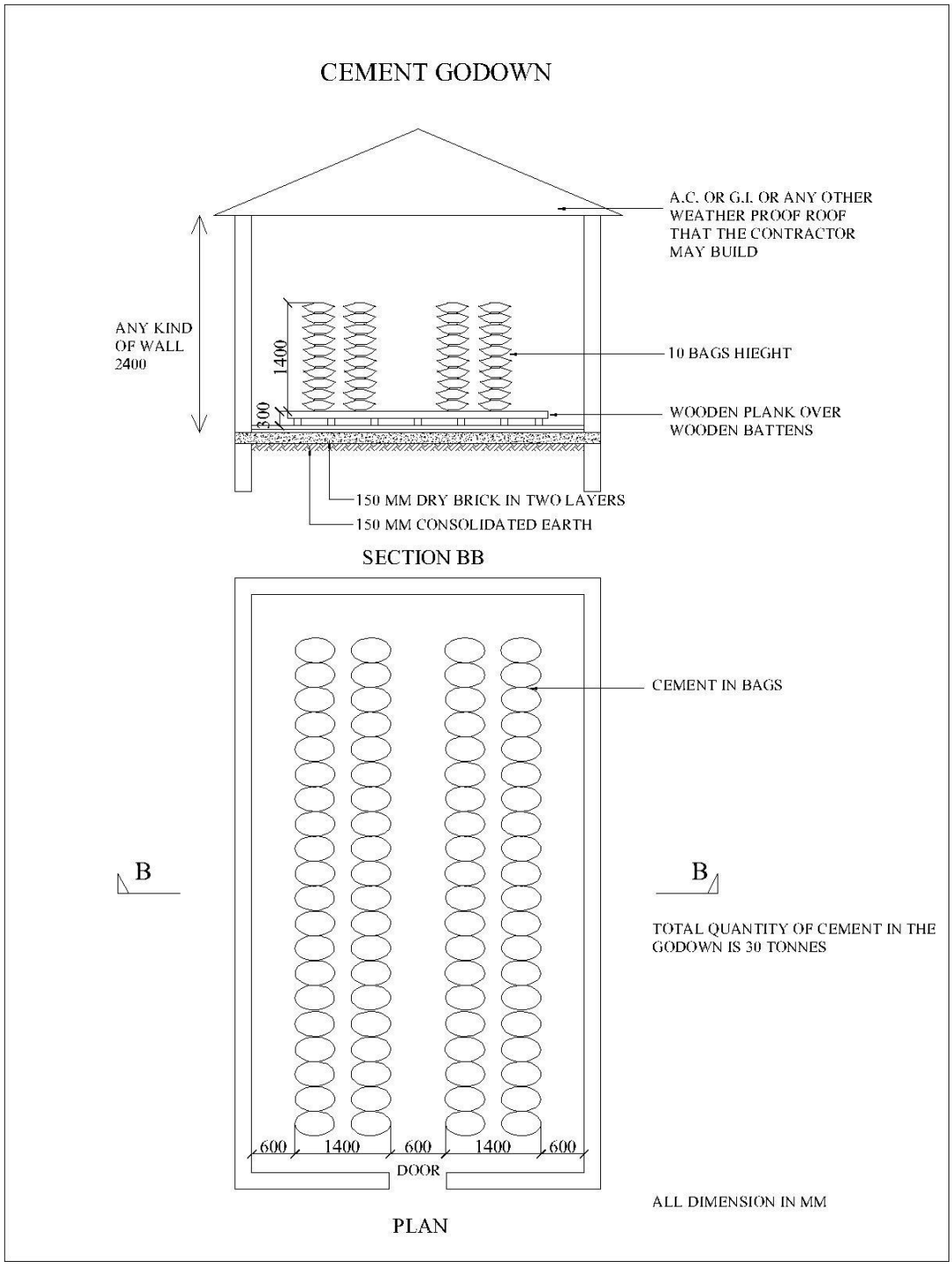
Note: (1) The staff at S. No. 1, 6, 7, 9 & 15 (1 no. each) above are required to be in position at site within 15 days of commencement of work. The balance along with other staff for specialised works to be in position at site as per requirements at project site or within 15 days of directions of Engineer-in-Charge, whichever is earlier. The above given strength shall be required to be deployed as and when necessity arises at site or so directed by Engineer-in-charge.

(2) Assistant Engineers retired from Government services, who are holding Diploma will be treated at par with Graduate Engineers.		
(3) Diploma holder with minimum 10-years relevant experience with a reputed construction company can be treated at par with Graduate Engineers for such deployment subject to the condition that such diploma holders should not exceed 50% of requirement of Graduate engineers. This shall however shall not be applicable for Project Manager.		
(4) Architect and Deputy Architect should be registered with Council of Architecture (COA).		
(5) The Bidder shall submit a certificate of employment of the technical representative(s) (in the form of copy of Form -16 or CPF deduction issued to the Engineers employed by him) along with every account bill/final bill and shall produce evidence of regular physical availability of such engineers on the above project if at any times so required by the Engineer-in-charge.		
Clause 35	Authority having option of terminating the Contract in event of death of Contractor	The Director, RIPANS
Clause 38		
i)	a) Schedule/statement for determining theoretical quantity of cement & bitumen on the basis of Delhi Schedule of Rates	CPWD Delhi Schedule of Rates 2018 with amendments up to the date of submission of the bid.
ii.)	**Variation permissible on theoretical quantities**	
a)	Cement	**2% plus/minus %**
b)	Bitumen all works	**2.5% plus & only & Nil on minus side.**
c)	Steel reinforcement and structural steel Sections	**2% plus/minus for diameter, section and category.**
d)	All other materials	**Nil**

RECOVERY RATES FOR QUANTITIES BEYOND PERMISSIBLE VARIATION

S. No.	Description of item	Rates in figure and words at which recovery shall be made from the contractor	
		Excess beyond permissible variation	Less used beyond permissible variation*
1	Cement	Nil	Rs. 5,716/- per Tonne
2	Steel reinforcement (TMT) Main Producers	Nil	Rs. 69,650/- per Tonne
3	Structural Steel	Nil	Rs. 55,500/- per Tonne

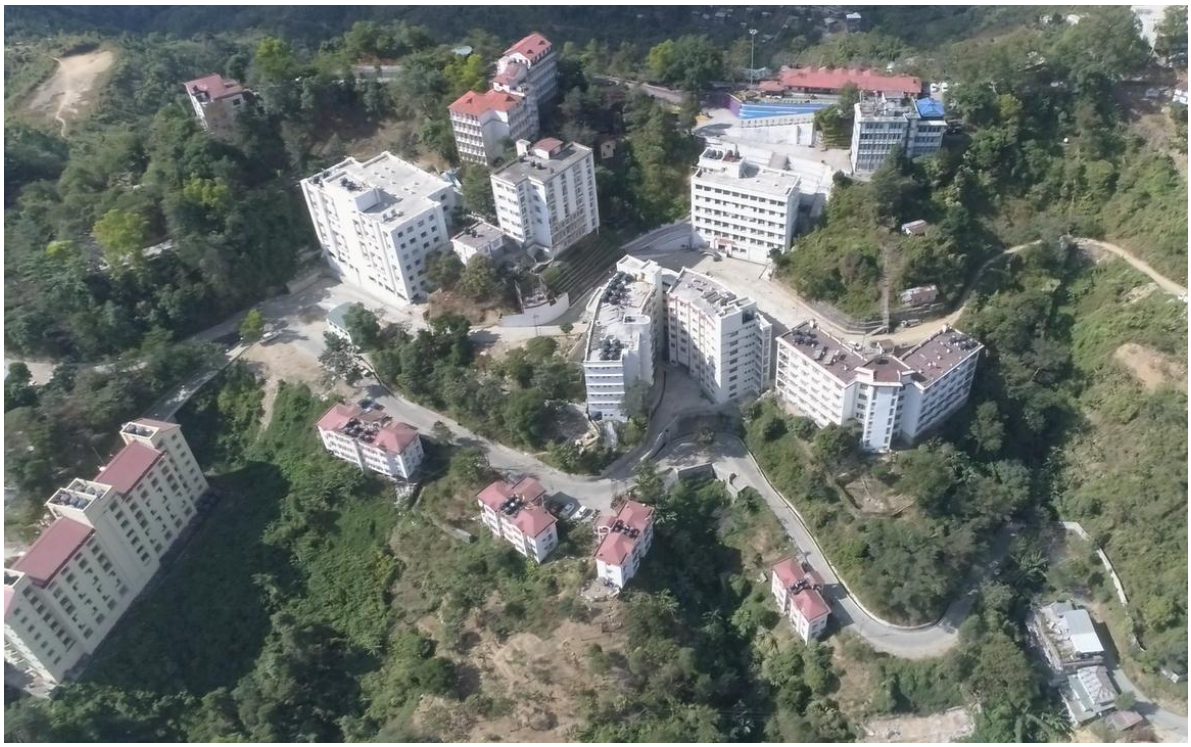
* Not Permitted. However in case it is observed that the quantities used are less beyond the permissible variation, the recovery shall be effective with the above rates.



END OF VOLUME - 2

Vol.-2A: Integrity Pact

UP-GRADATION AND DEVELOPMENT OF REGIONAL INSTITUTE OF PARAMEDICAL & NURSING SCIENCES,AIZAWL, MIZORAM



CLIENT
Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram
(Ministry Of Health and Family Welfare, Govt. of India)

PROJECT CONSULTANT
HLL Lifecare Limited
(A Government of India Enterprise)

HLL Lifecare Ltd. (HLL)

(A Govt. of India Enterprise)

on behalf of

Regional Institute of Paramedical & Nursing Sciences, (RIPANS) Aizawl, Mizoram

Invites

e-Tender

For

Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram

on EPC Basis

Tender No. HLL/RIPANS-Aizawl/2019

Volume-2A

INTEGRITY PACT

(September, 2019)

HLL Lifecare Limited
(A Government of India Enterprise)

B-14 A, SECTOR 62
NOIDA, UP 201 307
PH.: 0120 4071 500 FAX: 0120 4071 513

www.lifecarehll.com

Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram on EPC Basis

INDEX

INTEGRITY PACT

To,

……
……..
……..

Sub: Tender No. HLL /RIPANS-Aizawl/2019 for the work of Design, Engineering, Procurement and Construction (EPC) including Operation & Maintenance of Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram.

Dear Sir,

It is here by declared that the CLIENT/HLL are committed to follow the principle of transparency, equity and competitiveness in public procurement.

The subject Notice Inviting Tender (NIT) is an invitation to offer made on the condition that the Bidder will sign the integrity Agreement, which is an integral part of tender/bid documents, failing which the tenderer/bidder will stand disqualified from the tendering process and the bid of the bidder would be summarily rejected.

This declaration shall form part and parcel of the Integrity Agreement and signing of the same shall be deemed as acceptance and signing of the Integrity Agreement on behalf of the CLIENT/HLL .

Yours faithfully

Engineer-in-Charge

INTEGRITY PACT

To,

…….

(Designated authority of CLIENT/HLL *)*

Sub:

Dear Sir,

I/We acknowledge that the CLIENT/HLL is committed to follow the principles thereof as enumerated in the Integrity Agreement enclosed with the tender/bid document.

I/We agree that the Notice Inviting Tender (NIT) is an invitation to offer made on the condition that I/We will sign the enclosed integrity Agreement, which is an integral part of tender documents, failing which I/We will stand disqualified from the tendering process. I/We acknowledge that the making of the bid shall be regarded as an unconditional and absolute acceptance of this condition of the NIT.

I/We confirm acceptance and compliance with the Integrity Agreement in letter and spirit and further agree that execution of the said Integrity Agreement shall be separate and distinct from the main contract, which will come into existence when tender/bid is finally accepted by the CLIENT/HLL . I/We acknowledge and accept the duration of the Integrity Agreement, which shall be in the line with Clause 12 of the enclosed Integrity Agreement.

I/We acknowledge that in the event of my/our failure to sign and accept the Integrity Agreement, while submitting the tender/bid, the CLIENT/HLL shall have unqualified, absolute and unfettered right to disqualify the tenderer/bidder and reject the tender/bid is accordance with terms and conditions of the tender/bid.

Yours faithfully

(Duly authorized signatory of the Bidder)

PRE-CONTRACT INTEGRITY PACT

This Pre-Contract Integrity Pact (herein after called the Integrity Pact) is made on _____ day of the month of _____

Between

HLL Lifecare Ltd. A Government of India Enterprise with registered office at HLL Bhavan, Poojappura, Thiruvananthapuram 695 012, Kerala, India. (Hereinafter called "HLL", which expression shall mean and include, unless the context otherwise requires, his successors in office and assigns) of the First Party.

And

M/s _____ with office at .....represented by Shri _____ , Chief Executive Officer (hereinafter called the "BIDDER/Seller"/Contractor which expression shall mean and include, unless the context otherwise requires, his successors and permitted assigns) of the Second Party.

Preamble

[Both HLL and BIDDER referred above are jointly referred to as the Parties]

HLL intends to award, under laid down organizational procedures, Purchase orders / contract/s against Tender /Work Order /Purchase Order No. …….. HLL desires full compliance with all relevant laws and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder/s and Contractor/s.

NOW, THEREFORE,

To avoid all forms of corruption by following a system that is fair, transparent and free from any influence/prejudiced dealings prior to, during and subsequent to the currency of the contract to be entered into with a view to:-

1. Enable HLL to obtain the desired materials/ stores/equipment/ work/ project done at a competitive price in conformity with the defined specifications by avoiding the high cost and the distortionary impact of corruption on public procurement; and
2. Enable the BIDDER to abstain from bribing or indulging in any corrupt practice in order to secure the contract by providing assurance to them that their competitors will also abstain from bribing and other corrupt practices and HLL will commit to prevent corruption, in any form, by its officials by following transparent procedures.

The parties hereto hereby agree to enter into this Integrity Pact and agree as follows:

Clause.1. Commitments of HLL

1.1 HLL undertakes that HLL and/or its Associates (i.e. employees, agents, consultants, advisors, etc.) will not demand, take a promise for or accept, directly or through intermediaries, any bribe, consideration, gift, reward, favour or any material or immaterial benefit or any other advantage from the BIDDER, either for themselves or for any person, organization or third party related to the contract in exchange for an advantage in the bidding process, bid evaluation, contracting or implementation process related to the contract.

1.2 HLL will, during the tender process / pre-contract stage, treat all BIDDERs with equity and reason, and will provide to all BIDDERs the same information and will not provide any such information or additional information, which is confidential in any manner, to

any particular BIDDER which could afford an advantage to that particular BIDDER in comparison to other BIDDERs in relation to tendering process or during the contract execution.

1.3 All the officials of HLL will report to Chief Vigilance Officer of HLL (CVO), any attempted or completed breaches of the above commitments as well as any substantial suspicion of such a breach.

1.4 HLL will exclude from the process all known prejudiced persons and persons who would be known to have a connection or nexus with the prospective bidder.

1.5 If the BIDDER reports to HLL with full and verifiable facts any misconduct on the part of HLL 's Associates (i.e. employees, agents, consultants, advisors, etc.) and the same is prima facie found to be correct by HLL , necessary disciplinary proceedings, or any other action as deemed fit, including criminal proceedings may be initiated by HLL . Further, such an Associate may be debarred from further dealings related to the contract process. In such a case, while an enquiry is being conducted by HLL the proceedings under the contract would not be stalled.

Clause 2. Commitments of BIDDERs/ CONTRACTORs

2. The BIDDER commits itself to take all measures necessary to prevent corrupt practices, unfair means and illegal activities during any stage of its bid or during any pre-contract or post-contract stage in order to secure the contract or in furtherance to secure it and in particular commit itself to the following:-

2.1 The BIDDER will not offer, directly or indirectly (i.e. employees, agents, consultants, advisors, etc.) any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of HLL , connected directly or indirectly with the bidding process, or to any person, organization or third party related to the contract in exchange for any advantage in the bidding, evaluation, contracting and implementation of the contract.

2.2 The BIDDER further undertakes that it has not given, offered or promised to give, directly or indirectly any bribe, gift, consideration, reward, favour, any material or immaterial benefit or other advantage, commission, fees, brokerage or inducement to any official of HLL or otherwise in procuring the contract or forbearing to do or having done any act in relation to obtaining or execution of the contract or any other contract with HLL for showing or forbearing to show favour or disfavor to any person in relation to the contract or any other contract with HLL.

2.3 The BIDDER will not engage in collusion, price fixing, cartelization, etc. with other counterparty(s).

2.4 The Bidder (s) will not pass to any third party any confidential information entrusted to it, unless duly authorized by HLL.

2.5 The Bidder (s) will promote and observe ethical practices within its Organization and its affiliates.

2.6 BIDDER shall disclose the name and address of agents and representatives and Indian BIDDERS shall disclose their foreign principals or associates.

2.7 The Bidder (s) will not make any false or misleading allegations against HLL or its Associates.

2.8 BIDDERs shall disclose the payments to be made by them to agents/brokers or any other intermediary, in connection with this bid/contract.

2.9 The BIDDER further confirms and declares to HLL that the BIDDER is the original manufacture/integrator/authorized government sponsored export entity of the defense stores and has not engaged any individual or firm or company whether Indian or foreign to intercede, facilitate or in any way to recommend to HLL or any of its functionaries, whether officially or unofficially to award the contract to the BIDDER, nor has any amount been paid, promised or intended to be paid to any such individual, firm or company in respect of any such intercession, facilitation or recommendation.

2.10 The BIDDER while presenting the bid or during pre-contract negotiations or before signing the contract, shall disclose any payments he has made, is committed to or intends to make to officials of HLL or their family members, agents, brokers or any other intermediaries in connection with the contract and the details of services agreed upon for such payments.

2.11 The BIDDER will not accept any advantage in exchange for any corrupt practice, unfair means and illegal activities.

2.12 The BIDDER commits to refrain from giving any complaint directly or through any other manner without supporting it with full and verifiable facts.

2.13 If the BIDDER or any employee of the BIDDER or any person acting on behalf of the BIDDER, either directly or indirectly, is a relative of any of the officers of HLL , or alternatively, if any relative of an officer of HLL has financial interest/stake in the BIDDER's firm, the same shall be disclosed by the BIDDER at the time of filing of tender.

The term 'relative' for this purpose would be as defined in Section 2(77) of the Companies Act 2013

2.14 The BIDDER shall not lend to or borrow any money from or enter into any monetary dealings or transactions, directly or indirectly, with any employee of HLL .

2.15 The BIDDER will not collude with other parties interested in the contract to impair the transparency, fairness and progress of the bidding process, bid evaluation, contracting and implementation of the contract, and will not enter into any undisclosed agreement or understanding with other Bidders, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.

2.16 The BIDDER will not commit any offence under the relevant Indian Penal Code, 1860 or Prevention of Corruption Act, 1988; further the Bidder(s)/ Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the HLL as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically. The BIDDER also undertakes to exercise due and adequate care lest any such information is divulged.

2.17 The BIDDER will not instigate third persons to commit offences outlined above or be an accessory to such offences.

2.18 The Bidder(s)/Contractors(s) of foreign origin shall disclose the name and address of the Agents/representatives in India, if any. Similarly the Bidder(s)/Contractors(s) of Indian Nationality shall furnish the name and address of the foreign Principal(s), if any.

2.19 The Bidder(s) shall not approach the courts while representing the matters to IEM and the Bidder(s) will await their decision in the matter.

Clause.3. Previous contravention and Disqualification from tender process and exclusion from future contracts

3.1 The BIDDER declares that no previous contravention occurred in the last three years immediately before signing of this Integrity Pact, with any other company in any country in respect of any corrupt practices envisaged hereunder or with any Public Sector Enterprise in India or any Government Department in India that could justify BIDDER's exclusion from the tender process

3.2 The BIDDER agrees that if it makes incorrect statement on this subject, BIDDER can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

If BIDDER before award or during execution has committed a contravention through a violation of Clause 2, above or in any other form such as to put his reliability or credibility in question, HLL is entitled to disqualify the BIDDER from the tender process.

Clause.4. Equal treatment of all Bidders/Contractors / Subcontractors

4.1 The Bidder(s)/ Contractor(s) undertake(s) to demand from his Subcontractors a commitment in conformity with this integrity Pact.

4.2 HLL will enter into agreements with identical conditions as this one with all Bidders and Contractors.

4.3 HLL will disqualify from the tender process all bidders who do not sign this Pact or violate its provisions.

Clause.5. Consequences of Violation / Breach

5.1 Any breach of the aforesaid provision by the BIDDER or any one employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER) shall entitle HLL to take all or any one of the following action, wherever required:-

i. To immediately call off the pre-contract negotiations without assigning any reason or giving any compensation to the BIDDER. However, the proceedings with the other BIDDER(s) would continue.

ii. If BIDDER commits violation of Integrity Pact Policy during bidding process, he shall be liable to compensate HLL by way of liquidated damages amounting to a sum equivalent to 5% to the value of the offer or the amount equivalent to Earnest Money Deposit/Bid Security, whichever is higher.

iii. In case of violation of the Integrity Pact after award of the contract, HLLwill be entitled to terminate the contract. HLL shall also be entitled to recover from the contractor liquidated damages equivalent to 10% of the contract value or the amount equivalent to security deposit/ performance guarantee, whichever is higher.

iv. To immediately cancel the contract, if already signed, without giving any compensation to the BIDDER.

v. To recover all sums already paid by HLL, and in case of an Indian BIDDER with interest thereon at 2% higher than the prevailing Prime Lending Rate of State Bank of India, while in case of a BIDDER from a country other than India with interest thereon at 2% higher than the LIBOR. If any outstanding payment is due to the BIDDER from HLL in connection with any other contract for any other stores, such outstanding payment could also be utilized to recover the aforesaid amount.

vi. To encash the advance bank guarantee and performance guarantee /warranty bond, if furnished by the BIDDER, in order to recover the payments already made by HLL, along with interest.

vii. To cancel all or any other contract with the BIDDER. The BIDDER shall be liable to pay compensation for any loss or damage to HLL resulting from such cancellation/recession and HLL shall be entitled to deduct the amount so payable from the money(s) due to the BIDDER.

viii. To debar the BIDDER from participating in future bidding processes of HLL for a minimum period of five (5) years, which may be further extended at the discretion of HLL or until Independent External Monitors is satisfied that the Bidder (s) will not commit any future violation.

ix. To recover all sums paid in violation of this Pact by BIDDER(s) to any middleman or agent or broker with a view to securing the contract.

x. In cases where irrevocable Letters of credit have been received in respect of any contract signed by HLL with the BIDDER, the same shall not be opened.

xi. Forfeiture of performance guarantee in case of a decision by HLL to forfeit the same without assigning any reason for imposing sanction for violation of the pact.

5.2 HLL will be entitled to all or any of the actions mentioned in para 5.1(i) to (x) of this pact also on the commission by the BIDDER or any one employed by it or acting on its behalf (whether with or without the knowledge of the BIDDER), of an offence as defined in Chapter IX of the Indian Penal Code, 1860 or Prevention of Corruption Act, 1988 or any other statute enacted for prevention of corruption.

5.3 The decision of HLL to the effect that a breach of the provisions of this Pact has been committed by the BIDDER shall be final and conclusive on the BIDDER. However, the BIDDER can approach the Independent External Monitor(s) appointed for the purposes of this Pact.

Clause.6. Fall Clause

The BIDDER undertakes that it has not supplied/is not supplying similar product/systems or subsystems OR providing similar services at a price / charge lower than that offered in the present bid in respect of any other Ministry/Department of the Government of India or PSU and if it is found any stage that similar product/systems or sub systems was supplied by the BIDDER to any to the Ministry/Department of the Government of India or a PSU at a lower price, then that very price, with due allowance for elapsed time will be applicable to the present case and the difference in the cost would be refunded by the BIDDER to HLL , if the contract has already been concluded.

Clause.7. Independent External Monitor(s)

7.1 HLL has appointed Shri M.J. Joseph ICAS (Retd.) Ex-Controller General of Accounts (Secretary Rank) as Independent External Monitor(s) (hereinafter referred to as IEM(s)) for this Pact in consultation with the Central Vigilance Commission. Contact details of IEM is as below:

Shri M.J. Joseph ICAS (Retd.)

Ex-Controller General of Accounts (Secretary Rank)

Email : iemhll@lifecarehll.com

Mobile: +91 8130588577

Email: iem@hllhites.com

7.2 The responsibility of the IEM(s) shall be to review independently and objectively, whether and to what extent the parties comply with the obligations under this Pact.

7.3 The IEM(s) shall not be subject to instructions by the representatives of the parties and perform their functions neutrally and independently.

7.4 Both the parties accept that the IEM(s) have the right to access all the documents relating to the project/ procurement, including minutes of meetings.

7.5 As soon as the IEM(s) notices, or has reason to believe, a violation of this pact, he will so inform the CVO.

7.6 The BIDDER(S) accepts that the IEM(s) have the right to access without restriction to all project documentation of HLL including that provided by the BIDDER. The BIDDER will also grant the IEM(s), upon his request and demonstration of a valid interest, unrestricted and unconditional access to his project documentation. The same is applicable to subcontractors engaged by the BIDDER. The IEM(s) shall be under contractual obligation to treat the information and documents of the BIDDER/ Subcontractor(s) with confidentiality.

7.7 HLL will provide to the IEM(s) sufficient information about all meetings among the parties related to the Project provided such meeting could have an impact on the contractual relation between the parties. The parties will offer to the IEM(s) option to participate in such meetings.

7.8 The IEM(s) will submit a written report to the CVO of HLL within 8 to 10 weeks from the date of reference or intimation to him by HLL /BIDDER and, should consent arise, submit proposals for correcting problematic situations.

Clause.8.Criminal charges against violating Bidder(s)/ Contractor(s)/ Subcontractor(s)

If HLL obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if HLL has substantive suspicion in this regard, HLL will inform the same to the Chief Vigilance Officer, HLL

Clause.9. Facilitation of Investigation

In case of any allegation of violation of any provisions of this Pact or payment of commission, HLL or its agencies shall be entitled to examine all the documents, including the Books of Accounts of the BIDDER and the BIDDER shall provide necessary information and documents in English and shall extend all possible help for the purpose of such examination.

Clause.10. Law and Place of Jurisdiction

Both the Parties agree that this Pact is subject to Indian Law. The place of performance and hence this Pact shall be subject to Delhi/ NCR Jurisdiction.

Clause.11. Other legal Actions

The actions stipulated in the Integrity Pact are without prejudice to any other legal action that may follow in accordance with the provisions of the extant law in force relating to any civil or criminal proceedings.

Clause.12. Validity and Duration of the Agreement

This Pact begins when both parties have legally signed it. It expires for the Contractor/Successful bidder 12 months after the last payment under the contract or the complete execution of the contract to the satisfaction of the both HLL and the BIDDER /Seller,

including warranty/ Defect Liability Period, whichever is later, and for all other Bidders/unsuccessful bidders 6 months after the contract has been awarded.

If any claim is made / lodged during this time, the same shall be binding and continue to be valid despite the lapse of this pact as specified above, unless it is discharged / determined by Chairman and Managing Director of HLL .

Clause.13. Other provisions

13.1 Changes and supplements as well as termination notices need to be made in writing. Both the Parties declare that no side agreements have been made to this Integrity Pact.

13.2 If the Contractor is a partnership or a consortium, this agreement must be signed by all partners or consortium members.

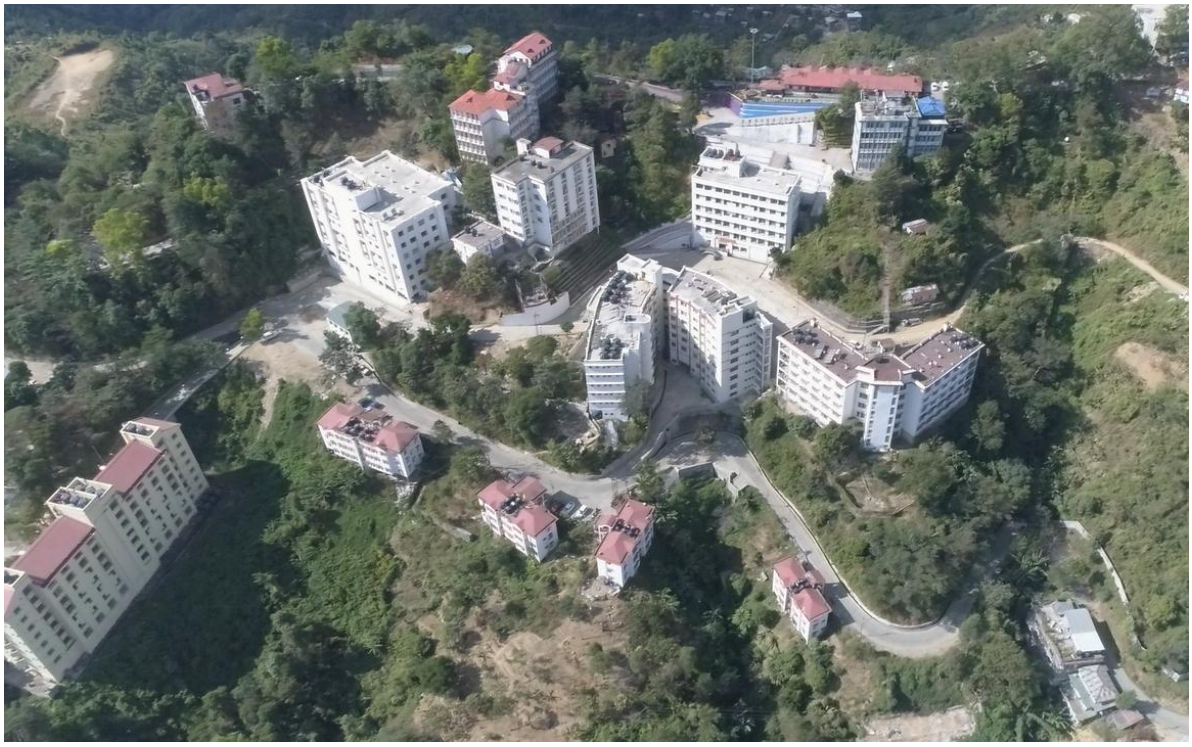
13.3 Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intentions

IN WITNESS THEREOF the parties have signed and executed this pact at the place and date first above mentioned in the presents of following witnesses:

HLL Lifecare Ltd.	**Bidder**
_____	_____
Witness	Witness
1……..	1……
2……	2……..

Vol.-3: Specific Conditions of Contract

UP-GRADATION AND DEVELOPMENT OF REGIONAL INSTITUTE OF PARAMEDICAL & NURSING SCIENCES,AIZAWL, MIZORAM



CLIENT
Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram
(Ministry Of Health and Family Welfare, Govt. of India)

PROJECT CONSULTANT

HLL Lifecare Limited
(A Government of India Enterprise)

HLL Lifecare Ltd. (HLL)

(A Govt. of India Enterprise)

on behalf of

Regional Institute of Paramedical & Nursing Sciences, (RIPANS) Aizawl, Mizoram

Invites

e-Tender

For

Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram

on EPC Basis

Tender No. HLL/RIPANS-Aizawl/2019

Volume-3

SPECIFIC CONDITIONS OF CONTRACT

(September, 2019)

HLL Lifecare Limited
(A Government of India Enterprise)

B-14 A, SECTOR 62
NOIDA, UP 201 307
Ph.: 0120 4071 500 Fax: 0120 4071 513

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Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram on EPC Basis

INDEX

Specific Conditions of Contract

SPECIFIC CONDITIONS OF CONTRACT

A. SCOPE OF WORK

These Specific Conditions of Contract shall be read in conjunction with General Conditions of Contract. If there are any provisions in these Specific Conditions of Contract which are at variance with the provisions in the above mentioned documents, the provisions in these Specific Conditions of Contract shall take precedence.

1. Scope of Work:

1.1. **General:**

In order to augment the supply of skilled manpower and to promote the training through standardization of such education / courses across the country, the Ministry of Health and Family Welfare proposes to upgrade and develop the existing Regional Institute of Paramedical & Nursing Sciences (RIPANS), Aizawl. The Regional Institute of Paramedical & Nursing Sciences has appointed HLL Lifecare Limited as Project Consultant for the Project.

The scope of work relates to Up-gradation and Development of Regional Institute of Paramedical & Nursing Sciences (RIPANS), Aizawl. The work is to be executed on Design, Engineering, Procurement & Construction (EPC) basis.

The RIPANS is located in Zemabawk on the slope of a hill in out skirts of Aizawl which is capital of Mizoram. The total area of campus is around 13.20 Acres. The surrounding districts are Kolasib, Champhai, Mamit, Serchhip and Lunglei. The stretch of land is rolling hill with valleys and it is around 10 Kms from city Aizawl and 39 Kms from Airport and 10 kms from existing Civil Hospital. The site falls under the jurisdiction of Aizawl Municipal Corporation (AMC), Aizawl. The connectivity to the site is augmented via NH 54 road.

A. Existing RIPANS Infrastructure

The existing RIPANS Infrastructure comprise of following buildings with allied infrastructure:

a. Academic:

i. Academic Building Block - I
ii. Academic Building Block -II
iii. Academic Building Block -III
iv. Library & Examination Hall

b. Hostels

i. Girls Hostel with Hostel warden Qtr.
ii. Boys Hostel with Warden Quarters
iii. Boys Hostel
iv. Additional Girls Hostel
v. Additional Boys Hostel
vi. Assam Type Additional Boys Hostel

c. Administrative Block

d. Residences & Staff Quarters

i. Director Quarter
ii. Type – I (6 Units)
iii. Type – II (6 Units)
iv. Type – III (6 Units)
v. Type – IV (6 Units)

e. Miscellaneous and other buildings: - such as Canteens, Workshops etc.

B. Infrastructure – proposed upgradation

The RIPANS, in this tender, proposes to undertake construction of following Buildings/ blocks in the existing campus to enable development of the proposed infrastructure. All buildings shall be sustainable, energy efficient and use space optimally.

A. Institute Complex

i. Academic Building Block

ii. Guest House

iii. General Hostel Block

iv. Indoor Sports Complex & Auditorium

B. Hospital Complex

i. 100 Bedded Hospital i/c Services Block

ii. Resident Doctor's Quarters

iii. Medical Superintendent Quarter

iv. Staff / Nurse Quarters

C. Related ancillary buildings and integrated infrastructure

The bidders is being provided with a Master Plan of the complex, Concept Plans of the proposed buildings in the existing complex, Technical specifications and other details forming the part of bid documents. Based on these drawings and documents, the Bidders shall prepare their detailed designs and in conformity with the local Bye-laws. Any modification in the master plan and concept plan, required to meet the conformance to the local bye laws, shall be done with the approval of Client/HLL.

The location and height of retaining wall/ Concept drawings prepared in respect of the Project is being provided only as a preliminary reference document by way of assistance to the Bidders who are expected to carry out their own due diligence, surveys, investigations and other detailed examination of the Concept drawings/ location and height of retaining walls before submitting their Bids. Nothing contained in the concept drawings/ location of retaining walls shall be binding on the HLL/RIPANS. HLL/ RIPANS shall have no liability whatsoever in relation to or arising out of any or all contents of the Concept Drawings. Bidders are expected to do their own due diligence and investigations into the Project and its related details prior to submission of their Bids.

Present scope of work involves construction of various buildings/blocks as per Master Plan and concept designs in the existing campus with a total tentative area of *33,945* sqm. Besides, all required MEP, HVAC and other services, Utilities, Retaining wall(s), Stabilization of slopes, External Development, Horticulture, Landscaping, Roads including Pavements and culverts, Parking, Pathways, Water Supply, Plumbing, Storm Water Drainage, Signage's (internal & external), Furniture for Auditorium, Equipment for Indoor Sports Complex and all related utilities and as mentioned in the Design Basis Report and Tender drawings otherwise taking into consideration with respect to all statutory regulations as required for development and functioning of campus are also included in the scope of work.

The tentative area of proposed buildings is tabulated below:

Sl. No.	Building / Block	Area (in Sqm.)
A. Institutional Buildings		
1.	Academic Block	8,495
2.	Guest House	708

3.	General Hostel Block	5,155
4.	Indoor Sports Complex Cum Auditorium	3,470
B. Hospital Buildings		
1.	100 Bedded Hospital (including Service Block)	10,477
2.	Resident Doctor Quarters -2 blocks (22 Units)	3,688
3.	Medical Superintendent Quarter	157
4.	Staff Quarters (18 Units)	1,795
	Total Area (A+B)	**33,945**

1.2. **Tender Drawings:**

The tender drawings are for e-Tender Purpose only and are intended as a guide to the Bidder / Contractor and give general layout of buildings and general information of the structures and general positions of utilities, services and equipment. The Drawings and Specifications provide an indicative requirement of the works and general design principles and shall be developed, tested and warranted to comply with the design & drawings, specified performance criteria and requirements, and relevant statutory and project requirements.

The bidder/contractor shall prepare their designs & drawings based on the tender drawings and Design Basis Report provided in the tender document. The master plan shall not be varied without approval of the Engineer-In-Charge. The drawings of the respective buildings/ blocks, as provided in the tender documents, shall also be followed unless there is a requirement for their modification/correction as per requirement of the statutory bye laws, and, changes, if any required, due to structural designs consideration shall also be incorporated with the approval of the Engineer-In-Charge. This shall also hold good in respect of drawings/ SLD/ schematic/ P&I diagrams/ drawings for Services Components. All relevant modifications/revisions as required are to be done by the contractor at his own cost and any claim raised by the contractor in this regard shall not be valid in this contract and shall not be accepted by the HLL.

1.3. **Design**

The Design Basis Report and Drawings provided to the bidders are to ensure a clear understanding of the building design standards and other associated parameters that the Client/ HLL wishes to achieve for different components of the project. While the Client/ HLL is keen to see innovation, but the required standards of design must be achieved. Contractors shall outline the means by which they will ensure design quality and the design objectives, which have influenced their scheme. This shall include details of how the Client/ HLL's objectives are to be achieved.

1.3.1. General Standards:

The facilities shall be completed to high standards of construction and specification. The facilities shall be technically sound and functionally suitable in line with the provisions given in the DBR and to meet the Client/HLL's objectives:

i. The Architectural finishes shall be of approved brand as per tender documents and such quality that will ensure better hygienic conditions, provide clean room environment in the modernized facilities as well as the new facilities.

ii. The architectural design of Auditorium should take in to account the required Acoustic Parameters.

iii. The architectural design of should take in to account the required Green

Building Parameters.

iv. The architectural design should take in to account the requirements of physically challenged persons.

v. All the material procured or to be used should be with the approval and the satisfaction of the Engineer in charge, before being put to use.

vi. All materials including fittings and fixtures shall be of approved make. For other materials, the same shall be as per approval of Engineer- in-charge.

vii. The design should provide for underground/surface Tanks and overhead water tanks with necessary pumping arrangement for both portable and firefighting requirements.

viii. The design should incorporate fire fighting system with hydrants, sprinklers, fire extinguishers, electrical and fire alarm system in accordance with the rules and regulations of the local fire authority, NBC 2016, NFPA, Relevant IS codes, (the Tariff Advisory Committee (TAC) of the Insurance Association of India- for guidance only), as amended up to date.

ix. Planning and design should also incorporate the requirements with respect to the recreational & sports facilities in the project as per requirement.

x. Lighting should conform to relevant IS Code of practice for Lighting. All electrical system, fixtures, fittings etc. should confirm to CPWD specifications, latest IS code, NBC etc.

xi. The planning should include landscaping and horticulture as per requirements. The contractor shall create parking, approach roads and other requirements for the building.

xii. Provision should be made for internal and external signage's, display boards, public address system in the required area.

xiii. Furnishings in the room should be complete in all respects including, communication networking for Data, telephone connection, power points etc. It should also include the provisions of raceways to be laid in floors as per requirements.

xiv. Mechanical services shall be designed and installed with provisions to contain noise and the transmission of vibration generated by moving plant and equipment schedules to achieve acceptable noise and vibration with respect to human beings specified by ISO standards 13.140 and 13.160

xv. All moving plant, machinery and apparatus shall be statically and dynamically balanced at manufactures work place and certificate issued.

xvi. All aspects of Bio Medical Waste(Management & Handling) Rules 1998 with subsequent amendments, if any, issued by the Ministry of Environment and Forest, Government of India should be addressed in the provision for Waste Management.

xvii. Provision should be made for Operation theatres based on seamless integration and complete Medical Gas Pipeline System.

1.3.2. Statutory, Industry and Local Standards:

The following standards shall apply unless otherwise stated:

- Standards set out in National Building Code of India 2016
- Relevant Development Control Rules/Planning Act/Development Act/ Municipal Act/ any other applicable statutes and local bye-laws
- National Electrical Code, 1985

- Indian Electricity Act 2003
- Bio Medical Waste (Management & Handling) Rules 1998
- Requirements of the local Water Supply Company, Electricity Supply Company/Department
- Requirements of the Pollution Control Board, Fire Department, Aviation authorities and other statutory authorities, as applicable
- Requirements of any other standards and bye laws as applicable.

1.3.3. Preliminary & Detailed Design:

Based on the details provided, as mentioned above, the Contractor shall prepare preliminary & detailed design of all the building & services including external development and these shall be in conformity with the Tender drawings, Technical Specifications, Design Basis Report and other standards set forth in the contract document subject to applicable statutory bye-laws/ regulations as listed below:

a. Topographic Site Survey and Sub-Soil Investigation & submission of Site Survey Report & Sub-Soil Investigation Reports to HLL.

b. Preparation & submission of Preliminary & Detailed Architectural design /drawings of various buildings & blocks including preparation of Site Plan, Structural designs & drawings with complete services etc. in conformance with Master Plan & other Tender drawings, Design Basis Report & General specifications for the work provided in the Tender Document with complete foundations and sub-structure / structure with all furnishings and interiors including acoustics treatment, as required. The Contractor shall ensure that the drawings shall meet the requirements of the local bye-laws/ statutory bodies etc.

c. The contractor shall prepare complete structural design drawings for foundations, superstructure, services, and for other structures to be provided/constructed, as per the provision contained in IS Codes / NBC 2016, taking into consideration the protection against seismic forces required for earthquake resistance structures. The shear walls, due to structural requirement shall be provided, as required.

d. The structural drawings shall be got approved from HLL. The contractor shall ensure proof checking of structural designs and drawings from IIT/NIT or other Govt. Institutes as approved by HLL. After approval of the structural drawings by Engineer-in-Charge, if any modification in design/drawing is needed, as per site conditions, the Contractor shall do /re-do without any extra cost.

e. Scope of work shall include scheme finalization based on DBR, tender drawings, concept designs, master plan etc. Contractor shall submit detailed room wise Heat Load Sheet of Air Conditioned Buildings, CFM sizing of ventilation/pressurization fans, detailed electrical load sheets, Equipment sizing, SLDs/Schematic for all MEP services, Technical Submittals & GA Drawings of all MEP Equipment, Lighting/Energy Simulation Reports for MEP Services, Detailed Water Requirement Sheet & Tank /Pump Sizing etc. complete as per requirement of HLL.

f. Preparation & submission of Preliminary & Detailed Design & drawings of all internal and external services viz. Electricals including DG Sets, Provision of different types of Lifts, HVAC, Networking, LAN & Wi-Fi, CCTV & PA System, Fire detection, Fire Alarm & firefighting, BMS, Waste Management System, ETP, STPs & Water Treatment Plant, Nurse Call System, Solar Hot Water System etc. & all other systems as mentioned in DBR & elsewhere in this Tender.

g. Planning and designing of all external services like water supply, system for recycling of waste water, R.O plant, sewerage system including provisions of soak pits & Septic Tanks, drainage system, parking lots, Recreational & sports

facilities, internal campus roads, pathways, and all connected sub-structures and superstructures within the premises, as per bye-laws and norms of the local bodies including making connections with the peripheral services after getting the services design approved from the local bodies/statutory bodies. HLL's/Client's role shall be limited only to sign the application / drawings / documents for submission to the local bodies in the capacity of the owner for approval. In case of water supply, sewerage and drainage, the cost of getting the scheme approved from service provider is included in the scope of work/bid. The cost of connection of water supply lines/sewer lines from peripheral connection point/outfall sewer shall also be borne by the Contractor apart from internal and external water supply/sewerage lines to be laid to make the system of water supply and sewerage functional/complete. However, statutory charges, if levied by the service provider towards cost of laying of their peripheral services shall only be reimbursed by HLL/Client on production of relevant payment receipts/documents by the Contractor to the satisfaction of Engineer-in-charge.

h. The necessary arrangements are to be provided for supply of water through dual pipe system i.e. recycled water duly treated pumped through underground tanks/surface Tank to overhead tanks and piped to flushing in each location/utility as directed by the Engineer-in-charge. However, the requirement in respect of each of the buildings is laid down while specifically detailing the requirement for respective building.

i. Planning and designing underground tanks, pump houses for water supply, for firefighting tanks, storm water collection tank including installing of pumps etc. as per approved drawings/ specifications or as directed by Engineer-in-charge.

j. Planning and designing of all electrical and mechanical services including related external services for works such as HT/LT Electrical works, firefighting works, Lifts, Internal electrification, LV works, HVAC, STP/ETP/WTP etc., as per bye-laws and norms of the statutory and local bodies including making connections with the peripheral services after getting the services design approved from the local bodies/statutory bodies. HLL's/Client's role shall be limited only to sign the application / drawings / documents for submission to the local bodies in the capacity of the owner for approval. However, statutory charges, if levied by the service provider towards cost of providing services shall only be reimbursed by HLL/ Client on production of relevant documents by the Contractor to the satisfaction of Engineer-in-charge.

k. Planning & designing of waste water recycle system, rain water drainage, storage and recycle system including laying of pipe lines and construction of related structures.

l. Preparation & submission of Preliminary & Detailed design & drawings for Landscaping & Horticulture work, development plans showing Internal Roads, Pathways, Parking lots, Paved areas, Court Yards Landscaping, Drains, Culverts, Compound walls etc. if required, External lighting arrangements, Under Ground /Surface tanks & Overhead tanks, Rain Water Collection tank, Internal & external Signage's, Recreational Sports facilities etc. complete in all respect.

m. Preparation of landscaping plan including parks, planters and other details etc. for the horticulture works and execution of same including providing unfiltered/recycled water supply lines, construction of pump houses and installation of pumps therein etc. complete will be responsibility of Contractor. Development of parks, construction of its boundary wall, providing MS railings (including painting), wicket gates, water hydrants, the grassing, creepers and planting trees & relocation of existing trees within campus etc. shall be completed as per the specification and drawing approved by the Engineer-in-charge.

n. Planning & designing of MS gates, Wicket gates, sign boards, guide maps, location boards, direction boards, Numbering of houses/hostels etc. all complete as per the drawing approved and direction of Engineer-in- charge.

o. Planning & detailed design of Medical Gas Pipeline System complete in all respect as per specification/matrix/description and direction of Engineer-in-charge.

p. However, the requirement of services in respect of each of the buildings is laid down while specifically detailing the requirement for respective building.

q. Setting up a Testing Laboratory at site equipped with the necessary apparatus needed for day to day testing of construction materials during construction period as directed by the Engineer-in-charge.

r. Obtaining approval of HLL/ Client for all the Detailed/Preliminary Architectural, Structural & Services drawings & designs.

s. Prepare and submit three dimensional model(s) of suitable scale as and when required by the HLL/ local authority at no extra cost.

1.3.4. Scale

All drawings shall be prepared to the scale as required for proper explanation and shall indicate the size and location of all equipment and accessories therein. The Contractor shall follow all dimensions of approved architectural drawings for the work or part concerned and check proposed drawings for any interference with the building structure or other equipment or services.

1.4. **Statutory Approvals:**

HLL/RIPANS has initiated the process for obtaining required statutory approvals including for the pre-construction stage from the Aizawl Municipal Corporation, Fire Department. It is anticipated that such approvals shall be received in time before the commencement of work. However, in case, the local bodies take further time, the EPC contractor shall take all necessary action to obtain such approvals before commencement of work. The Contractor shall, however, be responsible for ensuring all the requisite statutory approvals from other local bodies like Water supply agencies concerned, Electric Supply and Inspectorate Agencies concerned, Police and Security Agencies, Chief Controller of Explosives, Civil Aviation Department, in accordance to prevailing rules, Building Bye-Laws, etc., as the case may be with related to/ required for Construction/ Completion. The contractor shall also assist and liaison for obtaining EIA approval, as required. All expenditure on this account will be borne by the contractor.

These approvals shall also include:-

i. The Environment impact assessment is also part of the scope of work as such its clearance from Ministry of Environment and forest Department, CPCB & State PCB as applicable is the responsibility of the contractor. The contractor shall assist and liaison with the respective department for obtaining the EIA approval, as required.

ii. Obtaining approval of the Architectural drawings from relevant local statutory body & obtaining Commencement Certificate from local bodies leading to commencement of construction of the project, as required.

iii. Any other approval required from the appropriate Statutory Authorities/ Local Bodies including obtaining approval of AERB, as required.

iv. Compliance as per GRIHA norms and obtaining approval and certification for minimum 3 Star, Green Building Rating for following buildings /blocks from GRIHA Council etc.

- Hospital Block
- Academic Block

The original documents of approval/certificates etc. shall be submitted to the HLL.

1.5. **Detailed Drawings/ Shop drawings/ Design**

The Contractor shall furnish for approval of the Engineer-in-charge requisite sets of detailed drawings/ Shop drawings as stipulated /as per requirements of the contract and specially for Façade work, Aluminum works, Door/Windows, Glazing Work, Structural Steel work, Sanitary, Plumbing, Firefighting (external & internal), Pump room, Electrical works, LV works, HVAC, STP/ETP/WTP, MGPS and all other works within scope of this contract.

Solar Hot Water System & all other services, equipment and materials required to complete the work as per specifications well in advance. These drawings /documents shall contain details of construction, size, arrangement, operating clearances, performance characteristics, and capacity of all items of equipment, as also the details of all related items of work of other trades. The work will be executed by the contractor based on the approved detailed/shop drawings from the Engineer-in-charge/ concerned authority and accordingly contractor will be responsible for obtaining all required final NOC / clearance from concerned authorities. All shop drawings are to be made in accordance with latest fire safety norms and building codes.

a. All drawings necessary for assembly, erection, maintenance, repair and operation of the equipment shall be furnished and different parts shall be suitably numbered for identification and ordering of spare parts.

b. For any amendments proposed by Engineer-in-charge/ concerned authority in the above drawings, the Contractor shall supply fresh sets of drawings with the amendments duly incorporated, along with the drawings on which corrections were indicated.

c. No material or equipment may be brought at Site until the Contractor has the approved Shop drawings for that particular material or equipment.

d. After approval of the drawings by the Engineer-in-charge, the Contractor shall further furnish six sets of Shop drawings for the exclusive use of and retention by the Engineer-in-charge.

e. Approval of drawings by the Engineer-in-charge shall not relieve the Contractor of any obligation to meet all the requirements of the Contract or of the correctness of his drawings. The Engineer-in-charge's approval of specific item shall not mean the approval of the assembly of which it is a component. The Contractor shall be responsible for and is to bear the cost for all alternations of the works due to discrepancies or omission in the drawings or other particulars supplied by him, whether such drawings have been approved by the Engineer-in-charge or not.

f. Where the work of the Contractor has to be installed in close proximity to, or will interfere with the work of other trades, the Contractor shall assist in working out the space conditions to make a satisfactory adjustment. If so directed by the Engineer-in-charge, the Contractor shall prepare composite working drawings and sections to a suitable scale not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, and it is cause for any interference with the work of other trades, he shall make all the necessary changes without extra cost.

g. All shop drawings and detail drawings will be made as per requirements of local authorities and tender drawings incorporating all latest regulations and requirements. No separate drawings will be, issued for making shop drawings.

h. Unless otherwise prescribed, the contractor shall submit two sets of shop drawings/technical submittals/data sheets/any other details required for approval of the Engineer-In-Charge. The contractor, after incorporating modifications / deletions/observations/ amendments suggested by the Engineer-In-Charge, shall submit six corrected sets of such documents for final approval and issuance.

1.6. **Approved Makes:**

a. Specification/brands names of materials/equipment to be used or supplied as per the scope of work are listed in the Vol-5 Technical Specifications. For all other materials /equipment the same shall conform to the relevant Indian Standards or in their absence conform to any International Standards and as approved by the Engineer-in-Charge.

b. All material and equipment shall conform to the relevant Indian Standards/ IEC codes and bear IS marking where ever applicable. Where interfacing is involved, such equipment shall be mutually compatible in all respects.

c. Where an item of equipment, other than as specified or detailed on the drawings, is approved by Engineer-in-charge, requires any re-design of the structure, partitions, foundation, piping, etc. or any other part of the mechanical, electrical or architectural layout, all such re-design, and all new drawings and detailing required therefore, shall be prepared by the Contractor at his own expense and approval obtained from the Engineer-in-charge.

d. All similar equipment, materials, removable parts of similar equipment etc. shall be inter-changeable with one another.

e. The contractor shall submit to the Engineer-in-charge for approval details of all proposed materials, equipment, accessories, equipment characteristics and capacity details of all equipment, accessories and devices etc. as per the specifications and obtain approval of the Engineer-in-charge.

1.7. **Project/ Work Execution/Construction:**

1.7.1. **Commencement of work.**

The commencement of work is to be reckoned as per Clause 5 of the General Conditions of Contract (GCC). The work is being executed as per EPC mode. It is anticipated that the Contractor shall be taking up planning and design activities, and mobilization for initial two months, before any construction can commence at the site. No extension of time whatsoever shall be granted on account of planning and design & mobilization activities or delay if any, accruing on account of these activities.

1.7.2. **Handing Over and Clearing of Site:**

a. The site of work is available.

b. The contractor is required to arrange the resources to complete the entire project within the total stipulated time. Traffic diversion, if required, is to be done and maintained as per requirement of the traffic police and / or as per specifications, by the contractor at his own cost and the contractor shall not be entitled for any extra payment, whatsoever, in this regard.

c. There may be some services crossing the earmarked area of the project premises. The scope of work includes dismantling of services, if any, falling in the construction area and supporting/shifting & making functional existing services/sewerage and water supply lines etc. The contractor shall properly take care & safe guard the all the existing services in the area affected by the construction for up-gradation & development of RIPANS Complex.

d. Necessary arrangement including its maintenance is to be made by the contractor for temporary diversion of flow of existing services, drain(s) and road(s) etc., as the case may be. The existing services, drain(s) and road(s) etc., would be demolished, wherever required with the progress of work under the scope of proposed project. The existing services drain(s) and road(s) etc., which are not in the alignment of the said project but are affected and / or need to demolish during execution for smooth progress of the project, shall be rehabilitated to its original status and condition (including black topping) by the contractor at his own cost. The cost to be incurred by contractor in this regards shall be deemed to be included in the quoted rates and contractor shall not be entitled for any extra payment whatsoever in this regard.

e. The information about the public utilities (whether over ground or underground) like electrical/telephone/water supply/sewerage lines, OFC Cables, open drain etc. is the responsibility of contractor to ascertain the utilities that are to be affected by the works through the site investigation.

f. The contractor shall be responsible to obtain necessary approval from the respective authorities for shifting/re-alignment of existing public utilities. HLL/Client shall only assist the contractor for liaisoning in obtaining the approval from the concerned authorities.

g. Any services affected by the works must be temporarily supported by the contractor who must also take all measures reasonably required by the various bodies to protect their service and property during the progress of works. It shall be deemed to be the part of the contract and not extra payment shall be made to the contractor for the same.

h. If the work is carried out in more than one shift or during night, no claim on this account shall be entertained. The Contractor must take permission from the different statutory/ Govt. authorities etc. if required for work during night hours. No claim / hindrance on this account shall be considered if work is not allowed during night time.

i. The Contractor shall be responsible for the watch and ward / guard of the buildings safety, fittings and fixtures provided by him against pilferage and breakage during the period of installations and thereafter till the building is physically handed over to the department. No extra payment shall be made on this account.

1.7.3. **Construction of Building & Infrastructure:**

Based on the Master Plan, Concept Designs, Design Basis Report and other drawings, Technical Specifications and other documents given in the tender, approved Good for Construction Drawings/ Shop Drawings, Finishing /Flooring Schedule, approved makes of materials/equipment, Schedule of Doors / Windows fittings & fixtures, Schedule of Plumbing/Sanitary Fittings /Fixtures, Scale of amenities, the Construction of all buildings/ blocks, associated infrastructure & external development work & services shall be carried out and completed by the Contractor in a phased schedule as specified in the tender document. Scope of the Construction work shall also include but not limited to the following:

a. As per approved Architectural, Structural Drawings & Designs, Construction of foundation/sub structure & entire structure work of different buildings as specified shall be executed including carrying out complete internal & external finishing work, flooring work, doors & windows, external façade work, water proofing treatment of terrace & toilets /kitchen/ pantry etc. & of all blocks & buildings to cater for the complete up-gradation & development of RIPANS Complex.

b. Construction of roads, pathways, dropouts at main entrances of Hospital, Academic Block, Indoor Sports Complex Cum Auditorium and other building & blocks etc. Parking lots, recreational & sports facilities, STP/ETP/WTP, water supply, sewerage, drainage works, horticulture & landscaping, Planters, including external lighting, etc. complete as per approved drawings and design.

c. Complete leveling/dressing including filling of earth, its supply, disposal of surplus earth / debris / malba etc. if any is to be completed as directed by the Engineer-in-charge.

d. Besides the scope of work as referred above, the construction of Building & Services with associated infrastructure shall include the following along with other utilities required for smooth functioning of proposed Building /Blocks of RIPANS taking into consideration all statutory regulations:

   i. Fire Fighting, Fire Detection & Fire Alarm System with required underground & overhead fire water tanks, rain water collection tanks, other overhead/underground domestic/flushing/ soft water tanks etc., firefighting pumps, equipment, panels, ring mains, fire & smoke detectors, fire alarm panels, PA System etc. complete including construction of Pump room.

   ii. Centralized HVAC System in Hospital Building and Indoor Sports Complex & Auditorium.

   iii. Internal Electricals with all fittings & fixtures, Rising Mains, DBs & Panels etc.

   iv. LAN Network, IPABX System and UPS etc.

   v. DG Sets, Street Lighting, Sandwich rising mains, LT Panels, Capacitor Panels etc. complete with necessary foundations and approaches etc. including required cabling & connections as required. Scope of work for EPC Contractor shall commence from Two Pole Structure (LT) located at various substation to be provided by State Govt.

   vi. Audio-Video & Stage Lighting System shall be provided for Auditorium and Audio-Video System shall be provided for Lecture Theatres. The following facilities for Auditorium and Lecture Theatres shall be provided:

      - Audio System for Auditorium, Seminar/Conference/Meeting Rooms & Lecture Theatres.
      - Lighting System embedded in Acoustic Interior Works for Auditorium.
      - Stage Lighting & Stage Furnishing for Auditorium.
      - Video Projection & Control System for Auditorium, Seminar / Conference/Meeting Rooms & Lecture Theatres.
      - Paneling Works considering all architectural, and acoustic measures and as per requirements

   vii. RO Plant Work shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialized services as described hereinafter and as specified in the schedule of quantities and/or shown on the plumbing drawings for RO Plant.

   viii. Supply, installation, testing & commissioning of Portable Water Purifier (RO+UV) of adequate water flow rate with sufficient storage capacity incl. RO membrane, pumps, motors, cartridge filters, interconnecting pipes,

valves, cable etc. complete in all respects as per manufacturer's standards & as directed by Engineer-In-Charge.

ix. Procurement and installation of 1000 Chairs in the Auditorium Block as given below:

- Main Auditorium Hall -1000 chairs (Base Price without taxes- Rs.10,685/each)
- Indoor Sports Complex Equipment, as per norms prescribed by SAI for:-
    a. Basket Ball
    b. Volley ball
    c. Table Tennis

x. Planning, Designing, Construction with respect to all required Green Building Parameters and Acoustic Parameters.

xi. All aspects of quality assurance, including testing services components of the work,

xii. Training and orientation of Client's personnel on various systems installed as part of this contract

xiii. Project Management to ensure completion of Project as per specified timelines.

xiv. Submission of the completion (i.e. as built) drawings and other related documents.

xv. Clearance of site before handing over of the facilities to fulfill after full filling all the obligations.

xvi. Handing over of the facilities after completion of project after fulfilling all obligations and responsibilities as per Contract.

xvii. Making Good any defect (if any) within Defect Liability Period

1.8. The Contractor shall take all precautionary measures to safeguard safety measures against any accidents for the Contractor's employees, labour, public, and staff of HLL/Client by providing all necessary safety equipment, helmets etc. at work site.

1.9. The scope of work includes cost of all materials, manpower, equipment, T&P fixtures, accessories, royalties, taxes, watch & ward, and all other essential elements for completion Any change, modification, revision etc. required to be done by HLL/Client, CFO, local bodies, proof consultants, GRIHA Council etc. in accordance with applicable standards and bid document will have to be done at Contractor's cost and nothing extra shall be payable.

1.10. The scope of work is only indicative and not exhaustive. In additions to the above the Contractor shall be responsible for executing all the works/ items required for completing all the building and other services in all respect under up-gradation and development of RIPANS project habitable and ready for occupation as per direction of Engineer-in-charge.

1.11. Approval of Engineer of Client/HLL at any stage of planning, design and construction of the project will not absolve the ingrained responsibility of the Contractor to execute the construction flawless and at par excellence and, if any aspect contrary to this owning up of responsibility is glaring, the Contractor will be held liable for such gross deviation.

1.12. The work shall be executed in accordance with the drawings /design approved by HLL which are prepared by the Contractor in conformity with the scope of the project & specifications, standards and statutory requirements. The Contractor shall carry out and complete the said work in every respect in accordance with this Contract and with the directions of and to the satisfaction of the Engineer-in-charge.

1.13. The Engineer-in-charge may in his absolute discretion and from time to time review the drawings/ designs & approve drawings/ designs and/or written instructions, details, directions and explanations, in regard to:

a. The variation or modification of the drawings, design, quality or requirement of works or the addition or omissions or substitution of any item.

b. Any discrepancy in the drawings or between the requirement of works and /or drawings and/or specifications.

c. The removal from the site of any material brought thereon by the contractor and the substitution of any other material thereof.

d. The removal and/or re-execution of any works executed by the contractor.

e. The removal of any persons employed by the contractor on the site.

f. The opening up for inspection of any work covered up.

g. The amending and making good of any defects noticed during or after execution of the work.

1.14. The contractor shall be solely responsible for the means, methods, techniques sequence and procedure of construction. The Contractor shall be responsible to see the completed work complies accurately with the Contract requirements. The Contractor shall provide all necessary superintendence during the execution of the Works as per contractual provisions.

a. The Contractor shall be responsible for the correct positioning of all parts of the Works, and shall rectify any error in the positions, levels, dimensions or alignment of the Works. Contractor agrees and undertakes that the construction shall be completed within the Project Completion Schedule and any extension of time granted according to the provisions of this Agreement.

b. The Contractor shall, subject to the provisions of the Contract, and with due care and diligence, execute and complete the Works & remedy any defects therein in accordance with the Contract. The Contractor shall provide all labour, including the supervision thereof, materials, Constructional Plant and Machineries and all other things, whether of a temporary or permanent nature, required in and for such execution, completion, maintenance and remedying of any defects, so far as the necessity for providing the same is specified in or is reasonably to be inferred from the Contract.

c. The Contractor must bear in mind that all the work shall be carried out strictly in accordance with the specifications as given in these documents and also in compliance of the requirements of the local public authorities and to the requirements/ satisfaction/ direction of the Engineer-in-charge and no deviation of any account will be permitted.

d. The Contractor shall have to use materials from the makes / manufacturers specified in the list of materials of approved brand and/or manufacture contained in the contract documents and as approved by the Engineer - in-Charge. Wherever different pattern/ Design/ Quality of materials with same specification/ make as specified in the contract, is available in the market, Engineer-in-Charge will approve the pattern/ Design/ Quality of the material/ item which shall be final and binding on the contractor. The contractor shall supply samples of all the materials / fittings / fixtures proposed to be used in the work

and obtain approval of the Engineer - in- Charge. These samples shall be retained at site till completion of the work. If subsequently it is found that approved material upon testing does not meet the requirement as specified in the contract the contractor shall get approval of alternate material.

e. The work shall be carried out in conformity with the relevant drawings and the requirement of architectural, electrical, structural, and other specialised service drawings approved by HLL.

f. The Contractor shall make provision of hangers, sleeves, structural openings and other requirements during construction to avoid holding up progress of the construction schedule. The Contractor should ensure that the structure is designed for additional loads or cut outs. Subsequent Cutting of holes in the RCC structural members /slab shall not be allowed.

g. The contract items comprise of furnishing of all materials, equipment, labour& transportation etc. necessary to render the installation / item fully operational as per the intent of specifications and drawings, including any necessary adjustment or corrections. Further the installation / item shall be in conformity with local laws and manufacturer's instructions applicable.

1.15. **Training & orientation of Client's Personnel**

The contractor shall provide necessary training and orientation to the technical personnel deployed by client. The contractor shall arrange visits of the technical personnel / technicians of respective OEM /vendors involved in installation of various electrical and mechanical works under this contract. The duration of training period shall be 15 days or as directed by Engineer-In-Charge with respect to various installed systems like electrical sub-station, HVAC, STP, ETP, WTP, LV Works, Audio Video & Stage Lighting System, MGPS and any other system installed under this contract.

SPECIFIC CONDITIONS OF CONTRACT

B. GENERAL

1. General:

1.1. **Force Majeure:**

Any failure or delay in the performance by either party hereto of its obligations under his Contract shall not constitute a breach thereof or give rise to any claims for damages if, and to the extent that it is caused by occurrences beyond the control of the party affected, namely, acts of God, floods, explosions, wars, riots, storms, earthquakes, insurrection, epidemic or other natural disasters. The party so affected shall continue to take all actions reasonably within its power to comply as far as possible with its obligations under this Contract. The affected party shall promptly notify the other party after the occurrence of the relevant event and shall use every reasonable effort to minimize the effects of such event and act in all good faith with due care and diligence.

1.2. **Compliance with Statutes, Regulations, etc.**

The contractor shall conform to the provisions of all statutes, ordinance, laws, acts of the legislature relating to the works, and to the regulations and by-laws of any local or other duly constituted authority and of any water, electric supply and other companies and/or authorities with whose systems the structure is proposed to be connected. The Contractor shall keep the HLL indemnified against all fines or penalties or liability of every kind for breach of any such statutory ordinance, law act of the legislation, regulations, and byelaws as aforesaid.

The contractor shall before making any variations from the drawings or specifications that may be necessitated by such regulations, give to the Engineer- in-charge written notice, specifying the variation proposed to be made and the reasons for making it and apply for instructions thereon. The contractor will not execute any work without written permission from the Engineer-in- charge

The contractor shall bring to the attention of the Engineer-in-charge any specific requirement of the local authorities or any notice required for execution by virtue of such acts, regulations or bye-laws of such authority, or public office. All fees that may be chargeable in respect of these works shall be reimbursed by the HLL on production of authorised receipts.

1.3. **Boreholes & Exploratory Excavation**

If, at any time during the execution of the Works, the Engineer-in-charge shall require the Contractor to make boreholes or to carry out exploratory excavation, such requirement shall be ordered in writing and shall be deemed to be an additional ordered under the provisions unless a provisional sum in respect of such anticipated work shall have been included in the schedule of items.

1.4. **Fossils, Etc.**

All fossils, coins, articles of value or antiquity and structures and other remains or things of geological or archaeological interest discovered on the site of the works shall be the property of the HLL/ CLIENT/ Government.

1.5. **Absence of Specifications**

If the user requirements, specifications etc., do not contain particulars of materials and works which are necessary for its proper execution, all such materials shall be supplied and item shall be executed by the Contractor without extra charge and if the Contractor requires any information, he shall request in writing well in advance to commencement of the particular work to the Engineer-in-charge who will

clarify the issue within a reasonable time.

1.6. Works by Other Agencies

The Engineer-in-charge reserves the right to use premises and any portion of the site for the execution of any work not included in this contract which it may desire to have carried out by other persons simultaneously, and the contractor shall allow the reasonable facilities for the execution of such work, but shall not be required to provide any plant or material for the execution of such work except by special arrangement with the other agency. Such work shall be carried out in a manner so as not to impede the progress of the works included in the contract, the contractor shall not be responsible for any damage or delay which may happen to or occasioned by such work.

The contractor shall co-operate with other agencies working in the same project, and coordinate his plans and time schedules so that there will be no interference. The Contractor shall forward to the Engineer-in-charge all correspondences and drawings exchanged. Failure to check plans for conditions will render the Contractor responsible for bearing the cost of any subsequent changes found necessary or damages done.

The Engineer-in-charge shall not entertain any claim on account of the Contractor affording necessary facilities to execute the work simultaneously with other agencies executing the works for the same project.

1.7. Quality Assurance

1.7.1. Quality Assurance Programme

The Contractor shall ensure that the Construction, Plants, Goods & Materials and workmanship are in accordance with the requirements specified in this Agreement, Specifications and Standards and Good Industry Practice.

Sources of Materials being supplied shall be intimated to the Engineer and are subject to his approval. Materials that are not specified in the Contract document shall conform to the relevant Indian Standards or in their absence conform to any International Standard approved by the Engineer.

To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the HLL's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the HLL after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following:

- His organization structure for the management and implementation of the proposed quality assurance programme.
- Documentation control system.
- Qualification data for bidder's key personnel.
- The procedure for purchases of materials, parts components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.
- Control of non-conforming items and system for corrective actions.
- Inspection and test procedure both for manufacture and field activities.

- Control of calibration and testing of measuring instruments and field activities.
- System for indication and appraisal of inspection status.
- System for quality audits.
- System for authorizing release of manufactured product to the HLL.
- System for maintenance of records.
- System for handling storage and delivery.
- A quality plan-detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

The CLIENT/HLL or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his Vendor's quality management and control activities.

1.7.2. Quality Assurance Documents

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after dispatch of the equipment.

- All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.
- Welder and welding operator qualification certificates.
- Welder's identification list, listing welders and welding operator's qualification procedure and welding identification symbols.
- Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.
- Stress relief time temperature charts/oil impregnation time temperature charts.
- Factory test results for testing required as per applicable codes/ mutually agreed quality plan/standards referred in the technical specification.
- The quality plan with verification of various customer inspection points (CIP) as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactorily.

1.8. Additional Conditions of National Green Tribunal

i. The Contractor shall not store/ dump construction material or debris on the metaled road.

ii. The Contractor shall get prior approval from Engineer-in-Charge for the area where the construction material or debris can be stored beyond the metaled road. This area shall not cause any obstruction to the free flow of traffic /inconvenience to the pedestrians. It should be ensured by the Contractor that no accidents occur on account of such permissible storage.

iii. The Contractor shall take appropriate protection measures like raising wind breakers of appropriate height on all sides of the plot/area using CGI sheets or plastic and/or other similar material to ensure that no construction material dust fly outside the plot area.

iv. The Contractor shall ensure that all the trucks or vehicles of any kind which are

used for construction purposes/or are carrying construction material like material like cement, sand and other allied material are fully covered. The Contractor shall take every necessary precaution that the vehicles are properly cleaned and dust free to ensure that en-route their destination, the dust, sand or any other particles are not released in air/contaminate air.

v. The Contractor shall provide mask to every worker working on the construction site and involved in loading, unloading and carriage of construction material and construction debris to prevent inhalation of dust particles.

vi. The Contractor shall ensure that C&D waste site only and due record shall be maintained by the Contractor.

vii. The Contractor shall compulsory use of wet jet in grinding and stone cutting.

viii. The Contractor shall comply with all the preventive and protective environmental steps as stated in the MoEF guidelines, 2010.

ix. The Contractor shall carry out on- Road-Inspection for black smoke generating machinery. The Contractor shall use cleaner fuel.

x. The Contractor shall ensure that all DG Set comply emission norms notified by MoEF.

xi. The Contractor shall use vehicles having pollution under control certificate. The emissions can be reduced by a large extent by reducing the speed of a vehicle to 20 Kmph. Speed bumps shall be used to ensure speed reduction. In case where speed reduction cannot effectively reduce fugitive dust, the Contractor shall divert traffic to nearby paved areas.

xii. The Contractor shall ensure that the construction material is covered by tarpaulin. The Contractor shall take all other precaution to ensure that no dust particles are permitted to pollute air quality as a result of such storage.

xiii. The paving of the path for plying of vehicles carrying construction material is more permanent solution to dust control and suitable for longer duration projects. The HLL/Client shall carry out cost benefit ratio analysis of the same.

xiv. It is mandatory to use of wet jet in grinding and stone cutting.

xv. Wind breaking wall around construction site.

xvi. As per EIA Notification of 2006, sufficient green belt around the building shall be provided. Such green belts shall be in existence prior to applying for occupancy certificate and handing it over.

xvii. The Contractor shall take appropriate protection measures like raising wind breakers of appropriate height on all sides of the plot/area using CGI sheets or plastic and / or other similar material to ensure that no construction material dust fly outside the plot area. The HLL shall take such item in the schedule of quantity to ensure that the construction activity does not cause any air pollution during course of construction and/or storage of material or construction activity.

xviii. The paving of the path for plying of vehicles carrying construction material is more permanent solution to dust control and suitable for longer duration projects. The HLL shall carry out cost benefit ratio analysis of the same. Based on the benefit ratio analysis, the HLL shall include the item of paving of path in schedule of item which can be utilized as a permanent path for client after construction of project.

xix. It shall be ensured that C & D waste is transported from the site in after keeping due record on behalf of Engineer-in-charge. The C& D waste shall only be dumped at sites declared as Dumping ground and having arrangements for recycling of C& D waste in the region.

xx. Any violation of orders of MoEF including guidelines of State Government, SPCB or any officer of any department shall lead to stoppage of work for which Contractor shall be responsible and no hindrance shall be accounted in this regard.

1.9. Intellectual Property Rights and Royalties

i. Insofar as the patent, copyright or other intellectual property rights in any Plant, Design Data, plans, calculations, drawings, documents, Materials, know-how and information relating to the Works shall be vested in the Contractor, the Contractor shall grant to the HLL, his successors and assignees a royalty-free, non-exclusive and irrevocable licence (carrying the right to grant sub-licences) to use and reproduce any of the works, designs or inventions incorporated and referred to in such Plant, documents or Materials and any such know-how and information for all purposes relating to the Works (including without limitation the design, manufacture, installation, reconstruction, Testing, commissioning, completion, reinstatement, extension, repair and operation of the Works).

ii. If any patent, registered design or software is developed by the Contractor specifically for the Works, the title thereto shall vest in the HLL and the Contractor shall grant to the HLL a non-exclusive irrevocable and royalty-free licence (carrying the right to grant sub-license) to use, repair, copy, modify, enhance, adapt and translate in any form such Software for his own use.

iii. If the Contractor uses proprietary software for the purpose of storing or utilising records the Contractor shall obtain at his own expense the grant of a licence or sub-licence to use such software in favour of the HLL and shall pay such licence fee or other payment as the grantor of such licence may require provided that the use of such software under the licence may be restricted to use relating to the design, construction, reconstruction, manufacture, completion, reinstatement, extension, repair and operation of the Works or any part thereof.

iv. The Contractor's permission referred to above shall be given, inter alia, to enable the HLL to disclose (under conditions of confidentiality satisfactory to the Contractor) programmes and documentation for a third party to undertake the performance of services for the HLL in respect of such programmes and documentation.

v. Any software is developed under the Contract or used by the Contractor for the purposes of storing or utilising records over which the Contractor or a third party holds title or other rights, the Contractor shall permit or obtain for the HLL (as the case may require) the right to use and apply that Software free of additional charge (together with any modifications, improvements and developments thereof) for the purpose of the design, manufacture, installation, reconstruction, testing, commissioning, completion, reinstatement, extension, repair, modification or operation of the Works, or any part thereof, or for the purpose of any Dispute.

vi. The HLL reserves the right to use other Software on or in connection with the Works.

1.10. Obtaining Information's related to Execution of work:

No claim by the Contractor for additional payment will be entertained which in consequent upon failure on his part to obtain correct information as to any matter affecting the execution of the works, nor will any misunderstandings or the obtaining of incorrect information or the failure to obtain information relieve him from any risks or from the entire responsibility for the fulfillment of the contract.

1.11. **Examination of Work before covering up:**

(a) No part of the works shall be covered up or put out of view without the written approval of the Engineer-in-charge and the contractor shall give due notice to the Engineer-in-charge whenever any such work or foundation is or ready or about to be ready for examination and the Engineer-in-charge shall, examine and measure any work before it is covered up or put out of view and to examine foundations before further work is placed thereon.

(b) Uncovering and making openings

The contractor shall uncover any part or parts of the works or make openings in or through the same as the Engineer-in-charge may direct from time to time and shall reinstate and make good such part or parts to the satisfaction of the Engineer-in-charge at his own cost.

1.12. **Miscellaneous:**

(a.) Tax Deduction at Source

All Taxes and surcharge as applicable on date shall be deducted from the amount due to the Contractor towards the value of the work done. TDS certificate thereof shall be issued to the Contractor.

(b.) By-Laws of Statutory Authorities

The Contractor and his labour shall not violate municipal /sanitation /health or any other byelaws.

(c.) Delay in starting the work

No compensation shall be allowed for any delay caused in the starting of the work on account of acquisition of land, encroachment or in the case of clearance of works, on account of any delay in according sanction to estimates in issue of drawings, decisions etc. However, the extension of time shall be granted as per relevant conditions of Contract.

(d.) Site instruction book

For the purpose of quick communication between Engineer-in-charge and the Contractor or his representative, site instruction book shall be maintained at site as described below:

Any communication, relating the works may be conveyed through instructions in the site instruction book. Such a communication from Engineer-in-charge to the Contractor shall be deemed to have been adequately served in terms of the contract once the entries are made and signed by the authorised representative of the contractor. For this purpose the contractor should authorise one of his employees on the site itself. Site instruction book shall have machine numbered pages and shall be carefully maintained and remain under custody of Engineer-in-charge. The contractor can also avail of the site instructions book for urgent communication with Engineer-in-charge. Any instruction which Engineer-in- charge may like to issue to the Contractor may be recorded by the Engineer-in-charge in site instruction book.

(e.) Signages

The Contractor shall provide at his own cost, sign board(s) at directed location(s) having overall size preferably 2 metres by 4 metres, or any other size, indicating name of the project, and a three-D view of the project as well as the name of the Contractor and the CLIENT and HLL with addresses, cost of the Project, date of start & completion, as approved by Engineer-In-Charge. The signboard should be

illuminated during night.

(f.) No idling charges or compensation shall be paid for idling of the contractor's labour, staff or P&M etc. on any ground or due to any reason whatsoever.

(g.) The Contractor shall mobilize and employ sufficient resources for completion of all the works within the stipulated time period as per agreement and as indicated in the approved Bar Chart/ Network. No additional payment will be made to the contractor for any multiple shift work or other incentive methods contemplated by him in his work schedule even though the time schedule is approved by Engineer-in-charge.

2. Contract Price and Payments

2.1. The bidder shall quote their rates in the prescribed format as per "Vol. 7-FINANCIAL BID"of the tender documents. The quoted rates shall be inclusive of all costs towards site visits, planning, designing , site surveys, soil investigations all material, labour, plant and machinery, tools and tackles, batching plant etc. including water & electricity, overhead charges, all taxes (including GST) , duties, levies statutory charges / levies applicable from time to time and others as specified etc., incidental works and all other charges for items contingent to the work, such as inspection, packing, forwarding, insurance, freight and delivery at Site, watch and ward of all materials & successful installation, testing & commissioning at site etc., including handing over of the works to the Client/ HLL, The quoted rates shall also include cost of all other inputs required in the execution of the item, all taxes and duties including Goods & Services Tax. The fee paid by the contractor for obtaining various statutory approvals shall be reimbursed to him after submission of payment receipts and other relevant documents by the contractor.

The successful bidder shall submit within 15 days from the date of Letter of Award, the breakup of total quoted amount of each item of Financial Bid as Base Rate & GST separately which shall form part of the agreement and bills for the executed work shall be raised accordingly.

i. Rates quoted shall be firm and shall not be subject to any price variations except as specifically provided in the contract.

ii. The quantities given in the Schedule of Quantities (Vol-7) are liable to variations. Such variations in quantities shall not, however, vitiate the contract in any way whatsoever. Contractor shall be paid for the actual measured quantities of work executed by the bidder.

iii. Unless otherwise specified the rates tendered by the contractor shall be all inclusive and shall apply to all shapes, heights, lifts, leads and depth of the building and nothing extra shall be payable to him on any account.

iv. Royalty, whenever payable, shall be borne by the contractor on the boulders, metal, shingle, sand and bajri etc., or any other materials collected by him for the work direct to the revenue authority of the District / State Government concerned and nothing extra shall be payable on this account.

v. The words "as specified", "as described", "as shown", "as directed", or "as approved", shall mean as described in the specifications, Schedule of Quantities and other Contract documents as shown on the drawings or as directed by Engineer-in-Charge.

2.2. The payments shall be made on the area basis with respect to each building. The area for the purpose of payment shall be the plinth area actually constructed. The tentative plinth area is as per the Schedule of Quantities-(Volume -7). Following

areas shall not be reckoned with for working out the plinth area and their cost shall be deemed to be included in the respective subheads / items of works.

i. Open courtyards, Lift wells, Shafts/Niches, Lift Machine rooms, Mumties, Chajjas

ii. 50% of area of Projections such as Covered drop off's, Balconies, Cantilever projections, refuse terrace area, Ramp in hospital, Entrances & Porch.

iii. Architectural features like boxing, pergolas etc.

iv. Retaining walls, stability of slopes etc.

v. Building approach /drop off including sub-base, KERB Stone, Pavers, Toe Wall, Railing, Signages (Internal & External) etc.

vi. External works such as pump rooms, underground structures including Overhead/UG Tanks/Surface Tanks, ETP/ STP/ WTP etc.

vii. The culverts for storm water/ rain water along the road alignment

Payments for Roadwork, Pathways and Surface Parking etc. shall be on the basis of finished area of each item. Subgrade, Kerb stone, joints, culverts, retaining/ toe walls & stone pitching, stabilization of slopes, Signages etc. are included in the respective item(s) as per tender drawing, DBR & specifications.

2.3 All running / intermediate & final payments shall be made to the contractor in accordance with the following schedule and on pro-rata basis:

a. Planning, Designing, and Construction on EPC Basis of **Hospital Building including Services Block** with support services & allied facilities by incorporating stipulated specifications, all services including handing over complete as per scope of work and directions of Engineer In charge.

S. No	Description of Item	Break up of total % payable cost		% of Total payable cost
		item	Sub-group	
A.	**Planning, Design & Engineering Works-** Investigation, Planning, Designing and obtaining approvals for works			**1.00%**
	a. On approval of the inception report, soil investigation report & detailed survey, review of master plan and architectural drawings ensuring their conformance to the requirements of the local bodies and statutory authorities as per requirements.		0.05%	
	b. On obtaining all required approvals, if any, from statutory authorities and local bodies for commencement of construction as per requirements.		0.05%	
	c. On approval of structural design by the proof consultant, submission of Good for Construction (GFC) drawings as per requirements and directions of Engineer-in-charge.		0.40%	
	d. On submission of all Good for Construction (GFC) drawings as per requirements:		0.25%	
	i. Architectural drawings	0.10%		
	ii. Design & Drawings for Services	0.15%		
	e. On completion of construction		0.25%	
	i. On Completion of Foundation work	0.02%		
	ii. On Completion of 100% Super structure	0.04%		
	iii. On Completion of work	0.05%		
	iv. On obtaining required statutory approvals after completion of works	0.12%		

	v. On handing over to Client	0.02%		
B	**CONSTRUCTION**			
	1. Civil Works			
	i. Foundation Work including retaining walls upto Level 01	19.00%		
	ii. Structure Work RCC frame of the entire building including retaining walls from plinth level to terrace, stair roof, underground/surface/overhead tanks, Lift machine room, stabilization of slopes, etc. including water proofing etc.	20.00%		
	iii. Brickwork & partitioning work	4.00%	**60.00%**	
	iv. Flooring, skirting, dado, wall lining work	4.00%		
	v. Doors & Windows.	3.50%		
	vi. False Ceiling Work	2.00%		
	vii. Finishing Work i/c painting (inside)	3.00%		
	viii. Finishing Work i/c painting (outside)	2.00%		
	ix. Other Works, viz. Steel work, railing, panelling etc.	2.50%		
	2. Services			
	a. HVAC	**6.00%**		
	i. HVAC High Side equipment like Chillers, Pumps, HWG, piping and related electrical works	3.00%		
	ii. Low side equipment like AHU, FCU, Cassette units, Ducting, grill, diffuser, Chilled/Hot Water Piping, Split AC units and related electrical work	2.00%		
	iii. Ventilation System and related electrical work	1.00%		
	b. Electrical Works	**17.50%**		**97.00%**
	i. DG Set(s) including exhaust stack piping, LT Panel etc.	5.00%		
	ii. Internal Electrical Works, rising mains, floor panels and DB & other related works	7.00%		
	iii. Earthing & Lightning Protection System	0.50%		
	iv. LV & BMS System	1.50%		
	v. Nurse Call System	0.50%		
	vi. UPS System	0.50%	**37.00%**	
	vii. Light Fixtures, Fans and Occupancy Sensors	2.50%		
	c. Water Supply & Sewerage System	**5.00%**		
	i. WTP System	0.25%		
	ii. Water Supply System	1.00%		
	iii. Sanitary & Sewerage System	1.75%		
	iv. Strom water drainage	1.00%		
	v. Fittings & Fixtures	1.00%		
	d. Fire Protection System	**3.75%**		
	i. Wet Riser System / Down Comer System	1.00%		
	ii. Automatic Sprinkler System	1.75%		
	iii. Fire Extinguishers	0.25%		
	iv. External Hydrants etc.	0.50%		
	v. Fire Alarm System & Other Works	0.25%		
	e. RO, Solar Hot Water Generator System	**0.50%**		
	f. STP & ETP	**0.80%**		
	g. Lifts & Dumb waiter	**3.00%**		
	h. Solar PV System	**0.25%**		
	i. Signage (internal+external)	**0.20%**		
C	**Completion and Handing Over**			**2.00%**
	i. Testing & Commissioning		1.00%	
	ii. Handing over		1.00%	
	Total =			**100.00%**

b. Planning, Designing, and Construction on EPC Basis of **Academic Building** with support services & allied facilities by incorporating stipulated specifications, all services including handing over complete as per scope of work and directions of Engineer In charge.

S. No	Description of Item	Break up of total % payable cost		% of Total payable cost
		item	Sub-group	
A.	**Planning, Design & Engineering Works-** Investigation, Planning, Designing and obtaining approvals for works			**1.00%**
	a. On approval of the inception report, soil investigation report & detailed survey, review of master plan and architectural drawings ensuring their conformance to the requirements of the local bodies and statutory authorities as per requirements.		0.05%	
	b. On obtaining all required approvals, if any, from statutory authorities and local bodies for commencement of construction as per requirements.		0.05%	
	c. On approval of structural design by the proof consultant, submission of Good for Construction (GFC) drawings as per requirements.		0.40%	
	d. On submission of all Good for Construction (GFC) drawings as per requirements:		0.25%	
	i. Architectural drawings	0.10%		
	ii. Design & Drawings for Services	0.15%		
	e. On completion of construction		0.25%	
	i. On Completion of Foundation work	0.02%		
	ii. On Completion of 100% Super structure	0.04%		
	iii. On Completion of work	0.05%		
	iv. On obtaining required statutory approvals after completion of works	0.12%		
	v. On handing over to Client	0.02%		
B	**CONSTRUCTION**			**97.00%**
	1. Civil Works		**70.00%**	
	i. Foundation Work including retaining walls upto Level 01	22.00%		
	ii. Structure Work RCC frame of the entire building including retaining walls from plinth level to terrace, stair roof, underground/surface/overhead tanks, Lift machine room, stabilization of slopes, etc. including water proofing etc.	25.00%		
	iii. Brickwork & partitioning work	5.00%		
	iv. Flooring, skirting, dado, wall lining work	5.00%		
	v. Doors & Windows.	3.50%		
	vi. False Ceiling Work	2.00%		
	vii. Finishing Work i/c painting (inside)	3.00%		
	viii. Finishing Work i/c painting (outside)	2.00%		
	ix. Other Works, viz. Steel work, railing, panelling etc.	2.50%		
	2. Services		**27.00%**	
	a. HVAC	**2.00%**		
	i. Split AC units and related electrical work	1.50%		
	ii. Ventilation System and related electrical work	0.50%		
	b. Electrical Works	**15.00%**		
	i. DG Set(s) including exhaust stack piping, LT Panel etc.	4.00%		
	ii. Internal Electrical Works, rising mains, floor panels and DB & other related works	7.00%		
	iii. Earthing & Lightning Protection System	0.50%		
	iv. LV System	1.00%		
	v. UPS System	0.50%		

	vi. Light Fixtures, Fans and Occupancy Sensors	2.00%		
	c. Water Supply & Sewerage System	**3.00%**		
	i. Water Supply System	0.75%		
	ii. Sanitary & Sewerage System including Septic tanks	1.00%		
	iii. Strom water drainage	0.50%		
	iv. Fittings & Fixtures	0.75%		
	d. Fire Protection System	**4.00%**		
	i. Dry Riser System /Down Comer System	2.50%		
	ii. Fire Extinguishers	0.25%		
	iii. External Hydrants etc.	1.00%		
	iv. Fire Alarm system & Other Works	0.25%		
	e. RO, Solar Hot Water Generator System	**0.50%**		
	f. Lifts	**2.00%**		
	g. Solar PV System	**0.30%**		
	h. Signage (internal+external)	**0.20%**		
C	**Completion and Handing Over**			**2.00%**
	i. Testing & Commissioning		1.00%	
	ii. Handing over		1.00%	
	Total =			**100.00%**

c. Planning, Designing, and Construction on EPC Basis of **Guest House** with support services & allied facilities by incorporating stipulated specifications, all services including handing over complete as per scope of work and directions of Engineer In charge.

S. No	**Description of Item**	**Break up of total % payable cost**		**% of Total payable cost**
		item	**Sub-group**	
A.	**Planning, Design & Engineering Works-** Investigation, Planning, Designing and obtaining approvals for works			**1.00%**
	a. On approval of the inception report, soil investigation report & detailed survey, review of master plan and architectural drawings ensuring their conformance to the requirements of the local bodies and statutory authorities as per requirements.		0.05%	
	b. On obtaining all required approvals, if any, from statutory authorities and local bodies for commencement of construction as per requirements.		0.05%	
	c. On approval of structural design by the proof consultant, submission of Good for Construction (GFC) drawings as per requirements.		0.40%	
	d. On submission of all Good for Construction (GFC) drawings as per requirements:		0.25%	
	i. Architectural drawings	0.10%		
	ii. Design & Drawings for Services	0.15%		
	e. On completion of construction		0.25%	
	i. On Completion of Foundation work	0.02%		
	ii. On Completion of 100% Super structure	0.04%		
	iii. On Completion of work	0.05%		
	iv. On obtaining required statutory approvals after completion of works	0.12%		
	v. On handing over to Client	0.02%		
B	**CONSTRUCTION**			**97.00%**
	1. Civil Works		**65.00%**	
	i. Foundation Work including retaining walls upto Level 01	20.00%		
	ii. Structure Work RCC frame of the entire building including retaining walls from plinth level to terrace, stair roof, underground/surface/overhead tanks,	23.00%		

	Lift machine room, stabilization of slopes, etc. including water proofing etc.			
	iii. Brickwork & partitioning work	5.00%		
	iv. Flooring, skirting, dado, wall lining work	4.00%		
	v. Doors & Windows.	3.50%		
	vi. False Ceiling Work	2.00%		
	vii. Finishing Work i/c painting (inside)	3.00%		
	viii. Finishing Work i/c painting (outside)	2.00%		
	ix. Other Works, viz. Steel work, railing, panelling etc.	2.50%		
	2. Services			
	a. HVAC	**2.00%**		
	i. Split AC units and related electrical work	1.50%		
	ii. Ventilation System and related electrical work	0.50%		
	b. Electrical Works	**16.00%**		
	i. Internal Electrical Works, rising mains, floor panels and DB & other related works	9.50%		
	ii. Earthing & Lightning Protection System	0.50%		
	iii. LV System	4.00%		
	iv. Light Fixtures, Fans	2.00%		
	c. Water Supply & Sewerage System	**5.00%**		
	i. Water Supply System	1.00%	**32.00%**	
	ii. Sanitary & Sewerage System	2.00%		
	iii. Strom water drainage	1.00%		
	iv. Fittings & Fixtures	1.00%		
	d. Fire Protection System	**3.00%**		
	i. Dry Riser System /Down Comer System	2.25%		
	ii. Fire Extinguishers	0.25%		
	iii. External Hydrants etc.	0.25%		
	iv. Fire Alarm system & Other Works	0.25%		
	e. RO, Solar Hot Water Generator System	**0.80%**		
	f. Lifts	**5.00%**		
	g. Signage (internal+external)	**0.20%**		
C	**Completion and Handing Over**			**2.00%**
	i. Testing & Commissioning		1.00%	
	ii. Handing over		1.00%	
	Total =			**100.00%**

d. Planning, Designing, and Construction on EPC Basis of **Staff/ Nurses Quarters** with support services & allied facilities by incorporating stipulated specifications, all services including handing over complete as per scope of work and directions of Engineer In charge.

S. No	Description of Item	Break up of total % payable cost		% of Total payable cost
		item	Sub-group	
A.	**Planning, Design & Engineering Works-** Investigation, Planning, Designing and obtaining approvals for works			
	a. On approval of the inception report, soil investigation report & detailed survey, review of master plan and architectural drawings ensuring their conformance to the requirements of the local bodies and statutory authorities as per requirements.		0.05%	**1.00%**
	b. On obtaining all required approvals, if any, from statutory authorities and local bodies for commencement of construction as per requirements.		0.05%	
	c. On approval of structural design by the proof consultant, submission of Good for Construction (GFC) drawings as per requirements.		0.40%	

	d. On submission of all Good for Construction (GFC) drawings as per requirements:		0.25%	
	i. Architectural drawings	0.10%		
	ii. Design & Drawings for Services	0.15%		
	e. On completion of construction		0.25%	
	i. On Completion of Foundation work	0.02%		
	ii. On Completion of 100% Super structure	0.04%		
	iii. On Completion of work	0.05%		
	iv. On obtaining required statutory approvals after completion of works	0.12%		
	v. On handing over to Client	0.02%		
B	**CONSTRUCTION**			**97.00%**
	1. Civil Works		**67.00%**	
	i. Foundation Work including retaining walls upto Level 01	21.00%		
	ii. Structure Work RCC frame of the entire building including retaining walls from plinth level to terrace, stair roof, underground/surface/overhead tanks, Lift machine room, stabilization of slopes, etc. including water proofing etc.	24.00%		
	iii. Brickwork & partitioning work	5.00%		
	iv. Flooring, skirting, dado, wall lining work	4.00%		
	v. Doors & Windows.	3.50%		
	vi. False Ceiling Work	2.00%		
	vii. Finishing Work i/c painting (inside)	3.00%		
	viii. Finishing Work i/c painting (outside)	2.00%		
	ix. Other Works, viz. Steel work, railing, panelling etc.	2.50%		
	2. Services		**30.00%**	
	a. Electrical Works	**15.00%**		
	i. DG Set(s) including exhaust stack piping, LT Panel etc.	3.00%		
	ii. Internal Electrical Works, rising mains, floor panels and DB & other related works	7.00%		
	iii. Earthing & Lightning Protection System	0.50%		
	iv. LV System	1.50%		
	v. Ventilation system	1.00%		
	vi. Light Fixtures, Fans	2.00%		
	b. Water Supply & Sewerage System	**5.00%**		
	i. Water Supply System	1.00%		
	ii. Sanitary & Sewerage System including Septic tanks	2.00%		
	iii. Strom water drainage	1.00%		
	iv. Fittings & Fixtures	1.00%		
	c. Fire Protection System	**4.00%**		
	i. Dry Riser System /Down Comer System	2.50%		
	ii. Fire Extinguishers	0.25%		
	iii. External Hydrants etc.	1.00%		
	iv. Fire Alarm system & Other Works	0.25%		
	d. Solar Hot Water Generator System	**0.80%**		
	e. Lifts	**5.00%**		
	f. Signage (internal+external)	**0.20%**		
C	**Completion and Handing Over**			**2.00%**
	i. Testing & Commissioning		1.00%	
	ii. Handing over		1.00%	
	Total =			**100.00%**

e. Planning, Designing, and Construction on EPC Basis of **General Hostels** with support services & allied facilities by incorporating stipulated specifications, all services including handing over complete as per scope of work and directions of Engineer In charge.

S. No	Description of Item	Break up of total % payable cost		% of Total payable cost
		item	Sub-group	
A.	**Planning, Design & Engineering Works-** Investigation, Planning, Designing and obtaining approvals for works			
	a. On approval of the inception report, soil investigation report & detailed survey, review of master plan and architectural drawings ensuring their conformance to the requirements of the local bodies and statutory authorities as per requirements and directions of Engineer-in-charge.		0.05%	
	b. On obtaining all required approvals, if any, from statutory authorities and local bodies for commencement of construction as per requirements and directions of Engineer-in-charge.		0.05%	
	c. On approval of structural design by the proof consultant, submission of Good for Construction (GFC) drawings as per requirements and directions of Engineer-in-charge.		0.40%	**1.00%**
	d. On submission of all Good for Construction (GFC) drawings as per requirements and directions of Engineer-in-charge:		0.25%	
	i. Architectural drawings	0.10%		
	ii. Design & Drawings for Services	0.15%		
	e. On completion of construction		0.25%	
	i. On Completion of Foundation work	0.02%		
	ii. On Completion of 100% Super structure	0.04%		
	iii. On Completion of work	0.05%		
	iv. On obtaining required statutory approvals after completion of works	0.12%		
	v. On handing over to Client	0.02%		
B	**CONSTRUCTION**			
	1. Civil Works			
	i. Foundation Work including retaining walls upto Level 01	21.00%		
	ii. Structure Work RCC frame of the entire building including retaining walls from plinth level to terrace, stair roof, underground/surface/overhead tanks, Lift machine room, stabilization of slopes, etc. including water proofing etc.	24.00%	**67.00%**	
	iii. Brickwork & partitioning work	5.00%		
	iv. Flooring, skirting, dado, wall lining work	4.00%		
	v. Doors & Windows.	3.50%		
	vi. False Ceiling Work	2.00%		
	vii. Finishing Work i/c painting (inside)	3.00%		**97.00%**
	viii. Finishing Work i/c painting (outside)	2.00%		
	ix. Other Works, viz. Steel work, railing, panelling etc.	2.50%		
	2. Services			
	a. HVAC	**1.00%**		
	i. Ventilation System and related electrical work	1.00%		
	b. Electrical Works	**16.00%**		
	i. Internal Electrical Works, rising mains, floor panels and DB & other related works	8.00%	**30.00%**	
	ii. Earthing & Lightning Protection System	0.50%		
	iii. LV System	5.00%		
	iv. Light Fixtures, Fans	2.50%		
	c. Water Supply & Sewerage System	**5.00%**		
	i. Water Supply System	1.00%		

	ii. Sanitary & Sewerage System including Septic tanks	2.00%		
	iii. Strom water drainage	1.00%		
	iv. Fittings & Fixtures	1.00%		
	d. Fire Protection System	**4.00%**		
	i. Wet Riser System /Down Comer System	2.50%		
	ii. Fire Extinguishers	0.25%		
	iii. External Hydrants etc.	1.00		
	iv. Fire Alarm system & Other Works	0.25%		
	e. RO & Solar Hot Water Generator System	**0.80%**		
	f. Lifts	**3.00%**		
	g. Signage (internal+external)	**0.20%**		
C	**Completion and Handing Over**			**2.00%**
	i. Testing & Commissioning		1.00%	
	ii. Handing over		1.00%	
	Total =			**100.00%**

f. Planning, Designing, and Construction on EPC Basis of **Resident Doctor's Quarters & MS Quarter** with support services & allied facilities by incorporating stipulated specifications, all services including handing over complete as per scope of work and directions of Engineer In charge.

S. No	Description of Item	Break up of total % payable cost		% of Total payable cost
		item	Sub-group	
A.	**Planning, Design & Engineering Works-** Investigation, Planning, Designing and obtaining approvals for works			**1.00%**
	a. On approval of the inception report, soil investigation report & detailed survey, review of master plan and architectural drawings ensuring their conformance to the requirements of the local bodies and statutory authorities as per requirements and directions of Engineer-in-charge.		0.05%	
	b. On obtaining all required approvals, if any, from statutory authorities and local bodies for commencement of construction as per requirements and directions of Engineer-in-charge.		0.05%	
	c. On approval of structural design by the proof consultant, submission of Good for Construction (GFC) drawings as per requirements and directions of Engineer-in-charge.		0.40%	
	d. On submission of all Good for Construction (GFC) drawings as per requirements and directions of Engineer-in-charge:		0.25%	
	i. Architectural drawings	0.10%		
	ii. Design & Drawings for Services	0.15%		
	e. On completion of construction		0.25%	
	i. On Completion of Foundation work	0.02%		
	ii. On Completion of 100% Super structure	0.04%		
	iii. On Completion of work	0.05%		
	iv. On obtaining required statutory approvals after completion of works	0.12%		
	v. On handing over to Client	0.02%		
B	**CONSTRUCTION**			**97.00%**
	1. Civil Works		**70.00%**	
	i. Foundation Work including retaining walls upto Level 01	23.00%		
	ii. Structure Work RCC frame of the entire building including retaining walls from plinth level to terrace,	25.00%		

	stair roof, underground/surface/overhead tanks, Lift machine room, stabilization of slopes, etc. including water proofing etc.			
	iii. Brickwork & partitioning work	5.00%		
	iv. Flooring, skirting, dado, wall lining work	4.00%		
	v. Doors & Windows.	3.50%		
	vi. False Ceiling Work	2.00%		
	vii. Finishing Work i/c painting (inside)	3.00%		
	viii. Finishing Work i/c painting (outside)	2.00%		
	ix. Other Works, viz. Steel work, railing, panelling etc.	2.50%		
	2. Services			
	a. HVAC	**0.50%**		
	i. Ventilation System and related electrical work	0.50%		
	b. Electrical Works	**14.50%**		
	i. DG Set(s) including exhaust stack piping, LT Panel etc.	3.00%		
	ii. Internal Electrical Works, rising mains, floor panels and DB & other related works	7.00%		
	iii. Earthing & Lightning Protection System	0.50%		
	iv. LV System	2.00%		
	v. Light Fixtures, Fans	2.00%		
	c. Water Supply & Sewerage System	**5.00%**	**27.00%**	
	i. Water Supply System	1.00%		
	ii. Sanitary & Sewerage System	2.00%		
	iii. Strom water drainage	1.00%		
	iv. Fittings & Fixtures	1.00%		
	d. Fire Protection System	**4.00%**		
	i. Dry Riser System /Down Comer System	2.00%		
	ii. Fire Extinguishers	0.25%		
	iii. External Hydrants etc.	1.50%		
	iv. Fire Alarm system & Other Works	0.25%		
	e. Solar Hot Water Generator System	**0.80%**		
	f. Lifts (only for Resident Doctor's Quarters)	**2.00%**		
	g. Signage (internal+external)	**0.20%**		
C	**Completion and Handing Over**			**2.00%**
	i. Testing & Commissioning		1.00%	
	ii. Handing over		1.00%	
	Total =			**100.00%**

g. Planning, Designing, and Construction on EPC Basis of **Indoor Sports Complex & Auditorium and Fire Pump Room including equipment, Underground Tank catering to Indoor Sports Complex & Auditorium and Hospital building** with support services & allied facilities by incorporating stipulated specifications, all services including handing over complete as per scope of work and directions of Engineer In charge.

S. No	Description of Item	Break up of total % payable cost		% of Total payable cost
		item	Sub-group	
A.	**Planning, Design & Engineering Works-** Investigation, Planning, Designing and obtaining approvals for works			
	a. On approval of the inception report, soil investigation report & detailed survey, review of master plan and architectural drawings ensuring their conformance to the requirements of the local bodies and statutory authorities as per requirements.		0.05%	**1.00%**
	b. On obtaining all required approvals, if any, from statutory authorities and local bodies for commencement of construction as per requirements.		0.05%	
	c. On approval of structural design by the proof		0.40%	

	consultant, submission of Good for Construction (GFC) drawings as per requirements and directions of Engineer-in-charge.			
	d. On submission of all Good for Construction (GFC) drawings as per requirements:		0.25%	
	i. Architectural drawings	0.10%		
	ii. Design & Drawings for Services	0.15%		
	e. On completion of construction		0.25%	
	i. On Completion of Foundation work	0.02%		
	ii. On Completion of 100% Super structure	0.04%		
	iii. On Completion of work	0.05%		
	iv. On obtaining required statutory approvals after completion of works	0.12%		
	v. On handing over to Client	0.02%		
B	**CONSTRUCTION**			**97.00%**
	1. Civil Works		**63.00%**	
	i. Foundation Work including retaining walls upto Level 01	17.00%		
	ii. Structure Work RCC frame of the entire building including retaining walls from plinth level to terrace, stair roof, underground/surface/overhead tanks, Pump Room, stabilization of slopes, etc. including water proofing etc.	20.00%		
	iii. Brickwork & partitioning work	4.00%		
	iv. Flooring, skirting, dado, wall lining work	4.00%		
	v. Doors & Windows.	3.50%		
	vi. False Ceiling Work	2.00%		
	vii. Finishing Work i/c painting (inside)	2.00%		
	viii. Finishing Work i/c painting (outside)	1.00%		
	ix. Chairs, Wall Panelling & Sports equipment's	7.00%		
	x. Other Works, viz. Steel work, railing, panelling etc.	2.50%		
	2. Services		**34.00%**	
	a. HVAC	**6.00%**		
	i. HVAC High Side equipment like Chillers, Pumps, HWG, piping and related electrical works	3.00%		
	ii. Low side equipment like AHU, FCU, Cassette units, Ducting, grill, diffuser, Chilled/Hot Water Piping, Split AC units and related electrical work	2.00%		
	iii. Ventilation System and related electrical work	1.00%		
	b. Electrical Works	**15.00%**		
	i. DG Set(s) including exhaust stack piping, LT Panel etc.	3.00%		
	ii. Internal Electrical Works, rising mains, floor panels and DB & other related works	7.00%		
	iii. Earthing & Lightning Protection System	0.50%		
	iv. LV & BMS System	2.00%		
	v. UPS System	0.50%		
	vi. Light Fixtures, Fans	2.00%		
	c. Water Supply & Sewerage System	**2.50%**		
	i. Water Supply System	0.50%		
	ii. Sanitary & Sewerage System	0.50%		
	iii. Water connection system from UG Tanks to Indoor Sports Complex & Auditorium and Hospital building	0.50%		
	iv. Strom water drainage	0.25%		
	v. Fittings & Fixtures	0.75%		
	d. Fire Protection System	**5.00%**		

	i. Fire Pump Room Equipment	2.00%		
	ii. Wet Riser System /Down Comer System	1.00%		
	iii. Automatic Sprinkler System	1.00%		
	iv. Fire Extinguishers	0.25%		
	v. External Hydrants etc.	0.50%		
	vi. Fire Alarm system & Other Works	0.25%		
	e. Audio, Video & Stage Lighting	**4.50%**		
	f. RO, Solar Hot Water Generator System	**0.80%**		
	g. Signage (internal+external)	**0.20%**		
C	**Completion and Handing Over**			**2.00%**
	iii. Testing & Commissioning		1.00%	
	iv. Handing over		1.00%	
	Total =			**100.00%**

h. Planning, Designing, and Construction on EPC Basis of **INFRASTRUCTURE & EXTERNAL DEVELOPMENT** with support services & allied facilities by incorporating stipulated specifications, all services including handing over complete as per scope of work and directions of Engineer In charge.

S. No	Description of Item	Break up of total % payable cost		% of Total payable cost
		item	Sub-group	
A.	**Planning, Design & Engineering Works-** Investigation, Planning, Designing and obtaining approvals for works			**1.00%**
	f. On approval of the inception report, soil investigation report & detailed survey, review of master plan and architectural drawings ensuring their conformance to the requirements of the local bodies and statutory authorities as per requirements.		0.05%	
	g. On obtaining all required approvals, if any, from statutory authorities and local bodies for commencement of construction as per requirements.		0.05%	
	h. On approval of structural design by the proof consultant, submission of Good for Construction (GFC) drawings as per requirements and directions of Engineer-in-charge.		0.40%	
	i. On submission of all Good for Construction (GFC) drawings as per requirements:		0.25%	
	i. Architectural drawings	0.10%		
	ii. Design & Drawings for Services	0.15%		
	j. On completion of construction		0.25%	
	i. On Completion of Foundation work	0.02%		
	ii. On Completion of 100% Super structure	0.04%		
	iii. On Completion of work	0.05%		
	iv. On obtaining required statutory approvals after completion of works	0.12%		
	v. On handing over to Client	0.02%		
B.	Infrastructure Development Works complete as per scope of works :			
	Roads, Gates, Path ways, Open/ Surface Parking, Drainage System, Culverts, Hume pipe crossings, External Street Lighting System, cabling, signages etc. & Planters, Retaining Wall, stabilization of slopes & Stone Pitching on pro-rata basis.	97.00% (Split up for various sub items shall be as under)		
	i. RCC Roads / Pathways (complete including sub base, kerb stones, making & filling of joints, retaining/toe walls/ stone pitching, side drain, signages etc. complete)			**97%**

	ii. Open/ Surface Parking (including subgrade, retaining/toe walls/ stone pitching, Signages etc. complete)		**97%**
	iii. External Street Lighting System including Cables, Panels etc.		**97%**
	iv. Landscaping and Horticulture works (Including Planters)		**97%**
	v. Main Gates including Security cabin, Wall Railing etc. on Front Side of Hospital Area		**97%**
C	**Completion and Handing Over**		**2.0%**
	i. Testing & Commissioning	1%	
	ii. Handing over	1%	
	Total =		**100.00%**

Note : For each Items no. B(i),(ii),(iii),(iv) & (v) 1% payments is towards Planning, Design & Engineering Works, 97% for Main work of respective item and balance 2% towards completion & Handing over.

i. Planning, Designing, and Construction on EPC Basis of **Medical Gas Pipeline System** with support services & allied facilities by incorporating stipulated specifications, all services including handing over complete as per scope of work and directions of Engineer In charge.

S. No	Description of Item	Break up of total % payable	% of total payable
A.	**Planning, Design & Engineering Works-** Investigation, planning, Designing and obtaining approvals for works		**1.00%**
B	**Complete MGPS as per scope of work**		**95%**
	Note :The payment above item shall be regulated as under		
	i. Supply of equipment / material	75%	
	ii. Installation	25%	
C.	**Completion and Handing Over**		**4.00%**
	i. Testing & Commissioning	3.00%	
	ii. Handing over	1.00%	
	Total =		**100.00%**

2.3. Submission of bill Statement for Works

a. The HLL shall make interim payments to the Contractor as certified by the HLL's Engineer on completion of a stage, as specified and valued in accordance with the proportion of the Contract Price assigned to each item and its stage in Volume -7 of the Contract Document.

b. The interim payment shall be made on "Pro rata basis" and shall be worked out on the percentage of work done out of total scope of work under their activity/item.

c. The Contractor shall base its claim for interim payment for completed till the end of the month for which the payment is claimed, valued in accordance with the above sub-Clause, supported with necessary particulars and documents in accordance with this Agreement.

d. The proportion assigned to an item will apply only to the Contract Price stated in this Agreement. It shall not apply to any additions or reductions to the Contract Price arising from the issue of any Order for Change of Scope.

e. The Contractor shall submit interim RA bill, within the time stipulated as per General Conditions of Contract to the Engineer-In-Charge in the form as directed, showing the amount calculated to which the Contractor considers himself entitled for completed Works. The interim RA bill shall be accompanied with the required supporting documents.

f. The Contractor should submit a compliance certificate, as per Appendix A attached

to GCC, in every bill as per provisions of the EPF and ESI Act as amended from time to time.

2.4. Production of Records

a. The Contractor shall, whenever required by the Engineer, produce or cause to be produced for examination by the Engineer, any quotation, invoice, cost or other account books, vouchers, receipts, letters, memoranda or any copy of or extract from any such documents and also furnish information and returns, as may be required, relating to the execution of this Contract or relevant for verifying or ascertaining the cost of execution of this Contract or ascertaining the Materials supplied by the Contractor are in accordance with the Specifications laid down in the Contract. The Engineer's decision on the question of relevancy of any documents, information or returns shall be final and binding on the parties.

b. If any part or item of the work is allowed to be carried out by a subcontractor, assignee or any subsidiary or allied firm, the Engineer shall have power to secure the books of such sub-Contractor, assignee or any subsidiary or allied firm through the Contractor, and shall have power to examine and inspect the same. The above obligations are without prejudice to the obligations of the Contractor under any statute, rules or order.

3. Site Management

3.1. The contractor may construct temporary office, storage, accommodation and labour huts within the site premises where the space is available at site. In case, where surplus land is not available within the site and/or not permitted by the client, the contractor shall arrange the land for temporary office, storage, accommodation and labour huts at his own cost and is responsible for taking the clearance of local authorities, if required, for setting up / construction for labour camp and same is deemed to be included in the rates quoted by the contractor for the works. The contractor shall check the availability of land before tendering and no claim whatsoever in this regard shall be entertained. The contractor shall ensure that the area of labour huts is kept clean and sanitary conditions are maintained as laid down by the local authorities controlling the area. The land for the above purposes shall be so placed that it does not hinder the progress of work or access to the worksite. The vacant possession of the land used, for the purpose shall be given back by contractor after completion of the work.

3.2. **Contractor's Working Area**

Suitable working space will be provided by the Engineer-in-charge to the Contractor as per site conditions and availability. The Contractor may have to carry out some cutting / filling work for making this area workable. The cost of all such Works shall be deemed to have been included in the contract price quoted for the Works and no payment shall be made on this account.

Before commencement of the work, the Contractor shall obtain approval of the Engineer-in charge for the location of cement godown, steel stacking and fabrication yard, site office and shall from time to time take instructions from the Engineer – in- charge regarding collection and stacking of materials at the site.

No excavated earth or building material shall be stacked on areas where other buildings, roads, services or compound wall or any other structure are to be constructed.

3.3. **Site Office :**

a. The Contractor shall construct/provide one site office (semi-permanent structure) for use by Engineer-in-charge and his staff consisting of 3 rooms with toilet and one conference Room (15 seater) with toilet having area not less than 200 Sqm for HLL/Client's officers & staff. The location and plan shall be got approved

from Engineer-in-Charge. Specification for the site office shall be suitable and matching for running an office which shall be got approved from Engineer-in-charge. The Contractor shall provide a typical plan of site office & conference room (having light fixtures, wiring &, AC for conference room etc.) with specification within 30 days of award of work. The site office shall have a sample room, A.C conference room, staff rooms along with toilets & pantry with file storage facility, computers (5 Nos.), Broad band (1 Nos.) and printers (2 Nos.) with their consumables, a telephone, licensed version Primavera software, Auto-CAD etc. All running cost & charges for office including Electricity bill, water supply bills, RO/drinking water bills etc. shall be borne by the Contractor. The Contractor shall provide the following furniture (new) for use of HLL/Client's officers &staff at site office.

S. No.	Articles	Quantity
1.	Executive table with side racks	1 Nos.
2.	Executive Chair	1 Nos.
3.	Office Tables	4 Nos.
4.	Office Chairs	10 Nos.
5.	Almirah	4 Nos.
6.	Conference table with Chairs (for 15 seats)	1 Set i/c chairs
7.	Digital display arrangement & sound system	1 Set

b. Video conference facility, complete in all respects with necessary required equipment and software shall be provided at site office for frequent/periodical interaction between project site office and Corporate /Regional office of HLL.

c. Besides these, vehicle /car (one nos.) of good running condition inclusive of all services like drivers, consumables and maintenance etc. at all times to be provided for the exclusive use of Engineer-in-charge and his site staff/ HLL round the clock during the currency of the Contract till the end of defect liability period to HLL as per requirements given by the Engineer-in-charge.

d. Electricity & drinking water shall also be provided by the contractor free of cost for such period.

3.4. **Contractor's Temporary Structures**

i. The Contractor may, at his own expense and subject to the approval of the Engineer-in-charge and statutory authorities, as required, construct temporary structures for its site office, stores; Workshop etc. in the working area allocated to him as above and remove the same on completion of Works. The Contractor shall furnish such details of his Temporary Works as may be called for by the Engineer-in-charge and the Contractor shall satisfy the Engineer-in-charge as to their structural safety. The Contractor shall be solely responsible for the stability and structural safety of all temporary works including obtaining statutory approvals and payment of statutory fees, if any. Should it be necessary to shift the temporary works to some other place during the execution of the works, the Contractor shall do so, at his own cost.

ii. <u>Initial and Final Clearance of site for temporary works:</u>

The Contractor shall be responsible for the clearance of the site of all scrub, debris, rubbish, etc. to be removed off site to a location to be provided by the contractor and approved by the Engineer- in-charge. However, no trees shall be removed without the prior permission of the Engineer-in-charge. The structures, services and works required to be demolished and removed shall also be

removed off site to a location as mentioned above. The Contractor shall obtain necessary permissions and approvals from the local authorities for such disposals. The demolition shall include digging, excavating and removal of substructures, foundations and buried works. The cost of all this shall be borne by the Contractor.

The above is applicable for all site offices, labour camps, and godowns etc., which are not required after the work is completed.

iii. Storage, Cleaning and Dewatering

The Contractor shall at all the times during construction keep the Site clean and free from all debris and unwanted materials on a daily basis as per instructions of the Engineer-in-charge.

Storage of materials shall be in an organized manner and in proper compartments as directed by the Engineer - in- Charge. Storage on suspended floors shall not be permitted unless specifically approved in writing by the Engineer-in-charge for specific materials in specific locations and in approved manner. The Engineer-in-charge shall be furnished with load details, if requested, before seeking approval for storage.

Regular cleaning operations shall be undertaken to remove all dust, debris, waste materials etc. A cleaning schedule shall be maintained.

The Contractor shall make his own arrangement for storage of those materials, which can be accommodated at site. Contractor shall be fully responsible for safe custody of the same. Materials shall be considered as "Delivered at Site" only after the physical presence of materials at site are verified by the Engineer-in-charge. Storage of materials / equipment elsewhere shall not be considered as "Delivered at Site."

The Contractor shall be responsible to keep entire site free from water due to water coming from any source at any level and shall protect all materials and works from being damaged by the water from any source. Contractor shall make proper arrangements for drainage prior to use of water for curing, testing, cleaning etc.

Any expenditure incurred by the Contractor in fulfillment of his obligations under this sub-clause shall be deemed to have been included in the financial bid and subsequent contract.

iv. The security deposit of the contractor shall be released only after contractor demolishes all structures including foundations and gives back clear vacant possession of this land.

3.5. **Care of Works**

From the commencement to the certified completion of the whole of works, the contractor shall be responsible for the care, safety and maintenance of the works executed under the contract thereof and of all temporary works. In case of any damage/ loss or injury shall happen to the works or to any part thereof or to any temporary works from any cause whatsoever save and except the expected risks, the contractor shall at his own cost repair and make good the same, so that on completion the works shall be in good order and condition in conformity to every respect with the requirements of the contract. The contractor shall also be liable for any damage to the works occasioned by him including his subcontractors in the course of any operations carried out by him for the purpose of completing any outstanding work and complying with his obligations under the Contract. In case of failure on the part of the contractor the damage/ loss/ injury shall be made good by the HLL at the risk and cost of the contractor.

3.6. **Special care for existing building & Infrastructure:**

Construction operations in a RIPANS institute which has to be kept running need special attention and careful planning. As RIPANS is an existing and running institution, the existing operations cannot be stopped or hampered in any way due to the construction activities. The bidders are expected to study the site conditions thoroughly to understand the requirements of the functioning RIPANS Institute.

All necessary steps and arrangements to be taken care of for safety and precaution of the existing Institute during construction without any damage to the existing building during execution of foundations works or super structure construction activities. No extra payment will be made for the above conditions. Any rectification required will be done at the Contractors cost.

There may be some services crossing the construction area of the proposed Buildings/ Block. The scope of work includes dismantling of services falling in the construction area and supporting/shifting & making functional existing services/sewerage and water supply lines etc.

There may be some roadwork, foundation, water tank, septic tank or any other structure falling in the proposed construction area and EPC Contractor's scope of work includes dismantling and relocation /shifting and restoration of same as per site requirement.

3.7. **Safety in Construction**

The contractor shall adhere to the safety, health & environmental guidelines as prescribed in the tender document. The contractor shall employ only such methods of construction, tools and plant as are appropriate for the type of work or as approved by Engineer-in-Charge in writing.

The contractor shall take all precautions and measures to ensure safety of works and workmen and shall be fully responsible for the same. Safety pertaining to construction works such as excavation, centering and shuttering, trenching, blasting, demolition, electric connections, scaffolds, ladders, working platforms, gangway, mixing of bituminous materials, electric and gas welding, use of hoisting and construction machinery shall be governed by the Safety code, relevant safety codes and the direction of Engineer-in-Charge

The Contractor shall be fully responsible for the adequacy, stability and safety of all site operations and methods of construction, the contractor shall ensure that all safety norms are followed as per contractual and other statutory requirements.

3.8. **Contractor's Labour Camp**

The Contractor shall make arrangements at his own expense for labour camp / accommodation for labour and staff to be employed for execution of the work and their conveyance to Site. Proper ID Cards shall be got approved /authorized by the contractor from the Engineer-in-charge to authorise the Contractor's staff and workers to enter the Site.

3.9. **Mobilization of Resources:**

Contractor shall not mobilize his resources in terms of materials, machinery, tools & plants, facilities required to implement the project and shall not pay any advances to any party unless he receives letter of Award from HLL. Contractor shall himself be responsible for such cost incurred without receipt of notice to proceed and no such claim of contractor shall be entertained by the HLL.

3.10. **Water Supply & Power Supply**

The Contractor shall make his own arrangement for water supply at Site for drinking as well as construction purposes & Power Supply at his own cost. Non-availability of power supply and /or water from whatever source shall not entail any additional claims or extension of Contract period in this account.

3.11. **Watch & Ward and Lighting**

The Contractor shall throughout the execution and completion of the Works and the remedying of the site and the Works and the remedying of any defects therein have full regard for the safety of all persons entitled to be on the site and keep the site and the Works in an orderly state to avoid any accident or danger and provide safety measures, lights, guards, fencing and barricades where ever necessary or required by the Engineer-in-charge, or by any duly constituted authority, for the execution and for the protection of the Work, and/or for the safety and convenience of the public or others and take all reasonable steps to protect the environment on and off the site and to avoid damage or nuisance to person or property of the public or others resulting from pollution, noise and other causes etc. at his own cost.

3.12. **Temporary Barricading**

The Contractor shall at his own expense, erect and maintain in good condition temporary barricades all around the working area as per directions of the Engineer-in-charge. The barricading shall be as required or at least 3 meter high approx., whichever is higher. The specifications of barricading shall be got approved from Engineer-in-charge and external face of barricading to display name of CLIENT & HLL.

a. <u>The contractor shall make, till completion of the project arrangements for/of:</u>

i. Proper pumping for removing water from the basement or elsewhere at site.

ii. Proper security, safety, transportation, manpower, lighting arrangement for execution of works at night.

iii. Tower crane, batching plant and other plants & machinery, tools and tackles required for timely execution of work.

iv. Proper barricading around site so that existing buildings in the campus and surrounding area is made free from disturbances.

v. Diversion of underground services with the approval of Engineer-in- charge.

b. <u>Restriction in work areas.</u>

(a). The contractor must see the site of the work, its approaches carefully before tendering, No claim of any sort shall be entertained on account of any site conditions. If any approach from main road is required or existing approach is to be improved and maintained, for cartage and materials by the contractor, the same shall be done by the contractor his own cost.

(b). No Entry/exit/roads other than specified by the Engineer-in-charge for purpose of construction activities will be allowed to be used for construction activity purposes or movement of trucks/lorries/load-carriers and nothing extra/ delay whatsoever will be accounted for on this part.

(c). The Contractor shall take all necessary precautions to prevent any nuisance or inconvenience to the existing running campus/RIPANS Institute, owners, tenants or occupiers of adjacent properties and to the public in general and to prevent any damage to such properties and any pollution of smoke, streams and water-ways. He shall make good at his cost and to the satisfaction of the Engineer-in-Charge, any damage to roads, paths, cross drainage works or public or private property whatsoever caused thereon by the Contractor. All waste or superfluous materials shall be removed by the Contractor without any reservation entirely to the satisfaction of the Engineer-in-Charge.

(d). In the event of any restrictions being imposed by the Security agency, HLL/Client, Traffic or any other authority having jurisdiction in the area on the working or movement of labour /material, the Contractor shall strictly follow

such restrictions and nothing extra shall be payable to the Contractor on this account.

(e). In case the contractor is not permitted to erect the huts for labour at the site of work, the contractor will have to make his own arrangement to provide such accommodation elsewhere and nothing extra shall be paid on this account.

(f). The contractor shall obtain approval of the HLL to erect the hutments for labour etc. at the site of work; denial of approval shall not affect the construction activities.

(g). The contractor shall take all precautions to avoid accidents by exhibiting necessary caution boards such as day and night boards, speed limit boards, red lights and providing barriers. He shall be responsible for all damages and accidents caused due to negligence on his part. No hindrance shall be caused to traffic during the execution of the work.

c. Site Data

(a). The Contractor, with the Tender documents, has been made available such relevant data in HLL's possession on hydrological and sub-surface conditions. The accuracy or reliability of the data/studies/reports and of any other information supplied at any time by the HLL is not warranted with respect to the viability of his design and execution of Works and the Contractor shall be responsible for interpreting all such data. The Contractor shall conduct further investigations considered necessary by him at his own cost and any error, discrepancies if found in HLL's data at any stage will not constitute ground for any claim for extra time and costs.

(b). The Contractor shall be deemed to have obtained all necessary information as to risks, contingencies and other circumstances which may influence or affect the Tender or Works.

(c). The Contractor shall also be deemed to have inspected and examined the Site, its surroundings, the above data and other available information with respect to the viability of his design and execution of Works and to have satisfied himself before submitting the Tender, as to all the relevant matters including without limitation:

i. the form and nature of the Site, type of soil including the sub-surface conditions;

ii. the hydrological and climatic conditions;

iii. the extent and nature of the work, Plant, and Materials necessary for the execution and completion of the Works and the remedying of any defects;

iv. the applicable laws, procedures and labour practices

v. The Contractor's requirement for access, accommodation, facilities, personnel, power, transport and other services.

vi. The risk of injury or damage to property adjacent to the Site and to the occupiers of such property or any other risk.

d. Access Route

The Contractor shall be deemed to have satisfied himself as to the suitability and availability of the access routes he chooses to use. The Contractor shall (as between the parties) be responsible for the maintenance of access routes. The Contractor shall provide at his cost signs or directions, which he may consider necessary or as instructed by Engineer for the guidance of his staff, labour and others. The Contractor shall obtain any permission concessions and related easement right that

may be required from the relevant authorities for the use of such routes, signs and directions.

The HLL will not be responsible for any claims which may arise from the use or otherwise of any access route. The HLL does not guarantee the suitability or availability of any particular access route, and will not entertain any claim for any non-suitability or non-availability for continuous use during construction of any such route.

e. The Contractor shall pay all traffic surcharges and other royalties, licence fees, rent and other payments or compensation, if any, for getting stone, sand, gravel, clay or other materials, machine, process, systems, work methods, or Contractor's Equipment required for the Works.

f. Traffic regulation and safety measures by the Contractor

i. The Contractor shall take all the required measures and make arrangements for the safety of other inhabitants during the construction of the Project or a Section thereof in accordance with the provisions of Specifications as applicable.

It shall provide, erect and maintain all such barricades, signs, markings, flags, and lights as may be required by Good Industry Practice for the safety of the traffic passing through the Section under construction or maintenance.

ii. All works shall be carried out in a manner creating least interference to traffic passing through the Project Site or a Section thereof. In stretches where construction or maintenance works on the carriageway are taken up, the Contractor shall ensure that proper passage is provided for the traffic. Where it is not possible or safe to allow traffic on part width of the carriageway, a temporary diversion of proper specifications shall be constructed by the Contractor at its own cost. The Contractor shall take prior approval of the Engineer for any proposed arrangement for traffic regulation during Construction and Maintenance, which approval shall be granted promptly and reasonably.

4. Employment of Personnel

Notwithstanding the provisions in the General Condition of the Contract, the contractor shall preferably employ Indian Nationals as his representatives, servants and workmen after verifying their antecedents and loyalty. He shall ensurethat no personnel of doubtful antecedents and any other nationality in any way is associated with the works.

a. The Contractor shall ensure his presence at site all times during working hours throughout the course of the Contract or depute a Competent representative who shall be empowered to receive instructions from the Engineer - in- Charge in respect of all matters likely to arise in connection with the execution & coordination of the works at the site.

b. Unless the Contractor's Representative is named in the Contract, the Contractor shall, within 7 days of issue of LOA, submit to the HLL for consent the name and particulars of the person the Contractor proposes to appoint. The Contractor shall not revoke the appointment of the Contractor's Representative without the prior information to the Engineer-in-charge. The Contractor's Representative so nominated shall have full authority to act on behalf of the Contractor. The Contractor's Representative shall give his whole time to directing the preparation of the Construction and/or Manufacture Documents and the execution of the Works. The Contractor's Representative shall receive (on behalf of the Contractor) all notices, instructions, consents, no objection certificate approvals, certificates, determinations and other communications under the Contract. Whenever the Contractor's Representative is to be absent from the Site, a suitable replacement person shall be appointed, with prior consent of Engineer-in-charge. Failure on part of the Contractor to comply with these provisions shall constitute

a breach of Contract leading to action under Clause 3 of General Condition of Contract.

c. The contractor should submit curriculum vitae (CV) of the key personnel proposed to be deployed at site as per Schedule "F" of GCC for supervision and execution of work.

A list of all technical and key personal staffs must be submitted to the Engineer-in-Charge with their area of work / responsibility with verified signature and the link persons to receive the instructions at site (in case the main person was not found at site) during the inspection by representative of Engineer-in-charge. Any staff of contractor found incapable/unsuitable to execute the assigned work shall be replaced by the Contractor if desired by the Engineer-in-Charge.

The Contractor shall ensure that the personnel engaged by it in the performance of its obligations under this Contract are at all times appropriately qualified, skilled and experienced in their respective functions.

The contractor under normal circumstances would not be allowed to replace the key personnel during the execution of the contract. However, for any reasons, due to unavoidable circumstances if it becomes necessary in the interest of the project to replace any one / all the above key personnel the contractor must submit the CV of the new personnel (having qualifications and experience as per requirement of the contract) to Engineer-in-Charge for their approval.

d. The Contractor's Representative may delegate any of his powers, functions and authorities to any competent person, and may at any time revoke any such delegation. Any such delegation or revocation shall be in writing and shall not take effect until the Engineer-in-charge has given prior consent thereto. The Contractor's Representative and such persons shall be fluent in the language of day to day communication and the Contractor shall be bound by and fully liable for the acts or omissions of the Contractor's Representatives or any of his employees and/or delegates, agents or nominees.

e. In case HLL observes misconduct negligence or incompetence etc. on the part of any representative, agent, servant and workmen or employees etc. of the contractor, the HLL shall have full power and without giving any reason to the contractor, instruct the contractor to remove such engineer / staff / worker from site and provide suitable replacements. The decision of the Engineer-in-charge shall be final and binding on the contractor. The contractor shall not be allowed any compensation on this account.

f. Contractor's Authorized Representative shall take joint measurements and sign the measurement books / bills. Any direction, explanations, instructions or notices given by the Engineer-in-charge to such representative shall be held to be given to the Contractor. In case of absence of said Representative other alternative representative should also be mentioned having same responsibilities.

g. No unauthorized persons shall be allowed on the site. The contractor shall provide complete security arrangement for the campus during construction to avoid trespassing. The Contractor shall ensure all such persons are kept out and shall take steps to prevent trespassing. However the contractor will make sure to provide free access at any time for Engineer-in-charge to the site and other working places.

h. In case the Contractor is required to employ foreign nationals for execution of work, then the employment of foreign personnel by the Contractor and/or its Sub-contractors and their sub. Contractors shall be subject to grant of requisite regulatory permits and approvals including employment/residential visas and work permits, if any required, and the obligation to apply for and obtain the same shall and will always be of the Contractor. Notwithstanding anything to the contrary contained in this Contract, refusal of or inability to obtain any such permits and approvals by the Contractor or any of its Sub-contractors or their sub-contractors shall not constitute Force Majeure Event, and shall not in any manner excuse the Contractor from the performance and discharge of

its obligations and liabilities under this Contract.

5. Safety, Health and Environment

Over and above the provisions made in Safety Code (part of General Conditions of Contract) the following will also be applicable:

5.1. In respect of all workmen directly or indirectly employed in the work for the performance of the contractor's part of this agreement, the contractor shall at his expense arrange for the safety provisions as per Indian Standard Safety codes shown below and shall at his own expense provide for all facilities in connection there with. In case the contractor fails to make arrangement and provide necessary facilities, he shall be liable to pay compensations prescribed under Workmen Compensation Act 1923 as amended from time to time for each default and in addition the Engineer-in-charge shall be at liberty to make arrangement and provide facilities as aforesaid and recover the cost incurred on that behalf from the contractor, and no claims what so ever shall be entertained.

5.2. Details regarding some special provisions to be followed by contractor are as follows:

a. **Usage of quality Personal Protection Equipments (PPEs)** through approved vendors. PPEs would include amongst others the following items:

i. Safety Helmets.

ii. Hearing Protection.

iii. Respiratory Protection.

iv. Eye Protection.

v. Protective Gloves.

vi. Safety Footwear.

vii. High Visibility Clothing (Jacket) with approved Logo

All the items should be got approved before issued to the use in the work. Safety Jacket should have HLL Logo as per the size approved.

The contractor shall provide all the PPE (Personnel Protective Equipment) and safety appliances required to carry out the job to all the workmen deployed by the contractor and also ensure that his workmen use those PPE and safety appliances while on the job. The contractor shall not pay any cash amount in lieu of PPE to the workers/sub-contractors and expect them to buy and use during work. If the contractor fails to ensure provision of safety appliances and its workmen do not use the PPE and safety appliances as needed for safe working, the owner may ask the contractor to stop the work and comply with safety requirements first. The contractor shall at all time maintain a minimum of 10% spare PPEs and safety appliances and properly record and show to the HLL during the inspections. Failing to do so shall invite appropriate compensations as per the provisions of under Workmen's Compensation Act 1923 as amended from time to time.

It is always the duty of the contractor to provide required PPEs for all visitors. Towards this required quantity of PPEs shall be kept always at the security post.

b. Colour coding for helmets

Safety Helmet Color Code (Every Helmet should have the LOGO affixed /painted)	Person to use

White	RIPANS/HLL staffs, All Designers, Architect, Consultants, etc.
Violet	Contractor (Engineers / Supervisors)
Blue	All Sub-contractors (Engineers / Supervisors)
Red	Electricians (Both Contractor and Sub-contractor)
Green	Safety Professionals (Both Contractor and Sub-contractor)
Orange	Security Guards / Traffic marshals
Yellow	All workmen
White (with "VISITOR" sticker)	Visitors

i) Logo shall have its outer dimension 2"X2" and shall be conspicuous.

ii) Logo shall be either painted or affixed.

iii) No words shall come either on Top / Bottom of Logo.

c. Working at Heights

Contractor shall ensure that work at height is properly planned for any emergencies and rescue appropriately supervised, and carried out in a manner, which is reasonably practicable safe. Contractor shall ensure that work at height is carried out only when the weather conditions do not jeopardize the health or safety of persons involved in the work. Guardrail, Toe-board, Barrier or similar collective means of protection shall be of sufficient dimensions, of sufficient strength and rigidity for the purposes for which they are being used, and otherwise suitable.

Working Platform shall be of sufficient dimensions to permit the safe passage of persons and the safe use of any plant or materials required to be used and to provide a safe working area-having regard to the work being carried out there. Possess a suitable surface and, in particular, be so constructed that the surface of the working platform has no gap through which a person, material or object could fall and injure a person. A working platform and any supporting structure shall not be loaded so as to give rise to a risk of collapse or to any deformation, which could affect its safe use. Strength and stability calculations for scaffolding shall be carried out by the contractor. The dimensions form and layout of scaffolding decks shall be appropriate to the nature of the work to be performed and suitable for the loads to be carried and permit work and passage in safety.

A personal fall protection system designed for use with an anchor shall be securely attached to at least one anchor, and each anchor and the means of attachment thereto shall be suitable and of sufficient strength and stability for the purpose of supporting any foreseeable loading. Suitable and sufficient steps shall be taken to prevent any person falling or slipping from a personal fall protection system. Any other steps in the opinion of engineer-in-charge suggested will also be taken in Protection system

Only metal ladders shall be allowed. Any surface upon which a ladder rests shall be stable, firm, of sufficient strength and of suitable composition safely to support the ladder so that its rungs or steps remain horizontal, and any loading intended to be placed on it. A ladder shall be so positioned as to ensure its stability during use. A suspended ladder shall be attached in a secure manner and so that, with the exception of a flexible ladder, it cannot be displaced and swinging is prevented. No interlocking or extension ladder shall be used unless its sections are prevented from moving relative to each other while in use.

d. Lifting appliances and gears.

The contractor shall maintain a register for record of examinations and test details of all lifting appliances. This register should also contain a system of identification of all tools and tackles, its date of purchase, safe working load etc. Contractors can utilize the services of any competent person as defined in Factories Act, 1948 and approved by Chief Inspector of Factories with the permission of the HLL.

e. Automatic safe load indicators

Every lifting appliances and gears like cranes, hydras etc, if so constructed that the safe working load may be varied by raising or lowering of the jib or otherwise shall be attached with an automatic indicator of safe working loads approved by Bureau of Indian standards/ International certifying bodies which gives a warning to the operator and arrests further movements of the lifting parts.

f. Qualification of operator of lifting appliances and of signaller etc.

The contractor shall not employ any person to drive or operate a lifting machine like crane, hydra etc whether driven by mechanical power or otherwise or to give signals to work as a operator of a rigger or derricks unless he is above twenty-one years of age and possesses a valid heavy transport vehicle driving license as per Motor Vehicle Act and Rules, is absolutely competent and reliable, possesses the knowledge of the inherent risks involved in the operation of lifting appliances by undergoing a formal training at any institution of national importance, is medically examined periodically.

6. Requirements for Planning & Design Capabilities

6.1. For planning and design of the RIPANS Aizawl (Mizoram), the bidder should have in-house design capacity to carryout comprehensive planning and design of this project as per requirements and the bidder with his in-house design capacity should have satisfactorily completed the planning & design of at least one Super-Specialty/ Multi-Specialty Allopathic Hospital Project of minimum 100 beds comprising construction of RCC framed structure including finishing works, water supply and sanitary installations, electrical works, firefighting, LV works and HVAC works during the last 7 years ending the previous day to the last date of submission of tender. The bidder shall submit within 7 days of issue of Letter of Award, the particulars of such in-house design capacity available with him and the documentary evidence with respect to Hospital project as per the above referred criteria completed by him with his in house design capacity.

6.2. In case, the bidder does not have in house capacity to carryout comprehensive planning and design of this project, then the bidder shall engage Firm/ Consultant which shall provide the required comprehensive consultancy services for planning and design from commencement to completion of the project based on the Site plan & Concept designs and DBR provided to the bidder as a part of bidding documents. In such a case the bidder shall depute Project Design Coordinator of requisite qualification and experience who shall coordinate all the required planning & design activities. The criteria for engagement of such Firm/Consultant shall be as under:

a. The Firm/ Consultant which should be an Indian Consultancy firm and should have in-house design capabilities with minimum experience of 7 years in the field of Consultancy.

b. The Firm / Consultant should have provided the consultancy services for the planning & design of at least one completed Super-Specialty/ Multi-Specialty Allopathic Hospital Project of minimum 100 beds comprising construction of RCC

framed structure including finishing works, water supply and sanitary installations, electrical works, firefighting, LV works and HVAC works during the last 7 years ending the previous day to the last date of submission of tender.

c. The bidder shall within 7 days of award of work shall submit the details with the design capabilities along with documentary evidence of the Firm/Consultant proposed to be engaged by him and meeting the criteria as given in a & b above for approval by Engineer-In-Charge

d. The approved Firm/Consultant shall be associated with the project from commencement till completion.

e. Irrespective of the approval of Firm/Consultant as proposed by the bidder and approved by Engineer-In-Charge, the entire responsibility for all coordination and providing the required design services is sole responsibility of the Contractor.

f. The Contractor's in house design personnel or approved Firm/Consultant design personnel (in case of outside agency) inclusive of Architects, Structural, MEP, Landscaping etc. shall regularly visit the project site and other locations during execution of work for discussions, clarifications and attending various meetings with Client/HLL etc. wr.t the project and as per directions of Engineer-In-Charge.

6.3. **Building Information Management:**

The EPC Contractor is required to do BIM modeling, clash detection, screen shots, incorporating all disciplines - Architectural, Structural, & MEP services such as Lighting Design, Landscape etc. broadly the points given below are to be followed:

i. Development of 3D models from architecture, landscape and engineering drawings like structure, MEP etc., showing all elements of works for the basement and super structure of buildings and site.

ii. Views/ screenshots (jpeg) or any other appropriate format for the conflict points to be generated for review by the decision taking parties.

iii. All the Elements shall be modeled as specific assemblies accurate in terms of quantity, size, shape, location and orientation.

iv. A 3D BIM model for Hospital Block shall be developed from advanced detailed drawings on Revit/Arch-cad software and Co-ordinated construction drawing shall be issued from 3D BIM model for all the internal and external services in the building. Structural drawing (Good for Construction) shall be prepared duly coordinated with 3D BIM drawings. The same model of completed work shall also be prepared and submitted to Engineer-in-charge.

6.4. **Design and Construction**

6.4.1. Obligations prior to commencement of Works

Within 7 (seven) days of the Commencement Date, the Contractor shall:

(a) appoint its representative (the "Contractor's Representative") duly authorised to deal with the HLL in respect of all matters under or arising out of or relating to this Agreement;

(b) appoint a design head (the "Design Head") who will head the Contractor's design units and shall be responsible for surveys, investigations, collection of data, and preparation of preliminary and detailed designs;

(c) undertake and perform all such acts, deeds and things as may be necessary or required before commencement of Works under and in accordance with this Agreement including approval from Statutory Authorities, Applicable Laws and Applicable Permits; and

(d) Make its own arrangements for procurement of materials needed for the Project under and in accordance with the Applicable Laws and Applicable Permits.

6.4.2. Project completion Schedule is set out in the contract document. Design shall be developed in conformity with the specifications and standards set forth in the contract document.

6.4.3. Engagement of Proof Checking Consultant

The Proof checking consultant for vetting/proof checking of structural designs shall be engaged by the Contractor and the same shall be from any Indian Institute of Technology/National Institute of Technology/ Govt. Institute as approved by HLL for which the requisite request shall be submitted by the Contractor. The Contractor shall get the structural details / design & drawings proof checked from the approved proof checking consultant as per requirements and at his own cost. Nothing extra shall be payable to the contractor by HLL on this account.

6.4.4. The Contractor shall submit the designs and drawings, duly certified by the Proof Consultant, to the Engineer for review. Provided, however, that the contractor shall ensure and provide the Engineer-In-Charge additional drawings that may be required for its review in accordance with Good Industry Practice. The programme for submission of the design shall be finalised in consultation with the Engineer-In-Charge.

6.4.5. Considering the need for specific green building parameters and to obtain the required GRIHA Green Building Rating Certification with respect to project the Contractor shall arrange to comply with required Green Building parameters in designs and construction of various facilities in line with the provisions of the DBR and as per scope of work.

6.4.6. Contractor's Warranty of Design

(a) The Contractor shall be fully responsible, for the suitability, adequacy, integrity, durability and practicality of the Contractor's proposal.

(b) The Contractor warrants that the Works have been or will be designed, manufactured, installed and otherwise constructed and to the highest standards available using proven up-to-date good practice. By submitting the Drawings for review to the Engineer-in-charge, the Contractor shall be deemed to have represented that it has determined and verified that the design and engineering, including field construction criteria related thereto, are in conformity with the Scope of the Project, the Specifications and Standards and the Applicable Laws.

(c) The Contractor warrants that the Contractor's Proposals meet the requirements and is fit for the purpose thereof. Where there is any inadequacy, insufficiency, impracticality or unsuitability in or of the Requirements or any part thereof, the Contractor's Proposal shall take into account, address or rectify such inadequacy, insufficiency, impracticality or unsuitability at Contractor's own cost.

(d) The Contractor warrants that the Works will, when completed, comply with enactments and regulations relevant to the Works.

(e) The Contractor warrants that the design of the Works and the manufacture of plant have taken or will have taken full account of the effects of the intended manufacturing and installation methods, Temporary Works and Contractor's Equipment.

(f) The Contractor shall also provide a guarantee from the Designer for the design for suitability, adequacy, and practicality of design for HLL's Requirements.

(g) The Contractor shall indemnify the HLL against any damage, expense, liability, loss or claim, which the HLL might incur, sustain or be subject to arising from any breach of the Contractor's design responsibility and/or warranty set out in this Clause.

(h) The Contractor further specifies and is deemed to have checked and accepted full responsibility 'for the Contractor' s Proposal and warrants absolutely that the same meets the HLL's Requirements:

The Contractor shall be fully responsible for the Plants, Materials, goods, workmanship, preparing, developing and coordinating all design Works to enable that part of the Works to be constructed and/or to be fully operational in accordance with the Contract's requirements.

Apart from the Contractor, the above warranty shall also be applicable for his designer. This warranty shall be a part of his sub contract with the designer and should be made available at the time of signing of the Agreement.

No claim for additional payment or extension of time shall be entertained and/or no review and/or observation of the Engineer-In-Charge and/or its failure to review and/or convey its observations on any Drawings shall relieve the Contractor of its obligations and liabilities under this Agreement in any manner nor shall the Engineer or the HLL be liable for the same in any manner; and if errors, omissions, ambiguities, inconsistencies, inadequacies or other Defects are found in the Drawings, they and the construction works shall be corrected at the Contractor's cost, notwithstanding any review under this section.

6.4.7. In respect of the Contractor's obligations with respect to the design and Drawings of the Project as set forth in tender document, the following shall apply:

(a) The contractor shall furnish design and drawings to HLL and in such sequence as is consistent with the Project Completion Schedule, required number of copies of all Drawings, to the HLL for review;

(b) Within 7 (seven) days of the receipt of the Drawings, the HLL shall review the same and convey its observations to the Contractor with particular reference to their conformity or otherwise with the Scope of the Project and the Specifications and Standards. The Contractor shall not be obliged to await the observations of the HLL on the Drawings submitted pursuant hereto beyond the said period of **21 (twenty one) days** and may begin or continue Works at its own discretion and risk;

(c) If the aforesaid observations of the HLL indicate that the Drawings are not in conformity with the Scope of the Project or the Specifications and Standards, such Drawings shall be revised by the Contractor and resubmitted to the HLL for review within 7 days of receipt of communication from Engineer. The HLL shall give its observations, if any, within 7 (seven) days of receipt of the revised Drawings; and

(d) the Contractor shall be responsible for delays in submitting the Drawing as set forth in Schedule-F caused by reason of delays in surveys and field investigations, and shall not be entitled to seek any relief in that regard from the HLL.

6.4.8. The Contractor's time and cost impacts of revisions arising from review by the HLL of designs caused by the Contractor's non-compliance with the requirements of this Agreement shall be borne by the Contractor, unless there is a change in the Scope of the Works.

6.4.9. The Works shall be executed in accordance with the design reviewed by the HLL, and shall not thereafter be amended or altered without the prior written approval of the HLL. If HLL/ Contractor becomes aware of an error or defect of a technical

nature in the design that HLL/ Contractor shall promptly give notice to the other Party of such error or defect. Such error or defect shall be rectified by the Contractor, without any cost to the HLL.

7. Setting out of the Works

The contractor shall be responsible for the true and proper setting-out of the Works in relation to original points, lines and levels or reference issued by Engineer-in-charge in drawing or in writing and for the correctness, subject as above mentioned, of the position, levels, dimensions and alignment of all parts of works and for the provision of all necessary instruments, appliances and labour in connection therewith. If, at any time during the progress of the works, and during defects liability period, any error shall appear or arise in the position, levels, dimensions or alignment of any part of the Works, the Contractor, on being required to do by the Engineer-in-charge and/ or his authorized representative shall at his own cost, rectify such error to the satisfaction of the Engineer-in-charge. The checking of any setting out or of any line or level by the Engineer-in-charge not in any way relieve the Contractor of his responsibility for the correctness thereof. The Contractor shall carefully protect and preserve the benchmarks; sight-rails, pegs and other things used in setting-out the Works. Any rectification works required should be done by the Contractor at his own cost.

8. Quality of Materials & Equipment, Workmanship and Test

8.1. All the materials used in the work shall be subjected to the mandatory tests as prescribed in the specifications detailed in Schedule F of the General Conditions of Contract and other specifications referred to in the contract and workmanship shall be the best of the respective kinds described in the Contract and in accordance with the Engineer-in- charge's instructions and shall be subjected from time to time to such tests as the Engineer-in-charge may direct at the place of manufacture or fabrication or on the Site or at an approved testing laboratory. The source of supply and / or manufacturing within/ outside India may be inspected by the Engineer-in-charge or any representative as nominated by the HLL. The expenditure on this account is deemed to be included in the rate quoted.

The contractor shall upon the instruction of the Engineer-in-charge's representative furnish him with documentation to prove that the materials & goods comply with the requirements of contract and for requirement stated above. The Engineer-in-charge may issue instruction in regard to removal of material from site or any work, if these are not in accordance with the contract. The contractor shall provide such assistance, instruments, machinery, labour and materials as are required for examining, measuring, sampling, testing of material or part of work.

8.2. Audit Inspection/ Technical Examination/Third Party Inspection

The HLL/ Engineer-In-Charge shall have the right to cause Audit Inspection by Audit team under Comptroller and Accountant General of India./ Technical Examination by Chief Technical Examiner under Central Vigilance Commission, Govt. of India /Third Party Inspection of the works and the final bills of the contractor including all supporting vouchers, abstracts, etc. to be made as per payments of the final bill. The Contractor shall provide all assistance and full access to site to carry out inspection and perform tests at site, to provide samples for testing in outside laboratories and to show site records and their records as asked for by the inspecting teams. Findings of such inspection shall be notified to contractor and contractor shall be bound to take remedial measures to the satisfaction of Engineer-in-charge. If as a result of such Audit Inspection/ Technical Examination/Third Party Inspection, the sum is found to have been overpaid in respect of any work done by the contractor under the contract and found not to

have been executed, the contractor shall be liable to refund the amount of over payment and it shall be lawful for the HLL/ Engineer-in-charge to recover the same from the Security Deposit or Performance Security of the contractor or from any dues payable to the contractor. If it is found that the contractor was paid less than what was due to him under the contract in respect of any work executed by him under it, the amount of such under payment shall be duly paid. Since, the work comes under the purview of CVC, all such orders and instructions issued by CVC are applicable to this work.

In the case of any audit examination and recovery consequent on the same the contractor shall be given an opportunity to explain his case and the decision of the HLL/ Engineer-in-charge shall be final. Payment on this account will be recovered from the contractor.

In the case of Technical Audit /Third Party Quality Assurance /Audit by an independent agency/ individual/firm/institute at any time, consequent upon which there is a recovery from the contractor, recovery shall be made with orders of the HLL/ Engineer-in-charge whose decision shall be final.

8.3. Samples

i. The HLL will not supply any materials required for execution of the Works under this Contract. The Contractor must, therefore, make his own arrangements for timely procurement of various materials including steel and cement etc.

ii. Prior to ordering any equipment/ material/ system, the Contractor shall submit to the Engineer-in-charge the catalogues, along with samples from approved list of manufacturers. No material shall be procured without written approval of the Engineer-in-charge.

iii. All samples of materials and /or items of works in adequate numbers, sizes, shades & pattern as per specifications shall be supplied free of charge by the contractor without any extra charge. All other expenditure required to be incurred like conveyance for taking the samples for testing at the laboratory, packing, etc., shall be borne by the contractor. If the test results do not conform to the specifications and standards laid down, the materials shall be rejected, the contractor shall remove such materials from site. The laboratory for testing of samples shall be decided by the Engineer – in charge, whose decision shall be final and binding.

iv. Contractor shall submit Samples to the Engineer-in-charge for approval. If certain items proposed to be used are of such nature that samples cannot be presented or prepared at the site, detailed literature / test certificate of the same shall be provided to the satisfaction of the Engineer-in-charge. Each Sample will be identified clearly as to material, Supplier, pertinent data such as catalogue numbers and the use for which intended and otherwise as the Engineer-in-charge may require to review the submittals for the limited purposes required by paragraph (d) below. The numbers of each sample to be submitted will be as specified in the Specifications, or as shall be specified by the Engineer-in-charge.

v. Submittal Procedures

   a. Before submitting each Sample, Contractor shall have determined and verified all materials with respect to intended use, fabrication, shipping, handling, storage, assembling and installation pertaining to the performance of the Work and All information relative to Contractor's sole responsibilities in respect of means, methods, techniques, sequences and procedures of construction and safety precautions and programmes incident thereto.

   b. Each submittal will bear a specific written indication that Contactor has

satisfied Contractor's obligation under the Contract Documents with respect to Contractor's review and approval of that submittal.

c. At the time of each submission, contractor shall give the Engineer-in-charge specific written notice of such variations, if any; that the sample submitted may have from the requirements of the contract document. Such notice shall be separate from the submittal and in addition shall cause a specific notation to be made on each sample submitted for review and approval of each such variation

vi. Review and Approval:

a. Sample shall be reviewed and approved only to determine if the items covered by the submittals will, after installation or incorporation in the work, conform to the information given in the contract documents and be compatible with the design concept of the completed project functioning as a whole as indicated by the contract documents, drawings.

b. Review and approval will not extend to means, methods, techniques, sequences or procedures of construction. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions. Contractor shall make corrections required by Engineer-in-charge and shall submit as required new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for and by the Engineer-in-charge on previous submittals.

c. Above referred review and approval of Samples shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Document unless Contractor has in writing called the Engineer-in-charge attention to each such variation at the time of submission as specified above and received written approval of each such variation by specific written notation thereof incorporated in or accompanying the Sample approval; nor will any approval by Engineer-in-charge relieve Contractor from responsibility for complying with the requirements of contract.

d. Only when the samples are approved in writing by the Engineer-in-charge, the contractor shall proceed with the procurement and installation of the particular material / equipment. The approved samples shall be signed by the Engineer-in-charge for identification and shall be kept on record at site office until the completion and acceptance of the work and shall be available at the site for inspection / comparison at any time. Samples approved shall be kept in the sample room till the completion of the work. The contractor shall keep with him a duplicate of such samples to enable him to process the matter.

e. For items of works where the samples are to be made at the site, the same procedure shall be followed. All such samples shall be prepared at a place where it can be left undisturbed until the completion of the project.

f. The Engineer-in-charge shall communicate his comments / approval to the Contractor to the samples at his earliest convenience. Any delay that might occur in approving of the samples for reasons of its not meeting with the specifications or other discrepancies, inadequacy in furnishing samples of appropriate quality from various manufacturers and such other aspects causing delay on the approval of the materials / equipment's etc., shall be ascribable to the account of the contractor. In this respect the decision of the Engineer-in-charge shall be the final.

vii. On delivery of the supplies of materials / equipments for permanent works at the site, the contractor shall specifically arrange to get the supply inspected by the Engineer-in-charge and compared with the approved sample and his specific

approval obtained before using the same in the work.

viii. Cost of Tests

The cost of making any test shall be borne by the Contractor as intended by or provided for the Contract or as found necessary by the Engineer-in- charge for ascertaining whether the quality of materials intended to be used by the Contractor in the Works is acceptable, whether any finished or partially finished work is appropriate for the purposes for which it was intended to fulfill.

ix. Testing facilities

The Contractor shall, at his own cost, provide testing facilities as per CPWD specifications and IS Codes at site as stipulated in the General Conditions of Contract (GCC) or as directed by the Engineer-in-charge including staff required for testing. The tests shall be carried out jointly in the presence of Engineer-in-charge or his representative and the contractor or his representative.

The contractor shall also provide suitable weighing and measuring arrangement and testing instruments and machines for testing of materials and cubes at site as per details given in GCC.

The contractor shall carryout all the mandatory tests and shall maintain records of testing & checks of material, in formats, checklists etc. to be given by Engineer-in-charge. All such records shall be maintained jointly by the contractor and Engineer-in-charge these shall remain under the custody of the Engineer-in-charge.

The laboratory shall be connected to the main potable water, electricity and other Services.

Some of the mandatory tests for each item of work and /or materials shall be carried out in approved outside laboratory as directed by the Engineer-in-charge. The Contractor shall bear the entire cost of testing charges for samples of items of work and /or materials and also the other expenditure towards making samples, packaging, and transport etc.

The materials brought at site of work shall not be used in the work before getting satisfactory test result as per relevant mandatory tests, detailed in the relevant CPWD specifications and BIS codes.

8.4. Manufacturer's Instructions

Where manufacturers have furnished specific instructions relating to the materials and equipment used, covering points not specifically mentioned in these documents, manufacturer's instructions shall be followed with the approval of Engineer-in-charge.

8.5. Inspection & Testing during manufacturing of Equipment

The Engineer-in-charge shall be entitled to inspect, examine and test during manufacturing of the materials and workmanship and check the progress of manufacturing of all fabrication materials to be supplied under the contract on the contractor's premises during working hours, and if part of the said materials is being manufactured on other premises, the contractor shall obtain Engineer-in-charge permission to inspect the same at such premises. This inspection, examination or testing shall not relieve the contractor from any obligation under the contract. Inspection Call for any equipment shall be given 15 days in advance from the actual date of Inspection.

Following Equipment shall be invariably offered for Inspection:-

1) LT Panels
2) DG Sets

3) Bus Ducts & Rising Mains

4) Chillers

In case of other equipment, the Contractor shall intimate HLL/Engineer-in-charge regarding their readiness so as to decide their inspection if any.

The Engineer-in-charge reserves the right to request inspection and testing at manufacturer's Works at all reasonable times during manufacture of items for this Contract.

The Engineer-in-charge or his authorised representative shall have full power to inspect the materials and workmanship at the Contractor's Works or at any place from which the materials or equipment is obtained. Approval by the Engineer-in-charge of any material or equipment shall in no way relieve the Contractor of his responsibility for meeting the requirements of the specifications. The cost incurred towards boarding, lodging etc. (inland/abroad) of inspection engineer/engineers deputed by HLL shall be fully borne by the contractor & all such costs shall be deemed to be included in the Bid. Nothing extra shall be paid on this account whatsoever. The inspection and testing shall cover, but not limited to, the following:-

i. Routine and typical tests for the various items of equipment shall be performed at the Manufacturer's/ Contractor's Workshop in the presence of Engineer-in-charge or his authorised representative, results recorded and test certificates issued.

ii. After installation has been virtually completed, the Contractor shall carry out under the direction and in the presence of the representative of the Engineer-in-charge such tests and inspections as have been specified, or as considered necessary to determine whether or not the requirements of the item, drawings and specifications have been fulfilled. In case the work does not meet the full intent of the drawings and specifications and further tests after making require changes and as considered necessary shall be done again, the Contractor shall carry them out and bear the expenses thereof. If tests fail to demonstrate the satisfactory nature of the installation or any part thereof, then no claims for the extra cost of modifications, replacement or retesting will be considered. The decision of the Engineer–in-charge shall be regarded as final as to what constitutes a satisfactory test.

iii. The Contractor shall provide all necessary instruments such as Theodolite, Dumpy level, steel tapes, weighing machine, plumb bobs, spirit levels, hammers, micro-meters, thermometers, hydraulic cube testing machine, smoke test machine and labour, etc. for conducting tests. All such equipments shall be tested for calibration by an approved laboratory. The Contractor shall make adequate records of the test procedures, readings and results to be maintained by the Engineer-in-charge who shall issue test certificates signed by the person authorised by him.

iv. The contractor shall arrange all necessary instruments, tools, tackles and testing facilities free of cost for such inspections. Contractor shall arrange for inspection visit(s) and bear all inspection costs including Inland/ abroad travel (Air/Rail/Road), conveyance, lodging and boarding expenses etc. free of cost for the Inspection Engineer(s) deputed by HLL.

v. The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere

vi. Dates for Inspection & Testing

The dates of Inspection & Testing, after receipt of written request by the Contractor, shall be mutually agreed by the Engineer-in-charge and the contractor.

vii. Facilities for Testing at Manufacturer's Works

Where the contract provides for tests on the premises of the contractor or of any sub-contractor the contractor shall provide such assistance, labour, materials, electricity, fuel, stores, apparatus and instruments as may be required and as may be reasonably demanded to carry out such tests.

viii. Rejection

If as a result of such inspection, examination or test of the works (other than a Test on Completion the Engineer-in-charge shall decide that such material is defective or not in accordance with the contract he shall notify the contractor accordingly stating in writing his observations and reasons thereof. The contractors shall with due diligence make good the defect and ensure that the material complies with the Contract. Thereafter, if required by the Engineer-in-charge, the tests shall be repeated under the same terms and conditions till satisfactory results are made available.

ix. Delivery of Materials and Equipment

The contractor shall be responsible for all materials and equipment brought at site for the purposes of the contract. Unless the Engineer-in-charge directs, no material shall be brought to the site which is not required for execution of the work.

x. Inspection & Testing and Re-inspection

All deficiencies revealed by testing and inspection shall be rectified by the contractor at his own expense and to the satisfaction and approval of the Engineer-in-charge. Rectified components shall be subject to re-testing till desired results are obtained.

xi. Delayed Tests

If the Engineer-in-charge opines that Tests on Completion are being delayed by the Contractor, the Engineer may by notice require the Contractor to carry out such Tests within14 (fourteen) days after the receipt of the notice. The Contractor shall carry out such Tests on such day or days as the Contractor may fix and of which he shall give notice to the Engineer.

If the Contractor fails to carry out the Tests on Completion within14 (fourteen) days, the Engineer may proceed with such Tests at the risk and cost of the Contractor. The Tests on Completion then shall be deemed to have been carried out in the presence of the Contractor and the results of such Tests shall be accepted as accurate.

xii. Inspection Reports

The contractor shall provide the Engineer - in- Charge with five copies of reports of all inspection and tests.

8.6. **Access for Inspection**

Persons nominated by Engineer-in-charge shall at all reasonable times have free access to work and/ or to the workshops, factories or other places where materials are lying or from which they are being obtained and the Contractor shall extend necessary service to Engineer-in-charge and their representatives every facility necessary for checking measurements, inspection and examination and test of the materials and workmanship.

9. Time Schedules

9.1. Time shall be the essence of the contract. Time allowed for carrying out the work as mentioned in the contract shall be strictly observed by the contractor and it shall be reckoned from the issue of the Letter of Award. It may be noted that the construction of RIPANS at Aizawl (Mizoram) involves construction of various building including development of the complex as detailed in the detailed user requirement. The milestones shall be as detailed in schedule "F" of the General Condition of the Contract. The contractor shall before commencing the work prepare a detailed work schedule. This schedule shall be strictly followed by the contractor. For completing the work in time, the contractor may have to work round the clock without interruption and no claim whatsoever shall be entertained on this account.

9.2. Commencement of Works

i. The Contractor shall commence the Works on the date specified in the Letter of Award. Thereafter the Contractor shall proceed with due diligence, without delay, and in accordance with the programme or any revised or modified programme of the Works.

ii. The Contractor shall not commence the construction, manufacture or installation of the Works or of any part of the Works unless and until the Engineer has endorsed the relevant Drawings in accordance with the HLL's Requirements.

9.3. Time for Completion

i. Project completion Schedule including setting out date of completion in phases as defined under Schedule F of the GCC Vol-II.

ii. Time is the essence of Contract and will remain so at all times during the pendency of the Contract including the extended period of Contract. The Contractor shall complete works as per completion schedule and ensure defect free completion and have passed the tests on the completion, including integrated testing where ever in the scope of work and commissioning of the whole of the Works and/or parts thereof before the same is taken over by the Client/HLL.

9.4. Mile Stones

i. The time allowed for execution of the Works and Mile Stones shall be as specified in the Schedule F of GCC, Vol-II. In case, the contractor does not achieve a particular milestone mentioned in or the re-scheduled milestone(s) by the HLL, the amount shown against that milestone shall be retained and will be adjusted against the Liquidated Damages at the final grant of Extension of Time after completion of work.

ii. On failure to achieve a milestone, retaining of this amount from payments due to the contractor shall be automatic without any notice to the contractor. However, if the contractor catches up with the progress of work on the subsequent milestone(s), the entire retained amount shall be released. In case the contractor fails to make up for the delay in subsequent milestone(s), amount mentioned against each milestone missed subsequently also shall be retained. However, no interest, whatsoever, shall be payable on such amount retained by the HLL.

10. Completion Certificate

10.1. Provisional Completion Certificate

For the purpose of issuing Provisional Completion Certificate on substantial completion of the phase wise work as provided in Clause 1(v) of GCC (Volume-II), the work shall be deemed to have been substantially completed after fulfillment of all the following for respective phases of construction by the Contractor:-

a. The phase(s) of the work as per milestone(s)/whole of the Work are substantially completed and have satisfactorily passed required tests that may be prescribed under the Contract and ready to use. The contractor shall

handover such certificates to the Engineer-in-charge.

b. Obtaining all required approvals from the statutory authorities as required for occupation and use of the works and handing over such certificates to the Engineer-in-charge.

c. Submitting As-Built Drawings, Catalogues, Brochures, and Data Sheets, manuals etc. in the form as directed by Engineer in Charge.

On fulfillment of the above for respective phases of construction, the contractor shall give a written notice to this effect within 10 days of completion along with an undertaking to rectify any shortcoming/defects that may be found during inspection. The Engineer - in- Charge shall jointly inspect the work with the contractor within 15 days of receipt of such notice and see if they are in such a condition so as to be put to its proper or other intended final use and /or occupied without any short comings and no major or minor items of works are remaining which in the opinion of the Engineer-in-charge will cause undue difficulties in satisfactory use/ occupation of the works and issue Certificate of substantial Completion for the respective phases of construction.

10.2. Final Completion Certificate

The contract shall not be considered as completed until a certificate of Final Completion has been issued by the Engineer-In-Charge stating that the works are completed in all respect to his complete satisfaction as per contract and remedying/rectifying all the defects/snags along with the submission of relevant permits/clearance from statutory bodies. It is also a pre requisite that the certificate of Final Completion shall be issued after taking over of the works by the Client/HLL.

The composite work shall be treated as complete when all the phases and components of the work are complete. The Certificate for Final Completion of the total work shall be recorded by the Engineer-in-charge after obtaining / recording of final completion certificate of all the components/phases.

The Defect Liability Period (DLP) for complete work shall start with effect from the date of issuance of the final completion certificate(s) of the complete work.

Provided always that the issue of the Certificate of Final Completion shall be a condition precedent to payment or return to the Contractor the Performance security in accordance with the conditions set out in the contract.

10.3. Certificate of Overall Completion

The Engineer-in-charge shall give the Certificate for Overall Completion as per the following, whichever is later:

- Twenty-eight days after the expiration of the Defects Liability Period

OR

- If different Defect Liability Periods shall become applicable to different sections or parts of the Works, the expiration of the last such period

OR

- As soon as thereafter any works ordered during such period and have been completed to the satisfaction of the CLIENT/HLL.

Provided always that the issue of the Certificate of overall Completion shall be a condition precedent to payment or return to the Contractor the security deposit in accordance with the conditions set out in the contract.

10.4. The contractor shall give performance test of the entire work as per standards

specifications before the work is finally accepted and nothing extra whatsoever shall be payable to the contractor for the tests.

11. Handing over & Taking Over Process

Handing over & taking over process shall be done as prescribed in the tender document. Following services / works have to be complied with by the contractor:

a. Submission of Guarantees in stamp paper, of appropriate value, (in prescribed format) for all water proofing treatment and Anti termite treatment etc. executed in the works for a period of ten years. If any defects noticed within 10 years from completion of defect liability period the contractor shall be sole responsible for the defects and same shall be rectified by the contractor as per information from CLIENT/HLL within a period of 10 days from the notice.

b. Rectification of all defects shall be carried out by the contractor before Handing over/ Taking over process.

c. As built drawings : - 6 (six) sets for Architectural, Structural, Plumbing, Electrical, HVAC system, Specialized services and other required drawings as approved by Engineer-in-charge alongwith their soft copies in the required software version shall be submitted by the contractor before handing over & taking over process.

d. All services/equipment are to be run and checked before handing over & taking over process as per requirements of Engineer-in-charge.

e. Contractor has to arrange water, electricity, fuel , consumables and manpower at their own cost for the purpose of testing of services and equipments. No amount shall be payable on this account.

f. The Contractor shall submit catalogues, brochures, operation manual, manufacturer test certificate, Guarantee/ Warranty papers, licence etc. for all equipment /materials before handing over & taking over process.

12. Guarantees

Notwithstanding provisions in the General Condition of the Contract and elsewhere in these Specific Conditions of Contract, the contractor shall furnish the **guarantees** in the prescribed form appended herewith. These guarantees shall be provided at the stage of virtual completion of work and shall be effective from the completion of work, to be reckoned from the date after the expiry of the maintenance period prescribed in the contract. In case a specialized agency has been approved for execution of a work/system, the Contractor shall ensure that the Guarantees shall be though such agencies (Obligators/Guarantor). The guarantees shall be provided in respect of following works (as per formats appended to this document) and any additional works, as provided for in the contract.

i. For removal of defects after completion in respect of Water Supply and Sanitary Installations.

ii. For Water Proofing Treatment for Basements

iii. For Water Proofing Treatment for Roof

iv. For Water Proofing Treatment (Under floors)

v. For Anti-Termite Works

vi. For Aluminum Works

vii. For Structural Glazing / Curtain Wall System /works

viii. For Mechanical/ Seismic Expansion Joint/ Works

ix. For any other work, as prescribed in the tender document.

13. Defect after completion

a) General

Any defect, shrinkage, settlement or other faults that may appear within the "Defects Liability Period" which in the opinion of the Engineer-in- charge are due to materials or workmanship not in accordance with the contract, shall be rectified as per the directions in writing of the Engineer-in- charge to the Authorized representative of the contractor within such reasonable time as shall be specified therein by the contractor, at his own cost. In case of default, the Engineer-in-charge may employ any person's to amend and make good such defects, shrinkage, settlements or other faults and all expenses consequent thereon or incidental thereto shall be borne by the contractor.

All preventive/routine & breakdown maintenance related to all works executed under this Contract shall be in the scope of Contractor & cost incurred to this effect shall be deemed to be included in the Bid. Nothing extra will be paid on this account whatsoever.

b) Execution of work of repair etc.

Any defects, shrinkage, settlement or other faults which may appear or be noticed within the defect liability period, and arising in the opinion of the Engineer-in-charge from materials or workmanship not having in accordance with the contract, shall upon the direction in writing of the Engineer-in-charge's representative and within such reasonable time as shall be specified therein and without any delay, be amended and made good or replaced by the contractor at his own cost.

c) Cost of Execution of Work of Repair, Etc.

All such works shall be carried out by the Contractor at his own expense if the necessity thereof shall, in the opinion of the Engineer-in- charge, be due to the use of materials or workmanship not in accordance with the Contract, or due to neglect or failure on the part of the Contractor to comply with any obligation, expressed or implied, on the Contractor's part under the Contract.

d) Contractor's personnel to be at site

During the defects liability period the contractor shall depute at least one of his authorized representative at site along with required tradesmen to attend the defects to the satisfaction of Engineer-in-charge.

14. Dues not paid by the Contractor

The contractor shall pay all dues or fees to Statutory authorities and Electric and Water supply authorities & Lift licensing authority etc. within due period and indemnify the CLIENT/ HLL and the Engineer-in-charge from any claims or compensations or penalties or damages arising out of non-payment of any such dues or fees. However, in case some dues or fees are not paid by contractor and or claims for compensations or penalties etc. are raised by the Statutory authorities, the HLL may deposit the required amount or any or all of the above and recover or deduct the same from any money payable to the contractor by the HLL or any other means available to the HLL such as bank guarantee.

15. Urgent Repairs

If, by reason of any accident, or failure, or other event occurring to or in connection with the works, or any part thereof, either during the execution of the works, or during period of Defects Liability any remedial or other work or repair, shall, in the opinion of the Engineer-in-charge be urgently necessary for the safety of the Works and the Contractor is unable or unwilling to do such work or repair despite notice, the Engineer-in-charge may employ and pay other persons to carry out such work or repair as the case may be and may consider necessary. If the work or repair so done by the other agency is the work which, in

the opinion of the Engineer-in-charge the Contractor was liable to do at his own expense under the Contract, all expenses incurred by Other agency in so doing shall be recoverable from the Contractor by the Engineer-in-charge, or shall be deducted by the Engineer-in- charge from any monies due or which may become due to Contractor.

16. Plant Temporary Works & Materials

a) Plant, etc. Exclusive use for the Works

All Constructional Plant, Temporary Works and materials provided by the Contractor shall, when brought on to the Site, be deemed to be exclusively intended for the execution of the Works and the Contractor shall not remove the same or any part thereof except for the purpose of moving it from one part of the Site to another, without the consent, in writing of the Engineer-in-charge, which shall not be unreasonably withheld.

b) Removal of Plant etc.

Upon completion of the Works, the Contractor shall remove from the Site all the said Constructional Plant and Temporary Works remaining thereon and any unused materials provided by the Contractor, within 10 days of obtaining the completion certificate/ Virtual completion of the work.

17. Reports by Contractor

a) The Contractor shall submit CPM – PERT Chart and activity wise bar charts, indicating the duration of various subheads of the work, for the complete work within 15 days of award of work or as per Clause 5 of the GCC, whichever is earlier, for approval by the Engineer - in- Charge. On the basis of approved bar charts contractor shall submit Progress Charts on or before 5th day of every month. Soft copy of PERT chart shall be supplied whenever demanded by the Engineer-in-charge.

b) The Contractor shall submit Monthly Progress Report in triplicate in format approved by Engineer-in-charge. Failure to submit reports may result in holding up or delay in Payment of bills.

c) Monthly Progress Photographs:- The Contractor shall arrange at his own cost to maintain a progress record of the works by taking postcard size colour photographs (preferably digitized photographs) 6 Nos. or more per month per block as directed by the Engineer-in-charge during the construction stages and after completion shall supply three sets at no extra cost. The Contractor will be required to submit monthly reports on the progress of his work as per the format approved by the Engineer-in-charge.

d) The Contractor shall prepare Weekly Reports of planned and actual progress of work and subsequent week's scheduled work. These will also include material procurement status. These reports shall be submitted to the Engineer-in-charge & shall be reviewed in Weekly Co-ordination Meetings.

e) The Contractor shall file daily category-wise labour report to the Engineer-in- charge. The report shall indicate scheduled requirement against actual strength.

f) The contractor shall maintain daily weather record. Daily maximum and minimum temperature and corresponding, humidity shall be recorded and charted. Rainy days shall be recorded when the rain lasting more than one hour hampers the work. Any other inclemency in weather shall be recorded. The records shall be regularly shown to the Engineer-in-charge and his signature obtained.

18. Operations and Maintenance Manual

The Contractor shall provide and submit to the Engineer-in-charge with six copies of the Operation and Maintenance Instruction Manuals. The arrangement of these manuals shall be as follows:

SECTION A:	Index
SECTION B:	Salient features of the Project.
SECTION C:	Description and details of materials, items and fittings and fixtures used for the project along with Catalogues /Brochures Operation & Maintenance Manuals etc.
SECTION D:	Operation & Maintenance instructions
SECTION E:	List of recommended Spare parts /consumables.

Until above mentioned documents are received and approved by the Engineer-in-charge, Contract shall not be considered as complete and payment will be withheld until such documents etc. have been submitted to and approved by the Engineer-in-charge. The cost of providing such records including proper submission thereof is deemed to be included in the Bid.

19. Co-ordination Meetings

The Contractor shall be required to attend co-ordination meetings with the HLL/ CLIENT and the other Contractors during the period of Contract as intimated by the Engineer-in-charge. All costs incidental to such interaction shall be to the Contractor's account and no claim will be entertained by the HLL/ CLIENT on this account.

20. Compliance of Statutory Obligations and obtaining Approvals/ Completion Certificates:

The Contractor shall comply all the statutory obligations and obtain all required clearances to implement the project without any financial repercussions to Engineer-in-charge and ensure all follow up actions with the local authorities in this respect for smooth completion of the project. The Contractor shall obtain all necessary approvals from Municipal bodies and other local bodies including, Water/Sewer supply agencies, Electric Supply and inspectorate agencies, Police and Security Agencies, Chief Controller of Explosives, Fire Department, Civil Aviation Department, Lift inspector, Pollution Control Board, , tree replantation, permission for bore well and for temporary structures etc. in accordance to prevailing rules, Building Bye-Laws etc., as the case may be with related to Construction/ Completion. The contractor shall assist the Engineer-in-charge to obtain all NOC, completion & Occupancy certificates from respective local bodies and other statutory authorities, such as:

i) Construction Permit, if required

ii) Pollution control Board,

iii) Environment Clearances,

iv) Provisional & Final NOC from fire department,

v) Lift license i/c NOC,

vi) Chief Electrical Inspector CEA,

vii) Local Municipal authority.

viii) Airport Authority,

ix) Forest Department for tree replantation etc.,

x) Explosive Department,

xi) Local Municipal authority for water and sewer connection,

xii) Building Occupancy Certificate

xiii) Obtaining AERB approvals for required facilities such as LINAC etc. and furnish to HLL/ Client.

xiv) Any other statutory requirement for execution of work and to occupy the buildings and run the services in all respects.

Contractor shall organize all inspections of concerned authorities & obtain the NOC's within the time for completion. The Engineer-in-charge may, at the written request of the Contractor, assist him in obtaining the approvals from relevant authorities. However any such request by the Contractor shall not bind the Engineer-in-charge in any manner.

All expenditure on these accounts will be borne by the contractor. However the fees paid by the contractor to these statutory authorities only for obtaining the required statutory approvals shall be reimbursed by HLL on submission of valid payment receipts from these statutory authorities.

The contractor is required to submit the relevant drawings/filled application forms as per prescribed format & any other details like completion Drawings and any other statutory documentary requirements of local bodies in copies as per requirement to obtain the above etc. at their own cost.

21. Training and Operating Instructions

a. If required by the Engineer-in-charge, the Contractor shall at his cost, train members of the maintenance staff of Client/HLL either at his or the subcontractor's workshop or at such other place or places as may be considered suitable by the Engineer-in-charge.

b. Upon completion of all work and all tests, the Contractor shall furnish the necessary skilled/unskilled/semi-skilled personnel for operating the entire installation for a period of thirty (30) working days. During this period, the Contractor shall instruct and train the HLL/ CLIENT's representative(s) in operation, adjustments and maintenance of the equipment installed.

c. The Contractor shall submit to the Engineer-in-charge draft comprehensive operating instructions and maintenance schedule for all systems and equipment included in this Contract. This shall be supplemented, not substituted, by manufacturer's operating and maintenance manuals. Upon approval of the draft, the Contractor shall submit to the Engineer-in-charge six (6) complete bound sets of operating and maintenance schedules along with manufacturers printed literature/catalogues.

22. Test Certificates

The contractor shall submit test certificates for all the materials / systems issued by the Engineer-in-Charge approved inspection / office / manufacturer certifying the Equipment / Materials / installation and its function are in agreement with the requirements of relevant specifications and accepted standards.

23. Quiet Operation and Vibration

All equipment shall operate under all conditions of designed load without any sound or vibration, which is considered objectionable by the Engineer-in-charge. Such conditions shall be corrected by the Contractor at his own expense. Decision of the Engineer-in-charge shall be final in this regard.

24. Accessibility

The Contractor shall locate all equipment, which require servicing, operation or regular maintenance in fully accessible positions. The exact location and size of access panels, required for each valve or other devices requiring attendance, shall be finalised and communicated to Engineer - in- Charge well in time, to facilitate working by other agencies, failing this, the Contractor shall make all the necessary repairs and changes at his own expense.

25. Licenses and Permits

The Contractor or the approved specialized agency engaged by them shall hold a valid license for services like plumbing, electrical, Lifts etc. & wherever required in addition, issued by the Competent Authority under whose jurisdiction the work falls.

SPECIFIC CONDITIONS OF CONTRACT

C. ELECTRICAL SERVICES

1. General

i. The Specific Conditions of the Contract - Electrical Services shall read in conjunction with the Specific Conditions of the Contract-Scope of Work, and, Specific Condition of the Contract-General. In case of variations / deviations, if any, the Specific Conditions of the Contract- Electrical Services shall prevail.

ii. The electrical installations shall be in total conformity with the Shop Drawings, Single Line Diagrams (SLD), Design Basis Report, Schematic Drawings, Power & Control wiring drawings etc. prepared by the Contractor and approved by the Engineer-in-charge & shall be tested & commissioned in the presence of the Contractor and the Engineer - in- Charge.

iii. The responsibility for the sufficiency, adequacy and conformity to the Contract requirements of the electrical installation work lies solely with the Contractor.

iv. The planning, design, construction and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance and service life and shall be complete in all respects. Any materials or accessories which may not have been specifically mentioned, but which are necessary for the satisfactory and trouble free operation and maintenance of the equipment shall be provided without any extra cost. This shall also include spares, consumables, tools & tackles required for commissioning of the equipment.

v. The Contractor shall obtain all statutory approvals (electrical loads, approval of drawing/ ESS/ D.G. / approval of meter room etc.) from the concerned statutory authorities and permits required for the HT/LT electrical installation work. All statutory fee payable in this regard will be reimbursed against production of receipts/documentary evidence. On completion of work, the contractor shall obtain NOC from SEB/ Power Distribution Company & Director of Safety of the concerned state; a copy of the same shall be delivered to HLL. Contractor shall be responsible for dealing with SEB/ Power Distribution Company and other statutory authorities till project commissioning/ handing over and getting electricity in the complex.

vi. The HLL shall have full power for getting the materials or work tested by independent agency at the electrical contractor's expenses in order to prove their soundness and adequacy. The contractor will rectify the defects/ suggestions pointed out by HLL/ independent agency at his own expenses.

2. Regulations and Standards

i. The installation shall comply in all respects with the requirements of Indian Electricity Act 1910, Indian Electricity Rules (IER) 1956 and other related Laws and Regulations as amended up to date, there under and special requirements, if any, of the State Electricity Boards/ Power Distribution Company etc. The bidder is liable to furnish the list of authorized licensed persons/ employed/deputed to carry out the works/perform the assigned duties to fulfill the requirements of IER 1956 as amended up to date.

ii. Wherever these Specific Conditions call for a higher standard of material and /or workmanship than those required by any of the above regulations, then these Specific Conditions shall take precedence over the said Regulation and Standards. All Internal & External Electrical works, LV works, HVAC, Fire Fighting, Fire detection & alarm system etc. to be done as per specifications & relevant BIS codes and other applicable codes as relevant.

3. Conformity with Statutory Acts, Rules and Standards

i. All installations shall be in conformity with the Bye-laws, Regulations and Standards of

the local authorities as applicable. But if the specifications and drawings call for a higher standard of material and/or workmanship than those required by any of the above Regulations and Standards, then the specifications and drawings provided in the contract shall take precedence over the said regulations and standards as per the directions of the Engineer-in-charge.

ii. However, if the drawings or specifications required something which violates the Bye-laws and Regulations, then the Bye-laws and Regulations shall govern the requirement of this installation as per the directions of the Engineer-in-charge.

iii. Indian Electricity Act and Rules: All electrical works in connection with installations of the system shall be carried out in accordance with the provision of the Indian Electricity Act, 1910 and the Indian Electricity Rules 1956, both amended up to date.

iv. CPWD Specifications: as at Schedule "F" of GCC.

v. Indian Standards: The system / components shall conform to relevant BIS wherever they exist and to the National Building Code-2016 and ECBC with latest amendments / addendums.

vi. Nothing in these specifications shall be construed to relieve the Contractor of his responsibility for the design, manufacture and installation of the equipment with all its accessories in accordance with applicable Statutory Regulations and safety codes in force.

4. Completeness of Bid

All sundry fittings, assemblies, accessories, hardware items, foundation bolts, termination lugs for electrical connections as required, and all other sundry items which are useful and necessary for proper assembly and efficient working of the various components of the work shall be deemed to have been included in the quoted prices, whether such items are specifically mentioned in the Bid documents or not.

5. Works to be done by the Contractor :-

Unless and otherwise mentioned in the Bid documents, the following works shall be done by the Contractor, and their cost shall be deemed to be included in the contract price:

i. Foundations for equipment and components where required, including foundation bolts

ii. Cutting and making good all damages caused during installation and restoring the same to their original finish

iii. Sealing of all floor openings including shafts and niches etc. provided for pipes, ducts, cables, bus bars etc from fire safety point of view, after laying of the same.

iv. Painting at site of all exposed metal surfaces of the installation other than pre-painted items like fittings, fans, switchgear/ distribution gear items, cubicle switch board etc. damages during erection, shall however be rectified by the contractor.

v. Testing and commissioning of complete installation.

6. Cutting of structural members

No structural member shall be chased or cut without the written permission of the Engineer-in- Charge.

7. Drawings

The tender drawings have been appended to the tender document for guidance of the contractor. The contractor shall plan and design all services and prepare shop drawings. The shop drawings shall cover, but not limited to, the extent and general arrangements of the fixtures, controlling switches, wiring system, distribution boards, panels, sub-panels etc. The Contractor shall submit requisite number of working electrical drawings based on

tender drawings including reflected ceiling plan for the Engineer-in-charge's approval. Contractor has to make necessary changes if any as per comments given by Engineer-in-charge before execution. The work shall be executed as indicated in the approved drawings, however any minor changes found essential to co-ordinate the installation of this work with the other trades shall be made in consultation with the Engineer-in-charge.

Any discrepancies noticed shall be reported to the Engineer-in-charge for clarification. In case of failure to do so Contractor shall not be entitled to any cost for omissions or defects in electrical drawings due to any conflict with other services work.

Any information/data shown/not shown in these drawings shall not relieve the contractor of his responsibility to carry out the work as per the specifications. Additional information required by the bidder/tenderer for successfully completing the work shall be obtained by him.

8. Position of HT/LT Switch Boards & DG Sets

The recommended position of the switch boards & DG Sets as shown on the layout drawings will be adhered to as far as practicable.

The contractor shall procure such equipment/ materials as per list of the approved makes with prior approval of Engineer-In-Charge. For all non-specified items, approval of the HLL shall be obtained prior to procurement of the same. HLL shall in no way be liable for rejection of the any material due to poor quality, poor workmanship, poor material etc.

9. Shop Drawings

Prior to the laying of the conduits and trunking, the Contractor shall submit the shop drawings for the approval of the Engineer-in-charge. The observations, if any, of Engineer-In charge shall be incorporated and drawings shall be re-submitted for the approval of the Engineer-in-charge.

The Contractor shall prepare and submit to the Engineer-in-charge for his approval detail shop drawings, General Arrangement Drawings, SLD, power/ control wiring drawing for Main & Sub Panels / Distribution Boards, special pull boxes, light & fan switchboards, telephone distribution boards, FDA system and lightning protection system and other equipment to be procured/ fabricated by the Contractor.

The contractor shall prepare detailed coordinated electrical shop drawing indicating lighting/lighting fixtures, convenience outlets, DG Sets, LT Panel Boards/ Panels, PCC, DB's, Rising Mains, Cable Schedule with other relevant services and submit for approval of the Engineer-in-Charge before commencing the work. The shop drawings shall indicate all setting out details and physical dimensions of all components, GA Drawings, wiring and cable details for LT Panels, Package Substation, D.G.'s, PCC's, MCC's, cable schedule and routes, manhole trap etc. The fixing details for conduits indicating run and size of wire/cables, outlet/pull/junction boxes etc. with fixing details etc. shall be provided. All works shall be carried out after the approval of these drawings. However, approval of these drawings do not relieve the contractor of his responsibility for providing maintenance free and fool proof system including any missing component/ accessories to meet with the intent of the specifications. Contractor will submit requisite no of prints for preliminary approval and finally requisite sets of prints for distribution.

The Contractor shall submit and get approved the relevant drawings atleast 15 days before placing of the orders with manufacturers/suppliers.

The approval of shop drawings, schedule, brochures etc. by Engineer-in-charge and shall not relieve the Contractor from responsibility for any deviation from drawings or specifications unless he has in writing informed by Engineer-in-charge of such deviations at the time of submission of the drawings nor shall it relieve the Contractor from any responsibility for errors or omissions of any kind in the shop drawings.

10. Materials & Equipment and Approval Thereof

All the materials and equipment shall be of the approved make and design. Unless otherwise called for any approval by Engineer-in-Charge, only the best quality materials and equipment shall be used.

All materials and equipment shall be ISI marked, as applicable, and shall be of the make and design approved by the Engineer-in-charge. Unless otherwise called for, only the best Grade of materials and equipment shall be used. The Contractor shall be responsible for the safe custody of all materials and equipments till these are taken over by CLIENT/HLL and shall insure them against theft, damage by fire, earth quake etc. A list of items of materials and equipment, together with a sample of each shall be submitted to the Engineer-in-charge for his approval and shall be kept in the sample box.

All materials used on the Works shall be new and of the approved quality, conforming to the relevant specifications. Prior approval shall be obtained in writing from the Engineer-in-charge for all materials proposed and when approved, sample shall be duly identified and labeled, it shall be deposited with the by Engineer-in-charge/ and shall be kept in the sample room at Site

10.1. Technical Submittals

The Contractor shall submit Technical Submittals for all materials, equipment and machinery for approval in writing of the Engineer-in-charge before placing orders. The material submittals shall comprise of at least the following:

i. Manufacturer's technical catalogues and brochures giving technical data about performance and other parameters

ii. Manufacturers drawings / sketches showing construction, dimensional and installation details

iii. Rating charts and performance curves clarifying rating of equipment proposed.

10.2. Samples, Catalogues, Brochures and Data

Contractor shall submit the samples & catalogue of the material, which are proposed to be used at Site as per the approved makes for obtaining approval of the Engineer-in-charge.

The Contractor shall submit the number of copies, as required, of all brochures / manufacturer's description data, operation manuals with internal complete circuit diagrams and other similar literature while obtaining the approval of product from Engineer-in-charge.

11. Inspection, Testing and Inspection Certificate

a. The HLL or duly authorized representative shall have at all reasonable times free access to the Contractor/ Manufacturer's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, the Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the HLL and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

b. All equipment being supplied shall conform to Routine and Type Tests in accordance with relevant IS Codes requirements stipulated under respective sections. Routine and Type Tests shall be carried out at manufacturers' works/ factories. Expenditure incurred on conducting such tests shall be to the Contractor's account. Bidder shall submit the routine & type tests reports to Engineer-In-charge.

c. The contractor shall inform HLL within fifteen (15) days from the date of inspection or as defined, inform in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with

the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.

d. Before dispatch to site, the contractor shall offer the equipment for inspection at premises of the manufacturer, 15 days in advance and inform HLL about the date of inspection. Subsequently, HLL shall depute its Inspection Engineer(s) for carrying out the inspection at premises of the manufacturer on mutually agreed date(s). Contractor shall invariably depute his representative(s) for witnessing the complete inspection procedure jointly with Inspection Engineer(s) of HLL.

e. The contractor shall arrange all necessary instruments, tools, tackles and testing facilities free of cost for such inspections. Contractor shall arrange for inspection visit(s) and bear all inspection costs including Inland/ abroad travel (Air/Rail/Road), conveyance, lodging and boarding expenses etc. free of cost for the Inspection Engineer(s) deputed by HLL.

f. For tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by HLL or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.

g. The inspection by HLL and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

h. The HLL will have the right of having at his own expenses any other tests(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material comply with the specifications.

i. The HLL reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the Contractor.

j. HLL reserves the right to waive off inspection of any equipment, items etc at its sole discretion.

k. Notwithstanding approval of tests or equipment by the by Engineer-in-charge, the Contractor shall be required to perform site tests and prove the correctness of ratings and performance of equipment / machinery and materials supplied and installed by the Contractor as per the Contract specifications and conditions. The Engineer-in-charge shall also have the power to order the material or work to be tested by an independent agency at the Contractor's expense in order to prove soundness & adequacy.

12. Testing and Commissioning

The Contractor shall pay for and arrange without any cost to the Engineer-in-charge, all necessary balancing and testing equipment, instruments, materials, accessories, power, water, fuel and the requisite labour for testing. Any defects in materials and/ or in workmanship detected in the course of testing shall be rectified by the Contractor entirely at his own cost, to the satisfaction of the Engineer-in-charge. The installation shall be retested after rectification of defects and shall be commissioned only after approval by the Engineer-in-charge. All tests shall be carried out in the presence of the Engineer-in-charge or his representative.

13. PACKAGING

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of

availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. HLL takes no responsibility of the availability of any special packaging/transporting arrangement.

14. TESTS

i. Charging

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the HLL and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. given and shall be included in the Contractor's quality assurance programme.

ii. Commissioning Tests

The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, unmeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Contractor will apply proper corrections in calculation, to take into account conditions, which do not correspond to the specified conditions.

All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

Pre-commissioning test shall be carried out as per relevant IS and/or as specified.

The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimbursed by HLL on production of requisite documents.

15. Performance Guarantee Certificates for Equipment

All equipment shall be guaranteed against unsatisfactory performance and/or break down for a minimum period of 12 (Twelve) months or date of handing over of work to the CLIENT/ HLL, whichever is later. The equipment or component or any other part of installation so found defective within the guarantee period shall be replaced / repaired by the Contractor free of cost to the satisfaction of the CLIENT / HLL. The above guarantee and/ or warrantee provided by the manufacturer will be submitted along with all the test certificates from manufacturer to HLL.

16. Completion Drawings (As Built Drawings)

On completion of the work and before issue of certificate of virtual completion, the Contractor shall at his own cost submit to the Engineer-in-charge requisite Sets of layout drawings drawn at the approved scale indicating the actual installations. These drawings shall clearly indicate the complete plant layouts, and piping layouts, location wiring, exact location of all the concealed piping, valves, controls, wiring and other services. The Contractor shall also submit requisite sets of consolidated control diagrams, technical literature on all automatic controls and complete technical literature on all equipment and materials. The Contractor shall mount a set of all consolidated control diagrams and all piping diagrams/Single Line diagrams in a frame with glass, and display in the plant room.

Also, the contractor shall submit soft copy of 'As Built' drawings (in AutoCAD & PDF format) of the work including write up (trouble shooting, installation, operation and maintenance manual with instructions) incorporating all such changes and modifications

during engineering and execution along with warrantee & guarantee certificates from manufacturers. As-Built Drawings for all buildings/ blocks/ facilities constructed in RIPANS Complex shall be provided as following:

a. Single Line diagrams showing 33/11 kV Substation and all 11/0.433 kV Substations, all LT Panels, DB, Rising mains etc.
b. Routing and locations of Conduits, inspection and junction boxes etc.
c. Locations and rating of Light, Power and UPS sockets and switches
d. Location and details of main & sub distribution boards, distribution boards indicating the circuit number controlled by them
e. Type of fitting viz. fluorescent, pendants, brackets, bulkhead etc., including their rating & type of lamp, fans and exhaust fans
f. A complete wiring diagram as installed and schematic drawing showing all connections for the complete electrical system
g. Location of telephone outlets, junction boxes and sizes of various conduits and number & sizes of wire drawn
h. Layout of Telephone/ LAN/OFC cables
i. Location of all earthing stations, route and size of all earthing conductors, manholes etc.
j. Layout and particulars of cables & sub mains.
k. Schematic drawing for Telephone & IPABX System
l. Layout of conduits & locations of for LAN/ Wifi Points
m. Layout and details of Earthing Network & Lightning protection system including Insulation tests and earth test results
n. PA System drawings & Fire Alarm Control System Drawings
o. Cable TV/ Dish Antenna drawings
p. General Arrangement drawings for all Electrical & LV Equipment
q. Cable route layout of HT, LT, Control cables & other cables
r. External lighting drawing with road layout
s. Schematic Drawings for BMS System
t. GA & Layout Drawings for Audio Video & Stage Lighting System
u. Any other drawings/details as per requirements and directions of Engineer-in-charge

17. Checks during Defect Liability Period

During the Defect Liability Period/ Maintenance Period, the Contractor shall monthly check all controls in various areas to ensure that these are functioning satisfactorily. This shall apply to all pressure switches and pressure gauges, contacts, relays, controller switches, high and low pressure cut-outs etc.

18. Check List

The Contractor shall provide to the HLL/ Engineer-in-charge, 4 (four) copies of a comprehensive maintenance checklist and shall place a copy of it in the Substations & Plant Room. The checklist shall be a list of each piece of equipment in this Contract, and shall provide a space for each of the next fifty-two weeks to record the maintenance results and status of various equipments during the maintenance period. This list shall be updated every month at the time of inspection. The Contractor shall certify on this check list that he has examined each piece of equipment and that; it is operating as intended in the contract/ by the manufacturer, and that all necessary tests have been performed.

19. Repairs

All equipment that requires repairing shall be immediately serviced and repaired during the maintenance period. All spares/parts and labours shall be furnished by the contractor free of cost.

20. Training of Personnel

The Contractor shall arrange for training of the HLL/ CLIENT's personnel prior to provisional takeover of the project including for the following:

a. Substation Equipment

b. Telephone Exchange

c. All other Equipment like pumps, panels etc.

d. Adjustment of setting for controls and protective devices

e. Preventive maintenance

f. Operation of all electrical panels including their interconnectivity and interlocking scheme

g. All LV Works

h. BMS

i. Any other specialized system as executed under this contract

21. Safe Custody and Storage

Safe custody of all machinery and equipment dismantled, shifted & supplied by the Contractor shall be his own responsibility till the final taking over by the CLIENT/HLL. The Contractor should, therefore, employ sufficient staff for watch and ward at his own expenses. CLIENT/HLL may, however, allow the Contractor to use the building space for temporary storage of such equipment, if such space is available.

22. Handling, Storing and Installation

- In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the HLL or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented.
- Contractor shall follow the unloading and transporting procedure at site, as well as storing, testing and commissioning of the various equipment being procured by him separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's Engineer(s) and shall extend full co-operation to them.
- In case of any doubt/ misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the HLL. Contractor shall be held responsible for any damage to the equipment consequent for not following manufacturer's drawings/instructions correctly.
- Where assemblies are supplied in more than one section, Contractor shall make all necessary connections between sections. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.
- The Contractor shall submit to the HLL every week, a report detailing all the receipts during the week. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the

equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

- The Contractor shall be fully responsible for the equipment/material until the same is handed over to the HLL in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by HLL, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment, which require indoor storage.
- The words 'erection' and 'installation' used in the specification are synonymous.
- Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- The minimum phase to earth, phase to phase and section clearance along with other technical parameters for the various voltage levels shall be maintained as per relevant IS codes.

23. Operation and Running of entire system

The contractor shall pay for and arrange for operation & running of entire electrical system and other equipment for a minimum period of one month after satisfactory completion of work as desired by Engineer-in-charge. Cost of operation & running of entire system including required material e.g. Water, electricity, consumables, tools & tackles, requisite manpower etc. shall be deemed to be included in the contract price and nothing extra shall be paid.

24. Layout of all services, SLD/ P&I diagrams, operating and maintenance instructions, DO's and Don'ts's etc. for all the Substations, Plant rooms, pump room, control panels etc. must be provided along with coloured prints at each floor.

SPECIFIC CONDITIONS OF CONTRACT

D. HVAC SYSTEM

1. General

The Specific Conditions of the Contract - HVAC System shall be read in conjunction with the Specific Conditions of the Contract-Scope of Work, and, Specific Condition of the Contract-General. In case of variations / deviations, if any, the Specific Conditions of the Contract- HVAC System shall prevail.

2. Scope of Contract

The scope of works to be carried out under this section comprises of Design, Supply, Installation, Testing and Commissioning of Heating, Ventilation and Air-conditioning works as illustrated in Tender Drawings, Schematic Diagram, Design Basis Report, Technical Specifications etc.

3. Stores and Materials

The contractor shall provide everything necessary for the proper execution of the work according to the intent and meaning of the drawings and specifications etc. taken together whether the same may or may not be particularly shown or described therein provided that the same can be reasonably inferred there from.

4. Supply of Equipment

Equipment shall be strictly as per the list of approved makes/ manufacturers given in the Bid documents subject to approval of the Engineer-in-charge. The Contractor shall submit manufacturer's test certificates of equipment supplied.

5. Shop / Working Drawings etc.

5.1. To achieve the desired parameters/requirements as specified in Design Basis Report/Technical Specifications/Tender Drawings etc., the Contractor shall prepare detailed Heat Load Sheets of all rooms/occupancies of Air conditioned areas, CFM sizing of Fans (ventilation/pressurization) & submit to Engineer-in-charge for approval.

5.2. Subsequent to approval of the scheme as above, the Contractor shall prepare and submit to the Engineer-in-charge for approval, requisite sets of detailed shop drawings/layouts of various rooms/floors, Plant Room, External Layout. GA drawing of various equipment like Chillers/Cooling Towers /pumps /AHUs /FCUs /Panels along with foundation & other relevant details etc., equipment characteristics, pump curves and capacity details of all equipment, accessories and devices etc. as per specifications shall be submitted well in advance or as required for approval of Engineer-in-charge. The structure works should not be affected due to delay on this account. No claims for extension of time shall be entertained because of any delay in the work due to failure on part of the contractor to produce shop drawings in time.

5.3. If the Engineer-in-charge makes any amendment in the above drawings, the Contractor shall supply requisite sets of fresh drawings with the amendments duly incorporated, along with the drawings on which corrections were made. After final approval has been obtained from the Engineer - in- Charge, the Contractor shall submit a further requisite sets of shop drawings for the exclusive use of and retention by the Engineer-in-charge.

5.4. Approval of shop drawings shall not be considered as a guarantee of measurement or of building condition. It will in no way relieve the contractor from his responsibility of furnishing materials or performing work as required by the contract.

6. Completion Drawings(As Built Drawings):-

Following "AS BUILT" drawings shall be submitted by the Contractor on completion of the

work:

a. Plant Room/ AHU Room installation drawings giving complete details of the entire equipment including Chillers, Cooling Towers, Pumps, Hot Water Generators, AHU's and their foundations.

b. Ducting drawings showing all sizes, damper (Fire/VCD) locations and sizes of all air outlets and intakes, for all floors.

c. Electrical drawings showing cable sizes, equipment capacities, control components and control wiring.

d. Schematic control drawings giving detailed sequence of operation and notes to explain the operation of the control circuit.

e. Piping drawings showing all pipe sizes, valves and fittings etc.

f. Any other drawings to be supplied as per instructions of the Engineer-in-charge .

7. Operation and Service Manuals

7.1. The Contractor shall submit requisite sets of operation and service manuals in respect of the air-conditioning plant including salient details of plant including internal circuit diagrams. Following minimum details shall be furnished:

i. Detailed equipment data as approved by the Engineer-in-charge.

ii. Manufacturer's maintenance and operating instruction.

iii. Approved test readings.

7.2. The Contractor shall also submit requisite sets of technical literature on all automatic controls and complete technical literature on all equipment and materials. The Contractor shall frame under glass, in the Air conditioning plant room all consolidated control diagrams and all piping diagrams.

7.3. Coloured Layouts of all electrical lines in A-1 size properly laminated to be fixed at various locations at the time of handing over of building.

8. Inspection at Work / Contractor's Premises

8.1. The CLIENT/ HLL or their representatives shall at all reasonable time have free access to the Contractor's premises/works. The Contractor shall give every facility to them and necessary help for inspection and examinations and test of the materials and workmanship.

8.2. These representatives shall have full powers to inspect drawings of any portion of the work or examine the materials and workmanship of the plant at the Contractor's works or at any other place from where the material or equipment is to be obtained. Acceptance of any material or equipment shall in no way, relieve the Contractor of his responsibility for meeting the requirement of the specifications.

8.3. The contractor shall arrange all necessary instruments, tools, tackles and testing facilities free of cost for such inspections. Contractor shall arrange for inspection visit(s) and bear all inspection costs including Inland/ abroad travel (Air/Rail/Road), conveyance, lodging and boarding expenses etc. free of cost for the Inspection Engineer(s) deputed by HLL.

9. Sub-contracting

The Contractor may sub-contract part of the works with the written approval of the Engineer-in-charge . Sub-contractors as approved by the Engineer - in- Charge shall be appointed for carrying out the entire work of supplying, installation, testing and commissioning of all the equipment covered under this package. However, the overall responsibility for compliance of the Contract lies with the Contractor. The agency/ sub-

contractor so chosen shall be got approved from the Engineer-in-charge.

10. Technical Submittals

The Contractor shall submit Technical Submittals for all materials, equipment and machinery for approval in writing of the Engineer-in-charge before placing orders. The material submittals shall comprise of at least the following:

i. Manufacturer's technical catalogues and brochures, pump curves, Certifications etc. giving technical data about performance and other parameters.

ii. Manufacturers drawings / sketches showing construction, dimensional and installation details.

iii. Rating charts and performance curves clarifying rating of equipment proposed.

11. Samples and Prototypes

The Contractor shall submit samples of items such as grilles/ diffusers, controls and/ or any other parts or equipment as required by the Engineer-in-charge for prior approval in writing before placing the order. The Contractor shall also construct prototype or samples of work as laid down in the Contract or as instructed by the Engineer-in-charge.

12. Testing and Commissioning

12.1. Tests on equipment as called for in the specifications shall be carried out by the Contractor in accordance with the specifications, the relevant Bureau of Indian Standard Codes (BIS) and International Standards.

12.2. The initial tests shall include but not be limited to the following:

i. To operate and check the proper functioning of all electrically operated components viz., compressor motor, pumps, blowers, air handling units, rotating machine, fans, boilers, etc.

ii. To operate and check the proper functioning of all electrical panels, switch gears, safety and other controls

iii. To adjust and balance air, water, steam and gas quantities to provide the designed flow rates by adjusting valves, dampers, diverters etc.

iv. To check the systems against leaks in different circuits, alignment of motor, `V' Belt adjustments etc.

v. To check the vibration and noise levels of the equipment

vi. Setting of all control and all such other tests which are essential for smooth functioning of the plant.

12.3. The Contractor shall pay for and arrange without any cost, all necessary balancing and testing equipment, instruments, materials, accessories, power, water, fuel and the requisite labour for testing. Any defects in materials and/or in workmanship detected in the course of testing shall be rectified by the Contractor entirely at his own cost, to the satisfaction of the Engineer-in-charge. The installation shall be tested again after removal of defects if any and shall be commissioned only after approval by the Engineer-in-charge. All tests shall be carried out in the presence of the Engineer-in-charge or his representative.

12.4. After completion of the HVAC system, the same shall be put to a continuous running test for a period of 72 (Seventy Two) hours. All adjustments should be made prior to this test so that proper conditions / working are achieved during this testing. The Contractor shall pay for and arrange at his own cost for materials, accessories, power, water, fuel and the requisite labour for this testing the test readings shall be noted in the Testing format approved by the Engineer-in-charge.

13. Final Performance and Capacity Test

In addition to the above testing, final performance and capacity tests shall be carried out on the equipment as per the "Testing Schedules" during the defects liability period as follows:

i. Peak summer / monsoon test during the period from 15th May to 31st July on the dates decided by HLL/ CLIENT. The installations should be able to maintain the specified inside temperature/conditions within the tolerance limits prescribed in the Contract and the duration of the test shall be 72 hours.

ii. Peak winter test during the period from 1st December to 15th February on the dates decided by HLL/ CLIENT. The installations should be able to maintain the specified inside temperature within the tolerance limits permitted in the Contract. The duration of the test shall be 72 hours.

All the arrangements required for making the entire system operational /running, for the performance test as above, including cost of manpower, and fuel (Gas etc.), electricity etc. will be borne by the Contractor.

13.1. The user shall have the right to get the operation of all equipment, if these are in the operating condition if such equipment, have been accepted as complete and satisfactory. Repairs and alterations if required shall be carried out by the Contractor as and when directed by the CLIENT/ HLL. In special circumstances, CLIENT/ HLL may request Air conditioning of some areas even before the completion of whole of HVAC work. The Contractor shall arrange accordingly as per requirements.

14. Guarantee and Defects Liability Period

All equipment shall be guaranteed against unsatisfactory performance and/or break down for a minimum period of 12 (Twelve) months or date of handing over of work to the CLIENT/ HLL, whichever is later. The equipment or component or any other part of installation so found defective within the guarantee period shall be replaced / repaired by the Contractor free of cost to the satisfaction of the CLIENT / HLL. The above guarantee and/ or warrantee provided by the manufacturer will be submitted along with all the test certificates from manufacturer to HLL.

15. Performance Guarantee from Sub-contractor

The Contractor shall submit a performance guarantee certificate from the agency which executed the HVAC work, counter signed by the Contractor that the system shall maintain the desired parameters within tolerance limit of the specified parameters who shall also guarantee that the capacity of various components as well as the whole system covered under the scope of work, technical schedules and requirements etc., shall not be less than the specified capacities. The guarantee of the specific equipment supplied alone with regard to the performance of the system shall not be acceptable and overall responsibility of the Contractor for performance of HVAC work & its compliance with the Contract terms and conditions remains unchanged.

16. Maintenance

The Contractor shall carry out routine and special maintenance of the plant and attend to any defects that may arise in operation of the plant during the Defects Liability Period.

17. Validation: -Validation of Classified Areas (such as OTs/ICUs/Labs & other Critical Areas etc.) shall be in the scope of EPC contractor & nothing extra will be paid in this regard.

It shall include as follows:-

- Documentation for DQ/IQ/OQ with certificates of all brought items

- Duct leakage testing during duct installation as & when required.
- Air flow velocity test
- Air borne particulate test
- Temperature & RH monitoring test
- Area recovery test
- Room pressure balancing & any other test as required.

18. Painting

All equipment and ancillary items such as pipes, supports etc., will be painted in an approved manner, using standard paints as approved by HLL/ Engineer-in-charge

19. Safe Custody and Storage

The contractor shall be responsible for safe custody of all machinery and equipment supplied and installed till the final taking over by the CLIENT/ HLL.

20. Training of Personnel

The Contractor shall arrange to train the HLL/CLIENT's personnel on the following aspects prior to provisional takeover of the plant:

a) Operation of plant
b) Gas charging and pumping down of the system
c) Adjustments of settings for controls and protective devices
d) Preventive maintenance
e) Disassembling and assembling of compressor including identification and replacement.

21. Operation and Running of entire system

The contractor shall pay for and arrange for operation & running of entire HVAC system for a minimum period of one month after satisfactory completion of installation including testing & commissioning of work as desired by Engineer-in-charge. Cost of operation & running of entire system including required material e.g. consumables, water, electricity, refrigerant, tools & tackles, requisite manpower etc. shall be deemed to be included in the contract price and nothing extra shall be paid on this account.

SPECIFIC CONDITIONS OF CONTRACT

E. GRIHA RATING SYSTEM

1. This Project is to be designed & executed for achieving min. GRIHA 3 star rating Certifications as per latest version stipulated by GRIHA (Green Rating for Integrated Habitat Assessment) Council in respect of the buildings & blocks listed in the Design Basis Report.

2. Accordingly, the contractor is required to adhere to the various environment friendly and GRIHA compliance aspects of construction as well as documentation with respect to use of Materials, Manpower, Machinery and other relevant mandatory requirements. Nothing extra shall be payable over and above the quoted rates as per the financial bid to comply with such requirements.

3. **Certification of Facilities as per GRIHA Standards:**

All required services from concept planning to completion, documentation including obtaining certification from GRIHA Secretariat/Council are included in the scope of work. This shall also include Energy Simulation and Modeling, Documentation & Co-ordination with GRIHA Council and obtaining Provisional & Final Certification. The Contractor shall ensure that the Project shall be registered with GRIHA Council after award of work. The Contractor shall be required to incorporate all the necessary provisions required for minimum Three Star GRIHA Rating in the drawings, specifications etc. & to undertake the necessary documentation and submissions with GRIHA Council accordingly. They will also be required to provide the various services as referred below:

a. Feasibility:

The Contractor will evaluate the certification levels that may be achieved by the project. The feasibility report will comprise of a report, which will divide the overall points in three categories:

i) Points that are already planned, if any,

ii) Points which are possible to be planned

iii) Points those are not feasible (not applicable) for the project.

b. All the design and documents prepared for Civil, Structural, MEP, HVAC, and Firefighting Systems etc. shall be in conformity to GRIHA requirements.

c. The Contractor, upon award of work, shall ensure registration of the Project with GRIHA Council.

d. The Contractor shall ensure that the materials are in conformity with the requirements to achieve Minimum Three Star Rating under GRIHA Green Building Rating Systems.

e. To periodically monitor the parameters set out in the planned score card & suggest remedial measures in case of any shortcomings.

f. To carry out Building Envelope Analysis, Orientation and Shading Analysis, Day lighting Studies, Energy Modeling, Water Balance Charts etc. using relevant simulation tools.

g. Preparation, submission and documentation from initiation till completion and receipt of required Green Building Rating for the Project which amongst other requirements as per GRIHA shall include collection, compilation & preparation of filled-in templates/documents, under intimation & in co-ordination with HLL, submission of complete compliance documents as required by GRIHA Council in order to get the minimum GRIHA- 3 Star Rating for the Project. This shall also include all required coordination with GRIHA Council etc. and other relevant statutory bodies inclusive of responding to queries from these offices.

h. Contractor shall ensure & follow necessary Guidelines, Procedures and formats for records to be maintained (at various stages of the Project) as per requirements of GRIHA Council.

i. Contractor should apprise HLL of the status with regard to implementation of provisions of GRIHA periodically as per the requirements.

j. The Contractor shall arrange to get the Energy Audit completed & report prepared through BEE Certified Energy Auditor as per GRIHA norms for obtaining Final GRIHA Certification from GRIHA Council & nothing extra is payable on this account.

k. The Contractor shall co-ordinate with GRIHA Council & all other relevant statutory authorities as per requirements and nothing extra is payable on this account. However, the required statutory fee payable to the GRIHA Council /statutory authorities, if any, will be borne by HLL. The Contractor shall incur such expenditure after prior approval of HLL who shall pay/ reimburse the same to Contractor on submission of payment receipts and documents towards this expenditure. However, Contractor shall be responsible for all the required coordination and liaisoning work.

l. The contractor shall be responsible for carrying out Orientation Workshop, Due Diligence Site Visits etc. & all expenditures on this account shall be borne by the Contractor.

m. Any suggestion/remedy indicated by GRIHA Council shall be the responsibility of the contractor, without any extra cost.

4. The Contractor shall also adhere to the following during construction :

4.1. Soil excavation, soil erosion and sedimentation control etc.:- Proper site management strategies shall be followed on the site to ensure proper material staging, soil spill prevention, soil erosion and sedimentation control. The following strategies are listed below:

a) Temporary sedimentation basins shall be made on the lowest possible elevation on site during construction to manage all the storm water generated during rains at the site. Photographs of the sedimentation tank shall be submitted to the Engineer-in-charge.

b) Spill prevention and control: Spill prevention and control plans to ensure so as to stop the source of the spill and dispose the contaminated material and hazardous wastes. Hazardous wastes include pesticides, paints, cleaners, and petroleum products.

c) Proper construction material staging shall be executed on the site.

d) Trenches shall be laid along the periphery of the site to carry the storm water from the various locations on the site to the sedimentation basins.

e) During the earth excavation, top soil of 0.20m shall be stacked separately on or near by the site at a maximum height of 0.40m.

f) Vegetation / mulching of the areas shall be done where the excavated top soil is stacked.

g) The soil excavation, particularly during rainy season, shall be done in such a way to minimize site disturbance such as soil pollution due to spillage of construction material and mixing with rainwater.

h) The existing vegetation shall be protected by preventing disturbance or damage to specified areas during construction. This will minimize the amount of bare soil exposed to erosive forces. All existing vegetation shall be barricaded on site and marked on a site survey plan.

i) Stacked top soil shall be mulched and protected by barricading as stated above and re-laid over pre-designated landscape areas post construction.

j) The contractor shall not store /dump construction material or debris on metalled road.

k) The contractor shall get prior approval from Engineer-in-Charge for the area where the construction material or debris can be stored beyond the metalled road. This area shall not cause any obstruction to the free flow of traffic/inconvenience to the pedestrians. It should be ensured by the contractor that no accidents occur on account of such permissible.

4.2. Proper site management strategies shall be followed on the site to ensure labour safety and sanitation. Some of these are listed below:

a) Display warning and safety signs all across the site. Also ensure that safety nets and harnesses are provided for construction workers working on higher floors. The walking boards and formwork shall also be stable. Workers shall be provided with safety equipment like safety helmets, jackets, boots and gloves.

b) Provide fire extinguishers and barrels of water with bucket tans on the site and sufficient light for workers to work safely at night.

c) The Contractor shall provide adequate level of sanitation and safety facilities for construction workers.

d) Provide accommodation and amenities for all staff and labours, employed for the purpose of, or in connection with the contract including fencing, water (both for drinking and other uses), electricity, furniture and other such requirements. Such accommodation and amenities shall be provided by the contractor at a location specifically demarcated by the Client/ HLL, in case such space is made available by the Client/ HLL. In case the contractor makes his own arrangement, all such facilities shall be provided in such accommodation. On completion of the contract, such accommodation shall be removed and the site shall be cleared.

e) The contractor shall employ an officer on the site concerned solely with the safety and protection of all staff and labour against accidents. The officer shall be qualified and shall have authority to issue instructions and take protective measures to prevent accidents or the contractor may setup a working arrangement with a local practitioner to handle injury in an emergency situation.

f) Contractor shall provide PPE (Personal Protective Equipment) like safety shoes, safety belt/harness, Helmets to all workers at site.

g) The contractor shall provide mask to every worker working on the construction site and involved loading, unloading and carriage of construction material and construction debris to prevent inhalation of dust particles. The contractor shall provide all medical help, investigation and treatment to the workers involved in the construction of building and carry of construction material and debris relatable to dust emission.

h) The contractor shall establish a fully equipped first aid centre on site to deal with accidental injuries and workers health. The first aid box shall be marked with a red cross on a white background.

i) The contractor shall not allow an individual to work on site while his ability or alertness is impaired by fatigue, illness or some other cause which might expose him to injury.

4.3. Proper site management strategies shall be adopted on the site such as:

a) Preparation of site :

i. Clear vegetation only from the areas where work will start right away.

ii. Vegetate/mulch areas where vehicles don't ply.

iii. Apply gravel to the area where mulching/paving is impractical.

iv. Identify roads on site that would be used for vehicular traffic. Add surface gravel to reduce source of dust emission.

v. Limit vehicular speed on site to 10 km/hour.

b) During Construction and Demolition(C&D):-

i. Water shall be sprayed to prevent dust pollution on the following:

a. Any dusty materials before transferring, loading and unloading.

b. Areas where demolition work is being carried out.

c. Areas where excavation or earth-moving activities are to be carried out.

d. Arrangements for wheel washing should be made near the entry/exit gates to prevent air pollution.

ii. The contractor shall ensure that C&D waste is transported to the C&D dedicated place within the site earmarked for storing and sorting construction waste side only and due record shall be maintained by the contractor.

iii. The contractor shall compulsory use of wet jet in grinding and stone cutting.

c) The following activities shall be carried out:

i. The contractor shall take appropriate protection measures like raising wind breakers of appropriate height on all sides of the plot/area using CGI sheets or plastic and / or other similar material to ensure that no construction material dust fly outside the plot area.

ii. The contractor shall ensure that all the trucks or vehicles of any kind which are used for construction purposes / or are carrying construction material like cement, sand and other allied material are fully covered. The contractor shall take every necessary precautions that the vehicles are properly cleaned and dust free to ensure that en-route their destination, the dust, sand or any other particles are not released in air /contaminate air.

iii. Covering full stockpile of dusty material with impervious sheeting.

iv. Transferring, handling/storing dry loose materials like bulk cement, dry pulverized fly ash inside a totally enclosed system.

d) Concrete Curing: - Use of gunny bags, ponding for curing purposes. Adding admixtures to concrete which cause a reduction in the water required for curing as per directions of the Engineer-in-charge. Also construct curing tanks on the site for efficient usage of water.

e) Efficient use of available water.

f) Plan utilities efficiently and optimize on-site circulation efficiency.

g) Reduce air and noise pollution due to storage / use of materials and machinery.

h) Preservation and protection of landscape during construction.

i) Reduction in waste of construction materials.

j) Implement recycling programme as far as possible to recycle construction waste materials during construction.

k) Suitable arrangement for preventing dust and debris entering duct work and working areas.

l) Create physical barriers between work and non-work areas.

m) Protection of materials and equipment against moisture dust etc.

n) Keeping work area clean and dry as possible.

o) To take safety measures to avoid damage to existing plants and trees.

p) The contractor shall comply with all the preventive and protective environmental steps as stated in the MoEF guidelines, 2010.

q) The contractor shall curry out on road- Inspection for black smoke generating machinery. The contractor shall use cleaner fuel.

r) The contractor shall ensure that all DG sets shall comply with emission norms notified by MoEF.

s) The contractor shall use vehicle having pollution under control certificate. The emissions can be reduced by a large extent by reducing the speed of a vehicle to 20 kmph. Speed bumps shall be used to ensure speed reduction. In cases where speed reduction cannot effectively reduce fugitive dust, the contractor shall divert traffic to nearby paved areas.

4.4. Materials:-

i. Use of materials which conform to the GRIHA Rating System criteria.

ii. Use of low emitting materials, adhesives and sealants to -

a) reduce / avoid use of materials, which are irritating and naturally cause health problems to the construction workmen and occupants.

b) achieve specified Volatile Organic Compounds (VOC) limits as per the GRIHA requirements.

5. The Contractor shall maintain proper record of all the materials/ equipment procured with respect to their source & specifications with details of their manufacturing and recycled content etc. and submit along with all supporting documents to the Engineer-In-charge.

6. Construction Waste Management Plan :
As already detailed, the broad intent is to avoid materials going to landfills, during construction. It is required to develop a plan to recycle all possible waste generated during construction. Typical items would include land clearing debris, concrete, steel, ductwork, clean dimensional wood, paperboard and plastic used in packing, etc.

7. Indoor Air Quality (IAQ) Management plan.
The HVAC works, in general, shall conform to ECBC 2017. The contractor shall be required to take the specific measures during construction with respect to following main areas of concern:

a. <u>HVAC System Protection</u> :

- When performing construction activities that produce dust, such as drywall sanding, concrete cutting, masonry work, wood sawing or adding insulation, seal off the supply diffusers and return air system openings completely for the duration of the task.
- Shut down and seal off the supply diffusers and return air ducts during any demolition operations
- Till the HVAC system is put into use, seal-off the supply diffusers and return air system openings to prevent the accumulation of dust and debris in the duct system during construction.
- Do not use the mechanical rooms to store construction or waste materials. Keep rooms clean and neat.

- Provide periodic duct inspections during construction; if the ducts become contaminated due to inadequate protection, clean the ducts as per requirements and directions of Engineer-In-Charge

b. Contaminant Source Control:

i. Use low VOC products as indicated by the specifications to reduce potential problems

ii. Restrict traffic volume and avoid idling of motor vehicles as their emissions could be drawn into the building

iii. Utilize electric or natural gas alternatives for gasoline and diesel run equipment where possible and practical. Use low-sulphur diesel in lieu of regular diesel

iv. Cycle equipment off when not being used or needed

v. Exhaust pollution sources to the outside with portable fan systems

vi. Prevent exhaust from re-circulating back into the building

vii. Keep containers of wet products closed as much as possible. Cover or seal containers of waste materials that can release odour or dust.

viii. Protect stored on-site or installed absorptive building materials, for instance, Cement, Gypsum / POP etc. from weather and moisture; wrap with plastic and seal tight to prevent moisture absorption.

c. Pathway Interruption:

i. Provide dust curtains or temporary enclosures to prevent dust from migrating to other areas including existing Hospital Complex, as applicable.

ii. Locate pollutant sources as far away as possible from supply ducts and areas occupied by workers when feasible. Supply and exhaust systems may have to be shut down or isolated during such activity.

iii. During construction, isolate areas of work to prevent contamination of clean or occupied areas. Pressure differentials may be utilized to prevent contaminated air from entering clean areas.

iv. Depending on weather, ventilation using 100% outside air will be used to exhaust contaminated air directly to the outside during use of VOC emitting materials.

d. Housekeeping:

i. Provide regular cleaning concentrating on HVAC equipment and building space to remove contaminants from the building prior to occupancy.

ii. All coils, air filters, fans & ducts shall remain clean during installation and, if required, will be cleaned prior to performing the testing, adjusting and balancing of the systems.

iii. Suppress and minimize dust with wetting agents or sweeping compounds. Utilize efficient and effective dust collecting methods such as a damp cloth, wet mop, or vacuum with particulate filters, or wet scrubber.

iv. Remove accumulations of water inside the building. Protect porous materials such as insulation and ceiling tile from exposure to moisture.

v. Thoroughly clean all interior surfaces prior to replacing filters and running HVAC system for system balancing, commissioning and building flush-out.

e. Scheduling and Construction Activity Sequence:

Schedule high pollution activities that utilize high VOC level products (including paints, sealers, insulation, adhesives, caulking and cleaners) to take place prior to

installing highly absorbent materials (such as ceiling tiles, gypsum wall board, fabric furnishings, carpet and insulation, for example)

8. Green Building (GRIHA) provisions for Electrical works and Materials

The Electrical works, in general, shall conform to latest ECBC Norms. Moreover, the contractor shall be required to take the specific measures during construction with respect to following:

i. All items shall be as per the Green Building provisions and shall adhere to GRIHA Green Building rating system and other Green building standards. This is irrespective of whether the same have been mentioned in the technical specifications or the requirement.

ii. The vendor to conform during negotiation meetings and before quoting that the MAKE of MATERIAL specified in the e-Tender conforms to Green Building norms and requirements and in case of any queries would clarify during the negotiation meeting. Since we are aiming for the GRIHA 3 Star rating, it is mandated that all products have to be accordingly compliant and if the contractor has not accounted for it in his cost, he WILL NOT be entitled for any further compensation and will have to provide in the same cost.

iii. Minimum allowable luminous efficacy of all the lamps shall be as per latest ECBC/ NBC 2016.

9. Photographs :

During various stages of construction, the photographs shall be taken by contractor and submitted to the Engineer-In-charge, showing details of specific requirements / measures being taken by the contractor towards above for documentary compliance and records.

10. Contractor shall coordinate with suppliers of various materials and equipment to be procured by him for use in works and provide all required details with respect to their manufacturing facilities; raw materials etc. as per requirements of GRIHA Certification guidelines. Preference should be given to GRIHA compliant products/ materials.

FORMATS FOR GUARANTEES

GUARANTEE TO BE EXECUTED BY THE CONTRACTOR FOR REMOVAL OF DEFECTS AFTER COMPLETION IN RESPECT OF WATER SUPPLY AND SANITARY INSTALLATIONS

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this……. Day of ……. Two thousand and …….. between …….. S/O……. (hereinafter called the GUARANTOR of the one part) and the ---------- (herein after called the Client of the other part). WHEREAS THIS agreement is supplementary to the contract. (Herein after called the Contract) dated……and made between the GUARANTOR OF THE ONE PART AND the Client of the other part, whereby the contractor interalia, undertook to render the work in the said contract recited structurally stable workmanship and use of sound materials.

AND WHEREAS THE GUARANTOR agreed to give a guarantee to the effect that the said work will remain structurally stable and guarantee against faulty workmanship, finishing, manufacturing defects of materials and leakages etc.

NOW THE GUARANTOR hereby guarantee that work executed by him will remain structurally stable, after the expiry of maintenance period prescribed in the contract for the minimum life of ten years, to be reckoned from the date of completion of work, to be reckoned after the expiry of maintenance period prescribed in the contract.

The decision of the Engineer- in- charge with regard to nature and cause of defects shall be final.

During the period of guarantee the guarantor shall make good all defects to the satisfaction of the Engineer- in-charge calling upon him to rectify the defects, failing which the work shall be got done by the Client by some other contractor at the guarantor's cost and risk. The decision of the Engineer –in- charge as to the cost payable by the Guarantor shall be final and binding.

That if the guarantor fails to make goods all the defects, commits breach there-under then the guarantor will indemnify the Principal and his successor against all loss, damage cost expense or otherwise which may be incurred by him by reason of any default on the part of THE GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and/or damage and/or cost incurred by the Client the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WEHREOF those presents have been executed by the obligator. And …….. by for and on behalf of the Client on the day, month and year first above written.

Signed sealed and delivery by OBLIGATOR in the presence of:
1.
2.
SIGNED FOR AND ON BEHALF OF ---------- BY……. in the present of:
1.
2.

GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR FOR ANTI TERMITE TREATMENT.
(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this_____day of _____two thousand and_____between_____ S/o_____(hereinafter called the GUARANTOR of the one part) and the ---------- (hereinafter called the Client of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated_____and made between the GUARANTOR OF THE ONE PART AND the Client of the other part, whereby the contractor interalia, undertook to render the building and structures in the said contract recited completely Anti Termite proof.

AND WHEREAS GUARANTOR hereby guarantee that the effect that the building and structures will remain completely Anti Termite proof for TEN years, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that Anti Termite treatment given by him under agreement Item No. ……., will render the structure completely Anti Termite proof and the minimum life of such Anti Termite treatment given by him will render the structures completely leak proof and the minimum life of such Anti Termite treatment shall be TEN years, to be reckoned from the date of completion of work.

Provided that THE GUARANTOR shall be not responsible for leakage caused by earth quake or structural defects or misuse of Building or alteration and for such purpose:

a. misuse of Building shall mean any operation which will Anti Termite treatment to the Building.

b. Alteration shall mean construction of any addition or construction adjoining to existing Building whereby Anti Termite treatment is removed/damaged in parts ;

c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee the guarantor shall make good all defects and in case of any defect being found to render the Anti Termite proof treatment of the building to the satisfaction of the Engineer at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer calling upon him to rectify the defects failing which the work shall be got done by the Client by some other contractor at the GUARANTORS cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if the guarantor fails to execute the Anti Termite treatment, or commits breach there-under then the guarantor will indemnify the Principal and his successor against all loss, damage, cost of expenses or otherwise which may be incurred by him by reason of any of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement.

As to the amount of loss and/or cost incurred by the Client on the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator _____and by_____by for and on behalf of ---------- on the day, month and year first above written.

Signed sealed and delivered by OBLIGATOR in presence of:
1._____ 2.

SIGNED FOR AND ON BEHALF OF ---------- BY_____ In presence of:
1._____ 2._____

GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR FOR WATER PROOFING TREATMENT FOR BASEMENTS.

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this_____day of _____two thousand and_____between_____ S/o_____(hereinafter called the GUARANTOR of the one part) and the ---------- (hereinafter called the Client of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated_____and made between the GUARANTOR OF THE ONE PART AND the Client of the other part, whereby the contractor interalia, undertook to render the building and structures in the said contract recited completely water and leak proof.

AND WHEREAS GUARANTOR hereby guarantee that the effect that the building and structures will remain completely water and leak proof for TEN years, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that water proofing treatment given by him under agreement Item No. ……., will render the structure completely leak proof and the minimum life of such water proofing treatment given by him will render the structures completely leak proof and the minimum life of such water proofing treatment shall be TEN years, to be reckoned from the date of completion of work.

Provided that THE GUARANTOR shall be not responsible for leakage caused by earth quake or structural defects or misuse of Basement or alteration and for such purpose:

a. misuse of basement shall mean any operation which will damage proofing treatment to the basement of the Building.

b. Alteration shall mean construction of any addition or construction adjoining to existing basement whereby proofing treatment is removed in parts ;

c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee the guarantor shall make good all defects and in case of any defect being found render the building water proof to the satisfaction of the Engineer at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer calling upon him to rectify the defects failing which the work shall be got done by the Client by some other contractor at the GUARANTORS cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if the guarantor fails to execute the water proofing, or commits breach there-under then the guarantor will indemnify the Principal and his successor against all loss, damage, cost of expenses or otherwise which may be incurred by him by reason of any of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement.

As to the amount of loss and/or cost incurred by the Client on the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator _____and by_____by for and on behalf of ---------- on the day, month and year first above written.

Signed sealed and delivered by OBLIGATOR in presence of:
1._____ 2.

SIGNED FOR AND ON BEHALF OF ---------- BY_____ In presence of:
1._____ 2._____

GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR FOR WATER PROOFING TREATMENT FOR ROOF.

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this_____day of _____two thousand and_____between_____ S/o_____(hereinafter called the GUARANTOR of the one part) and the ---------- (hereinafter called the Client of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated_____and made between the GUARANTOR OF THE ONE PART AND the Client of the other part, whereby the contractor interalia, undertook to render the building and structures in the said contract recited completely water and leak proof.

AND WHEREAS GUARANTOR hereby guarantee that the effect that the building and structures will remain completely water and leak proof for TEN years, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that water proofing treatment given by him under agreement Item No……., will render the structure completely leak proof and the minimum life of such water proofing treatment given by him will render the structures completely leak proof and the minimum life of such water proofing treatment shall be TEN years, to be reckoned from the date of completion of work.

Provided that THE GUARANTOR shall be not responsible for leakage caused by earth quake or structural defects or misuse of Basement or alteration and for such purpose:

a. misuse of roof shall mean any operation which will damage proofing treatment like chopping of fire wood and things of the same nature which might cause damage to the roof of the building.

b. Alteration shall mean construction of any additional storey or part of the roof or construction adjoining to existing roof whereby proofing treatment is removed in parts ;

c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee the guarantor shall make good all defects and in case of any defect being found to render the building water proof to the satisfaction of the Engineer at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer calling upon him to rectify the defects failing which the work shall be got done by the Client by some other contractor at the GUARANTORS cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if the guarantor fails to execute the water proofing, or commits breach there-under then the guarantor will indemnify the Principal and his successor against all loss, damage, cost of expenses or otherwise which may be incurred by him by reason of any of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement.

As to the amount of loss and/or cost incurred by the Client on the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator _____and by_____by for and on behalf of ---------- on the day, month and year first above written.

Signed sealed and delivered by OBLIGATOR in presence of:
1._____ 2.

SIGNED FOR AND ON BEHALF OF ---------- BY_____ In presence of:
1._____ 2._____

GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR FOR WATER PROOFING TREATMENT (UNDER FLOORS).

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this_____day of _____two thousand and_____between_____ S/o_____(hereinafter called the GUARANTOR of the one part) and the ---------- (hereinafter called the Client of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated_____and made between the GUARANTOR OF THE ONE PART AND the Client of the other part, whereby the contractor interalia, undertook to render the toilets, terraces and such related areas of the building in the said contract recited completely water and leak proof.

AND WHEREAS GUARANTOR hereby guarantee that the effect that the said toilets, terraces and such related areas will remain completely water and leak proof for TEN years, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that water proofing treatment under the floors in toilets, terraces and such related areas given by him under the contract, will render the areas completely water and leak proof and the minimum life of such water proofing treatment shall be TEN years, to be reckoned from the date of completion of work i.e. to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

Provided that THE GUARANTOR shall be not responsible for leakage caused by earth quake or structural defects or misuse of floors or alteration and for such purpose:

a. misuse of such floors shall mean any operation which will damage proofing treatment and things of the same nature which might cause damage to the such floors of the building.

b. Alteration shall mean construction of any addition or construction adjoining to existing such floors whereby proofing treatment is removed in parts;

c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee the guarantor shall make good all defects and in case of any defect being found to render the building water proof to the satisfaction of the Engineer at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer calling upon him to rectify the defects failing which the work shall be got done by the Client by some other contractor at the GUARANTORS cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if the guarantor fails to execute the water proofing, or commits breach there-under then the guarantor will indemnify the Principal and his successor against all loss, damage, cost of expenses or otherwise which may be incurred by him by reason of any of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement.

As to the amount of loss and/or cost incurred by the Client on the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator _____and by_____by for and on behalf of ---------- on the day, month and year first above written.

Signed sealed and delivered by OBLIGATOR in presence of:
1._____ 2.

SIGNED FOR AND ON BEHALF OF ---------- BY_____ In presence of:
1._____ 2._____

GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR IN RESPECT OF ALUMINIUM WORKS.

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this_____day of _____two thousand and_____between_____ S/o_____(hereinafter called the GUARANTOR of the one part) and the ---------- (hereinafter called the Client of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated_____and made between the GUARANTOR OF THE ONE PART AND the Client of the other part, whereby the contractor interalia, undertook to render the Aluminum Works in the said contract recited safe against water leakage, unsound material and workmanship and defective anodizing etc..

AND Whereas GUARANTOR agreed to give a guarantee to the effect that the Aluminum Work will remain safe against water leakage, unsound material and workmanship and defective anodizing for TEN years from the date of completion of work, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that the Aluminum Works executed by him will remain safe against water leakage, unsound material and workmanship and defective anodizing for TWO years from the date of completion of work, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

Provided that the guarantor shall not be responsible for any damage caused by earth quake or misuse of the Aluminum Work or alteration and for such purpose:

a. misuse of the Aluminum Work shall mean any operation which will damage the Aluminum Work executed by him;

b. Alteration shall mean construction of an addition to the Aluminum Work executed by him or part thereof or construction adjoining to the existing Aluminum Work whereby the Aluminum Work is likely to be effected/ damaged;

c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee the guarantor shall make good all defects and in case of any defect being found to render the Aluminum Work to the satisfaction of the Engineer at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer calling upon him to rectify the defects failing which the work shall be got done by the Client by some other contractor at the GUARANTORS cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if the guarantor fails to execute the water proofing, or commits breach there-under then the guarantor will indemnify the Principal and his successor against all loss, damage, cost of expenses or otherwise which may be incurred by him by reason of any of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and/or cost incurred by the Client on the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator _____and by_____by for and on behalf of ---------- on the day, month and year first above written.

Signed sealed and delivered by OBLIGATOR in presence of:
1._____ 2.

SIGNED FOR AND ON BEHALF OF ---------- BY_____ In presence of:
1._____ 2._____

GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR IN RESPECT OF STRUCTURAL GLAZING/ CURTAIN WALLSYSTEM/WORKS.

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this_____day of _____two thousand and_____between_____ S/o_____(hereinafter called the GUARANTOR of the one part) and the ---------- (hereinafter called the Client of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated_____and made between the GUARANTOR OF THE ONE PART AND the Client of the other part, whereby the contractor interalia, undertook to render the Structural Glazing / Curtain Wall System/ work under agreement Item No _____ safe against water leakage, unsound material and workmanship and defective anodizing etc..

AND Whereas GUARANTOR agreed to give a guarantee to the effect that the Structural Glazing/ Curtain Wall System/Work will remain safe against water leakage, unsound material and workmanship and defective anodizing for FIVE years from the date of completion of work, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that the Structural Glazing/ Curtain Wall System /Work executed by him will remain safe against water leakage, unsound material and workmanship and defective anodizing for FIVE years from the date of completion of work, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

Provided that the guarantor shall not be responsible for any damage caused by earth quake or misuse of the Structural / Curtain Wall System/ Work or alteration and for such purpose:

a. misuse of the Structural Glazing / Curtain Wall System /Work shall mean any operation which will damage the Structural Glazing / Curtain Wall System /Work executed by him;

b. Alteration shall mean construction of an addition to the Structural Glazing / Curtain Wall System Work executed by him or part thereof or construction adjoining to the existing Structural Glazing / Curtain Wall System / Work whereby the Structural Glazing / Curtain Wall System/Work is likely to be effected/ damaged;

c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee, the guarantor shall make good all defects and in case of any defect being found to render the Structural Glazing / Curtain Wall System /Workto the satisfaction of the Engineer-in- Charge at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer calling upon him to rectify the defects failing which the work shall be got done by the Client by some other contractor at the GUARANTORS cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if Guarantor fails to rectify the Structural Glazing / Curtain Wall System /work or commits breach there under then the Guarantor will indemnify the Principal and his successors against all loss, damage, cost, expense or otherwise which may be incurred by him by reason of any default on the part of the Guarantor in performance and observance of the supplementary agreement. As to the amount of loss and/ or damage and/or cost incurred by HLL/Client, the decision of Engineer will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator _____and by_____by for and on behalf of ---------- on the day, month and year first above written.

Signed sealed and delivered by OBLIGATOR in presence of:
1._____ 2.

SIGNED FOR AND ON BEHALF OF ---------- BY_____ In presence of:
1._____ 2._____

GUARANTEE BOND TO BE EXECUTED BY THE CONTRACTOR IN RESPECT OF SEISMIC/ MECHANICAL JOINT WORKS.

(On a Non- Judicial Stamp Paper of Rs. 100/- (Rupees One hundred Only)

The agreement made this____day of _____two thousand and_____between_____ S/o_____(hereinafter called the GUARANTOR of the one part) and the---------- (hereinafter called the Client of the other part).

WHEREAS this agreement is supplementary to a contract (Herein after called the Contract) dated_____and made between the GUARANTOR OF THE ONE PART AND the Client of the other part, whereby the contractor interalia, undertook to render the Seismic/ Mechanical Joint System/Work under agreement Item No _____ in the said contract recited safe against water leakage, unsound material and workmanship and defective anodizing etc..

AND Whereas GUARANTOR agreed to give a guarantee to the effect that the Seismic/ Mechanical Joint System/Work will remain safe against water leakage, unsound material and workmanship and defective anodizing for TEN years from the date of completion of work, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

NOW THE GUARANTOR hereby guarantees that the Seismic/ Mechanical Joint System/Works executed by him will remain safe against water leakage, unsound material and workmanship and defective anodizing for TWO years from the date of completion of work, to be reckoned from the date after the expiry of maintenance period prescribed in the contract.

Provided that the guarantor shall not be responsible for any damage caused by earth quake or misuse of the Seismic/ Mechanical Joint System/Work or alteration and for such purpose:

a. misuse of the Seismic/ Mechanical Joint System/Work mean any operation which will damage the Aluminum Work executed by him;

b. Alteration shall mean construction of an addition to the Seismic/ Mechanical Joint System/Work executed by him or part thereof or construction adjoining to the existing Seismic/ Mechanical Joint System/Work whereby the Seismic/ Mechanical Joint System/Work is likely to be effected/ damaged;

c. The decision of the Engineer with regard to nature and cause of defects shall be final.

During this period of guarantee, the guarantor shall make good all defects and in case of any defect being found to render the Seismic/ Mechanical Joint System/Work non-functional to the satisfaction of the Engineer at his cost and shall commence the work for rectification within seven days from the date of issue of the notice from the Engineer –in-charge calling upon him to rectify the defects failing which the work shall be got done by the Client by some other contractor at the GUARANTORS cost and risk. The decision of the Engineer as to cost, payable by the Guarantor shall be final and binding.

That if the guarantor fails to execute the Seismic/ Mechanical Joint System/Work, or commits breach there-under then the guarantor will indemnify the Principal and his successor against all loss, damage, cost of expenses or otherwise which may be incurred by him by reason of any of any default on the part of the GUARANTOR in performance and observance of this supplementary agreement. As to the amount of loss and/or cost incurred by the Client on the decision of the Engineer in charge will be final and binding on the parties.

IN WITNESS WHEREOF those presents have been executed by the obligator _____and by_____by for and on behalf of ---------- on the day, month and year first above written.

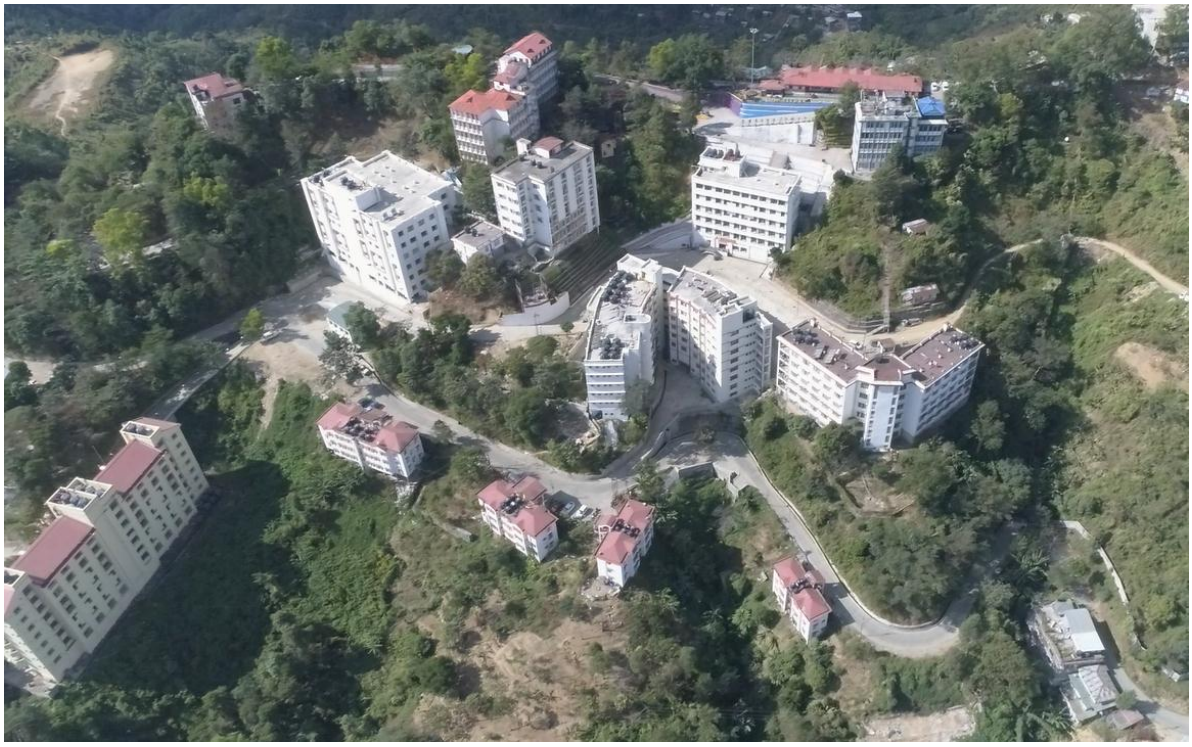
Signed sealed and delivered by OBLIGATOR in presence of:
1._____ 2.

SIGNED FOR AND ON BEHALF OF ---------- BY_____ In presence of:
1._____ 2._____

END OF VOLUME – 3

Vol.-4: Design Basis Report

UP-GRADATION AND DEVELOPMENT OF REGIONAL INSTITUTE OF PARAMEDICAL & NURSING SCIENCES,AIZAWL, MIZORAM



CLIENT
Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram
(Ministry Of Health and Family Welfare, Govt. of India)

PROJECT CONSULTANT

HLL Lifecare Limited
(A Government of India Enterprise)

HLL Lifecare Ltd. (HLL)

(A Govt. of India Enterprise)

on behalf of

Regional Institute of Paramedical & Nursing Sciences, (RIPANS) Aizawl, Mizoram

Invites

e-Tender

For

Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram

on EPC Basis

Tender No. HLL/RIPANS-Aizawl/2019

Volume-4

DESIGN BASIS REPORT

(September, 2019)

HLL Lifecare Limited
(A Government of India Enterprise)

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NOIDA, UP 201 307
Ph.: 0120 4071 500 Fax: 0120 4071 513

www.lifecarehll.com

Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram on EPC Basis

DESIGN BASIS REPORT

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Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram on EPC Basis

DESIGN BASIS REPORT

A. GENERAL

1. INTRODUCTION

To overcome the need to provide basic paramedical health care facilities in the health institution of the North Eastern Regions, Regional Institute of Paramedical & Nursing Sciences was finalized by the North Eastern Council in 1992-93 with the approval of the government of India. All the allotted seats in disciplines of the institute are distributed as per quota fixed for the beneficiary states. The Institute was established in 1996 and started functioning as Regional Paramedical & Nursing Training Institute (RP&NTI) with no infrastructure of its own. Four storeyed building near Civil Hospital Aizawl was rented where all Academic activities were conducted. Administration was conducted from another rented building at Chanmari with a handful of staff. Boys and Girls students were also accommodated in different private buildings. The Institute, in 1996, started conducted the following course:

i. B.Sc (Nursing)
ii. Diploma in Laboratory Technology (DMCT)
iii. Certificate Course in Laboratory Technology (CMCT)
iv. Diploma in X-Ray Technology
v. Diploma in Pharmacy
vi. Diploma in Electro Cardiography (ECG)
vii. Diploma in Ophthalmic Technology (OT)
viii. Multipurpose Health Worker Course.

Formerly the name was Regional Paramedical and Nursing Training Institute (RP&NTI), which was rechristened as Regional Institute of Paramedical and Nursing (RIPAN). Later the word 'sciences' was added. The institute is named Regional Institute of Paramedical and Nursing Sciences (RIPANS). RIPANS is affiliated to the Mizoram University.

In order to augment the supply of skilled manpower and to promote the training through standardization of such education / courses across the country, the Ministry of Health and Family Welfare proposes to further upgrade and develop the existing Regional Institute of Paramedical & Nursing Sciences (RIPANS), Aizawl. The Ministry of Health and Family welfare appointed HLL Lifecare Limited as Project Consultant for the Project.

The project is to be executed on Turnkey i.e. EPC (Engineering, Procurement & Construction) basis wherein the Site Plans & Concept Designs shall be provided to the EPC Contractors and after award of work the EPC Contractor shall be responsible for complete detailed designing, engineering, procurement and construction of the project.

2. SITE ANALYSIS

2.1. Location and Description

The proposed site is located at Aizawl in Mizoram State. RIPANS is in the outskirts, about 10 km, from the capital city of Aizawl and 39 Kms from Airport. The site is surrounded by National Highway 54 on the southeast and a hospital and health departmental store on the northwest. The nearest airport is Lengpui Airport.

Mizoram is a land of rolling hills, valleys, rivers and lakes as many as 21 major hill ranges or peaks of different heights run through the length and breadth of the state, with plains scattered here and there. The average height of the hills to the west of the state is about 1,000 meters (3,300 feet). These gradually rise up to 1,300 meters (4,300 feet) to the east. Some areas, however, have higher ranges which go up to a height of over 2,000 meters (6,600 feet). Phawngpui Tlang also known as the blue mountain, situated in the south-eastern part of the state, is the highest peak in Mizoram at 2,210 meters (7,250 feet).

Aizawl is the capital of Mizoram. With a resident population of 293,416, it is the largest city in the state. It is also the center of administration, containing all the important government offices, state assembly house and civil secretariat. The population of Aizawl strongly reflects the different communities of the ethnic Mizo people. Aizawl is located north of the Tropic of Cancer in the northern part of Mizoram. It is situated on a ridge 1,132 meters (3715 feet) above sea level, with the Tlawng river valley to its west and the Tuirial river valley to its east. Aizawl has a mild, sub-tropical climate due to its location and elevation. Under the Köppen climate classification, Aizawl features a humid subtropical climate albeit a more moderate version of the climate. In the summer the temperature ranges from 20-30 degrees Celsius, and in the winter 11-21 degrees Celsius.

2.2. Existing Area

The State Government of Mizoram (Health and Family Welfare Department) Aizawl had, during 1991, donated 39.60 Bighas of land of a slope of a Hill at Zemabawk which is about10 Km away from Aizawl town. The development of RIPANS is being

done in a phased manner. The following infrastructural development of the Institute has been achieved through State Public Works Department and other CPSUs. The list of buildings etc. completed and under construction are as listed below:

a. Academic:

i. Academic Building Block - I
ii. Academic Building Block -II
iii. Academic Building Block -III
iv. Library & Examination Hall

b. Hostels:

i. Girls Hostel with Hostel warden Qtr.
ii. Boys Hostel with Warden Quarters
iii. Additional Girls Hostel
iv. Additional Boys Hostel
v. Assam Type Additional Boys Hostel

c. Administrative Block

d. Residences & Staff Quarters

i. Director Quarter
ii. Type – I (6 Units)
iii. Type – II (6 Units)
iv. Type – III (6 Units)
v. Type – IV (6 Units)

e. Miscellaneous and other buildings: - such as Canteens, Workshops etc.

f. External services:-

- Sewage Disposal System – Not existing
- Source of water supply quality of water: - PHE Pipe line water
- Source of Electric Supply
  - Power & Electricity Department Govt. of Mizoram- nearest tapping point – Around 100 metres

2.3. Connectivity &Circulation

The proposed site is located at Aizawl in Mizoram State. RIPANS is located in the outskirts, about 10 km, from the capital city of Aizawl. The site is surrounded by National Highway 54 on the southeast and a hospital and health departmental store on the northwest.

2.4. Building Regulations

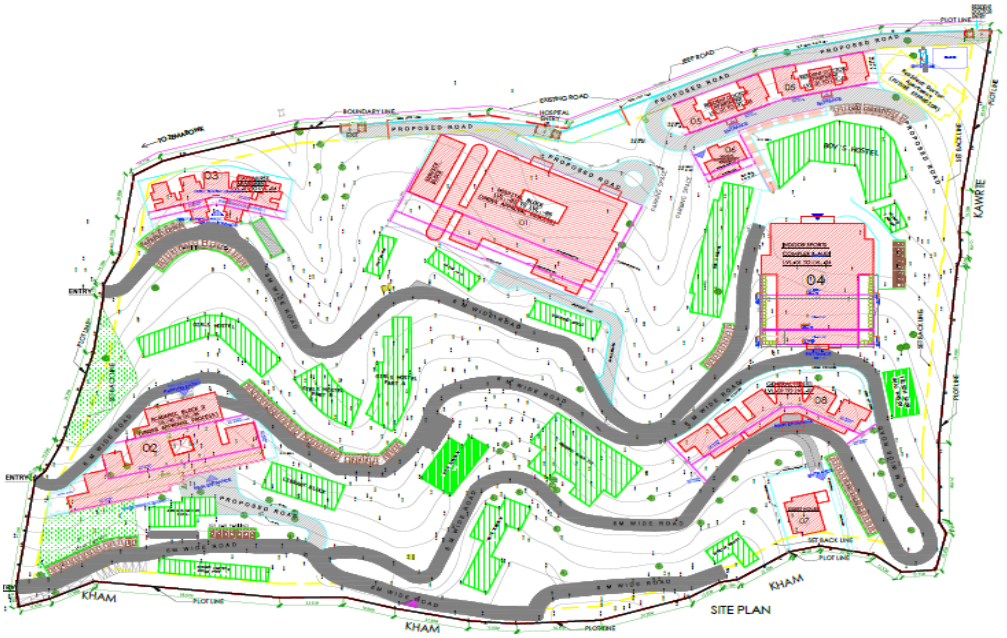
The site falls under the jurisdiction of Aizawl Municipal Corporation (AMC), Aizawl. The total area of RIPANS Campus admeasures around 39.60 Bighas. Few of the applicable building bye-laws/ regulations considered are given below, which need to be verified by the EPC Contractor and shall be responsible for adherence to their requirements.

Parameters	Permissible
Ground Coverage	50%
F.A.R	2.0
Height	• Institutional - as per Bye Laws • Residential - as per Bye Laws

- Minimum setbacks as per AMC
- Minimum staircase width for hospital = 2.00 m.
- Maximum travel distance to escape staircase=30 m, 45m for sprinkled building.

3. MASTER PLANNING

3.1. The Master Plan reflects the strategic planning of the proposed institute for the present and the emerging needs in view of advances in health care and the needs of the population. The objectives of Master Plan include integrated complex with zoning taking into account the environment and applicable bye-laws. However, the EPC Contractor shall verify and adhere to the requirements stipulated by the respective authorities. The master plan is as under:



3.2. Project Components:

The proposed up-gradation project includes construction/ augmentation of the following complex to make the campus self-sufficient:

1. Institute Complex
    i. Academic Building Block –IV
    ii. Guest House
    iii. General Hostel Block

iv. Indoor Sports Complex and Auditorium

2. Hospital Complex
   i. 100 Bedded Hospital
   ii. Resident Doctor's Quarters
   iii. Medical Superintendent Quarter
   iv. Staff / Nurse Quarters

In the present tender the scope of work relates to construction for required facilities as stated above with all services, road, pavements, pathways, parking, external lighting and other allied works.

3.3. Summary of Facilities to be provided:

Buildings/ Particulars	Quantity/Details
Main Hospital Block	100 Bedded
Medical Superintendent Quarter	1 No
Resident Doctor's Quarters	22 No
Staff / Nurse Quarters	18 No
Academic Block	Class Room -18, Lab-32, Lecture Theatre-2, Departmental Office - 6, Faculty Room-4, HOD Rooms-6, Museum & Library
General Hostel Block	168 Nos. (for Boys & Girls)
Indoor Sports Complex and Auditorium	Auditorium 980 Seats
Guest House	10 Rooms (8 Single Rooms+2 Suites)

A. Detail of building floors

S. No	Description	Floors/Levels
1	Main Hospital Block	5
2	Medical Superintendent Quarter	2
3	Resident Doctor's Quarters	6
4	Staff / Nurse Quarters	4
5	Academic Block	6

S. No	Description	Floors/Levels
6	General Hostel Block	7
7	Indoor Sports Complex and Auditorium	2
8	Guest House	4
This does not include the requirements at terrace.		

B. Comparison between Permissible & Proposed Built-up areas as per Local Building Bye-laws

Parameters	Permissible	Achieved
Ground Coverage	50% (26503.50 sqm)	20.85% (11055.35 sqm)
F.A.R	2.0 (106014.00 sqm)	1.15 (61072.00 sqm)
Height	19 m / 22 m (if one floor is for car parking)	19 m / 22 m (if one floor is for car parking)

4. PROPOSED DEVELOPMENT

The development of the institute, under the present scope of work, is proposed to be taken up for creating infrastructure facilities in respect of the following:

A. Institute Complex
   i. Academic Building Block –IV and related services
   ii. Guest House and related services
   iii. General Hostel Block and related services
   iv. Indoor Sports Complex and Auditorium and related services

B. Hospital Complex
   i. 100 Bedded Hospital and related services
   ii. Resident Doctor's Quarters and related services
   iii. Medical Superintendent Quarter and related services
   iv. Staff / Nurse Quarters and related services

C. External Development: - Roadwork, pathways, parking, external drainage, external development including related electrical services, signage's, HVAC, Firefighting System etc.

5. CONCEPT PLANNING

5.1. Academic Building Block- IV (Institute Complex)

The proposed Academic Building block is six story structures and is spread over in different levels and is stepped in its profile.

Floor	Occupancy
Level 1	Parking& Service Rooms
Level 2	Faculty Rooms, Laboratories& Class rooms
Level 3 (GF)	Laboratories, Class rooms, HOD& Faculty Rooms, Library, Kitchen & Canteen& Electrical Room
Level 4	Laboratories, Classrooms, Faculty Rooms& Electrical Room
Level 5	Laboratories, Class rooms, HOD& Faculty Rooms & Electrical Room
Level 6	Laboratories, Class rooms, Museum & Electrical Room
Terrace Level	Machine Room, Stair case room

5.2. General Hostel (168 Rooms)

The General Hostel is designed as two wings with total 168 single rooms for PG boys and PG girls.

Floor	Occupancy
Level 1	Parking, Services Rooms
Level 2	Kitchen, Dining, Girls Common room, Boys Common Room, Security Room & Store Room
Level 3 to Level 7	Rooms Hostel Rooms 168 Nos. , Warden Rooms (2 Nos.)
Terrace Level	Machine Room, Stair case room

5.3. Guest House

It is proposed to construct a Guest House with 10 units.

Floor	Function
Level 1	Reception, Kitchen & Dining, General Store
Level 2	Guest Room (4)
Level 3	Guest Rooms (4)
Level 4	Suite Rooms(2)

Terrace Level	Machine Room, Stair case room
Total	Units(10), Kitchen and Dining, General Store

5.4. Indoor Sports and Auditorium Complex

It is proposed to construct an auditorium with 1000 seating capacity (Approx). By using the topography of the area an integrated complex with Indoor Sports facilities and Auditorium has been planned and the services provided are as under:

i. Requirements: Auditorium (1000 seating capacity (Approx)) and Indoor Sports Complex (Basketball Court, Volleyball court, gallery, Sport Coordinator's Room, changing and shower areas, Locker rooms and store etc.)

ii. The Indoor Sports Complex and Auditorium is located in front of the Boys Hostel. While the Indoor Sports Complex is accessed from the same level as the Boys hostel, the Auditorium is accessed by an existing road. An already existing Basketball court in front of the boys' hostel is enclosed and included in the sports complex proposed in this up-gradation Project.

iii. Indoor Sports and Auditorium Complex shall be two storey structure with Indoor Sports Complex (Basketball Court, Volleyball court, gallery, Sport Coordinator's Room, changing and shower areas, Locker rooms and store etc.) at lower level and Auditorium (980 capacity) at Upper level. The other occupancies shall be as per tender drawings.

The auditorium shall be air conditioned and shall have optimum values of acoustic parameters. The auditorium is located with adjoining lawns, parking space and easy access for outsiders. The materials on the ceiling, walls and at stage shall be to achieve aesthetic values in addition to the technical requirements. The provision for required audio and video system and stage lighting & stage furnishing are to be provided.

5.5. 100 Bedded Hospital Block

The hospital shall have 5 floors in total. The ground floor is at Level 01 which is accessible from main road. There is an additional accessibility provided at level 04 of the hospital building. This additional access shall be connected by the pathway from the existing road on the rear side of the building. Separate service block has been provided to cater to the need of services for the hospital.

Floor	Function
Level 1	, Waiting Lobby, Registration, Pharmacy, Emergency Services i/c Minor OT, OPD (Orthopedic & Cardiac) etc.
Level 2	OPD (ENT, General Medicine, General Surgery, Ophthalmology, AYUSH,) waiting areas, Radio-diagnostics, Physiotherapy, Kitchen & Canteen
Level 3	Wards (Surgery, Medicine) Post-operative Wards (Surgery), Isolation Rooms, Doctor's & Nurse's lounges, etc.

Level 4	Administrative Area i/c Board room, Blood Bank & Labs., Labour complex/rooms, Wards (Gynecology/ Pediatrics/ Antenatal/ Newborn/ General) etc.
Level 5	OTs , ICU, Post & Pre-operative Wards/rooms, Post & Pre-Natal Wards, CSSD, Kitchen (Outsource) etc.
Terrace Level	Machine Room, Stair case room
Service Block for Hospital (Singly Storey)	Services such as HVAC Plant room, LT Room, laundry & Housekeeping, Pump room, Biomedical Waste, Mortuary

5.6. Resident Doctor's Quarters

It is proposed to construct residential accommodation for Resident Doctors total 22 no of Type-IV (Equivalent) quarters in two separate blocks.

5.7. Medical Superintendent Quarter

It is proposed to construct One Duplex Type-V Quarter accommodation for Medical Superintendent for Hospital.

5.8. Staff/ Nurse Quarters

It is proposed to construct 18 units of Residential accommodation for Staff /Nurses of various categories.

5.9. External Development

5.9.1. Site Levels

The plinth level for Hospital/ Academic / Residential Quarters /Auditorium and other buildings shall be as specified in tender drawings and as directed by Engineers-in-charge.

5.9.2. Circulation & Parking

The circulation and parking has to be planned to keep the pedestrian character of the complex. The open parking has to be carefully camouflaged and softens through vegetation or totally screened off with trees/ shrubbery.

5.9.3. Roads and pathways

The campus roads/approach roads to buildings shall be RCC M-30 Grade with minimum thickness of 200 mm (reinforced) laid over sub base etc. as per road section given in Tender drawings and as per IRC code. The culverts, as per requirement to allow for storm water/ rain water, shall be provided along the road alignment.

Pathways have been proposed for pedestrian approach to various buildings. These may require bridges/suspended slabs for proper connection as per site conditions. The pathways, as per site requirements, shall be planned and provided accordingly.

For pedestrian movement and parking areas, paver blocks/ Grass-Crete blocks /Chequered CC tiles shall be used, as required and as specified in drawings /technical specifications.

All roads edges shall be provided with kerb stones (Precast or Cast-in-Situ as specified in the Tender drawings) & finished with synthetic enamel paint of approved shade as per details given in tender drawing. Adequate no. of RCC Pipes of suitable dia. shall be laid across the roads / pathways etc. to meet the requirements for crossing of cables, service lines/ storm water etc as per site requirement.

All ramps for handicapped/disabled persons are to be provided as per norms for all buildings.

Painting and marking of the roads, parking, cycle tracks footpaths and handicapped ramps are to be completed as per standard road signs & specifications.

5.9.4. Parking

Provision for parking spaces has to be made on the basis of "Equivalent car space" (ECS) as laid down under "Building Bye Laws" of Aizawl Municipal Authority.

Parking space has to be planned with adequate vehicular access to a street and the area of drives, aisles and such other provisions required for adequate manoeuvring of vehicles shall be exclusive of the parking space.

5.10. Landscape

a. Objective

Main objective of the landscape theme is to create a pleasant outdoor environmental to this prestigious complex, complementary to the character of the built form.

b. Landscape Irrigation Design

Irrigation to the plantation shall be done with the irrigation techniques and manual irrigation methods, in line with the site conditions and local agro-climatic conditions and assist in conserving the landscapes besides saving water and ecology.

5.10.1. **Horticulture and Plantation:-**

The Horticulture and Plantation works shall be carried out around the various buildings as per the related plans. However, the requirements shall cover the following:

a. Lawns –

The lawns area shall be provided as shown in Master Layout Plan Drawing.

b. Trees / shrubs Plantation –

- The peripheral plantation of trees along the roads, green belts and buildings shall be planted as per nomenclature mentioned in Master

layout drawing. The minimum height of individual variety of plants shall be as per CPWD guidelines for Horticulture & Landscaping.

- Shrubs- The different variety of shrubs shall be planted as detailed in Master Layout Plan Drawing. The minimum height of individual variety of shrubs shall be as per CPWD guidelines for Horticulture & Landscaping.
- Ground Covers -The different varieties of Ground Covers shall be planted as shown in Master Layout Plan Drawing. The minimum height of individual variety of Ground Cover shall be as per CPWD guidelines for Horticulture & Landscaping.
- Climbers -The different varieties of Climbers shall be planted as shown in Master Layout Plan. The minimum height of individual variety of Climbers shall be as per CPWD guidelines for Horticulture & Landscaping.
- Roundabouts at different location as shown in the Master Plan shall be constructed as per drawing.
- Hard landscaping / Terrace gardens –Courtyards shall be developed as shown in the Master Plan shall be constructed as per drawing.

c. Maintenance of plants shall be one year after overall completion of the project.

5.11. Retaining wall / Slope protection:

Besides construction of the buildings, it may be required to provide RCC/ Stone Masonry retaining walls / Toe-walls and slope protection including pitching of slopes with stones and other such materials along proposed buildings & roads. The EPC contractor shall provide such structures as per site requirement/as specified in the drawings.

5.12. Signage:

Signage with different sizes & material specifications shall be provided for different locations. Signage for Hospital, Academic Block, Residential blocks & Hostels will be made bilingual or as per Local Government norms for all Internal, Campus Way finding and for Facade/Building. Bilingual signage shall be provided as per relevant local bylaws and Govt. norms. Facade Signage's for all the buildings shall be made of 304 Grade SS letters as per locations, drawings and specifications.

The directional Totems for the Hospital & Academic Block will be made with a combination of Aluminum Composite Panel (ACP), toughened Glass and approved vinyl sheet with required MS framework supports. Whereas the directional signage's for the Residential buildings, other external signage shall be a combination of SS and Acrylic sheet with approved reflective Vinyl.

The internal signages for the entire buildings will be made mainly with minimum 8mm white Acrylic as per approved shape & design in digital print with Matt lamination. Fire Signage as per relevant statutory norms shall also be provided in each buildings.

Emphasis will be given towards making the signage's with modern look & feel with uniformity and longevity with low maintenance cost in future.

6. GRIHA RATING & CERTIFICATION

6.1. Project Vision

Proposed up-gradation of RIPANS is envisioned to be designed and constructed based on sustainability and green building principles. The vision is to conserve energy & water; reduce waste; renewable energy generation; reduce urban heat island effect and use sustainable materials.

6.2. Project Approach &Strategies

Minimum 3-Star GRIHA rating for the below mentioned buildings at RIPANS, Aizawl shall be obtained by EPC Contractor with due compliance to various criteria stipulated under GRIHA Version 2015.

Buildings for which GRIHA certification is required are mentioned as below:

i. Hospital

ii. Academic Block

6.3. Key Strategies for Minimum GRIHA 3 Star Rating

Key considerations & strategies for targeted rating are indicated below in 3 broad categories as follows:

A. PLANNING –

1. Site Plan and building plans conform to government approvals/requirements.
2. Compliance to latest version of ECBC and NBC 2016 is mandatory.
3. Heat Island mitigation measures to be implemented like SRI paint, tree shade, and reduction in hard paving.
4. Net Imperviousness factor of site meets the NBC 2016 norms & the site is designed such that post-construction storm water discharge from the site is zero
5. Rainwater harvesting for managing the rainwater runoff from roof and ground surfaces.
6. Window to Wall Ratio to be limited in each building as per GRIHA V2015
7. Skylight to roof ratio to be limited in each building as per GRIHA V2015
8. All the fenestrations meet the SHGC requirement of ECBC (latest version) /Weighted Façade average SHGC (for each orientation) meets SHGC requirements of ECBC (latest version)
9. Energy Conservation Measures to achieve Energy Performance Index (EPI) lower than GRIHA V2015 Baseline EPI.
10. Insulation, refrigerants, fire suppression systems will be CFC, HCFC and Halon free.

11. Paints, adhesives and sealants to be low/free of VOC content as per GRIHA V2015 requirements.
12. Building Water demand to be reduced below GRIHA V2015 base case by using low flow fixtures in toilets, kitchen, cafeteria, pantry etc.
13. Sewage Treatment Plant to treat wastewater generated on site, as per GRIHA V2015.
14. All materials (calculated by surface area) used for building interiors should meet the GRIHA V2015 requirements.
15. BIS recommended waste materials to be used in building structure.
16. Renewable energy generation through solar PV Panels installed on roof, sizing as per GRIHA V2015.

B. DURING CONSTRUCTION

1. Replantation/Plantation to be done as per GRIHA V2015.
2. Air & Water pollution control measures including but not limited to –
   i. Provision of at least 3 meter high barricading around the construction area.
   ii. Wheel washing facility at the vehicular entrance of the site
   iii. Covering of fine aggregate and excavated earth on site with plastic/geotextile sheets
   iv. Water sprinkling on fine aggregate (sand) and excavated earth
   v. Diesel generator sets on site must have proper chimneys with their outlet facing away from the site
3. Adopt strategies to reduce water use during construction like –
   i. Using gunny bags for curing and using ponding for curing
   ii. Monitoring to avoid leaks and water wastage
   iii. Use of additives to reduce water requirements during curing
   iv. Use of treated waste water/captured storm water
4. Implement waste management practices during construction including but not limited to,
   i. Allocation of separate waste storage spaces
   ii. Safe disposal of waste
   iii. Hiring of waste haulers

C. POST CONSTRUCTION

   i. Monitoring of project's energy consumption by installing digital meters for Utility grid, on-site renewable energy system, diesel generator, AHU, Cooling tower etc

ii. Reduction in landscape water demand by using efficient irrigation techniques like drip irrigation, minimizing turf area and installing native trees, shrubs.

iii. Water used for drinking, irrigation to conform to BIS standards

iv. Monitoring of project's water consumption by installing digital meters at municipal supply, irrigation, cooling tower, STP/WTP/ETP.

v. Effective use of Sewage Treatment Plant to treat wastewater generated on site.

D. INNOVATION

A few other strategies should also be implemented for innovation, including but not limited to –

i. A GRIHA certified professional (Trainer or Evaluator) is involved in the project from beginning to end)

ii. Implementation of a technology for the first time in the country.

iii. E-waste recycling

iv. STP technologies

v. Net-Zero Energy/Water

7. AESTHETICS

Aesthetics is of utmost importance to enable a healing environment, this aesthetics shall be met by providing pleasing architectural elevation features, creating an enabling environment.

8. ARCHITECTURAL FEATURES OF THE PROJECT

The Architectural features of the project are as follows:

a. Green campus with seamless phasing

b. Clear structured into zones for hospital complex, teaching, hostels & recreation and residences, maximizing site potential, & connected through a pedestrian spine

c. Hospital complex is designed with healing gardens and seamless flexibility for expansion, with emphasis on pedestrian & barrier free movement

d. Permanent, durable and local materials have been integrated, low heat transmission heat reflective glass towards green building complex.

e. Windows:

f. The Hospital Block & Academic Block- IV is required to satisfy the norms for minimum 3 Star GRIHA Rating. All the exterior windows in the Hospital Block, where Air Conditioning (split A/C or central A/C) to be proposed, shall be provided with double glass units comprising of 6mm thick toughened glass (Outer face)-12 mm thick air gap

(HEARMATICALLY SEALED) - 6mm thick high performance toughened glass (Inner Face) DGU (VLT ≥ 35%, SHGC ≤ 0.25, U-value ≤ 1.8 W/sqm K) meeting the functional requirements.

g. In other areas such as Balance Hospital Block, Academic Block-IV, residential areas Guest House, Apartments, Hostels etc., and Auditorium, Clear/Tinted float glass SGU shall be provided. The thickness of float glass shall depend on the size of panel subject to requirements as per CPWD specifications.

h. Frosted glass shall be used in external windows in toilets and similar areas.

9. DESIGN PHILOSOPHY

The design philosophy takes into account the followings:

a. To cater for different functional requirements of user with creative indoor spaces, surroundings, better circulation and flexibility in space planning.

b. Integrated designs of electrical, mechanical and other services with structural system which should be planned with optimum cost, low maintenance and lowest consumption of energy and water.

c. Climate responsive Architecture with integration of daylight and electric light, thermal comfort, ventilation.

d. Consideration of green building principles.

e. Water and solid waste management with waste water recycling, water conservation and rain water collection & use.

f. Development of surroundings with site terrain consideration, traffic circulation, indigenous vegetation and plantation.

g. The complex/blocks proposed to be developed should be based on efficient construction technologies for fast track and ease in construction. The buildings shall be RCC framed structures.

B. Design Basis Report- Civil Structures

1. General

Master Plan & Concept Plans of the Up-gradation and Development of RIPANS, Aizawl shall be provided to the EPC Contractor. The EPC Contractor shall prepare the detailed architectural design and drawings of the Project for approval from the local bodies and statutory authorities as per requirement. The structural design of buildings shall be done by the EPC Contractor and Proof checked/vetted by the approved Institute. The requirements for the structural designs are briefed hereunder.

2. Geo Technical Investigations

The site is a hilly terrain sloping mainly from West to East direction. There are water channels flowing across the site. The EPC Contractor shall, after award of work, carry out the required site surveys and soil investigations and obtain soil investigation report as per codal requirements from the specialized agency, with the prior approval of HLL. This soil investigation report shall be got vetted by the approved design vetting Institute and additional requirements/ details will be included for implementation of structural design thereafter.

However, the data, as per the available Geo-Technical investigations conducted is given hereunder for reference/guidance only:

i. Soil Characteristics:-

As per the available soil report conducted, the subsoils are very good quality. It is characterised by a thin layer of hard clayey silt / yellowish brown clayey silt with decomposed rock, kankars & fine sand followed by a weathered rock layer and that continued upto the terminating depth of all the boreholes.

ii. Water Table: -The ground water table has not been encountered during the investigations.

iii. Soil Bearing Capacity:- The tentative bearing capacities are as under.

Building	Depth of Foundation below EGL (Ms)	Expected Foundation material	Net Allowable Bearing capacity (T/Sq Mts)	
			Isolated / Strip footing	Raft foundation
Indoor Sports Complex & auditorium	1.00	Weathered Rock	20	25
	1.50		25	30
Hospital Block	1.50	Hard Clay / Weathered Rock	20	18
	2.00		24	20
Guest House	1.00	Weathered Rock	20	25
General Hostel	1.50	Hard Clay / Weathered Rock	20	18
Academic	1.50	Weathered Rock	24	30

Block- IV	2.00		25	30

3. Design of Structural System

3.1. Objective

The objective is to lay down the structural analysis & design of proposed buildings and structures of RIPANS, Aizawl. It also incorporates the design process to establish the overall design philosophy to be adopted in the Analysis and design.

3.2. Description of the Project & Structural arrangement:

The RIPANS, Aizawl has several buildings. All the buildings shall be designed as structural framing system with beam – column arrangements. Shear walls, as required, shall be provided. The proposed buildings shall be of RCC frame structure with Isolated footings / Strip footings / Raft Foundation.

Since, the RIPANS is located in a hilly terrain, the buildings are required to be placed along the slopes. The site is heavily contoured and shall involve earth cutting and filling and construction of retaining wall for creation of terraces and protection of existing slopes. For construction and stability of the buildings, retaining walls may be required, which shall be planned accordingly. At certain locations, there shall be requirement for stabilizing the slopes. The required arrangements shall be provided as such locations. The Culverts, as per requirement, to be provided shall be designed as per structural norms & relevant codes.

The type of foundation shall be decided after the detailed soil investigation undertaken by the EPC contractor. The EPC Contractor shall also seek advice of the geological consultant before deciding the type of foundation.

In respect of the indoor sports complex and auditorium, the roofing shall be with sandwich puff panels supported on MS structural truss roofing system.

3.3. Statutory Requirements

The design of the Civil Structure will comply with the requirements of the following:

- National Building Code.
- Local Building Regulations.
- Bureau of Indian standard codes.
- International codes as applicable.
- Any other regulation as per requirements.

3.4. Design Philosophy

a. Site falls in Zone V as per IS: 1893(part-1) – 2016 of Seismic Zones of India

b. Type of Structure: RCC framed structure has been proposed for all the structures.

c. 3-D Analysis of all the building structures is to be carried out by The EPC Contractor using latest versions of modern software packages such as STAAD Pro/Etab and the

results of the analysis shall be used for designing the various elements. All designs shall strictly conform to the standards specified in National Building Code 2016 and to be proof checked.

d. HLL reserves the right to conduct third party design validation and the EPC Contractor shall provide all data and carry out all modifications that may be suggested by the third party so appointed.

e. The recommendations of the past Geo Technical investigation as above are indicative. The EPC Contractor shall conduct soil investigations on their own and shall be responsible for the adequacy of the design.

f. Overhead tank for domestic and fire-fighting purposes for the respective buildings shall be located at terrace level, unless planned otherwise.

g. Underground tanks: Shall be provided as per requirements.

3.5. Structural designs: -

The main considerations followed for the design of structure are:

- Structure safety and stability.
- To meet the demands of aesthetics conceived by the architect.
- Availability of material, equipment and expertise.
- Constructability and ease of maintenance.
- Durability.
- Economy.

3.6. Factor of Safety:

It shall be ensured that the factor of safety, as per codal requirements is strictly adhered to. In case the codes prescribed a range for the factor of safety, the highest value of the range shall be taken for design consideration and also for assessment of bearing capacity.

3.7. Design Standards

The relevant Indian Standard Codes, as given below shall be followed for structural design.

Sl. No.	Code	Description
1	IS: 875(Part 1)-1987	Code of practice for Design Loads (Other than Earthquake) for Building and Structures-Unit weights of Buildings Materials and Stored Materials.
2	IS: 875(Part 2) -1987	Code or Practice for Design Load (Other than Earthquake) for Buildings and Structures Imposed Loads.
3	IS: 875(Part 3) - 1987	Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures – Wind Load.

Sl. No.	Code	Description
4	IS: 875 (Part 5) - 1987	Code of Practice for Design Loads (other than Earthquake) for Buildings and Structures-Special Loads and Load combinations.
5	IS: 456 - 2000	Code of Practice for Plain and Reinforced Concrete with amendments
6	IS: 1786 - 2008	Specification for High Strength Deformed steel bars and Wires for Concrete Reinforcement.
7	IS: 1893 (Part1) – 2016	Criteria for Earthquake Resistance Design of Structures.
8	IS: 1904 - 1986	Code of Practice for Design and construction foundation in soil - General Requirements
9	IS: 2950 (Part-1) - 1981	Code of Practice for Design and construction Raft Foundation (Part-1)
10	IS: 3370 (Part1) - 2009	Code or practice for Concrete Structures for the storage of Liquids – General Requirements.
11	IS: 3370 (Part2) - 2009	Code of Practice for Concrete Structures for the Storage of Liquids – Reinforced Concrete Structures.
12	IS: 3370 (Part4) - 1967	Code of practice for Concrete Structures for the Storage of Liquids – Design Tables.
13	IS: 4326-2013	Earthquake Resistance Design and Construction of Building – Code of Practice.
14	IS: 1642-1989	Fire safety of buildings (general):details of construction code Of practice
15	IS: 13920-2016	Ductile detailing of reinforced Concrete structures subjected to Seismic forces — code of practice
16	SP:24-1983	Explanatory handbook on Indian standard code of practice for Plain and reinforced concrete (IS:456-1978)
17	SP:16-1980	Design aids for Reinforced concrete to IS : 456-I978
18	SP:34-1987	Handbook on Concrete Reinforcement and Detailing
19	IS: 800-2007	Code of Practice for General Construction in Steel.

Sl. No.	Code	Description
20	NBC - 2016	National Building Code of India 2016 (Vol- 1 &2)

3.8. Loads, Classification and Material Properties

3.8.1. LOADS

The structural members are loaded with various loads combinations during its services conditions. The loads on the structure are taken for analysis and design as per the relevant IS codes of practise.

- Dead load as per IS: 875 -1987 Part-1
- Imposed live load as per IS: 875 -1987 Part-2
- Wind loads as per IS: 875– 2015 Part 3
- Seismic Loads as per IS: 1893-2016

Dead loads comprise of the self-weight of all permanent construction including walls, slabs, beams, columns, water proofing treatment, water tanks, stair case, floor finish etc. Other super imposed loads shall be considered. The structure would be designed for earthquake resistance as per IS 1893:2016, with consideration for the structural detailing as per provisions of IS 13920-2016 and SP 34-1987.

A. Dead Loads (DL) (Ref: - IS:875 (part-1)-1987)

i.	Self-weight of reinforced concrete	: 25KN/m³
ii.	Self-weight of plain concrete	: 24KN/m³
iii.	Brick Masonry	:18.85KN /m³
iv.	Ceiling Artificial (12mm thick)	: 0.25 KN/m2
v.	Waterproofing (Av. 200 mm thick brick bat coba)	: 9.90 KN/m³
vi.	Cement plaster	: 20.40KN /m³
vii.	Glass	: 26 .00KN /m³
viii.	Aluminium	: 27 .00KN /m³
ix.	Water	: 10KN/m³
x.	Granite (average)	:26.70 KN/m³
xi.	Marble /Sand stone	: 24.00KN /m³
xii.	Steel	: 78.5 KN/m3

xiii.	Vitrified tiles (considering density as 2.4 gm/cc)	: 24.00KN/m3

B. Live loads (LL) (Ref: - IS: 875 (part-2)-1987)

The live loads shall be as per IS: 875 (part-2)-1987, read with NBC-2016. However live loads for some of the locations/occupancy classification shall be as follows: -

Location	Occupancy Classification	UDL (KN/m2)	Conc. Load #(KN)
Hospital Block, OPD	Laboratories	3	4.5
	X-ray rooms, Operating Rooms, general Storage area	3	4.5
	Office rooms and OPD rooms	2.5	2.7
	Wards and Dressing rooms	2.5	2.7
	Records/files stores room and storage space/ Cafeteria/ Corridors	5	4.5
	Assembly areas and fixed seats	4	-
Helipad		10	10
Common for all blocks	Class rooms	3	2.7
	Dormitory	2	2.7
	Wards	2	1.8
	Office	2.5	2.7
	Multipurpose hall	5	3.6
	Library	5	4.5
	Canteen	5	4.5
	Lecture hall, museum	4	-
	Kitchen	5	4.5
	Corridors, passages, lobbies	5	4.5
	Corridors and stair cases	5	4.5

Location	Occupancy Classification	UDL (KN/m2)	Conc. Load #(KN)
	including fire escapes		
	Plant rooms	7.5	4.5
	Baths & toilets	2.5	-
Hostels	All rooms	2	1.8
	Toilets and bathrooms	2	-
	Kitchen, Laundries, Corridor, passages, staircases i/c fire escapes and store rooms	3	4.5
	Dining/ Cafeteria	4	
Residential buildings	All rooms and kitchens	2	1.8
	Toilets and bathrooms	2	-
	Corridor, passages, staircases i/c fire escapes and store rooms	3	4.5
	Balconies	3	1.5 p/m run concentrated at outer edges
Terraces	Accessible	1.5	3.75 KN uniformly distributed over any span of 1m width of the roof slab and 9 KN over beams.
	Not accessible	0.75	1.9KN uniformly distributed over any span of 1m width of the roof slab and 4.5 KN over beams.
# The concentrated loads shall be considered to be applied in positions, which produce maximum stresses and where deflection is the main criteria.			

C. Wind Loads (Refer: - IS:875 (part-3)-2015)-Typical

Basic wind speed (Vb) : 55m/sec

Design life of the structure : 100 years

Risk coefficient (k1) (table-1) :1.08

Terrain category : 1

Maximum height of the structure from ground : 3ms. to 30 ms.

Structure size factor k2 (table-2) :1.03 to 1.175 as per structure height

Topography factor (k3) :1.0 to 1.36

Importance factor for Cyclonic Region (k4) :1 (Res.)

Design wind velocity (Vz) =Vb*k1*k2*k3 *k4

Design wind pressure (pz) =0.6 Vz^2

Note: Software STAAD pro/ Etab would be made use of for the application of above said loads on the said structure.

D. Seismic Load Parameters - (Ref: - IS: 1893 (Part-1)2016)

Location of proposal site lies in Zone V. The design parameters will be followed accordingly. However, the salient features are as under:

Seismic Zone	**Zone V**
Seismic Zone Factor, 'Z'	0.36
Soil Profile	Type-II, Medium
Occupancy of building	Hospital/Institutional/Residential
Seismic Importance Factor 'I'	
i. Hospital buildings, Medical College & Nursing College, Auditorium, substations and other important buildings:	1.5
ii. Residential, Hostels and other buildings	1.2
Response Reduction Factor and Fundamental Period of Vibration	The response reduction factor and fundamental period of vibration shall be taken as per IS 1893:2016, depending upon the structure and design requirements.
Percentage of Imposed Load to be considered in calculation of Seismic	

Building Weight (Refer Clause 7.3.1-IS 1893(Part-1)- 2016)	
Impose uniformity distributed floor load (KN/M2)	Percentage of Imposed loads
Up to and including 3.0	25
Above 3.0	50
Vb= Ah*W W= Seismic weight of the structure Ah= Horizontal seismic coefficient as per code	
Permissible increase in the SBC of Soil	25%
Overhead water tank projecting above the roof and cantilever projections attached to buildings and projecting over the roof would be designed and checked for stability for five times the design Horizontal seismic coefficient Ah as specified in IS 1893-2016 clause 6.4.2	

3.8.2. MAX. ALLOWABLE DEFLECTION – (Including the effect of temperature, creep and shrinkage)

i.	Concrete	-	Span / 250	(for gravity load) Floors
ii.	Steel / composite	-	Span / 325	(for gravity load) Floors
	For (i) & (ii)	-	Height / 500	(for lateral load)

3.8.3. LOAD COMBINATION

The following are the proposed Load combinations for designing with partial safety factors as per IS 456:2000, Cl 36.4.1 (Table 18)

Load Combination	Limit State of Collapse			Limit State of Serviceability		
	DL	LL	WL/EL	DL	LL	WL/EL
DL+LL	1.5	1.5	_	1.0	1.0	_
DL+WL	1.5 or 0.9	_	1.5	1.0	_	1.0
DL+LL+WL	1.2	1.2	1.2	1	0.8	0.8
DL+EL	1.5 or 0.9(1)	_	1.5	1	_	1
DL+LL+EL	1.2	1.2	1.2	1	0.8	0.8

i. This value is to be considered when stability against overturning or stress reversal is critical.

ii. Wind Load and Earthquake Load both are considered for both x and y directions.

For steel structure, commensurate load combinations as per respective IS Codes, shall be taken for analysis and design.

3.8.4. HAZARD CLASSIFICATION

Fire: The structure shall be designed for 2 hour fire rating, as the firefighting system and fire hydrants are available within the building. The minimum clear over to reinforcement and minimum dimensions of RC structural members as per clause 21.2 of IS: 456-2000 shall be as follows considering 2 Hr fire rating.

Sl. No.	Structural member	Minimum dimension	Minimum clear cover
1	Column fully exposure to fire	300 mm	40 mm
2	Beams (continuous)	200 mm	30mm
3	Beams (Simply supported)	200 mm	40mm
4	Floors (continuous)	125 mm	25 mm
5	Floors (Simply supported)	125 mm	35 mm
6	RCC walls	160 mm	25 mm

Earthquake: as explained earlier the building will be designed for the earthquake force in accordance with IS: 1893-2016.

3.8.5. MATERIAL PROPERTIES

a. Reinforced Cement Concrete (RCC): As per Table 5 of IS 456-2000 keeping in view loads the proximity of the Structure, Minimum grade of concrete to be used is M25. Exposure condition is Moderate. Maximum size of coarse aggregate is 20 mm. For columns and RCC retaining walls, shear walls the minimum grade of concrete shall be M30. For water retaining structures, the minimum grade of concrete shall be M30. Minimum cement content (including mineral admixtures) shall be as specified in IS 456-2000. Type of cement shall be Ordinary Portland Cement (OPC).

   The additions such as fly-ash or ground granulated blast furnaces slag may be taken into account in the concrete composition with respect to the cement content and water cement ratio, if the suitability is established and as long as the maximum amount taken in to account do not exceed the limit of Pozzolana specified in IS:1489 (part-1). However, the maximum percentage of fly-ash shall be 25% of the total cementcontent (including mineral admixtures).

   In case, Portland Pozzolana Cement (PPC) is used, no additional mineral admixtures shall be permitted.

b. Reinforcement: Reinforcement Steel is TMT bars of grade Fe-500 Conforming to IS: 1786-2008. Ductile detailing of reinforcement shall be provided for all

RCC structural components to take care of earthquake forces as per IS: 13920-2016.

c. Structural Steel**: -** Shall be FY 350 conforming to IS 800-2007.

3.8.6. COVER TO REINFORCEMENT

From durability consideration, exposure condition is assumed to be Severe. The clear cover to main reinforcement shall be considered in the design, satisfying durability & 2 hrs. fire rating requirement, which shall be as follows (Refer: clause No. 26.4.2, Clauses 21.4-,26.4.3 and Fig 1 of IS 456-2000 or clause 21.2 of IS:456-2000 or NBC 2016 whichever is higher)

A	Footing	50/60 MM
B	Columns	40/45 MM
C	Floor/Roof Beams	30/40/45 MM
D	Floor /Roof Slab	25/35 MM
E	Lintel Beams, Chajja & Loft	20MM
F	Staircase Waist Slab & Landing	25MM
G	Plinth Beam	40/45 MM
H	Walls	25MM

3.9. Computation Methods – Modeling, Analysis, Design & Detailing

3.9.1. Modelling

The structure is idealized as a 3-D space frame model using the software packages STAAD pro/ Etab. The masonry wall is used as filler wall and not constructed monolithically with structure. Hence this is not modeled in the analysis. In this package slab loads are applied as a floor loads. Wall loads are applied as UDL on beams. Self – weight is added in the software to have member loads.

The analysis of the proposed structure would be carried to

i. Analyze to ensure elastic behavior and fulfillment of serviceability criteria for un-factored load combination.

ii. Analyze to ensure adequate structural integrity for factored load combinations

iii. Obtain static displacements and rotations at various nodes.

iv. Obtain resultant member forces like bending moments, shear forces and axial forces.

v. Support reactions (axial force and moment) coming on foundations.

3.9.2. Control of Deflection (Vertical)

The deflections of a structure or part thereof shall not adversely affect the appearance or efficiency of the structure or finishes or partitions. The deflections shall generally be limited to the following (clause 23.2 of IS 456-2000):

The final deflections due to all loads including heat effects of temperature, creep and shrinkage and measured from the as-cast level of the supports of floors, and all other horizontal members, should not normally exceed span/250 or 20 mm whichever is less.

The deflection including the effects of temperature, creep and shrinkage occurring after erection of partitions and applications of finishes should not normally exceed span/350 or 20 mm whichever is less. When deflections are required to be calculated, the method given in Appendix –B of IS: 456-2000 will be used.

3.9.3. Design Philosophy

To meet the design life and durability requirements, codal provisions specified in clause 8.0 and table 5 of IS: 456- 2000 will be followed for reinforced Concrete Elements. All structural elements would be designed according to the Limit State Method as specified in IS: 456: 2000. Minimum of M 30 grade concrete for RCC structural Members such as beams, slabs footings, staircase, lift walls, columns etc. with Fe 500 Grade steel may be considered for design, subject to structural/design requirements. Higher grade of Concrete can be provided, if required as per structural requirements, with the approval of HLL.

a. Design of Floor / Roof Slab: All floor/roof slabs be designed in accordance with Annex- D of IS: 456-2000 with corners held down. Cranking of reinforcement at the support, as required, will be provided. Torsion reinforcement will be provided at corners of the slab as per clause D-1.8 of Annex-D of IS: 456-2000.

b. Design of Floor / Roof Beam: The beams shall be designed for the envelopes of maximum bending moment and shear force for the load combination that gives the maximum stresses using the latest STAAD Pro/Etab software as per the requirements of IS 456-2000. The critical members would be check manually also. Main reinforcement will not be bent – up and hence shear reinforcement shall be in the form vertical stirrups only.

c. Design of Columns: The columns shall be designed for vertical load (reduced in accordance with clause 3.2 of IS: 875 (part-2-1987) and uniaxial or biaxial bending depending on its location. Effective length of the column will be in accordance with Annex- E of IS: 456:2000, considering fixed end on both ends. Minimum diameter of longitudinal steel is 12mm and that for ties is 8mm. The columns shall be designed for the envelopes of maximum value as per latest STAAD Pro/Etab. The critical members would be check manually also.The minimum dimension of column shall not be less than,

i. 20db, where db is diameter of the largest diameter longitudinal reinforcement bar in the beam passing through or anchoring into the column at the joint, and
ii. 300mm

The cross-section aspect ratio of column shall not be less than 0.45.

d. Design of Footings: Assume 10% of the vertical load from the column as the self-weight of the footing a preliminary step for the design. The same shall be checked after designing the footing dimensions. The plan size of the footing will be determined on the basis of the SBC of the soil. The design pressure at the base of the footing shall be determined by algebraic addition of the pressure due to vertical load and that the due to moment at the base of the column.

The design pressure shall be less than SBC of soil except when seismic load are considered, where SBC can be increased as per Table-1 of IS: 1893-2016.

Base pressure = (P/A) +/- (Mx/Zx) +/- (My/Zy)

Where P = Vertical load on the footing

A = Plan area of the footing

Mx and My = Bending moment at the base of the column along the X and Y directions

Zx and Zy = Sectional modules of the footing along the X and Y directions = $ab^2/6$ or $ba^2/6$

a& b are the dimensions of the footing

The footing shall be designed in accordance with clause 34 of IS: 456:2000. The footing will be checked for the following:

i. Bending moment at a section on the face of the column /pedestal
ii. Shear force at a section at a distance equal to effective depth of the footing from the face of the column or pedestal.
iii. Bearing stress on the footing due vertical load of the column.
iv. Punching shear on the footing due to vertical load of the column.
v. The reinforcement will be determined as a rectangular section in accordance with Annex-G of IS: 456-2000 and SP-16.The size of reinforcement steel shall not be less than 12mm.

e. Design of Lintel Beams, Chajja & Loft

The lintel beams will be designed for:

- Weight of brick masonry above the lintel level.
- Load from RCC Chajja attached to the lintel.
- Torsion moment due to eccentricity of the Chajja/loft.

Lintel beam shall have a minimum bearing equal to the thickness of the wall on which it is supported or the depth of the lintel beam, whichever is greater. It shall be designed as a simply supported rectangular section. Chajja/loft will be designed as a cantilever slab.

f. Design of Staircase

The Internal staircase shall be designed in accordance with clause 33 of IS: 456-2000. The Staircase is slab type without stringer beam. The waist slab shall be designed as a simply supported rectangular section. The size of main reinforcement steel shall not be less than 12mm. The staircase would be analyzed, designed & detailed as per the provisions of SP-34.Staircase steps shall be in RCC and monolithic with Waist slab.

g. Underground Sump combined with WTP/Overhead Water tank

Underground water tank would be designed to sustain the following two cases-

- Tank full and No earth fill.
- Tank empty and active earth pressure acting from outside.

The walls and base slab would be designed as per the provisions of IS:3370 (Part1- Part4)-1965 using the working stress method. Overhead water tank would be designed to sustain the water load at full tank condition as per the provisions of IS: 3370 (Part 1- Part4) -1965 using the Working Stress method.

h. Auditorium Roofing System:

Roofing shall be designed with composite steel structure with the trusses and Purlins system. Puff panels (Sandwich) shall be supported on the purlin system. Catwalk, in structural steel, as required, shall be provided between the roofing/ structural trusses and the false ceiling.

i. Expansion &Construction Joints:

Seismic Expansion joints are recommended when structure exceeds 45m length. The width of the joints is being calculated as per IS-1893-2016, clause 7.11. However even though the length of building this project is more than 45m, the Seismic expansion joints are not provided but thermal analysis shall be carried out to ascertain their effect and accordingly the design shall be carried out.

Construction joints will be planned with the coordination of construction agencies.

j. Grade Slab

RCC grade slabs of required thickness (min. 100 mm) shall be provided at ground floor levels in all buildings.

3.9.4. Detailing

The reinforcement layout should take into account the strength requirements as well as the economy of construction. Following are the requirements of good detailing.

i. Reinforcement detailing should be simple for fabrication and placing.

ii. Cracking of concrete should be within the permissible limits.

iii. There should not be any free paths for propagation of cracks without being traversed by reinforcement.

iv. Joints and discontinuities should be capable of withstanding the same forces as the adjoining sections.

v. Reinforcement should not deviate excessively from the direction of tensile stresses.

vi. Reinforcement steel of same type and grade shall be used as main reinforcement in a structural member.

vii. Provisions of IS: 456-2000, IS 13920-2016 and IS: SP 34 will be followed for the purpose of detailing of reinforcement.

C. Design Basis Report- Civil Works

1 General

The Construction of building and allied works for Up-gradation and Development of RIPANS, Aizawl shall be done on Turnkey i.e. EPC (Design, Engineering, Procurement & Construction) basis and the EPC Contractor shall be responsible for shortfall of any technical propriety and of upholding prevailing standard of Code of Practice according to NBC 2016 and all other relevant IS-Codes on the way to accomplish the work according to requirement. The work shall in general conform to the Latest CPWD Specifications.

The new facilities shall be completed in conformity with high standards of construction and specification. The Architectural finishes shall be of such quality that will ensure better hygienic conditions. The design of building shall ensure control of noise due to walking, movement of trolleys and banging of doors etc. The architectural design should take in to account the requirements of physically challenged patients. The planning should include landscaping and horticulture to increase the comfort & hospitality conditions inside the building along with development of parking, approach roads and other service requirements meant for the Up-gradation & Development of RIPANS, Aizawl.

Based on the approved Master Plan & Concept Drawings, the EPC Contractor shall prepare the detailed architectural design and drawing of the Project for approval from the local bodies and statutory authorities as per requirement. The structural designs of the buildings and structures shall be done by the EPC Contractor and shall be Proof checked/vetted by the IIT/NIT/or any Govt. Engineering College as approved.

2 Site clearance, Excavation & Earth Work:

Before commencement of construction work at site, clearing of jungle including uprooting of rank vegetation, grass, brush wood and rubbish shall have to be removed and disposed of outside the campus. The Contractor shall carry out felling/ replanting of trees, if any, including cutting of trunks and branches, removing the roots and stacking of serviceable material and disposal of unserviceable material as per requirement.

Since the site is on hilly terrain, the EPC contractor shall under take necessary leveling, back filling/ cutting, if required, to maintain the levels as per Plans. The EPC Contractor shall be permitted to use the excavated good earth for filling, leveling, consolidating etc. for the Project. However, as per Project requirements, if additional good earth is required, the EPC contractor shall bring the Good earth from outside to maintain the required levels and shall ensure proper compaction.

The site is heavily contoured and shall involve earth cutting and filling and construction of retaining wall for creation of terraces and protection of existing slopes. The work in some cases may be carried out in the vicinity of existing buildings/ services therefore due diligence shall be exercised by the EPC contractor while carrying out excavation and other construction activities so that no damage is caused to existing buildings/ services. The contractor shall be solely responsible for any damage caused and consequences arising out of this damage. The contractor shall make good damage caused to building/ property at his own cost.

3 Anti-termite treatment:

Anti-termite treatment of all buildings in the project with Chloropyriphos 20EC,/Imidacloprid 30.50 SC as specified in IS-6313 (Part-2) 2013 shall be got done through approved specialized agencies only.

4 Damp-proof course:

The damp-proof course (DPC) shall be laid at plinth level/ or as per requirement in the brick work walls resting on brick foundations, as per approved drawings and as directed of 50mm thickness with cement concrete 1:1.5:3 (1 cement: 1.5 coarse sand: 3 graded stone aggregate 20mm nominal size) mixed with water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.

5 Plinth Protection:

Plinth protection with 75 mm thick of cement concrete 1:1.5:3 (1 cement :1.5 coarse sand : 3 graded stone aggregate 20mm nominal size) over 100 mm bed by dry brick ballast/ stone aggregates 40mm nominal size well rammed and consolidated and grouted with fine sand including finishing all around the buildings, as per tender drawings and approval of Engineer-in-charge. The width of the plinth protection shall be 750 mm (Minimum). The required brick toe wall/brick on edge/stone pitching on slope shall be provided as per site requirements.

6 Plain Cement Concrete and Reinforced Cement Concrete Work:

RCC Work (Concrete Mix Design):- The RCC work shall be done with Design Mix Concrete, unless otherwise specified. The contractor shall install the Batching plant (Digital) of adequate capacity with approval of the Engineer in charge. The contractor shall carry out the concrete mix design with and without admixture through one of the following laboratories/Test houses to be approved by Engineer-in-charge: -

a. IITs, NITs or any Govt. Engineering Colleges.

b. In the event of all the above laboratories being unable to carry out the requisite design/testing; the Contractor shall have to get the same done from any other reputed laboratory with prior approval of the Engineer-in-Charge.

c. Samples of materials (i.e. Cement, Coarse, fine aggregates & admixtures) shall be jointly sealed by Engineer-in-charge and contractor before sending the same for Mix design. The design mix shall be with or without admixtures as per specifications /requirements at site.

7 Brick Work:

i. The bricks used in the brick work shall be 7.5 class designation, common burnt clay bricks conforming to IS: 1077.

ii. Bricks used in the work shall be obtained from approved kilns and shall be best quality bricks. There characteristic compressive strength shall be in conformity to the provision in Latest CPWD Specifications for works.

iii. For mortar, use of PP Cement shall be preferred. The mortar shall be as under:

1. For brick work cement mortar 1:6 (1 cement: 6 coarse sand)

2. For half brick masonry cement mortar 1:4 (1 cement: 4 coarse sand)

iv. The half brick masonry (with F.P.S. bricks) shall be provided with 2 Nos. 6mm dia. M.S. bars at every third course of masonry.

v. RCC Coping of specified thickness and shape to be carried out over Brick Parapet walls/ Boundary/Toe walls etc. of required M25 Concrete Grade.

8 Random Rubble Masonry:

The Random Rubble masonry of required thickness with hard stone and Cement mortar1:6 (1 cement: 6 Coarse sand), finished with flush/ruled cement pointing, as per tender drawing shall be preferred for retaining walls / retention of slopes/pitching along slopes and other similar requirements.

9 Finishing:

The surfaces of brick work, RCC, CC etc. shall be treated and finished with Cement Plaster. The use of PP Cement shall be preferred. The cement plaster shall be provided as under:

a. Plane wall faces: 12mm thickness (minimum) cement plaster 1:6 (1 cement: 6 fine sand).

b. Rough wall faces: 15mm thickness (minimum) cement plaster 1:6 (1 cement: 6 fine sand).

c. Ceiling and RCC works: 6mm thickness (minimum) cement plaster 1:3 (1 cement: 3 fine sand). In respect of RCC works, in continuation with the brick work, plastering as per brick work shall be continued over RCC works.

d. All External faces including wall faces behind dry cladding and structural glazing: 18mm thickness (minimum) cement plaster in two coats, under layer 12mm thick cement plaster 1:5 (1 cement: 5 coarse sand) finish with a top layer of 6mm thickness (minimum) cement plaster 1:6 (1 cement: 6 fine sand).

e. The junction of RCC work and brick walls shall be covered with 24 gauge chicken wire mesh fixed with screws/washers to avoid cracks in plaster work.

f. The trenches / open drains: 15mm plaster finished with cement plaster 1:4 (1 cement: 4 fine sand) with floating coat of neat cement & adding of Water proof compound.

g. Provide drip course/ groove in plastered surface or moulding to R.C.C. projections and Grooves in plaster as per requirement.

10Painting:

The plastered surfaces shall be finished as per the finishing schedule/tender drawings. This shall include Antibacterial Paint/textures paint and other paints as per finishing schedule. The ceiling area below where false ceiling is carried out shall be finished with white wash coat(s) as per requirement. The false ceiling, as required, shall also be finished as per the finishing schedule appended to the tender document.

All paints shall meet the GRIHA requirements for minimum 3 Star Rating. Painting on doors, windows, Grills, MS work, structural steel, rolling shutters, railing and other

members requiring painting and polishing etc., wherever required, shall be treated with primer coat and finished with painting/polishing of approved shade and manufacture, as per CPWD Specifications, to meet the functional requirements.

a. All paint work on concrete and plaster surfaces shall include application of white cement based putty as base preparation, application of primer in compatibility with the respective type of paint and painting with 2 or more coats of paint as per technical specifications.

b. All paint work on structural components (excluding Stainless steel) shall include application of primer in compatibility with the respective type of paint and painting with 2 or more coats of paint as per technical specifications.

c. The soffits of all projections, jambs, parapet walls terrace (in side) shall be finished with premium acrylic smooth exterior paint with silicone additives of approved shade and make.

d. The wood work shall be painted / polished (melamine finish) as per finishing schedules / requirements.

11 Door & Windows

The doors and windows shall be provided as per the requirements indicated in the finishing schedules/tender drawings/ MOUD (Ministry of Urban Development) GPRA General Pool Residential Accommodation) Norms for residential buildings and technical specifications. In case of variance, the decision of HLL shall prevail. However the various types of Doors and Windows as per CPWD specification shall be as under:

a. Wooden

   i. 2nd class teak wood Paneled Doors & Windows

   ii. Partly paneled & partly glazed 2nd class teak wood doors & windows

   iii. Flush doors- laminated (factory Pressed), veneered, commercial

   Hardware: All hardware for doors and windows shall be of stainless steel or as specified.

b. Aluminum Works

   i. Doors, windows, ventilators and partitions with Powder coated aluminum extruded built up standard tubular sections/ appropriate Z sections/built up sections and/or other sections with minimum thickness of powder coating 50 micron of approved make conforming to IS: 733 and IS: 1285 as per CPWD specification.

   ii. All Aluminum frames shall be installed through Aluminum Sub-Frames. The Sub-Frames shall be fixed into position true to line and level using adequate number of expansion bolts or other appropriate fastenings.

   iii. Hardware: All hardware for doors and windows shall be of Powder coated aluminum or as specified.

   i. Fly proof SS wire-mesh doors/ windows with Aluminum Grill (Outside) for Residential/Hostel units as per finishing schedules/ tender drawings.

c. MS Works

i. Doors frame-pressed steel frame and T-iron as specified

ii. Windows – pressed steel frame-Glazed /wire gauge (SS)

iii. MS door shutter and frame at mumty and machine room.

iv. Hardware: All hardware for MS doors and windows shall be Powder coated MS or as specified.

v. M.S. Grill as specified

d. Rolling Shutter (Powder Coated)

i. With mechanical operation system.

ii. With MS grill / without MS grill as required.

e. Fire Check Doors and Partition:-

i. All fire checks door shall be of mild steel except, in the Auditorium where the wooden fire check doors, with acoustic lining on the interior face shall be provided.

ii. Fire Check doors of 120 minutes fire rating confirming to BS : 476 part 22 & IS : 3614 Part II . These doors shall be provided at all fire exit points, firefighting shafts, Service Duct and shafts. The MV panel room shall be provided with fire resistance wall and doors. The fire doors shall be of Metal (M.S.), as specified. The fittings such as Mortise Lock, Flush Bolts, Automatic Door Closer, Pull Handle, Fire Rated Panic exit device shall also be of 120 minutes fire rating. Smoke Seals, Acoustic Seals shall also be provided.

iii. Fire Resistant Glazed Doors, Windows & Partitions, as per requirements, 120 minutes fire rating shall be provided.

iv. The shafts and /or ducts, if penetrating multiple floors, shall be of masonry construction with fire damper in connecting ductwork or shall have fire rated ductwork with fire dampers at floor crossing. Alternatively, the duct and equipment shall be installed in room having walls, doors and fire damper in duct existing/entering the room of 120 min fire resistance rating. Such shafts and ducts shall have all passive fire control meeting 120min fire resistance rating requirement to meet the objective of isolation of the floor from spread of fire to upper and lower floors through shaft/duct work.

f. Frameless toughened Glass Door / partitions of minimum thickness 12mm (with toughened glass) with SS Patch Fittings and fixtures. Frosted Etching Film to be provided on Glass Door/Partitions as per requirement and as directed by Engineer-in-charge.

g. Hermetically Sealed Sliding-Lead lined Door-

Anti-Radiation sliding hermetically sealed doors with 2mm lead inside that comply with AERB requirements for X-Ray shielding Doors **(Lead Lined Doors)**. Three sided wall frame consist of 2mm lead lining. These Doors should withstand up to 75 Pa

Pressure.

Note: -

- Rubberized door flashing at the bottom rails of all external doors shall be provided for protection from insects & rainwater etc.
- All aluminum members shall be wrapped with self-adhesive non-staining PVC tapes of make approved by the HLL.
- Filling the gap in between aluminum frame & adjacent RCC/ Brick/Stone work by providing weather silicon sealant over backer rod of approved quality as per architectural drawings and direction of Engineer-in-charge complete.

12 Railing and Grill Work:

a. Grill Work**:**

i. The grills shall be provided in the windows in the residential complex and other units as specified in tender drawings and finishing schedule/as per scale of amenities.

ii. The open drains / channels in the machine room / plant room/cable trench shall be covered with the MS grill.

b. Stainless Steel Railing :

The Stainless Steel railing shall be provided in staircase / ramps of all buildings and other locations etc. as specified in the tender drawings/ finishing schedule and as per specifications.

13 Structural Steel

a. The roofing system for auditorium shall be as per designs as contained in the Civil-Structures Chapter of this Design Basis Report.

b. MS Ladder: Provision of suitable size MS Ladders finished with Epoxy paint as per CPWD Specification shall be provided for approach to terraces of single Storied Buildings, Mumties, Lift Machine Rooms, Water Tanks, and Pump Rooms etc. as per requirements.

14 Flooring:

a. The flooring shall be as per the finishing schedules and tender drawings or as specified

b. In order to keep the floor finish as per Architectural drawings and to provide required thickness of the flooring as per specification, the level of top surface of RCC shall be accordingly adjusted at the time of its centering, shuttering and casting. Alternatively, for maintaining the floor finish, grading with cement concrete with nominal mix 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 10mm nominal size) shall be provided.

c. Protective layer to be provided for all types of flooring, during construction.

d. The edges of steps in the staircases, counters, kitchen platform, window sills, facias and similar location shall be edge moulded. Staircase Tread should have Anti- Skid Grooves as specified in the tender drawing or as directed by Engineer-in charge.

e. Minimum Bed mortars for various types of flooring

i. Chequered tiles/stone flooring/kota stone flooring/granite flooring/ Ceramic glazed floor tile flooring/vitrified flooring - 20mm thick bed of cement mortar 1:4 (1 cement: 4 coarse sand).

ii. For dado, skirting and risers of steps in Chequered tiles/stone /kota stone /granite / Ceramic glazed floor tile /vitrified tiles- 12mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand).

iii. The vertical facia and drops shall be finished with epoxy resin based adhesive.

f. Types of flooring

The types of flooring shall be as per finishing schedule / tender drawings. However, these are brief as under:

i. Concrete Flooring

ii. Kota Stone Flooring

iii. Marble Flooring

iv. Granite Flooring

v. Vinyl Flooring

vi. Anti-conductive and anti-static Vinyl flooring

vii. Vitrified Tile (Multy-Charged) Flooring

viii. Wooden Laminate Flooring

ix. Carpet Flooring

x. Flooring For Microbiology Lab:- Acid resistant rectified, anti-skid, vitrified flooring, complying with flooring requirements as per Good Laboratory Practices norms.

xi. Flooring for SERVER/ EPABX/ Fire Control/ CCTV Room: - Removable raised/ false access flooring with system and its components of approved make for 300/450 mm height with possible height adjustment conforming to CPWD Specifications.

xii. Skirting/Dado:-

a. Skirting in respect of above shall be of the same material and specifications and the height as specified in tender drawings/finishing schedule.

b. The dado work in the toilets/ washroom/ kitchen/ pantry/ lobby area/ shall be with ceramic tiles and of height as specified in tender drawings/finishing schedule.

c. The dado work in the lift lobby, entrance halls and other similar locations shall be in Granite stone as specified in tender drawings/finishing schedule.

d. The dado work in the corridors of hospital Building, Academic Block and other locations shall be as specified in tender drawings/finishing schedule.

e. The dado work in staircase shall be with ceramic tiles of height as specified in tender drawings/finishing schedule.

15 False Ceiling

The types of false ceiling shall be as per finishing schedule / tender drawings. However, these are brief as under:

- False ceiling with Mineral Fiber Ceiling Tile
- False ceiling with Light Weight Calcium Silicate False Ceiling Tiles
- False ceiling with Powder coated metal false ceiling tiles (Seamless/ Perforated)
- False ceiling with gypsum board
- Gypsum false ceiling with coves
- Combination of above type of false ceilings
- In auditorium false ceiling with mineral fiber tiles ***(NRC value not less than 0.85)***
- Under Deck Insulation System - Polystyrene Rigid Insulation Board

16 Roofing

i. The roofing in the auditorium shall have roofing with sandwich puff panels of approved make and supported on MS structural roofing truss system designed and as per tender drawing/ technical specifications. The roofing shall be provided with proper water proofing treatment, as per requirement.

ii. Heat Resistant Tile Flooring shall be provided on the Terrace slabs of all buildings, as specified and as per CPWD specifications.

17 Paneling

The paneling shall be as per finishing schedule / tender drawings. The paneling shall be provided in the areas not limited to the following:

i. Auditorium complex

ii. Lecture Theatres

iii. Medical Superintendent's Room/ Board Room/Meeting Room(s)

The type of paneling shall be as under:

a. Wooden paneling

b. Acoustical wall paneling

c. Laminated wooden paneling

18 Water Proofing Treatment

i. All items for water proofing treatment for Roof Slab, sunken portion, Basement,

Water Tanks shall be guaranteed for TEN YEARS, to be reckoned from the date of expiring of the Defect Liability period prescribed in the contract.

ii. The Water proofing treatment of terrace shall be done with Integral Cement Based Water proofing treatment with brick bat coba, laid in proper slope, as per specification with Khurras, Golas etc. complete.

iii. Integral Cement Based Water Proofing Treatment for Sunken Floors of W.C`S/ Bathrooms etc. by applying cement slurry mixed with water proofing cement compound consisting of applying :

- First layer of slurry of cement @ 0.488 kg/sqm mixed with water proofing cement compound @ 0.253 kg/ sqm. This layer will be allowed to air cure for 4 hours.
- Second layer of slurry of cement @ 0.242 kg/sqm mixed with water proofing cement compound @ 0.126 kg/sqm. This layer will be allowed to air cure for 4 hours followed with water curing for 48 hours. It shall be protected with concrete screed, of required mix, laid in proper slope all complete.

iv. The water proofing of all tanks, ETP, WTP, and STP etc. shall be done by Crystallization Water proofing treatment as per latest Specifications/DSR Items of CPWD.

v. The work shall be got executed from the approved specialized agency.

19 Crash /Stretcher Guards & Corner Guard

Crash Guards (wall guards) and Corner Guards etc. shall be provided as per tender drawings, finishing schedule in corridors, lobbies etc. in Hospital Block having vinyl snap on cover (lead free) and bumper of 2mm thickness each and aluminum retainer of 2mm thickness that shall be fabricated from 6063-T5 aluminum having high impact resistance with size of 152 mm X 25 mm. The rigid vinyl profile shall resist an impact of 30.4 ft-lbs/ inch as per ASTM D-256-90b and shall not support fungal or bacterial growth in accordance with ASTM G-21. The system shall also confirm to class A fire rating and ASTM D-543 for chemical and stain resistance. The color and design shall be as per Engineer in-charge.

20 Built in Cupboards /Counters

Built in Cupboards, Registration/ Reception counters, Nurse Call station shall be provided by the EPC Contractor in Hospital, Academic Block, General Hostel & Guest House, Residences as specified in the tender drawings, finishing schedule & MoUD norms.

Suitable arrangement in the laboratories in Hospital and Academic Block by providing fixed counters with Granite top with sanitary and plumbing shall be provided. Built-in wooden storage units below such counters, as per requirements shall be part of scope of work.

21 Pavers

21.1. **Grass-Crete-pavers:**

In Surface Parking & other specified areas Grass -Crete Concrete Pavers shall be laid as per tender drawing. The Pavers shall be factory made of minimum thickness 70 mm thick shall and M-30 Concrete Mix Grade, suitably reinforced manufactured in joint less moulds on vibrator table finished smooth as per required shape size and pattern, colour.

21.2. **Interlocking Pavers :-**

The Interlocking pavers shall be provided in Pathways, roundabout, cycle track of required size and thickness 80 mm thick, factory made of cement concrete mix of M-30 manufactured in joint less moulds on vibrator table finished smooth as per required shape size and pattern, colour and to be laid over subgrade etc. as per CPWD specification.

22 Roadwork

All the roads are to be constructed as per IRC code and layout drawings. If any specification not available in IRC code, CPWD specification (up to date correction slip) shall be applicable. The roads shall meet the firefighting norms.

The roads shall be RCC Roads with minimum M-30 Grade and minimum 200 mm thickness and required reinforcement as per designs to be provided as per drawings of required width as specified. Service roads of required width from main RCC roads to all round the buildings shall be constructed as per NBC/ IRC Codes.

All the roads camber, super elevation , semi - circle, circle & gradient etc. are to be kept with respect to road levels decided in road sections and as per IRC code. Wherever cross drainage or for other purposes culverts are required, sufficient levels of road are to be raised with proper gradient to provide the sufficient depth of culvert. The width of W.B.M sub grade is to be kept sufficient to rest the kerb stone. Wherever box culverts/culverts are required the same shall be designed and provided as per I.R.C code.

All the road markings etc. shall be provided as per traffic rules. Footpaths connected to buildings plinths shall be provided with proper gradient, with brick masonry toe walls and MS/SS railing as specified. All footpath levels shall be 150 mm higher than road edge/green belt/ cycle track levels or as specified.

23 MS Gates, MS Grill over Toe wall in Front area of Hospital Complex

Existing Boundary wall along the plot line in the front area of Hospital side shall be dismantled as per requirement. The Gate Complex with security cabin and Roads shall be provided as shown in the tender drawings. The MS Grill shall be provided over the Toe wall / retaining wall made along the road in the front portion of the hospital complex side.

24 Kitchen/Laboratories Platforms:

Kitchen, Laboratories platforms shall be RCC M25 Grade (Pre-Cast/ Cast-in-situ) of required width & thickness as specified in tender drawings/ finishing schedule finished with 18 mm thick pre-polished Granite stone top & facia of approved shade etc. complete as per latest CPWD specifications. Wooden cabinet/shutters to be provided below platforms as specified in finishing schedule/tender drawings.

25 Window sills :

All projected window sills inside rooms of Hospital, Academic Block, General Hostels & Guest House shall be provided with 18mm thick pre-polished granite stone of approved shade with edges moulded.

26 Operation Theatre

The inside wall and ceiling surface of OT's shall be painted Anti-bacterial paint before fixing of false ceiling. All corners inside OT's shall have coving. Flooring of OT's shall be made antistatic with 2mm thick PVC . The Floor finish should pass over a concealed cove former and continue up to the wall upto 100mm. Doors shall be sliding and hermetically sealed with PUF sandwich HPL board & vision panel of 300mmx300mm of approved make. Windows shall be hermetically sealed and flush with the walls of OTs. Windows should have double frosted toughened glass and motorized venetian blinds of approved make.

27 Venetian Blinds/ Roller Blinds

The Roller / Vertical blinds of approved make, fabric and colour shall be provided in Hospital and Academic Block-IV in office areas, conference/meeting rooms, consultants rooms etc. as per requirements.

The fabric shall be 75% PVC & 25% Polyester with openness factor of 3%. Thickness of Fabric shall be minimum 0.6mm & Fire Resistance –NFPA 701, BS 5867 Part-2-Type-A & Light Fastness 6 Grade as per approved

28 Curtain rods

i. Drapery Rods (Min. 25 mm OD MS pipe having corrugated PVC extrusions i/c all bracket etc.) to all windows, doors in all rooms except kitchen, Toilets/ bath/WC in Guest House, MS Quarter.
ii. Curtain rods of Stainless steel SS grade 304, 20 mm dia & 1.20mm thick to all windows, doors in all rooms except kitchen, Toilets/ bath/WC in, General Hostel & Residential Units or as specified.

29 Scale of Amenities for Residential Units & Hostels:-

Scales of Civil & Electrical amenities for Residential Apartments are proposed as per guidelines of Ministry of Urban Development, and Scale of Amenities for Hostels are also listed below, EPC Contractor shall fulfill the requirements as indicated in the List given below:

29.1. **Scale of Amenities (Minimum)-Civil**

Items No		Item	Staff/ Nurse Qtr.	Resident Doctors Qtr.	Med. Suptd. Qtr.
1		**Kitchen Cabinets**			
	i)	Cooking Platform	Yes	Yes	
	ii)	Stainless Steel AISI 304 (18/8) Kitchen sink as per IS 13983 with	Yes	Yes	

Items No		Item	Staff/ Nurse Qtr.	Resident Doctors Qtr.	Med. Suptd. Qtr.
		drain board			
	iii)	Built in cupboard with shutters of 18mm thick pre-laminated decorative particle board below cooking platform as per architectural design and specifications.	Yes	Yes, with drawers	
	iv)	25mm thick and not more than 400mm wide pre-laminated non-decorative particle board/ plywood shelves in tiers up to 2.1m height or as overhead unit of equivalent area, covered with pre-laminated decorative particle board shutters along one wall as per architectural design & specifications.	Yes	Yes	
	v)	Factory made modular kitchen having sink with double bowl & double drain board, cooking platform and electric chimney of reputed company.			Yes
2		**Wardrobes**			
	i)	Wardrobes to be650mm deep and length as per tender drawing and hanger rod. Complete in all respect. 19mm thick Board finished with 1mm thick laminate on back, sides, base and top with shelves and shutter. 25mm thick Shutter finished with laminate both side 1mm thick with Stainless Steel locks and Handle (as per approved sample) and all inside surface and shelves finished with white paint	One in each bed room up to ceiling height	One in each bed room up to ceiling height	
		Factory made wardrobe carcasses, drawers, shelves, etc. manufactured in 19mm thick particle / block board and finished in emulsion paint and wardrobe shutter in 19mm thick			One in each bedroom upto ceiling height

Items No		Item	Staff/ Nurse Qtr.	Resident Doctors Qtr.	Med. Suptd. Qtr.
		particle/block board /plywood finished with exterior grade post formed lamination /natural veneer with melamine polish as per the approved samples.			
3		Magic Eye (of SS grade 316) in front entry door	One	One	One
4		Curtain rods with required accessories of SS grade 316	In all windows doors in all rooms except kitchen, Toilets	Drapery rods on all windows , doors in all rooms except kitchen, Toilets/ bath/WC	Drapery rods on all windows, doors in all rooms except kitchen, Toilets/ bath/WC
5		Set of Pegs SS grade 316	In all toilets/ bath/ WCs and Wardrobes		
6		18mm thick projected window Sill lining window jambs	Green Marble	Granite	Granite
7		**WC with seats in toilets**			
	i)	Orissa pan WC (European Style) with seat, lid and low level flushing PVC cistern.	One	One	One
	ii)	European-type floor mounted/ wall-hung WC with seat, lid and low level flushing PVC cistern, water jet /health faucet.	Yes	Yes	Yes, wall hung only
		Water jet /health faucet with EWC.	Yes	Yes	Yes
8		Wash Basin with CP Brass mixture type for hot & cold water with single lever, quarter turns, ceramic cartridges.	1 in each toilet	One in each toilet & one in dining area	One in each toilet & one in dining area
9		Tap (Kitchen, toilet, bath & WC) CP Brass bib cock provided with quarter turns.	2 in Kitchen and 1 in each toilet, bath &WC,	2 in Kitchen and 1 in each toilet, bath &WC,	2 in Kitchen and 1 in each toilet, bath &WC,
10		Shower with CP Brass mixture	1 in each	1 in each	1 in each

Items No		Item	Staff/ Nurse Qtr.	Resident Doctors Qtr.	Med. Suptd. Qtr.
		type tap for hot & cold water with single lever ceramic cartridges, quarter turns.	toilet/ bath	toilet/ bath	toilet/ bath
11		Tower rail of SS grade 316	1 in each toilet/bath	1 in each toilet/bath	1 in each toilet/bath
12		6mm thick Clear looking Mirror with 12mm thick BWP ply paint finish fixed SS flat button studs & Glass shelf supported on SS brackets.	600mmX 450mm with each wash basin	600mmX 450mm with each wash basin	As per design with each wash basin
13		Toilet paper holder of SS grade 316 with European WC.	Yes	Yes	Yes
		SS Soap rack as per architectural Design and Specifications	1 in each toilet/ bath		
14		Plumbing for water purifier and Geyser.	Yes, in each toilet/ bath & kitchen/ kitchenette		
15		Storage tank of capacity as per NBC-2016, provision of separate tank for WC and drinking water.	Separate tank as per requirements including for dual flushing system		

29.2. **Scale of Amenities(Minimum)-Civil (Finishing)**

S.NO.	Description	Staff/ Nurse Qtr.	Resident Doctors Qtr.	Med. Suptd. Qtr.
1	**Wall Finishes**			
	Internal Walls & Ceiling	Walls treated with white cement based Polymer Modified Coarse Putty as per CPWD specifications.		
	Living Room Drawing/ Dining Room	Low VOC Acrylic washable distemper		Low VOC Premium Acrylic Emulsion paint
	All Bedrooms	Low VOC Acrylic washable distemper		Low VOC Premium Acrylic Emulsion paint
	Kitchen	Ceramic Tiles on all walls size 300mm x 450 mm (minimum)& up to full height/ beam bottom.		
		Low VOC Acrylic washable distemper (ceiling/ other walls etc.)		

S.NO.	Description	Staff/ Nurse Qtr.	Resident Doctors Qtr.	Med. Suptd. Qtr.
	Toilets /Bathrooms/ WC	Glazed/digital/coloured ceramic tiles of size not less than 300mm x 600mm from floor to 2400 mm height. with decorative bands at certain intervals		
	Store /Dress	-	-	Low VOC Acrylic washable distemper
	Balcony /External Finishes	External grade Weather coat paint finish		
	Lift Wall Cladding	Pre-polished granite cladding		-
2.	**Flooring**			
	Living/ Drawing/Dining/ Family Lounge	Multi charged Vitrified tiles of size not less than 600mmx600mm		Multi charged Vitrified tiles of size not less than 600mmx1200mm
	Master Bedroom	Multi charged Vitrified tiles of size not less than 600mmx600mm.		Laminated wooden flooring.
	Other Bedrooms	Multi charged Vitrified tiles of size not less than 600mmx600mm		
	Kitchen	Anti-Skid Vitrified tiles of size not less than 300mmx300mm with water absorption less 0.08% laid seamless with joint finished with matching grout		Anti-Skid Vitrified tiles of size not less than 600mmx600mm with water absorption less 0.08% laid seamless with joint finished with matching grout
	Toilets/Bathroom /WC	Glazed ceramic Anti-skid tiles of size not less than 300mm x 300mm		
	Balcony	Anti-skid ceramic tiles 300mm x 300mm.		
	Store /Dress	-	-	Vitrified tiles (600mmx600mm)
	Common Circulation Area	Mirror polished Kota stone & matching skirting		18mm thick Gang Saw cut pre polished Granite stone.
	Fire Escape Staircase & Main Staircase	Pre-Polished Kota Stone in single length of treads & riser		18mm thick Gang Saw cut pre polished

S.NO.	Description	Staff/ Nurse Qtr.	Resident Doctors Qtr.	Med. Suptd. Qtr.
				Granite stone in single length of treads & riser
	Skirting in rooms & other area	100 mm to 150 mm high skirting matching the floor material		
	Kitchen Platform/ counter	Pre-polished Granite Stone with nosing		
	Note: All joints in stone/tiles flooring shall be finished with matching epoxy grout.			
3	**Door & Window Frames, Shutters and Hardware Fittings (Finishing schedule shall govern)**			
	Main Entrance/ Balcony Door Frame	Powder coated Aluminium extruded/ tubular section must have double rebates for fixing of mosquito proof SS Wire Mesh shutters		
	Internal Door Frame	Powder coated Aluminium extruded/ tubular section		
	Window Frame	Powder coated Aluminium extruded/ tubular section must have double rebates for fixing of mosquito proof SS Wire Mesh shutters		
	Toilet Door Frame	Powder coated Aluminium extruded/ tubular section		
	Main Entrance/ Balcony-shutter	Double shutters One of MS Box frame shutter (Powder Coated) with SS Wire Mesh (SS grade-304) & MS Grill & other 35mm thick laminated Flush (Factory Pressed)		*Main Door*: Safety door in stainless frame with mosquito proof SS 304 grade wire mesh and SS fittings *Room side Door*: - 35mm thick 2nd class teak wood framed panelled with decorative veneered both side with melamine polish finish
	Room-shutters	35mm thick Flush door Shutters (Factory Pressed)		35mm thick 2nd class teakwood styles & rails paneled of 12 mm thick both side natural wood veneer finish paneled/ glazed paneled shutter with 55 mm

S.NO.	Description	Staff/ Nurse Qtr.	Resident Doctors Qtr.	Med. Suptd. Qtr.
				thick float glass panes and finished in melamine polish.
	Toilets -	35 mm thick both side laminated Factory Pressed Flush shutters (one side decorative & other side balancing)		35 mm thick both side laminated Factory Pressed Flush shutters (one side decorative & other side balancing)
	Kitchen doors	35mm thick shutter having 12mm thick pre-laminated (one side decorative & other side balancing) particle board panel at the bottom part and stainless steel wire mesh at upper part		35mm thick shutter having 12mm thick pre-laminated(both side decorative) particle board panel at the bottom part and stainless steel wire mesh at upper part
	Window Shutter	Double shutter with Aluminium powder coated security powder coated grill between both shutters fixed on frame. One: - Aluminum frame with stainless steel fly mesh. Other Shutter : - Aluminum Glazed Shutter		Double shutter with SS grill between both shutters. One: - 2nd class teakwood framed glazed panel and other with SS wire mesh Glazed/paneled shutter fixed with wooden beading & melamine polish finish
	Hardware & Fittings for Doors	Sliding door bolts, two tower bolts (250x10mm) and handles (125mm) of SS grade 316 of approved make		Mortise Lock cum handle/ Sliding door bolts, two tower bolts (250x10mm) and handles (125mm) of SS grade 316 of approved make
	Hardware & Fittings for Windows	Two tower bolts (150x10mm) and handles (125mm) of Aluminium powder coated of approved make.		
	Note:- • Aluminium Sections for Door / Windows to be Powder Coated (min 50 micron) as			

S.NO.	Description	Staff/ Nurse Qtr.	Resident Doctors Qtr.	Med. Suptd. Qtr.
	per CPWD Specification • Rubberised door flashing at the bottom rails of all external doors shall be provided for protection from insects & rainwater etc.			
	Water Proofing	As per Technical Specification given		

29.3. **Scale of Amenities (Electrical)- Residential**

S. No	Description	Area/ Location	Type / Category of Accommodation		
			Staff/ Nurse Qtr.	Resident Doctors Qtr.	Med. Suptd. Qtr.
1	Power Points (16 Amp, 6 Pins)	Office	-	-	-
		Drawing Room	2	2	3
		Dining Room	-	2	3
		Family Lounge	-	-	-
		Bed Room	2	2	2
		Kitchen	2	2	2
		Utility Area	1	1	1
		Total (Max.)	9	13	15
2	Plug Points (6 Amp)	Office	-	-	-
		Drawing room	1	1	1
		Dining room	-	-	-
		Store	-	-	1
		Bed Room	1	1	1
		Kitchen	1	1	1
		Balcony	1	1	1
		Total (Max.)	5	7	8
3	Bracket Light LED fitting	Bed Room	1	2	2
		Kitchen	-	-	-

		Store	-	-	-
		Utility	-	-	-
		Toilet	-	-	-
		Total (Max.)	2	6	6
4	Ceiling Fans (1200 mm)	Drawing room/ living room	2	2	2
		Dining room	-	1	1
		Family lounge	-	-	-
		Bed room	1	1	1
		Balcony	-	-	1
		Total (Max.)	4	6	7
5	Call Bell Points		1	2	3
6	Exhaust Fans		One in each kitchen, bath and toilet	One in each kitchen, bath and toilet	One in each kitchen, bath and toilet
7	AC Points (Industrial , modular socket outlet with 32 A MCB & wiring)		One in each room except kitchen and toilets	One in each room except kitchen and toilets	One in each room except kitchen and toilets
8	Geyser Point (Industrial socket outlet with 32 A MCB & wiring)		1 in kitchen and one in each toilet	1 in kitchen and one in each toilet	1 in kitchen and one in each toilet
9	EDB/ MCB Point (Single phase)		1	-	-
10	EDB/ MCB Point (Three phase)		-	1	1
11	Cable TV Point	Office	-	-	-
		Drawing room/ Living room	1	1	1
		Dining room	-	-	-

		Family lounge	-	-	-
		Each Bedroom	1	1	1
12	Telephone Points	Office	-	-	-
		Drawing room/ living room	1	1	1
		Dining room	-	-	-
		Family lounge	-	-	
		Each Bedroom	-	-	1
13	LED Tube Light fitting & fixtures	Office	-	-	-
		Drawing room/ Living room	1	1	3
		Kitchen	1	1	1
		Dining room	-	1	3
		Family lounge	-	-	-
		Each Bedroom	1	1	2
		Toilet	1	1	1
		Utility Areas	1	1	1
		Total (Max.)	6	8	14
14	Modular Switches	Yes	Yes	Yes	Yes
15	LAN Points		-	-	Yes
Note: All the common area e.g. Lifts & Staircases lobbies, connecting corridors etc shall have lighting arrangement along with light fixtures as per actual Design. Concealed wiring shall be used in all electrical works. LED fixtures shall be provided.					

29.4. **Scale of Amenities (Electrical)- Hostels**

S. No.	Description	Location	General Hostels
1	Power Points	Reception/ Visitor Lounge	2

S. No.	Description	Location	General Hostels
	(16/6 Amp 6 Pins, Modular Switch & Sockets)	Hostel Office Room	1
		Care Taker Room	1
		Store Room	1
		Record Room	1
		Electrical Room	1
		Common Area/ Recreation Room	4
		Handicapped Toilet & Toilet	1
		Living Room	1
		Bedroom	1
		Single Room	1
		Kitchenette/Pantry/ Cloth Drying Area	1
		Verandah	1
		Other Areas	As per requirements
2	Plug Points (6 Amp 3 pin, Modular Switch & Sockets)	Reception/ Visitor Lounge	3
		Hostel Office Room	2
		Care Taker Room	2
		Store Room	1
		Record Room	1
		Electrical Room	1
		Common Area/ Recreation Room	2
		Living Room	1
		Bedroom	1

S. No.	Description	Location	General Hostels
		Single Room	1
		Kitchenette	1
		Other Areas	As per requirements
3	Bracket / Mirror Light/ LED Type	All Rooms & Areas	To meet minimum required illumination with Lux Level as per NBC 2016 and ECBC
		Common Toilet (Mirror Light)	As per NBC 2016 requirements
		Individual Toilet (Mirror Light)	1
4	Ceiling Fans (1200 mm)	Living Room	1
		Bed Room /Single Room	1
		Reception/ Visitor Lounge	As per NBC 2016 requirements
		Hostel Office Room	1
		Care Taker Room	1
		Store Room	1
		Record Room	1
		Common Area/ Recreation Room	As per NBC 2016 requirements
		Cloth Drying Area	0
		Other Areas	As per NBC 2016 requirements

S. No.	Description	Location	General Hostels
5	Call Bell Points		1
6	Exhaust Fans (min 300 mm)	Common Toilet	As per requirements
		Individual Toilet	
		Kitchenette	
7	AC points (Industrial/ Modular socket outlet with 32 A MCB & wiring)	Bed Room / Single Room	1
8	Geyser Point (Industrial socket outlet with 32 A MCB & wiring)	Common Toilet	As per requirements
		Individual Toilet	
		Kitchenette	
9	Cable TV Point	Reception & Visitor Lounge	2
		Hostel Office Room	1
		Caretaker Room	1
		Common Area/ Recreation Room	1
		Living Room(PG Married)	1
		Single Room (PG- Boys/ Girls/ Working Nurses)	1
10	Telephone Points	Reception & Visitor Lounge	1
		Hostel Office Room	1
		Caretaker Room	1
		Common Area/ Recreation Room	1
		Living Room/Single Room	1
11	Telephone Instruments	Reception & Visitor Lounge	1
		Hostel Office Room	1

S. No.	Description	Location	General Hostels
		Caretaker Room	1
		Common Area/ Recreation Room	1
		Living Room/Single Room	1
12	LAN Points	Reception & Visitor Lounge	1
		Hostel Office Room	1
		Caretaker Room	1
13	Wi-Fi Points	Common Area & Corridors	
Note: The provision of Services as detailed above has to be provided in all rooms and areas of Hostel Buildings. All the common area e.g. Lifts & Staircases lobbies, connecting corridors, Entrances etc. shall have lighting arrangement along with light fixtures to meet minimum required illumination Lux level as per NBC 2016 and ECBC. Only LED Light fixtures shall be provided.			

D. Design Basis Report- Plumbing (Water Supply and Sanitary Installation)

1. General:

The EPC Contractor shall carry out Design, Engineering, Supply, Installation, and Testing& Commissioning for Plumbing (Water Supply and Sanitary Installation System). The work shall in general conform to the Latest CPWD Specifications. The water supply and sewerage demand shall be estimated, based on the population as required by NBC norms, Local bye Laws & statutory norms. The different components related to services are listed as below: -

1.1. Internal Plumbing Works

i. Sanitary fixtures & C.P brass fittings
ii. Soil, waste & rain water piping system
iii. Internal domestic and flushing water supply system
iv. Hot water supply system
v. Disposal of soil, waste & rain water pipe to 1st manhole

1.2. External Water Supply System

i. The water supply to the campus shall be met from the local Municipality/Authority, Tankers, proposed a Rain Water Holding Tank and STP treated Water (only for hospital) Supply. Meeting the requirements covering the scope of construction, in the scope of work.
ii. The water received shall be treated to make it fit for human consumption & hospital needs.
iii. Rain water provision shall be made only for flushing purpose.
iv. Storage of Water
v. Distribution System

1.3. Sewerage System

i. For Hospital building, Sewerage system/Effluent Treatment Plant shall be provided. Separate system shall be provided for effluent discharge to the Effluent Treatment Plant. Treated Effluent from Effluent treatment plant will be fed to equalization tank of sewage treatment plant
ii. For other Buildings, Septic Tanks shall be provided for Sewerage System.

1.4. Storm Water Drainage System

The rainwater for all buildings shall be collected in separate underground Tanks and transferred in overhead tanks of respective buildings. The rain water shall be used for flushing for all buildings and also used for firefighting in Hospital & Indoor Sports Complex.

1.5. Garden Hydrant System

External gardening hydrants system to supply the water for horticulture purpose to be provided to cater for all landscaping/green area around the respective buildings.

1.6. **Pumps & Water Treatment Equipment**

For hospital building central water filtration / treatment/RO plant shall be provided and in other building area wise RO system shall be provided. All required pump (in building & terrace) shall be in scope of EPC contactor.

2. Basic Objectives

The basic objective is to provide all sanitary engineering services and specification in relation to:

i. High standards of materials and workmanship.
ii. Leak proof plumbing.
iii. Reliable and dependable engineering systems.
iv. Plan the system in such a way as to minimize the energy requirements.
v. Create minimum nuisance and disturbance to the environment.

3. List of Codes and Manuals

The following codes of practice and design manuals are being referred for designing the Sanitary Plumbing and Fire Fighting Systems:

i. National Building Code 2016
ii. Hand Book on Water Supply & Drainage (with Special Emphasis on Plumbing), Bureau of Indian Standards SP-35
iii. Manual on Water Supply & Treatment (Ministry of Urban Development)
iv. Manual on Sewerage & Sewage Treatment (Ministry of Urban Development)
v. CPWD Specifications
vi. National Building Code 2016 (Part-IV — Fire Protection)

4. Design for Water Supply/Waste Water Distribution System

For continuous water supply at adequate pressure, complete water supply system is designed with following type of pipe-lines.

4.1. The main incoming water supply lines/Tanker/Rain water near and inside building shall be connected with designed pipe line grids for buildings which shall be CPVC Pipe conforming to IS 15778 (for Internal Water Supply Pipe.) &GI pipes, conforming to the requirements of IS 1239 Part-I (for dia. 80 mm &above and For External Water Supply). The water supply lines have been designed with CPVC & G.I pipes of different diameters with push on joints, as per requirements. All the operational valves/fittings also designed with same Specials of class as per I.S 15778 &1239 material as per IS Code and shall be fixed in clay bricks/fly ash masonry chambers as per specification.

4.2. Water supply pipe from buildings to overhead tanks, ring main at terrace, down take from ring mains (in the shaft) up to the entry into the floors shall be with GI pipe (medium class). The water supply pipes from the shaft inside the floors concealed piping and to other end points shall be of C-PVC pipes of required grade/class, conforming to the requirements of IS 15778 Codes. To regulate the water supply, valves and fittings, at required places, shall be fixed as per specification.

Laying of these pipe lines upto building shafts shall be underground and in shafts, supported with standard clamps up to the overhead's tanks complete as per specification.

4.3. Flushing water pipe shall be of DI/GI/c-PVC pipes in line with the requirements as above, from STP/Rain water tanks to overhead tanks, inside shaft & concealed areas.

4.4. Storm water pipe/Rain water pipe from inside the building to the 1st manhole outside the building shall be of UPVC of required grade/class, 6kg/sqcm pressure rating conforming to relevant IS codes. The network system from 1st manhole onwards shall be NP2/NP3 pipes as required.

4.5. Irrigation water pipe shall be of UPVC of required grade/class, 10kg/sq.cm pressure rating conforming to relevant IS codes.

4.6. Soil/ Waste water pipe from building to 1st manhole shall be Hub less centrifugally cast (Span) iron pipes epoxy coated in sides and outside as per IS code 15905. From 1st manhole till STP, pipe shall be of RCC.

5. SANITARY WORKS

5.1. Sanitary Fixtures & C.P Brass Fittings

Plumbing fixtures, Chrome Fittings and accessories will be as per IS: 781-1984.

5.1.1. **Porcelain fixtures** of fairly high quality as given below.

i. **WCs -** Low volume dual flushing system comprising concealed cistern are proposed as per IS: 2556.

ii. **Lavatory Basins** available in all size and shapes including wall hung, over or under counter types etc. with infra-red sensor as per IS: 2256 (Part 7) 1995.

iii. **Urinals** shall be provided with Infra-red sensor battery operated as per IS: 2556 part.

iv. **Accessories:** - Soap dispensers, toilet paper holders, Towel rail, hand drier, etc shall be of Stainless Steel.

v. **Chrome Fittings: -** Provision for additional and special hospital fittings where required shall be made as per IS: 781 - 1984.

5.1.2. **Soil, Waste Pipe System**

i. General: -

- Above ground piping shall be designed on the basis of two pipe system as recommended in code of practice for soil and waste. Soil pipes shall carry the wastes from WC's & urinals etc. Soil pipes shall connect directly to the 1st manhole outside the building.
- Internal buildings sanitary disposal system will be under the RCC slab (By core cutting RCC slab and suspended at bottom) for hospital zone and with sunken floor in residential buildings. The core cutting shall meet the structural requirements.
- Waste pipes shall carry the wastes from waste appliances (lavatory basins, kitchen sinks etc.). Waste pipes shall connect to Gully Traps outside the buildings and shall be connected to the external manholes.

ii. Design Parameters

- Piping system has been designed in accordance with Code of Practice for Installation of Soil & Waste Pipes.

- All vertical stacks will terminate as vent pipes at terrace level.
- All Vertical Stacks in the buildings will terminate at the ground floor level and connected to the external sewer. Pipe dia. and slope will be as per connected load.

iii. Pipe Work

- All vertical stacks will be installed in pipe shafts on the external face of the buildings or in internal shafts within the building according to the architectural planning of the toilets.
- Provision has been made to provide cleanout doors and plugs for Roding and maintenance where necessary and required.

5.1.3. Materials for Soil, Waste & Vent Pipe System

Pipes used for Soil, Waste and Vent system shall be Hub less centrifugal cast (Span) iron pipes epoxy coated in-sides and out-side as per IS:- 15905. The pipes and fitting are jointed with SS 304 grade coupling with EPDM rubber gasket joints as per requirement and specifications.

6. Sewerage System

6.1. Design Parameters

a) Velocity

Minimum velocity at peak	=	0.60 m/sec
Maximum velocity at peak	=	3.00 m/sec

b) Peak Factor = 3 times the average flow

c) Interception factor = 0.80

d) Manning Constant = 0.011 (for uPVC pipes)

e) Design Equation = Manning Equation.

6.1.1. Flow conditions in pipe

Pipes upto 250 mm dia	=	50% full running.
Pipes from 400-900 mm dia	=	67% full running.

6.1.2. Min. depth for sewers

For branches	=	1 M.
For lateral, main & trunk sewers	=	1.5 M. / as per required gradient

a. **Type of Distribution**

Sewer flow shall be by gravity up to the final disposal point. The external sewer shall be connected to centralized sewage treatment plant.

b. **Kitchen Effluent**

Kitchen waste shall be passed through grease trap / oil separator before discharging in to the external sewer line.

c. **Manholes**

The manholes are to be constructed with brick masonry as per standard

specifications of NBC 2016 and shall have details as follows:

i. Rectangular manhole of size 900 x 800 mm upto 0.89 mtr depth.

ii. Circular manhole of size 910 mm dia for 0.9 to 1.64 mtr depth.

iii. Circular manhole of size 1220 mm dia for above 1.65 to 2.29 mtr depth

iv. Circular manhole of size 1520 mm dia for above 2.3 mtr depth.

d. **Spacing of Manholes**

i. Manhole shall be provided with all the junctions, change of directions, change in diameters and as per connection requirement from every units.

ii. A distance of 20 meters (maximum) on the main sewer line depending on dia of pipes and local conditions.

e. **Manholes Covers**

i. Medium duty S.F.R.C. manhole covers for manholes on service roads, gully traps and manholes / chambers not following in the road / pedestrian ways/side berms/lawn area.

ii. Heavy duty S.F.R.C. manhole covers for manholes /service chambers/ gully traps falling on main roads & service roads.

iii. Shape and dimensions of Manhole covers shall conform to CPWD specifications & IS 12592

f. **Treatment of Sewage**

Treatment of sewage shall be through the sewage treatment plant, the details for the same are specifically indicated hereinafter.

7. Storm Water Drainage System

7.1. Planning of Storm Water Drainage System

- The rainwater from the terraces, open surface areas, as per design, shall be collected in the clay brick masonry chambers, collection chambers and shall be taken through the internal rain water system (RCC Pipe) & ultimately connected to the proposed rain water holding tank.
- The network of storm water system shall be mostly catch basins and RCC pipe network, as per requirements.
- All paved/road/green areas, the run off shall directly connect to the main storm water drains.

7.2. Design Parameters

- The rainfall intensity of 80 mm/ hr is considered for designing of system for Aizawl Ripans.
- Minimum Pipe diameters for Rain Water Pipes from Terraces shall be 110mm and maximum 160 mm dia.
- All construction specifications with respect to the manhole sizes etc. will be respected and followed and as per CPWD specification.

- The complete campus storm water drainage system for Ripans Mizoram designed with RCC pipes, RCC open drain with cover system, clay brick masonry chambers and manholes etc.

8. Storm Water holding & Pumping System/ Arrangement: -

The rain water drainage system in the covering area shall be collected in the rain water storage tanks for one day, same shall be pumped out to overhead tank at terrace for half day. The capacity of Storage tanks shall be as per below –

Underground Water Storage Tank Capacity (One Day's Requirement)					
		Capacity (In KL.)			
S No.	Description	Fire Water Storage Tank	Raw Water Storage Tank	Domestic Water Storage Tank	Flushing Water Storage Tank
1	Academic Block			30.0	15.0
2	General Hostel			35.0	15
3	Guest House			7.0	1.5
4	Indoor Sports	150.0(Common for Indoor Sports & Hospital Building)		8.0	10.0
5	Staff's Nurse Apartment			8.5	4.5
6	Medical Superintendent Residence			1.5	1.0
7	Residential Doctor's			10.0	4.5
8	100 Bedded Hospital		45.0	45.0	20.0

Over head Water Storage Tank Capacity			
S No.	Description	Domestic Water Storage Tank	Flushing Water Storage Tank
1	Academic Block	13.5	7.0
2	General Hostel	17.0	7.0
3	Guest House	3.5	0.75
4	Indoor Sports	4.0	5.0
5	Staff's Nurse Apartment	4.5	2.5
6	Medical Superintendent Residence	0.75	0.5
7	Residential Doctor's	4.5	2.5
8	100 Bedded Hospital	30.0	10.0

Septic Tank Capacity			
		Capacity (In KL.)	
S No.	Description	IS 2470 (Part-I)	Septic Tank
1	Academic Block	With 40% diversity	60.0
2	General Hostel	With Full load condition	50.0
3	Guest House	With Full load condition	22.5
4	Indoor Sports	With 40% diversity	60.0
5	Staff's Nurse Apartment	With Full load condition	22.5
6	Medical Superintendent Residence	With Full load condition	5.0
7	Residential Doctor's	With Full load condition	22.5

For each rain water storage tanks shown for individual building, suitable capacity /head of submersible/ lifting pumps (1W+1S) shall be provided along with necessary piping /valves/fittings/cablings (power & control)/ outdoor type panel with necessary starters/ level controllers, auto start stop arrangement complete with all accessories.

In case of Over flow water shall be pumped out to designated locations with connections to outside Municipal drains /nearest canal or drain near Boundary wall as per directions of Engineer-In charge. Necessary piping arrangement shall be made accordingly by EPC contactor.

9. Water Storage Tanks :

The storage capacity of water storage tanks to be located at ground levels /underground shall be equal to minimum 1-day requirement in the case of Raw/ Domestic/ Flushing /Soft Water Tank. The final capacities of these tanks shall be freezed during detailed designing looking into the functional requirements &in line with directions of Engineer-in-charge. The Over Head Tanks at Terrace level shall be half day capacity. The storage capacity of firefighting tanks shall be as per NBC Code 2016, local bye-laws provisions and as per specific provisions of this DBR in the respective head. Internal walls and floors of RCC water storage tanks are to be finished with ceramic glazed tiles.

E. Design Basis Report

Water Treatment Plant (WTP)

1. General

The EPC Contractor shall carry out Design, Engineering, Supply, Installation, Testing and Commissioning for Water Treatment Plant.

1.1. The construction of RIPANS Mizoram Hospital is planned for individual buildings for providing WTP/ ETP/ STP & Hot Water System etc.

1.2. Population

Estimation of population is most critical element in identifying the infrastructure requirements for any development. All the demand estimations are based on the population or maximum expected capacity of the proposed development. The norms adopted for population estimation for entire campus is as per NBC Code 2016.

1.3. Basic Objectives

All related engineering services and specification shall be:

- High standards of materials and workmanship.
- Provide leak proof plumbing.
- Reliable and dependable engineering systems.
- Provide adequate safety and means to egress easily in case of fire.
- To plan the system in such a way as to minimize the energy requirements.
- To create minimum nuisance and disturbance to the environment.

2. Concept Planning

It is proposed to provide:

- Water Treatment Plant only for Hospital.
- Centralized RO System (catering to critical areas in Hospital like Labs, OT (scrub) & other areas as required).
- Portable R.O with Chilled/Hot Water System (catering to Drinking facility in Hospital/ Indoor Sports Complex & Auditorium/All Hostels/Guest House/ Cafeteria of respective buildings / Academic Block etc.).
- Effluent Treatment Plant cum Sewerage Treatment Plant only for Hospital.
- Hot Water System (Standalone building wise Air to Water Heat Pump for Hospital Building terrace. Energy Efficient BEE min. 3 star rated Geysers for other blocks).
- Solar Hot Water System with required capacity electrical back up for minimum 20 % of total hot water requirement or as per GRIHA Norms to be provided for all buildings.
- WTP/STP/ETP Rooms shall be provided with safety equipment/items like suitable elastomeric mat (as per relevant IS codes) for Panels, fire buckets, fire extinguishers, hand gloves, safety charts, framed Schematic/SLD etc.

WATER CONSUMPTION CHART												
S. No	**Description**	**No. of Labs/ Classrooms**	**No. of main occupants**	**As per NBC**	**Domestic water requirement**		**Hot Water Requirement (LPCD)**		**Flushing water requirement (LPCD)**		**TOTAL GROSS WATER**	**Flow to sewer (80%)**
					LPCD	**LPD**	**LPCD**	**LPD**	**LPCD**	**LPD**		
1.	MAINTAINENCE STAFF		10	45	20	200	0	0	25	1125	1325	1060
2.	Teacher		80	45	20	1600	0	0	25	1125	2725	2180
3.	Level-02											
4.	Lab @ 20 Person/Lab	5	100	45	20	2000	0	0	25	1125	3125	2500
5.	Class Rooms @ 20 Person /Classroom	1	20	45	20	400	0	0	25	1125	1525	1220
6.	Level-03											
7.	Lab 20 Person/Lab	6	120	45	20	2400	0	0	25	1125	3525	2820
8.	Class Rooms @ 20 Person /Classroom	3	60	45	20	1200	0	0	25	1125	2325	1860
9.	Level-04											
10.	Lab 20 Person/Lab	7	140	45	20	2800	0	0	25	1125	3925	3140
11.	Class Rooms @ 20 Person /Classroom	4	80	45	20	1600	0	0	25	1125	2725	2180
12.	Level-05											
13.	Lab 20 Person/Lab	7	140	45	20	2800	0	0	25	1125	3925	3140
14.	Class Rooms @ 20 Person /Classroom	4	80	45	20	1600	0	0	25	1125	2725	2180
15.	Level-06											
16.	Lab 20 Person/Lab	7	140	45	20	2800	0	0	25	1125	3925	3140
17.	Class Rooms @ 20 Person	4	80	45	20	1600	0	0	25	1125	2725	2180

	/Classroom											
18.	STAFF			15	45		0	0	25	375	375	300
19.	CAFETRIA			LS		4000					4000	3200
20.	Filter backwash Req.					2000					2000	
	Total			15		27000	0	0	325	13875	40875	31100
	Say					27	0	0	0	14	41	31

- Water Requirement Charts furnished above & elsewhere is tentative. The same needs to be detailed out while doing detailed engineering & any change due to the same needs to be incorporated while sizing of Tanks/Equipment/ Accessories as per directions of E-I-C.

3. Water Management System:

3.1. Following shall be focus area of design for the Campus.

- One and Half day storage shall be planned of the total domestic/Flushing water requirement to ensure continuous availability of water in all buildings.
- Recycled water from sewage treatment plant shall be used for flushing & irrigation in hospital building.
- Dispose roof run-off flows into the proposed Rain Water Storage Tank which will help in use for flushing Water in Buildings.
- Achieve water conservation by use of low flow fixtures. The flow rate shall be equivalent or better than that prescribed in Green building standard.
- Domestic water supply shall be fed through hydro pneumatic pumps for Hospital & other Buildings till OHT. Gravity system shall be followed for Supply Water in Buildings from OHT onwards.
- Flushing/Rain water supply shall be fed through Hydro Pneumatic Pump for Hospital and other buildings till OHT. Gravity system shall be followed for Supply Water in Buildings from OHT onwards.
- Air to Water Heat Pump of adequate capacity shall be provided to cater for hot water requirement for hospital building along with solar hot water generators. For balance buildings, hot water shall be provided through solar hot water system & geysers as per requirements.
- Hot water @ 20% of total hot water requirement shall be met through Solar Hot Water System as per MoEF guidelines.
- Broad guidelines for various requirements in individual building as below-

3.1.1. ACADMIC BLOCK

WATER CONSUMPTION CHART

S.N	Description	Number OF ROOMS	No. of main occupants	Total occupants	Domestic water requirement		Hot Water Requirement		Flushing water requirement (LPCD)		TOTAL	Flow to sewer (80%)
					LPCD	LPD	LPCD	LPD	LPCD	LPD		
1.	BASEMENT -2 (2 PERSON PER ROOM	13	26	26	65	1690	25	650	45	1170	3510	2808
2.	BASEMENT - 1 (2 PERSON PER ROOM	23	46	46	65	2990	25	1150	45	2070	6210	4968
3.	GROUND FLOOR (2 PERSON PER ROOM	33	66	66	65	4290	25	1650	45	2970	8910	7128
4.	FIRST FLOOR (2 PERSON PER ROOM	33	66	66	65	4290	25	1650	45	2970	8910	7128
5.	SECOND FLOOR (2 PERSON PER ROOM	27	54	54	65	3510	25	1350	45	2430	7290	5832
6.	THIRD FLOOR (2 PERSON PER ROOM	23	46	46	65	2990	25	1150	45	2070	6210	4968
7.	KITCHEN			LS		4000					4000	3200
8.	MAINTAINENCE STAFF			15	20	300			25	375	675	540
9.	Filter backwash Req.					2000					2000	
	Total			**319**		**26060**		**7600**		**14055**	**47715**	**36572**
	Say					**26**		**8**		**14**	**48**	**37**

3.1.2. GUEST HOUSE

WATER CONSUMPTION CHART												
S. N	**Description**	**Number of Rooms**	**No. of main occupants**	**Total occupants**	**Domestic water requirement**		**Hot Water Requirement**		**Flushing water requirement**	**TOTAL**	**Flow to sewer (80 %)**	
					LPCD	LPD	LPCD	LPD	LPCD	LPD		
1.	GUEST ROOMS (2 PER/ ROOM)	8	16	16	65	1040	25	400	45	720	2160	1728
2.	SUITE ROOMS (2 PER/ ROOM)	2	4	4	65	260	25	100	45	180	540	432
3.	KITCHEN			LS		3000					3000	2400
4.	MAINTAINENCE STAFF			15	20	300			25	375	675	540
5.	Filter backwash Req.					1000					1000	
	Total			**35**		**5600**		**500**	**115**	**1275**	**7375**	**5100**
	Say					**6**		**1**		**1**	**7**	**5**

3.1.3. INDOOR SPORTS COMPLEX

WATER CONSUMPTION CHART												
S.N	Description	Number OF SEATS	No. of main occupants	**Total occupants**	**Domestic water requirement**		**Hot Water Requirement**		**Flushing water requirement**		**TOTAL**	**Flow to sewer (80%)**
					LPCD	LPD	LPCD	LPD	LPCD	LPD		
1.	AUDITORIOM (1 PERSON/ SEAT)	980	980	980	5	4900			10	9800	14700	11760
2.	OFFICE (10SQM /PERSON)			3	20	60			25	75	135	108
3.	MAINTAINENCE STAFF & other			20		400		0		500	900	720
4.	Filter backwash Req.					2000					2000	
	Total			**1003**		**7360**		**0**		**10375**	**17735**	**12588**
	Say					**7.4**		**0**		**10.4**	**18**	**12.6**

3.1.4. STAFF NURSE APARTMENT

WATER CONSUMPTION CHART												
S.N	**Description**	**Number OF UNITS**	**No. of main occupants**	**Total occupants**	**Domestic water requirement**		**Hot Water Requirement**		**Flushing water requirement**		**TOTAL**	**Flow to sewer (80%)**
					LPCD	LPD	LPCD	LPD	LPCD	LPD		
1.	BASEMENT -1 & 2 (2BHK)	8	5	40	65	2600	25	1000	45	1800	5400	4320
2.	BASEMENT - 3 (2BHK)	4	5	20	65	1300	25	500	45	900	2700	2160
3.	GROUND FLOOR (2BHK)	6	5	30	65	1950	25	750	45	1350	4050	3240
4.	MAINTAINENCE STAFF			15	20	300			25	375	675	540
5.	Filter backwash Req.					1000					1000	
	Total			**105**		**7150**		**1250**		**4425**	**13825**	**10260**
	Say					***7***		**1**		**4**	**14**	**10**

3.1.5. MEDICAL SUPRINTENDENT RESIDENCE

WATER CONSUMPTION CHART												
S. No	**Description**	**Number OF UNITS**	**No. of main occupants**	**Total occupants**	**Domestic water requirement**		**Hot Water Requirement**		**Flushing water requirement**		**TOTAL**	**Flow to sewer (80%)**
					LPCD	LPD	LPCD	LPD	LPCD	LPD		
1.	RESIDENCE G+1 (3BHK)	1	8	8	65	520	25	200	45	360	1080	864
2.	MAINTAINENCE STAFF			5	20	100			25	125	225	180
3.	Filter backwash Req.					500					500	
	Total			**13**		**1120**		**200**		**485**	**1805**	**1044**
	Say					**1**		**0**		**0**	**1.5**	**1**

3.1.6. RESIDENTIAL DOCTOR APARTMENT

WATER CONSUMPTION CHART												
S.N	**Description**	**Number OF UNITS**	**No. of main occupants**	**Total occupants**	**Domestic water requirement**		**Hot Water Requirement**		**Flushing water requirement**		**TOTAL**	**Flow to sewer (80%)**
					LPCD	LPD	LPCD	LPD	LPCD	LPD		
1.	BASEMENT -2 (3BHK)	2	7	14	65	910	25	350	45	630	1890	1512
2.	BASEMENT - 1 (3BHK)	2	7	14	65	910	25	350	45	630	1890	1512
3	GROUND FLOOR (3BHK)	2	7	14	65	910	25	350	45	630	1890	1512
4.	FIRST FLOOR (3BHK)	2	7	14	65	910	25	350	45	630	1890	1512
5.	SECOND FLOOR (3BHK)	2	7	14	65	910	25	350	45	630	1890	1512
6.	THIRD FLOOR (3BHK)	2	7	14	65	910	25	350	45	630	1890	1512
7.	MAINTAINENCE STAFF			15	20	300			25	375	675	540
8.	Filter backwash Req.					1000					1000	
	Total			**99**		**6760**		**2100**		**4155**	**13015**	**9612**
	Say					**6.8**	**0.0**	**2.1**	**0.0**	**4.2**	**13.0**	**9.6**

3.1.7. 100-Bedded Hospital

Water Consumption Data - Patient Rooms, Other Areas														
			Cold Water Requirement				Hot Water Requirement		Total Domestic and Hot Water Requirement	Total Water Requirement	Water Flow to STP			
S. No.	Description	Occupancy	Flushing		Domestic						Domestic		Flushing	Total
			LPCD	LPD	LPCD	LPD	LPCD	LPD	LPD	LPD	% age	LPD	LPD	LPD
1	100 Patient Beds	100	110	11000	165	16500	65	6500	23000	34000	80%	18400	11000	29400
2	Staff & Employees (3 shifts per day)	180	20	3600	25	4500	0	0	4500	8100	80%	3600	3600	7200
3	Visitors (3 persons / Bed)	300	10	3000	5	1500	0	0	1500	4500	80%	1200	3000	4200
4	Kitchen for patients & Staff (3 meals per day)	LS				3000		3000	6000	6000	80%	4800	0	4800
5	De-ionized water for medical uses incl. Dialysis, CSSD, Labs	LS	-	0	-	8000	-	0	8000	8000	80%	6400	0	6400
6	Laundry	LS				6000		4000	10000	10000	80%	8000	0	8000
7	Filter backwash					6000	-	0	6000	6000				
8	RO Water Waste	LS				5000	-	0	5000	5000	80%	4000	0	4000
	Total	580		17600		50500		13500	64000	81600		46400	17600	64000
	Say			**17.6**		**50.5**		**13.5**	**64**	**81.6**				**64**

3.1.8. Water Supply System

Water requirements has been estimated on the basis of present acceptable standards, references from various sources such the National Building Code of India, Public Health Manuals, Ministry of Environment, Forests Guidelines, and CPWD Specifications etc.

3.2. **Water Treatment Plant**

- It is proposed to provide Water Treatment Plant of suitable Capacity to meet the specified outlet parameters of water. The system shall consist of following components but not limited to:-
- Water supply/Lifting Pumps/filter feed pumps/Non-Clogging type submersible sump pumps etc. – MoC preferably should be -SS-304/C. I casing, SS-304 /Bronze impeller & SS shaft suitable for operation 400/440 volts, 3 phase, 50 Hz, 2900 rpm, TEFC electric motor with best efficiency class preferably IE-3 complete with all accessories like flexible rubber bellows, strainers, valves, pressure gauges etc. Suitable PCC/RCC foundation with plaster, MS channel plate with primer and one coat of paint, Anti-vibration arrangement of cushy foot mountings should be provided.
- Water treatment filters and water transfer pumps shall be provided in one set for hospital building based on water quality parameters. The pumps selected shall be in N+1 configuration (1 standby) of required capacity. Each will cater 100% load of the water demand. For other Buildings, water transfer pumps shall be provided in one set, which will cater to 100% load of the water demand. The pumps selected shall be in N+1 configuration (1 standby) of required capacity.
- MSFRP Filters (dual media/activated carbon/pressurized sand/multi grade)/ Softeners shall be sized for optimum working pressure etc. in hospital. The same shall be provided as per requirements & water quality parameters & as per directions of E-I-C.
- Panels, Allied Equipment & Accessories (level controllers, probes, starters, valves, pressure gauges etc.
- All equipment shall be installed on suitable foundations true to level and in a neat workman ship.
- Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.
- Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.
- In hospital the water treatment process shall be designed depending upon the quality of water. pH, TDS, Turbidity, Total Hardness & other biological factors shall conform to latest IS Codes/GRIHA Norms. Suitable nos. of Filters/Softeners shall be considered & sized taking into consideration the diameter, OBR, depth of filter media, backwash arrangement, interconnecting pipes of GI pipe of heavy grade, instruments, valves etc.
- One standby pump shall be provided considered for each type.

- The entire water treatment plant shall be designed based on water quality parameters available at site. All required Equipment & accessories desired for getting output treated water characteristics shall be provided by EPC Contractor.
- The expected Treated Water Characteristics, after Filtration, shall be as under:

Expected Treated Water Characteristics after Filtration (Domestic Water Requirements for all Buildings) except drinking		
Sl. No.	**Parameters**	**Characteristics**
1	pH	6. 5 – 8.5
2	Total Dissolved Solids	800 ppm
3	Suspended solids	< 1 mg/ liter
4	Turbidity	Nil
5	Total Hardness	Less than 180 ppm

Expected Treated Water Characteristics after Filtration and Softener		
Sl. No.	**Parameters**	**Characteristics**
1	pH	6. 0 – 7.0
2	Total Dissolved Solids	750 ppm
3	Suspended solids	< 1 mg/ liter
4	Turbidity	Nil
5	Total Hardness	Less than 50 ppm

- Expected Treated Water parameters shall be in conformance to relevant IS standards & GRIHA Norms.

3.3. **Source of Water supply**

- The main sources of Domestic/Flushing water are from the Municipal Supply/Rainwater/Tankers. Detailed design distribution and requirement at individual Building at the location of as marked in Layout Plan subject to the confirmation by CGWB by the Contractor at his own cost. G.I Pipes & fittings are to be used in Municipal as per CPWD specifications and GI Water supply pipes & fittings with necessary gate valves area to be provided as per requirements from Municipal to underground tanks.

3.4. **Pumps & Water Treatment Equipment**

- It is proposed to provide all type of pumps including that for filter feed pumps, domestic water supply pumps, Rain water Transfer pump, flushing water supply

pumps (For flushing pumps will be installed in STP), make up pump to STP treated tank from raw water (in case of failure/maintenance of STP), Plant Room Sump Pump etc. catering to All Buildings.

- Water Treatment Plant shall be provided with various types of Filters and Softening Plant to ensure proper quality of water within acceptable limits of hardness, as well as bacteriological limits.
- Activated Carbon Filter/Pressurized Sand Filter/Dual Media Filters / Chlorinators for catering Domestic Water Requirements for all Buildings. Softeners will be installed only where soft water requirement is there for other critical areas etc.
- Sufficient maintenance space shall be provided inside the water treatment plant room for accessibility of various pumps, panels etc. during repair & maintenance activities.
- Water Treatment Plant Room shall be suitably ventilated considering adequate ACPH as per NBC 2016 code, preferably 15 ACPH.
- In hospital and Indoor Sports minimum 1.5 bar pressure shall be maintained at each outlet for both hot and cold-water supply.
- Suitable size Sumps with sufficient sized submersible pumps & level indicators to be considered in plant room for drainage. Also, proper slope to be provided in Water Treatment Pump room so that there is no stagnancy of water during any leakage & it is properly channelized to nearest drainage sump.
- Water treatment Pump Room shall be provided with safety equipment/items like suitable elastomeric mat (as per relevant IS codes) for Panels, fire buckets, fire extinguishers, hand gloves, safety charts, framed Schematic/SLD etc.
- Water test has to be conducted for detection of parameters like TDS, sulphate, chloride, pH, Total hardness, Calcium, magnesium, Alkalinity etc.

F. Design Basis Report-Reverse Osmosis System

1. General

The EPC Contractor shall carry out Design, Engineering, Supply, Installation, and Testing & Commissioning for RO System. For meeting the requirements of Laboratories, Dialysis needs (if any), OT scrubs & other critical areas of Hospital wherever R.O water is required other than drinking purpose, Centralized Reverse Osmosis Plant is proposed at the terrace level of Hospital. Portable type R.O System is proposed for Hospital / Guest House / Auditorium / Residences/Hostels/ Academic building etc. for meeting drinking water requirements in common areas (corridors etc.) etc. The Output of RO Water system shall comply with the minimum requirement specified as per BIS 10500 for Drinking Water.

2. Concept Planning

The Centralized RO shall comprise of RO High Pressure Feed Pumps (HPP), RO Raw Water Pumps (RWP) of Vertical multistage centrifugal type and suitable head to generate permeate flow as per requirements. The pump casing construction shall be preferably of SS-316 & impeller shall be also SS 316. The motor shall be TEFC with min. IE-2/IE-3 efficiency suitable for a supply of 415V / 3 Phase at 50 Hz. Supply. The pump shall be supplied complete with base channel, coupling foundation bolts, pressure gauge, valves at inlet and outlet of each pump. One standby pump needs to be considered for each type. Central R.O Plant shall be preferably placed at Hospital's Terrace. Capacity of Centralized R.O Plant shall be selected based on meeting functional requirement (RO water demand of each building/day) as stated above within minimum operating hours (preferably 10 hrs./day).

It shall consist of Package type RO module capable of giving a net treated water output as per requirement, Special Anti-scalant dosing system consisting of suitable no. HDPE tank of capacity as per requirement with a positive displacement diaphragm dosing pump having variable flow rate, Micron cartridge filter (shall be made of FDA compliant high quality poly propylene or some other suitable material) suitable for a flow rate as per requirements, CIP system (Cleaning in Place) consisting of HDPE tank with agitator complete with inlet/outlet, drain overflow etc. along with SS pump of capacity and cartridge filter of 10 micron, PH correction dosing system consisting of one HDPE tank with a positive displacement diaphragm dosing pump having variable flow rate, High pressure side piping from the RO high pressure pumps to the rejects stream control valves shall be of SS 316 using all SS fittings ball valves of suitable pressure rating shall be used till 50 mm size, above 50 mm, flanged globe / water butterfly valves in SS construction shall be used. Rejects pressure control valves shall be globe valve and feed flow control valve shall be of SS 316, SS 316 RO Water storage tank (Capacity as per requirements) of required thickness. Tank shall be provided with water flow meter at inlet & outlet, inlet / outlet valves, overflow / drain connection with MH cover.

All RO distribution pipes shall be with SS 304 with press fittings. Centralized control panel made out of CRCA sheet min. 2 mm thick having main contactors for all pumps.

All control and power cabling along with double earthing between the panels shall be provided. An emergency stop push button shall be provided in the panel.

Portable RO water unit shall be with water Cooler shall be of S.S construction of 80 Lit. (Approx.) Storage capacity & water flow rate 50 LPH through faucets including RO

membranes, pumps, motors, cartridge filters, interconnecting pipes, valves, cables etc. or as per OEM standards meeting each building's drinking water requirement & as per directions of E-I.C. The R.O Units shall be placed at different locations with minimum two Units on each floor or as per requirement. It should be complete with all interconnecting piping, valves, cartridge filters, diaphragm type pumps, RO membranes, cable, drain pipe & other related accessories. It shall be with UV unit. The system shall be suitable for a supply of 240 V AC / 50 Hz.

For Hospitals, the R.O. Water requirement per bed shall be provided at approximately 40 Liters. With the number of beds being 100, the total requirement comes out to be 4000 say 4000 Liters/day. Considering 10 Hours of operation, the capacity of Centralized R.O Plant comes out at around 400 LPH net flows after rejection of waste water (approx. 200 LPH) for which 600 LPH capacity should be proposed. The waste rejected water from RO will be discharged to STP or as desired by statutory bodies meeting all PCB & other related norms.

RO capacity (portable & centralized) mentioned above are indicative only. If while during detailed designing, the requirement increases, the EPC contractor needs to propose the R.O capacity accordingly in line with directions of E-I-C. During detailed designing, if required and found necessary, the capacity / rating of the equipment may be upgraded/ revised subject to concurrence of Engineer-In-Charge.

3. Design Basis (RO Plant)

Expected Treated Water Characteristics after RO (Reverse Osmosis Plant)	
Parameters	**Characteristics**
PH	6. 0 – 7.0
Total Dissolved Solids	<50 ppm
Suspended solids	Nil
Turbidity	Nil
Iron as Fe	Nil
Total Hardness	Less than 5 ppm

The Output of RO Water should comply with the BIS-10,500 for Drinking Water.

4. Instruments List including but not limited to (Provision to be considered in the Centralized R.O Plant)

Sr. No.	**INSTRUMENT**
1	Flow Indicator
2	Pressure Gauge
3	Pressure Switch (Low & High)
4	Conductivity Indicator
5	PH Meter etc.

G. Design Basis Report-

Sewage Treatment Plant & Effluent Treatment Plant

1. General

The EPC Contractor shall carry out Design, Engineering, Supply, Installation, and Testing & Commissioning for Sewage Treatment Plant & Effluent Treatment Plant for catering to Sewage & Effluent load of Hospital Building.

The source of sewage is soil and waste water namely from Toilets/ Pantry/ Kitchen/ etc. of Hospital Blocks etc. Drain lines for sewerage and pantry/kitchen waste needs to laid right up to the sewage treatment area. All equipment must be designed to fit within the allowable space and height at site. Treated Waste Water shall be used for meeting Flushing /Landscape irrigation water demand as much as possible. The STP capacity shall be sized taking into account ETP treated water. Both STP & ETP shall be underground/over ground as per site conditions & as per directions of E-I-C. The same will be finalized during detailed engineering. Also, the tanks of ETP & STP shall be preferably of RCC construction. However, the same may be of modular type of HDPE construction for some of the tanks after obtaining final approval from E-I-C. Common Plant Room for STP cum ETP shall be constructed for Hospital building. STP cum ETP shall be designed considering 16/20 hours of operation preferably.

Waste Water Estimation, Treatment, Distribution shall be considered only for the buildings/developments under the present scope of work and not for buildings planned for future expansion.

Sufficient maintenance space shall be provided inside the STP cum ETP Room for accessibility of various pumps, panels etc. during repair & maintenance activities.

STP cum ETP Room shall be suitably ventilated considering adequate ACPH as per NBC 2016 code.

Suitable size Sumps with sufficient sized submersible pumps & level indicators to be considered in plant room for drainage. Also, proper slope to be provided in STP/ETP room so that there is no stagnancy of water during any leakage & it is properly channelized to nearest drainage sump.

STP cum ETP tank sizes shall be as per functional requirements, OEM standards & as per directions of Engineer-in-Charge.

STP cum ETP Room shall be provided with safety equipment/items like suitable elastomeric mat (as per relevant IS codes) for Panels, fire buckets, fire extinguishers, hand gloves, safety charts, framed Schematic/SLD etc.

2. Sewage Treatment Plant (MBBR Technology)

Sewage Treatment Plant of suitable Capacity shall be provided to meet the specified outlet parameters of water. It should comprise of pumps with maximum efficiency {non clogging mono block type of suitable capacity & head}, blowers, bar screen chambers, grease trap, equalization tanks, reaction tanks, centrifuge/filter press, sludge holding tank, Multi grade Filters/Activated Carbon Filters/Pressurized Sand Filters, clear water tanks, MBBR hollow fibre Membrane, Anoxic Tank, Aeration Tank, MBBR Tank, Sludge Holding Tank, level sensors, instruments, interconnecting piping {PVC piping (10kg/sqcm)- For all

submerged waste water piping, MS (C Class) - For all exposed air piping and flexible stainless steel pipe for submerged air piping.

GI (C class) for all other water piping}, valves, tube settler, chlorine dosing, pressure gauges, control panel, electrical wiring, etc. complete including all necessary safety requirements. Tanks may be Partial Under/Over ground of suitable size and may be of RCC/Fabricated Metal type as per requirement. STP/ ETP plant room shall be suitably ventilated. One standby pump needs to be considered for each type.

STP Panel of required size and number of feeders to cater to all the clusters shall be considered during the first phase of execution itself with provision of necessary spares being kept for future.

3. Effluent Treatment Plant System:

The effluent generated namely from the Laundry/ Laboratories/OTs/Septic ICUs / Areas etc. shall be disposed by gravity system into the effluent treatment plant. After treatment in the ETP, the discharge shall be connected to the Equalization tank of STP.

In ETP, Flocculator, Flash Mixer & Chemical dosing system should be proposed for preliminary treatment of Hospital Lab/OT effluent after which semi treated water will be treated through the entire STP Plant.

Effluent Treatment Plant of suitable Capacity shall be provided to meet the specified outlet parameters of water. ETP shall comprise of bar screen chambers, flash mixer, level sensors, instruments, interconnecting piping {PVC piping (10kg/sqcm)- For all submerged waste water piping, MS (C Class) - For all exposed air piping and flexible stainless-steel pipe for submerged air piping. GI (C class) for all other water piping }, valves, tube settler, media in tube settler, chlorine dosing, pressure gauges, instruments, level sensors, non-clogging mono-block pumps of suitable capacity & head, lime/alum/polyelectrolyte dosing system consisting of ABS dosing pump with suitable capacity HDPE tank including all piping from the dozer to the reaction tank etc. control panel, high speed Agitator of SS 304 and Flocculator complete with single phase motor for flash mixer, electrical wiring, etc. complete including all necessary safety requirements. One standby pump needs to be considered for each type.

All RCC/HDPE tanks shall be constructed as per requirements.

Sewage Treatment Plant cum Effluent Treatment Plant shall be provided with both the installations being housed in a single plant room. The proposed Sewage Treatment Plant of 50 KLD (approx.) shall be with MBBR Technology or improved version, as applicable, and shall include the ETP discharge of 10 KLD (approx.) connected to Equalization tank of STP. The treated water generated shall be used for flushing & irrigation as much as possible.

- All civil tanks, plant & machinery to be installed for ETP cum STP shall be completed in a manner so that the same is completed & made operational along the completion of buildings.
- Preferably Plant room for STP cum ETP shall be common housing all required equipment.
- Bowl type Centrifuge of suitable capacity with required pumps catering to the final

sludge generated from both STP & ETP shall be provided & housed in the plant room.

4. Desired Quality After Treatment

a. Desired Effluent Quality (After Treatment):

Sl. No	Parameter	Unit	Treated water
1	pH	-	6.5 - 8.5
2	Suspended solids	Mg/l	< 100
3	BOD	Mg/l	< 150
4	COD	Mg/l	< 300
5	Oil &Grease	Mg/l	<5

For STP			
Sl. No.	**Pump**	**Pump Position**	**Application**
1	Submersible Raw Sewage Pump	Between Raw Sewage Tank and Anoxic tanks. Then over flow to aeration tank, then over flow to MBBR Tank	To transfer raw sewage to MBBR Tank
2	Recirculation Pump	Between Tube Settler Tank and Sludge Holding Tank	To transfer sludge generated in Tube Settler Tank to Sludge Holding Tank and MBBR Tank. The purpose of sending it to MBBR Tank is to dilute the concentration of sewage in the MBBR Tank which will increase the overall efficiency of the Plant.
3	Filter Feed Pump	Between Clear Water Tank and Multi-Grade Filter	To transfer Clear Water from Clear Water Tank to Multi-Grade Filter
4	Flushing Water Pump	Between Treated Water tank to Overhead Tank	To supply treated flushing water to Overhead tank filling of Buildings
5	Bypass Sewage Transfer Pump	Connected to Equalization Tank	To transfer sewage to the last manhole connection to municipal external drain.
Sump Pumps to be provided for plant room drainage			
FOR ETP			
Sl. No.	**Pump**	**Pump Position**	**Application**
1	Raw Sewage Pump	Between Equalization Tank and Flash Mixture	To pump effluent water from Equalization Tank to Flash Mixture
2	Alkali Dosing Pumps	To supply Alkali dosing mixture to Flash Mixture	For Alkali dosing treatment of Effluent Waste
3	Poly Dosing Pumps	To supply Poly dosing mixture to Flash Mixture	For Poly dosing treatment of Effluent Waste

4	Lime Dosing Pumps	To supply Lime dosing mixture to Flash Mixture	For Lime dosing treatment of Effluent Waste
5	Alum Dosing Pumps	To supply Alum dosing mixture to Flash Mixture	For Alum dosing treatment of Effluent Waste
6	Sludge Transfer Pump	Primary Settling Tank to STP Sludge Holding Tank	To Pump out Filter Backwash Water
7	Transfer Pump	Between Filter Feed Tank and STP Raw Sewage Tank	To convey water from Filter Feed Tank to STP-Raw Sewage Tank
Sump Pumps to be provided for plant room drainage			

The Pump Details, Position and Application given in the above table is indicative only. During detailed designing, if required and found necessary, the capacity / rating of the equipment may be upgraded/ revised subject to concurrence of Engineer-In-Charge.

The EPC contractor shall provide bye pass line with pump & piping arrangement to feed water to flushing/irrigation tank from WTP tanks in case of failure/maintenance of STP. Also, arrangement of collection of raw sewer from equalization tank in case of failure of STP/ETP & discharging the same to municipal sewer or any other alternate arrangement as per directions of E-I-C shall also be in the scope of EPC Contractor.

The Disposal point for excess sewage during STP overflow / failure (location of Existing manhole, invert level, pipe diameter and material, etc. shall be provided after ascertaining from the local bodies.

The Capacity of the STP/WTP/ETP/Centralized R.O Plant as mentioned in the DBR and the Technical Specifications is indicative only to meet minimum functional requirement. The rating and capacity of equipment indicated herein are minimum to be provided. During detailed Design, if it is concluded that there is any significant increase in the Water Demand, the Plant Size/Capacity shall be enhanced/upgraded accordingly in the required proportion along with the necessary enhancement of all associated equipment like Pumps, Filters, tanks etc. in order to meet the new functional requirement.

H. Design Basis Report

Hot Water System including Solar Hot Water System

1. General :

The EPC Contractor shall carry out Design, Engineering, Supply, Installation, and Testing & Commissioning for Hot Water System including Solar Hot Water System. Entire Hot Water Requirement of the Campus shall be met from Heat Pump, Energy Efficient Electric Geysers (min. BEE 3 star Rated) & through Solar Hot Water System. Solar system shall be provided meeting GRIHA Norm requirements for respective buildings for which 3 star rating is being targeted.

2. Heat Pump & Electric Geysers:

Water supplied to Heat Pump shall be first preheated through Solar Hot Water System. Heat Pump shall be considered for Hospital & Laundry Load and will be placed at Terrace of Hospital & Laundry Building. Hot Water needs to be considered for entire Hospital & Laundry buildings including showers, kitchen pantry sinks, wash basins etc. depending upon requirement meeting total hot water demand of individual buildings.

It is proposed that Solar Panel & Electric Geysers shall be provided for Residential Blocks/ Hostels/ Guest House/ Cafeteria of required buildings/ MS Residence/ Academic Block/Hostels/Indoor Sports Complex cum Auditorium etc. It needs to be considered for entire buildings including showers, kitchen pantry sinks, wash basins etc. depending upon requirement meeting total hot water demand of individual buildings. The scheme of integration of solar hot water with Heat pump, solar hot water with geysers etc. shall be finalized during detailed engineering by E-I-C.

3. Solar Hot Water Heating System:

Solar Hot Water Generation System with recirculation pumps shall be provided. Same shall be selected based on geographical location, cost optimization, functional requirement, space availability etc. It should be based on flat plate type solar hot water system. Solar Hot Water System shall be sized as per building hot water requirements. Recirculation system shall be provided for Hospital including Laundry.

It should be complete with solar collector panels, support for collectors, mixing tank (as per building requirement), absorbers, heat exchangers (as per building requirement), electrical control panel, back up heaters, make up water tank, recirculation pumps, inter connecting pipes with suitable insulation, valves, pressure gauges, thermometers etc. complete in all respect as per OEM standards & directions of Engineer-In-Charge.

All detailed calculations for arriving at hot water generation capacity of individual building based on relevant norms & occupancy needs to be furnished by EPC Contractor for finalizing the Equipment capacity. The same needs to be approved from E-I-C.

Solar Hot Water System shall be provided for all proposed buildings as per directions of E-I-C meeting minimum GRIHA requirements as applicable. The dedicated water supply system to meet the supply requirement shall be provided from the solar hot water tanks to the requisite locations. Wherever, geysers have been provided, directly water can be supplied to it or it shall be fed through the solar water heaters as per requirement & as per directions of E-I.C.

I. Design Basis Report

Fire Fighting System

1. General

The EPC Contractor shall carry out Design, Engineering, Supply, Installation, and Testing & Commissioning for Fire Fighting Works.

Fire Fighting system shall comprise of Down comer &Wet Riser /Hydrant (Internal & External), Sprinkler system, Down comer System, Gas flooding system for panels, Computer Rooms & other sensitive areas, Fire Extinguishers, Fire Signage's near Fireman's lift, Fire Exits, Fire Brigade Inlet/Draw Out Connections etc. proposed for various Buildings. Suitable size shafts, cutouts, Niche, openings etc. shall be provided to facilitate installation of Pipelines etc. in all floor slabs of various buildings for various service areas, as required. All shafts, cutouts, Niche, openings etc. provided on floor slabs shall be suitably closed after laying of services lines as per fire safety norms as per NBC 2016. Doors shall be provided for all shafts at all floors as per fire safety norms as per NBC 2016.

The ratings and capacities of various equipment are based on NBC 2016 Part - IV and subject to revision during detailed designing stage. The firefighting system is proposed on basis of type of occupancy as per NBC 2016 Part -IV and building height. The system proposed are water based and gas based. Water based Fire suppression system is having piping network inside and outside the building with internal and external Hydrants, First Aid Hose reel at regular intervals according to various type of occupancy. The distribution system is finally connected to ring main system for firefighting.

Sprinkler system with water distribution pipes sprinkler heads above and below false ceiling is designed to actuate automatically to extinguish the fire by discharge of water when room temperature crosses 68° C in case of fire.

1.1. The following standards, bye-law, manual has been followed in designing the firefighting system: -

a) Relevant IS codes published by Bureau of Indian Standards.

b) National Building code Part IV for fire Protection System 2016.

c) Pumps, Valves and Accessories shall be preferably UL listed and FM approved.

d) CPWD General Specifications for Electrical Works-part V (Wet Riser & Sprinkler System-2006).

e) NFPA/UL/FM certifications & TAC for guidance.

2. Water Requirements:

Water services for Hydrants and sprinkler system shall be stored in underground / overhead tanks.

a. <u>Partially Over/Under Static Fire Tank (RCC Type):-</u>

Indoor sport complex-Combined reservoir shall be provided of 150 KL capacity as per latest NBC requirement For Indoor Sports and Hospital meeting all local fire bye law's requirements.

b. Overhead Storage Fire Tank:-

Overhead fire water tanks on the terrace will be provided for down comer system and as supplementary fire storage as per NBC requirement/ local fire Bye laws.

The effective capacity of reservoir, as per Table 7 of NBC 2016 Part – 4, is given below:-

Sl. No.	Under/Overground/ Overhead Tanks	Capacity of Reservoir	Remarks
1.	Partially Under/Over Ground Static Water Storage Tank	150000 Lts (in 2 Compartments adjacent to Fire Pump Room near to Indoor Sports Complex)	Considering scattered locations of buildings, probability of fire spreading to different buildings is negligible, thus storage capacity has been devised as per max. requirement.
2.	Terrace Tank & Terrace Pump	Capacity as per NBC 2016 – Part IV –Table -7	
3.	Fire Pumps in Pump House	1 No. 2280 LPM- Fire Hydrant Pump 1 No. 2280 LPM –Sprinkler Pump 1 No. 2280 LPM –Diesel Pump (common for Hydrant & Sprinkler) 1 No. 180 LPM –Jockey Pump for Hydrant system 1 No. 180 LPM –Jockey Pump for Sprinkler system (Head of pump meeting all requirements) This will cater to both Hospital Building & Indoor Sports Complex	

Note: -

i. The Tables provided above has been prepared considering Buildings as per present scope of work.
ii. Fire Fighting Norms w.r.t NBC 2016 have been indicated in the column titled "As per NBC 2016". The requirements indicated in the column "Deliverable" are minimum to be provided by the EPC Contractor.
iii. Notwithstanding anything mentioned in above table above, additional firefighting provision specifically contained in the Bye laws, if any, shall have to be additionally provided.
iv. Any building not appearing in the above table shall be dealt with as per NBC 2016 norms & Bye law's provisions.

3. System Description: -

The Fire Fighting System shall consist of Diesel Fire Pumps, Electrical Driven Fire Hydrant pump, Electrical Driven Sprinkler pump, Jockey Pumps, Fire hydrant (Internal & External), Air Cushion Tank with air release valves for all risers, Down comer system with /without terrace pumps, Pressure vessel, associated instruments, cabling, piping (internal & external), valves, Fire Brigade inlet connections, draw out connections for each wet riser, fire signages, extinguishers, Gas based fire suppression system, Fire detectors, Discharge Nozzles, control panel etc. has to be provided as per NBC 2016 requirements. Jockey pumps shall maintain

pressure in all water lines for Hydrants & Sprinklers fully charged under pressure for full Automatic operation in case of fire. In case of slow pressure loss, jockey pump will start and at about 1 kg/cm^2 pressure loss in the system, jockey pump will not start and main pump will start automatically.

3.1 Shafts/ Cut Outs & Room Provisions:

Minimum size of shafts to be provided to accommodate sprinkler/wet riser/down comer /drain pipes etc. will be 1200 X 800 MM (approx.) and to be provided at suitable locations as per relevant codes & standards. At places where this size is not feasible, shaft size as per site conditions meeting functional requirement may be accepted as per directions of E-I-C.

- Shafts & Inspection doors shall be minimum of 120 minutes fire rated or as desired by relevant codes.
- Fire Control Room to be provided In Ground Floor which shall be easily accessible & shall accommodate all fire alarm system panel/public address system panel etc.

3.2 Egress components: -

- Egress components to be considered are the no. of exits to which access is provided, capacity of exit access, travel distance to an exit, directional exit etc.
- The width of corridors, aisles/ramps required for exit access shall be sufficient to ensure smooth flow of occupants to exit. Exits shall be so located that the travel distance on the floor shall not exceed distance as mentioned in NBC 2016.
- No exit doorway shall be less than 1000 mm in width except in assembly buildings where door width shall not be less than 2000 mm in width. All exit doorways shall not be less than 2000 mm in height.
- The requirements of nos. of staircases shall supplement the requirements of different occupancies as per NBC 2016 norms.

3.3 Pressurization & Compartment System: -

- Pressurization of enclosed Staircase/Lift Lobby/Lift well provisions to be considered as per NBC 2016 requirements.
- Mechanical ventilation system for basement to be designed to permit min. 12 ACPH or as per relevant codes in case of fire or distress call & 15 ACPH for Utility Areas.
- All floors shall be compartmented / zoned with area of each compartment conforming to NBC 2016 provisions depending upon usage & area/building type.
- Smoke exhaust fans in mechanical ventilation system shall be fire rated &shall withstand 250 degree Celsius for 120 minutes.

3.4 Access to Fire Tenders: -

For access to fire tenders, a clear motor able approach of at least 6meters shall be kept for movement of fire tenders all around the building. The width of the main entrance to the complex shall not be less than 5.5 meters.

3.5 Location & size of Fire Pump House: -

- The fire pump house shall be located adjacent to Partial Under/Over ground fire tanks. The slab of UGT shall be designed structurally to take the load of fire rescue tender (if coming in the drive way area).
- The base of the water tank shall be kept at a level preferably 450 mm to 600 mm (or as desired as per codes) above the level of base of fire pump room so that pumps operate under positive suction conditions & the entire water capacity is above the body of the fire pumps as per best fire engineering practice.
- Fire Pump House shall be separated by fire walls all around & doors shall be protected by fire doors (120 mins rated).
- The size of Fire pump house & distance between pumps, pumps & walls, panel & wall etc. shall be as per latest IS Codes/NBC 2016.
- Sufficient maintenance space shall be provided inside the fire plant room for accessibility of various pumps, panels etc. during repair & maintenance activities.
- Fire Plant Room shall be suitably ventilated considering adequate ACPH as per NBC 2016 code.
- Suitable size Sumps with sufficient sized submersible pumps & level indicators to be considered in plant room for drainage. Also, proper slope to be provided in Fire Pump room so that there is no stagnancy of water during any leakage & it is properly channelized to nearest drainage sump.
- Firefighting pipes from Fire Pump Room to various buildings shall be laid underground at suitable depth as per CPWD specs. Adequate no. of hume pipes having suitable dia. with spare shall be laid across the roads/pathways etc.
- Fire Pump Room shall be provided with safety equipment/items like suitable elastomeric mat (as per relevant IS codes) for Panels, fire buckets, fire extinguishers, hand gloves, safety charts, framed Schematic/SLD etc.

3.6 Pumps & related Equipment/Piping & Related Accessories: -

- Quantity & Type of Fire Pumps (Electric driven Jockey/ Electric driven Terrace Booster/ Electric driven Hydrant/ Electric driven Sprinkler/ Diesel driven Pumps) shall conform to NBC 2016/relevant IS codes.
- All fire pumps shall be with positive suction arrangements.
- Capacity of the Pumps shall be selected as per latest NBC 2016 /NFPA/IS codes & Head as per Building Height & Frictional losses due to bends, pipe lengths etc.
- Horizontally mounted end suction single/multi stage, single/multi outlet energy efficient centrifugal pump, suitable for operation on 415 volts $\pm$ 10%, 3 phase, 50 HZ A.C supply, IE-2 Class efficiency motor, complete with flexible coupling (double arch) and coupling guard as required. Fire pump having C.I. body, bronze/gunmetal impeller and S.S. Shaft with mechanical seal to be considered. Casing shall be designed to withstand 1.5 times the working pressure.

- Diesel driven pump with engine (Min. 4 Cylinders), Air cooled radiator based cooling & shall be complete with cooling system, fuel system, fuel tank (to cater for min. 2 hours), inter connecting piping, starting system, governing system, PRV, exhaust system with residential silencer suitable for outdoor installation & silencer piping shall be extended up to 1 m, outside pump house duly insulated with 50 mm thick glass wool/ rock wool & 1 mm thick aluminum cladding. Flexible connection in between exhaust pipe & pump needs to be provided to suppress vibrations.
- All the fire pumps shall cut-in automatically based on the pressure settings in pressure switch, so as to ensure that the entire fire main line, risers etc. are pressurized on a continuous basis.
- The jockey pump shall automatically cut-out based on the pressure settings of pressure switch. However, the remaining fire pumps shall cut off only in the manual mode.
- All Foundation (PCC/RCC) for Equipment including foundation bolts & vibration isolation springs/pads shall be provided.
- Mild steel (Class 'C') pipes confirming to IS: 1239/3589 including all fittings like bends, elbows, tees, anchor fasteners, couplings etc. shall be used in firefighting system.
- Suspenders, Brackets & Floor/Wall supports for suspending / supporting pipes to be provided.
- Pressure gauge needs to be provided at each landing/ floor of the building for wet riser/down comer system.
- Till 50 mm dia. Pipe, screwed joints shall be provided & 65 mm dia. & above, welded joints shall be provided.
- Suction dia. & discharge dia. of pumps shall be as per pump discharge as per OEM standards.
- The entire pipe work (above ground), pump etc. shall be painted with one coat of primer & two or more coat of red color shade no. 536 of IS: 5 (Post Office synthetic enameled red paint) as per directions of Engineer-in-Charge.
- At terrace/Remote level hydrant, minimum 3.5 kg/sq.cm. Pressure shall be maintained.
- The pipeline shall be designed with suitable flow velocity & friction factor as per relevant standards.
- All pipes below ground will be protected against soil corrosion by wrapping & coating material as per IS: 10221.
- Pipes of 150 mm dia. & below, will conform to IS: 1239. Pipes of 200 mm dia. & above will conform to IS: 3589.
- Suitable Nos. of Installation control Valve (ICVs) to be considered conforming to latest IS codes depending upon no. of sprinklers.

- All necessary valves of PN 16 rating (min.) like butterfly/ globe/ gate/ non return/ sluice, Y/Pot Strainers, pressure gauges etc. to be considered as per requirement (controlling flow/ isolating/one-way flow etc.) & meeting the functionality.
- Pressure vessels shall be provided with all the terrace pumps & at plant room also.
- All Pumps shall be provided with flexible bellows (double arch, PN-16 Rating) to dampen vibration/noise at source.
- Vibration Isolators/Anti Vibration Pads needs to be provided for all pumps to absorb vibration at source.
- Orifice Plate shall be considered to reduce pressure on individual hydrant to maintain operating pressure of 3.5 kg/sq.cm.
- Air vessel/Pressure vessel of suitable size need to be provided in fire plant room & near terrace pump.

  To compensate for slight losses of pressure in the system and to provide an air cushion for counteracting pressure surges / water hammer in the pipe work air vessel conforming to IS: 3844 shall be furnished in the pump room near pump. The air vessel shall normally be half full with water and remaining filled with air which shall be under compression when the system is in normal operation.
- Air cushion tanks with air release valves needs to be provided for all risers of sprinkler/hydrant. For one no. wet riser in shaft, one air cushion tank at riser/terrace pump may be acceptable as per directions of E-I-C. For hose reel risers, air release valve will be sufficient at the riser top.

- Pump/ Motor placed on Terrace /open area should be weather proof type & required size of canopy also needs to be provided.
- All pipes should be placed at fixed support. Pedestals at suitable distance to be provided as per requirements & directions of E-I-C.

3.7 Wet Riser& Hydrants System: -

3.7.1 External Yard Hydrants

- External yard hydrants shall be of 'Stand Post' type conforming to IS: 908 and comprising of stand post for single or double (conforming to NBC 2016) outlet with oblique pattern hydrant valve, Controlled Percolating (CP) Hose ISI marked (IS:8423) 63 mm dia. x 15 m long complete with instantaneous type gunmetal 63 mm dia. ISI marked Male & Female couplings, 63mm dia. Gunmetal branch pipe with gun metal nozzle of 20 mm nominal bore outlet with instantaneous type 63 mm dia. coupling M.S. fire hose weather proof cabinet (750x600x250mm approx. or as per requirement) made out of 16 gauge M.S. sheet capable of accommodating landing valve, hose pipes, branch pipe, nozzle, fittings & accessories. The box shall have a front glass door with lock and key arrangement & shall be painted with one coat of primer & two coat of finished stove enameled post office red color paint & "External Fire Hydrant" written on front.

- The ring main around the building will be laid min. 1 m below ground level, 2 m away, within 15 m from face of the building.
- The distance between the external hydrant post shall be considered as per hazard classification conforming to relevant IS codes. However, maximum distance shall be 45 m.

3.7.2 Internal Hydrants:

- It shall consists of Type -A- single headed or Type B double Headed (as per requirements), Gunmetal ISI marked oblique pattern hydrant landing valve with 80 mm dia. flange inlet and 63 mm dia. instantaneous type female out let, swinging type First Aid hose reel in red color drum with 36 mtr long and 20 mm dia. heavy duty rubber water hose, 20 mm dia. Globe valve stop cock, terminating with G.M. coupling & nozzle of 5mm outlet with shut off valve, 63mm dia. Gunmetal branch pipe with gun metal nozzle of 20 mm nominal bore outlet with instantaneous type 63 mm dia. coupling, fireman's axe with heavy duty insulated rubber handle,

  2 Nos. of 15 m long Non-Percolating Hose Pipe, suitable size of MS door made up of 16 gauges MS Sheet capable of accommodating fire hose reel, landing valve, hose pipes, fittings. The door shall have a front glass with lock and key arrangement & shall be painted with one coat of primer & two coat of finished stove enameled post office red color paint & "Internal Fire Hydrant" written on front.
- Quantity for the same need to conform to NBC 2016/relevant IS codes.
- One no. pressure gauge to be provided in each internal hydrant riser per floor.
- No. of risers/floor in each building shall be governed by the max. Travel distance as specified in NBC 2016.
- Adequate No. of FHC to be provided at Terrace for mitigating fire due to MEP Equipment placed at Terrace.

3.8 Fire Brigade Inlet Connections/ Draw Out Connection

- 4 Way Fire Brigade Inlet connection complete with all accessories (sluice valve/NRV etc.) shall be provided for connection to Ring mains, at delivery header in pump house, main hydrant line feeding to each building, Partial Under/Over ground tank.
- 2 Way Fire Brigade Inlet connection complete with all accessories (sluice valve/NRV etc.) shall be provided for connection to down comer system for residential/hostel buildings etc.
- 2 way draw out connections with foot valve for U.G Fire tanks to be considered near fire Pump House.
- All these above shall be in line with relevant IS codes & as per direction of E-I-C.

3.9 Sprinkler System:

- Automatic sprinkler system shall be provided as per requirements of NBC 2016 or relevant IS codes.

- As per hazard classifications, maximum/minimum distance between sprinklers, between sprinkler & walls to be maintained. Coverage area of each sprinkler & Assumed maximum area of operation shall conform to relevant IS codes.
- Side wall/pendant/upright sprinklers to be provided as per requirements, shall be UL & FM certified, complete with rosette plate, glass bulb temperature rating of 68 degree Celsius (red color), Quick response type, chrome plated finish & in compliance with NBC 2016 & relevant IS codes.
- Suitable Nos. of Installation control Valve (ICVs) to be considered consisting all accessories (Butterfly valve, Y strainer, water gong, Alarm Valve, drain valve, Pressure gauge etc.) conforming to latest IS codes.
- Sprinkler shall be selected as per temperature rating which shall be based on usage type. Color code shall be in conformance to relevant IS codes.
- Inspection test assembly/zonal control valve complete with flow switch & other related accessories (NRV/Butterfly, drain valve, Pressure gauge, sight glass etc.) to be provided in each floor sprinkler riser.
- Flexible pipe for connecting sprinklers (braided type) & UL & FM certified to be considered of various sizes as per site conditions to maintain symmetry & crossing of ducts & other utilities. The supporting system for flexible pipe shall be suitable for different type of false ceilings.

4 Portable Fire Extinguishers: -

- The sufficient qty. of portable/trolley mounted type fire extinguishers (Gas Based stored pressure type CO2 type /Ammonium Phosphate Type/ Mechanical Foam etc.) shall be provided at all levels of the building, plant room, basement, substation etc. at strategic locations as per requirements, generally to follow NBC-2016 and IS – 2190: 1992 to extinguish fire of class A, B ,C.
- Location of the Fire Extinguishers shall be considered near all the Internal Hydrants, HT Panel Room, LT Panel Room, Lift Machine Room, Fire Pump House, Server Room, UPS Room, Fire Control Room, Security Control Room, Car Parking, STP/ETP/WTP etc.
- Clean agent fire extinguishers need to be provided in all Labs, UPS/Batteries Room, BMS Room, Fire Control Room, other LV Rooms & any other critical areas where it is required as per functional requirements & as per directions of E-I-C.
- All Fire Extinguishers shall be Halon Free.
- Sand buckets 1 set (2 Nos.) of 9-liter capacity for each DG Set/Transformer/Diesel Driven Pump shall be provided. It shall also be in line with relevant norms & standards.
- Minimum provision of Fire Extinguishers as per IS 2190 to be provided in addition to provisions stated in DBR.

5 Gas based Fire Suppression System: -

5.1 <u>For Critical Areas:</u>

Gas Based Fire Suppression system is required in UPS/Server Rooms/ Data Centers & Laboratories (of critical nature) and any other rooms which are required as per functional requirements.

The Total Room Flooding system of fire detection and quenching is proposed in all Low Voltage Equipment rooms where Water sprinklers cannot be used. The Gas cylinder assembly should be UL/FM approved with seamless CCOE approved cylinder and will be connected to discharge nozzles through metal Piping. The master cylinder Kit fitted on Gas cylinder will be operated through separate Fire detection Panel and will release zero Ozone depletion potential Gas through the nozzles in case of fire.

5.2 For Electrical panels: Tube based Fire protection system shall be provided in the Electrical Panels installed in substations (LT panel, HVAC Panel, Capacitor Panel etc.). The detection Tube shall be installed throughout the compartment of panels.

Cylinder equipped with brass valve, pressure Gauge isolation valve will be fitted on the wall of the panel with suitable brackets and will be connected to the detection tube. In case of fire the tube shall rupture at a point. The rupture Tube shall result in formation of discharge and release of Gas in uniform pattern.

6 Fire Signage: -

Various types of signage are proposed in the complex as per NBC 2016 Part -4. Material of signage shall be of acrylic/aluminum of required dimensions. At every floor near Lift landing diagram showing stairways shall be provided mentioning instructions - 'IN CASE OF FIRE USE STAIRS UNLESS INSTRUCTED OTHERWISE'. The signage shall be above call push button in Lift Lobby. Floor Signage will be provided in each floor within the staircase & should easily readable. Each corridor of every floor will have directional signage indicating Fire Escape route. These Signage may be LED lit with UPS power backup or of photo Luminescent paint as per requirement & directions of E-I.C so that they will be visible in dark in case of power failure. Signage for Assembly Point also needs to be provided. Evacuation path signage & Emergency Exit signage shall also be provided. Some of the signages shall be hung from ceiling (both ways) to have proper visibility.

7 Electrical Works related to Fire Fighting System: -

7.1 General

- Firefighting panel of suitable size incomer & sufficient nos. of outgoing feeders for all pumps along with spares/spaces to be provided.
- Power cabling of suitable size to be laid from LT panel to firefighting panel. Power cabling of suitable size from firefighting panel to fire pumps to be laid. Control cabling from fire pumps to firefighting panel & firefighting panel to pressure switch to be done.
- Suspenders and/or cable trays for laying cables to be used.
- For sprinkler system, fire annunciation panel needs to be considered.
- Motor shall be TEFC squirrel cage AC induction type. The motor shall be suitable for continuous duty & rating necessary to drive the pump at 150% of its rated discharge

with at least 65% rated head. Motor shall be with class F insulation & IE-2 class efficiency. DOL/star delta starter to be provided as per H.P rating of motors.

- Adequate no. of NO/NC contacts for interlocks, indicating lamps, remote operation etc. shall be provided on starter/contactor.
- Metallic body of all motors, medium voltage equipment etc. shall be connected by 2 separate & distinct earth conductors to the earth stations of the installations. Looping of such body earth conductors is acceptable from one equipment to another.

Terrace pumps & terrace tanks at respective buildings as per NBC 2016 provisions & local fire bye laws needs to be provided.

All provisions like External Yard Hydrant, First aid hose reel, Wet riser, Fire Extinguishers, down comer etc. shall be provided by EPC Contractor as per NBC 2016 provisions.

A detailed chart needs to be furnished in this regard by EPC Contractor.

7.2 Design Calculation

7.2.1 PUMPING HEAD CALCULATION: (Mentioned Below or as per site conditions)

Total height of the building – between 15-24mtrs. (From average ground level around the building to the terrace floor)

A minimum of 3.5 kg / cm2 of pressure required to be provided at the farthest / last hydrant point. Plus, a minimum of 6% of Hydraulic pressure loss is considered in the entire system.

Total Head = 35 Mtr + 15 mtr + height of hydrant at Terrace Level from pump level + 6% length of pipe from pump to terrace level hydrant.

Hospital Block

Head=15.4+35+15+6 % of 400 Mtr = 89.4 Mtr, SAY =90 Mtr

Indoor Sports Head =17.4+35+15+6% of 400 Mtr = 91.4 Mtr, SAY =90 Mtr

The Head of Pumps worked out as above is tentative & the EPC contractor shall work out the Head of Pumps during detailed engineering as per buildings height, friction loss of pipe/fittings etc.

7.2.2 HYDRAULIC CALCULATIONS – SPRINKLERS SYSTEM (Mentioned Below or as per site conditions)

Minimum Design Requirements - AS PER NBC/TAC/IS 15105: -

Occupancy Classification Ordinary/Moderate Hazard (Group C-1 Sl. No 3) (As per NBC 2016-Part-4)

Design Density- 5 (L/min)/m2 (As per IS15105/TAC)

Hydraulically Remote Area	360m^2(As per IS 15105/TAC)
Water Demand = Remote Area x Density	360m2 x 5(L/min)/m2 = 1800LPM
Water Demand as per sprinkler	40 Nos. x 47.33 ltr = 1893.2 LPM
K-Factor	80.00

Sprinkler Temperature Classification 68°C

NPT Thread Size 15mm

Bulb Color Red

Sprinkler Distance Center to Center 2 - 4 Mtr

Max. Area Coverage by One Sprinkler (ceiling Type) -12 m^2
As per Pattern (A) Discharge in LPM Req. -47.33
Water Storage Tank Capacity including wet riser - 150000 Liters (2 X 75000 LIT)

Main Sprinkler/Hydrant/Diesel Pump Capacity -2280 LPM

Jockey Pump Capacity -180 LPM

Frictional pressure loss in pipe shall be calculated from the Hazen – Williams's formula as under: -

$$\mathbf{Pm = 6.05\ (Qm^{1.85} / C^{1.85} \times dm^{4.87})10^5}$$

Where,

Pm = frictional resistance in bar per meter of pipe.

Qm = Flow in LPM.

Dm = actual internal diameter in mm.

C = frictional loss coefficient.

L = Equivalent length and fittings (in Mtr).

For M.S. Pipe "C" value shall be 120 in sprinkler installation for calculation purpose.

J. Design Basis Report
Electrical and LV works

1. GENERAL

(a) The EPC Contractor shall carry out Design, Engineering, Supply, Installation, Testing & Commissioning of complete Internal & External Electrification works including Low Voltage (LV) and other works as required for smooth Functioning of the proposed RIPANS, Aizawl, Mizoram. All Electrical & LV works shall be designed and executed as per latest codes of practice for Electrical installations and meeting the requirements of Indian Electricity Rules/Act, applicable I.S. Codes/ Rules and relevant IS/ CPWD Specifications, Special requirements of Assam Electricity Board latest up to date.

(b) The rating and capacity of equipment indicated herein below are minimum to be provided. However during detailed designing, if required and found necessary, the capacity / rating of the equipment may be upgraded by the EPC Contractor.

2. SCOPE OF WORK

Electrical & Allied Services' required covers Electric Sub Stations, D.G Set Installation work, Internal Electrical Installations, HT/ LT Panels, Distribution Boards, External Electrical Installations, 11 KV HT and LT Cables, Road/ Compound Lighting, Solar Lighting Poles, Centralized UPS system, Internal & External Electrical Distribution work. It shall also include Direct Online Solar power station, IP-based Telephones System, Data Centre, LAN Networking & Wi-Fi System, CCTV System, Fire Alarm System, Public Address System, Building Management System, Nurse Call System, Access Control System, MATV System, Hospital Management Information System (wiring only), Lifts and Information Display System etc.

Suitable size shafts, cutouts, Niche, openings etc. shall be provided to facilitate installation of Rising Mains, Cable Trays, Ducts System etc. in all floor slabs of various buildings for various service areas, as required. All shafts, cutouts, Niche, openings etc. provided on floor slabs shall be suitably closed after laying of services lines as per fire safety norms as per NBC 2016. Suitable doors shall be provided for all shafts at all floors as per fire safety norms stipulated in NBC 2016.

Chain link fencing with suitable entry gates, as per functional & statutory requirements shall be provided for all Electrical Substation and DG Yard.

All Services, as required like electrical power panels, Light & Fan Points, Power Points, Telephone Points LAN/Data/Wi-Fi Points, UPS Panels & UPS Power Points, Earth Pits, Earthing Network, Raw/ Soft/ Hot water supply, drainage, plumbing, HVAC provisions, ducting etc. shall be adequately provided as per OEM requirements for all Medical Equipment, Modular OT Rooms, ICUs, CSSD, Laundry, Kitchen, MGPS, Pneumatic Tube System etc.

3. ELECTRICAL POWER REQUIREMENT

The Electrical Load requirement has been calculated on the basis of covered area of various buildings/ blocks as per NBC 2016 & ECBC latest as amended.

Load for the Central Air Conditioning Plant, Medical Equipment/Services, Lifts, Pumps, External Lightning, STP, WTP etc. has also been taken in to account.

Peak Electrical Connected load before overall diversity factor works out to **2140 kW** i.e. 2821 kVA.

4. SOURCE OF ELECTRICAL POWER SUPPLY:

a. Scope of Power & Electricity Department, Govt. of Mizoram

The Power & Electricity (P&E) Department, Govt. of Mizoram shall provide Main LT Power supply (0.433 kV) upto various proposed substations as per prevailing rules/ regulations of Power & Electricity Department Govt. of Mizoram, in RIPANS campus. P&E Deptt. shall carry out all the works related to installation of 11/0.433 kV substations in RIPANS complex. This work includes providing of 11 kV power supply, 11 kV HT cables, 11/0.433 kV Transformers, LT cables from transformers to LT Two Pole structures (to be located nearby proposed substations) along with required overhead structures/ poles for laying of overhead HT & LT cables.

Details of 11/0.433 kV Substation (5 Nos.) have been provided in Para No. 5 as below.

b. Scope of EPC Contractor:

Scope of work for EPC Contractor shall commence from Two-Pole structure (to be provided adjacent to each proposed substation at a designated point by Power & Electricity Department, Govt. of Mizoram) for tapping 0.433 KV LT power for onward distribution to the respective buildings. All LT panels, Capacitor panels, Floor LT Panels, DG Sets along with Exhaust Pipes & Exhaust Stack structure as mentioned in subsequent paragraphs shall be provided by the EPC Contractor. The civil foundations for all substation equipment like Transformers, DG Sets, Exhaust Stack Structure, Two Pole structure, GI chain link fencing etc shall be provided by the EPC Contractor.

It will be responsibility of EPC contractor to liaison & submit the requisite documents to P&E Deptt., Aizawl along with equipment details & specifications, required for providing 11/0.433 kV Substations in RIPANS campus through Engineer-In-Charge, HLL / Director, RIPANS.

Liaisoning required for enhancement of Sanctioned HT load from existing capacity to total required capacity, shall also be carried out by EPC contractor. Liaisoning includes submission of application following the due procedures with all necessary documents, as required for load enhancement.

0.433 KV LT Power supply shall be further fed to the proposed Main LT Panels, situated at various buildings / blocks to be constructed at various locations inside RIPANS campus.

5. ELECTRIC SUB-STATIONS (11/0.433 kV):

Details of 11/ 0.433 kV Electric Substations (5 Nos.) to be established in RIPANS, Aizawl Complex to meet the Peak Electrical Load Demand, are as following:

S.NO.	BUILDING NAME	TOTAL LOAD (KW)	Transformers 11/0.433 KV (In Client Scope)	DG Set @ 415V (In EPC Contractor Scope)	Capacitor Panel (In EPC Contractor Scope)

A.	**INSTITUTE BLOCK**				
1.	**ESS-1**				
a.	Academic Block	326	2 X 250 KVA	2 X 180 KVA	2 X 125 KVAR
	Total-A	**326**			
B.	**ESS-2**				
1.	General Hostel Block	309	2 X 500 KVA	2 X 400 KVA	2 X 225 kVAR
2.	Indoor Sports Complex & Auditorium	193			
3.	Guest House	71			
	Total-B	**573**			
C.	**ESS-3**				
1	100 Bedded Hospital	857	2 X 750 KVA	2 X 500 KVA	2 X 375 KVAR
2	Plumbing	25			
3	Fire Fighting (Jockey Pump)	10			
4	STP	15			
5	External Lighting	15			
	Total-C	**922**			
D.	**ESS-4**				
1	Resident Doctor Quarters	217	2 X 125 KVA	2 X 125 KVA	2 X 90 KVAR
2	M. S. Residence	8			
	Total-D	**225**			
E.	**ESS-5**				
	Staff & Nurse Apartment	94	1 X 160 KVA	1 X 100 KVA	1 X 75 KVAR
	Total-E	**94**			
	Total (A+B+C+D+E)	**2140**			

DG Sets shall have facility for auto & manual start/ stop, auto changeover, auto load management and Synchronization facility. The Mail LT supply from transformers & DG Sets shall be connected to respective LT Panels through suitable size LT power cables in all the substations.

Main LT Panel and all other Electrical Panels shall be compliant to IEC-61439 and other Relevant IS Codes, ECBC /NBC norms.

Trenches with suitable width & depth shall be provided for installation of HT/LT/ Capacitor Panels etc. and also for Laying of LT Power cables & Control Cables. Substation shall comprise of all ancillary equipment like Battery Charger etc. Suitable size MS Chequered Plates, duly painted of minimum thickness 6 mm shall be provided for trenches inside the panel room as required. Hot Dip Galvanized Perforated type Cable trays of suitable size shall be used as required. All armored LT power cables, control cables, telephone cables, signal cables etc. shall be laid underground or through overhead structure/ Pole as per

relevant norms. Adequate no. of Hume pipes/ DWC HDPE Pipes having suitable diameter with spare shall be laid across the roads/pathways etc.

All LT Panel Rooms/Floor panel Rooms shall be provided with safety equipment/items like suitable elastomeric mat (as per relevant IS codes), fire buckets, fire extinguishers, hand gloves, danger plates, safety charts, framed Schematic/ SLD etc. Suitable civil foundation/trenches etc. for all substation equipment shall be provided as per design load of respective equipment.

All LT Panels shall have 20% spare outgoing feeders for different rating of feeders. At least one spare outgoing feeder shall be of highest breaker rating of the panel.

Panel Bus Bar current rating shall be provided at 20% higher current rating (minimum) of the highest current rating of Incomer Breaker of the panel.

20% spare terminal blocks shall be provided for motor starter feeders and control wiring purpose in the panel.

Electrical Panel Rooms, Battery Room, Control Room and civil foundations & structures for all the equipment shall be constructed by EPC Contractor, as required.

In order to prevent storm water entering the ESS Buildings and DG Set area through the water collection-pits, the floor level of the substation area /ESS buildings/ DG Set area shall be at suitable height above the highest flood water level that may be anticipated in the locality or as directed by Engineer in charge.

5.1. Electric Sub Station -1 (ESS-1)

ESS-1 shall meet the electrical load requirements of Academic Block. As per projected peak load demand on ESS-1, Transformers with OFF Load Tap Changer of capacity 2 X 250 KVA along with 11 KV VCB/ Breaker Panel board of suitable Nos. of incoming & outgoing feeders are proposed, which shall be provided by Client.

DG Set Capacity for back up supply in ESS-1 will be 2 X 180 KVA. Location of DG Set shall be indicated in the Master Plan.

5.2. Electric Sub Station -2 (ESS-2)

ESS-2 shall meet the electrical load requirement of General Hostel Block, Indoor Sports Complex & Auditorium & Guest House and External Services etc. Location of ESS-2 has been indicated in the General Hostel building area. As per projected peak load demand on ESS-2, Transformers with On Load Tap Changer, RTCC Panel of capacity 2 X 500 KVA along with 11 KV VCB Panel/ Breaker board of suitable Nos. of incoming & outgoing feeders are proposed, which shall be provided by Client.

DG Set Capacity for back up supply in ESS-2 will be 2 X 400 KVA. Location of DG Set shall be indicated in the Master Plan.

5.3. Electric Sub Station -3 (ESS-3)

ESS-3 shall meet the electrical load requirement of Hospital, HVAC, Plumbing, STP and External Services etc. Location of ESS-3 has been indicated in the hospital building area. As per projected peak load demand on ESS-3, Transformers with On Load Tap Changer, RTCC Panel of capacity 2 X 750 KVA along with 11 KV VCB Panel board of

suitable Nos. of incoming & outgoing feeders are proposed, which shall be provided by Client.

DG Set Capacity for back up supply in ESS-3 will be 2 X 500 KVA. Location of DG Set shall be indicated in the Master Plan.

5.4. Electric Sub Station - 4 (ESS-4)

ESS-4 shall meet the electrical load requirements of Resident Doctor and M.S. Residence Buildings. As per projected peak load demand on ESS-4, Transformers with OFF Load Tap Changer of capacity 2 X 125 KVA along with 11 KV VCB Panel board of suitable Nos. of incoming & outgoing feeders are proposed, which shall be provided by Client.

DG Set Capacity for back up supply in ESS-4 will be 2 X 125 KVA. Location of DG Set shall be indicated in the Master Plan.

5.5. Electric Sub Station - 5 (ESS-5)

ESS-5 shall meet the electrical load requirements of Staff/ Nurse Apartment and external Services. As per projected peak load demand on ESS-5, Transformers with OFF Load Tap Changer of capacity 1 X 160 KVA along with 11 KV VCB Panel board of suitable Nos. of incoming & outgoing feeders are proposed, which shall be provided by Client.

DG Set Capacity for back up supply in ESS-5 will be 1X 100 KVA. Location of DG Set shall be indicated in the Master Plan.

5.6. DG Set For Backup Supply

Diesel Generator sets are to be provided for back up supply for essential Loads in case of electricity failure.

All DG Sets shall be provided with suitable PLC and AMF relay/ Automatic controller for achieving automatic start/stop, automatic load management. Additional provision for manual start/ stop of DG Sets shall also be provided. Transformer Incomer ACBs, DG Incomer ACBs and Bus Couplers shall be electro-mechanically interlocked with provision of auto and manual mode operation. Required control cabling/wiring in DG Sets, LT Panels etc. shall be provided as per requirement.

All DG Sets shall be outdoor type with Hospital Silencer and acoustic enclosure as per latest CPCB and other relevant norms. All Transformers, DG Sets & other Electrical Panels/equipment, to be installed outside, shall be provided with adequate shading with polycarbonate sheets supported with robust MS structures.

All DG Sets shall be radiator cooled type without cooling towers.

Independent exhaust pipe from each DG Set shall be taken out and exhaust Stack height of the DG Sets shall be as per CPCB/CPWD/Local Bye-Laws standards. Self-supporting MS Exhaust stack structure of suitable height as per CPCB norms, duly painted with synthetic enamel paint, shall be provided to support the exhaust pipes with expansion bellows as required. All exhaust pipes and silencers shall be insulated and clad with Aluminum sheets as per CPCB norms, CPWD Specifications and Technical Specifications.

All DG Sets shall be provided with individual Day Oil tank (Inbuilt / external) of suitable capacity.

Reliable & continuous Power Supply/ control supply to following Emergency & Life safety Systems shall be provided, as required:

1. Fire Pumps
2. Pressurization and smoke venting; including its ancillary system such as dampers and actuators.
3. Lifts
4. Exit Signage Lighting
5. Emergency Lighting
6. Fire alarm system
7. Public Address system (relating to emergency voice evacuation and annunciation)
8. Security rooms.

5.7. BMS SYSTEM:

Building Management System shall be provided with control system architecture using computers, networked data communications, graphical user interfaces for high-level process supervisory management, other peripheral devices such as programmable logic controller (PLC) and discrete PID controllers to interface with the various equipment, panels etc. in Hospital Building & HVAC plant room.

5.8. Power Factor Improvement:

Real time Automatic power factor control panels with ultra-heavy duty capacitors, Harmonic filters 7% detuned shall be provided in the substations to achieve overall power factor between 0.97 to unity (lagging) from existing Power Factor, as per ECBC with operation in both Auto and Manual mode. Necessary arrangement for automatic switching off of Capacitor Panels is to be provided during Power supply availability from DG Sets.

ELECTRICAL POWER DISTRIBUTION

The Electrical Power Distribution for electric supply shall be as detailed below.

a. Required Nos. of power cables of suitable size shall be provided from LT Two Pole Structure and DG Sets to Main LT Panels, Main LT Panels to HVAC Panel & all Capacitor Panels. Adequate runs of XLPE insulated armored Aluminum conductor cables shall be laid from Main LT Panel to LT Panels of individual buildings & blocks.

b. Separate distribution system shall be provided for lighting load, Power & AC Load & UPS load. Each distribution system shall be with Electrical panels, sandwich rising mains, Floor panels, Double door MCB Type DB's, VTPN DBs etc.

c. Various buildings as required shall have a HT/ LT room to receive power from the substation through armored cable and distribute power to the entire building through a LT Panel located in the LT room.

d. There shall be suitable Nos. of rising mains for catering to loads of Lighting, HVAC equipment, Power, Medical Equipment (Hospital Block), UPS etc. connected to Main LT Panel, as applicable.

e. Each rising main shall be sandwich type and have Tap off at every floor, feeding the floor panels with incoming & outgoing MCCBs of required capacities and numbers feeding the double door DBs/VTPN DBs.

f. Sub mains from floor panel to DBs shall be connected with armored cable on surface/cable tray.

g. Hot Dip Galvanized Perforated Type Cable trays of suitable size with perforation not more than 17% shall be provided as required in all the buildings.

h. The power cabling shall be sized so that the distribution losses do not exceed 3% of the total power usage in buildings. Voltage drop for feeders shall not exceed 2% at design load and for branch circuit; it shall not exceed 3% at design load as per ECBC norms.

i. Metering Panel with Energy Meters (Double Source) and Auto Changeover & Current Limiter (ACCL) of suitable rating, as required shall be provided for Resident Doctor Apartment, Staff Nurses Apartment & M.S. Residence.

6. EARTHING NETWORK

Earthing with GI Plate Earthing System & Copper Plate Earthing system, as required, shall be provided for Earthing of sub stations equipment's, Electrical Panel Boards, UPS and other Equipment /installations in each building. Earthing shall be in conformity with provisions of Indian Electricity Rules 1956 & as per IS-3043/ CPWD norms as amended up to date. Copper/GI earth strips shall be used for connecting the Electrical equipment's and Medical equipment's with Earth pits as per prevalent norms. Earth Leakage circuit breakers/RCBO shall be provided in the DBs for individual units.

Copper Earth strips and Copper Electrode Earth Pits shall be provided for Body & Neutral Earthing of all electrical equipment in the Substation area as per CPWD Specifications. Copper Earth strips and Copper Electrode Earth Pits shall also be provided for all Medical Equipment or as per OEM recommendations.

Earthing shall be carried out for all power distribution system and effectively bonding the equipment. Separate and dedicated earthing with copper electrode earth pits and suitable size copper earthing strips (as recommended by OEM) shall be provided for critical large medical equipment like MRI, CT Scan, X-Ray, Mammography, Fluoroscopy, OT Equipment, OT Isolation Panels/Transformers, OT UPS & its Panels, Ultra Sound etc. All other medical equipment shall be connected through a common earthing grid.

Separate and dedicated earth pits/stations with Copper electrode & Copper earth strips shall be provided for the following:

- HT Panels
- Main LT Panels, Capacitor Panels, RTCC Panel & HVAC Panels
- UPS system – Body & Neutral
- EPABX , LAN/DATA Server and other ELV Equipment

- Transformers - Neutral & Body
- DG Sets - Neutral & Body, DG Exhaust Stack
- Laboratory Equipment
- OT's
- ICU Equipment
- All types of Medical Equipment
- MGPS Equipment
- Any other equipment as required

However, GI strip earthing with GI electrode earth pit shall be provided for Electrical Floor panels located in various buildings. For Lifts, Copper /GI strip earthing with Copper /GI electrode earth pit shall be provided as per OEM requirements.

Suitable sized Elastomeric Safety Mats with suitable thickness shall be provided for all HT/LT Panels installed in the substations and all buildings, as required.

All three phase electrical installations shall be provided with double Earth connection and single phase electrical installations with one Earth connection as per CPWD specifications & NBC 2016.

7. LIGHTNING PROTECTION SYSTEM

Lightning protection of various buildings and blocks shall be provided as per IS/ IEC-62305-1:2010 (latest as amended), CPWD Specifications and NBC 2016 norms. The main and most effective measure for protection of structures against physical damage is considered to be the lightning protection system (LPS). An external LPS which consists of air-termination system, down-conductor system and earthing system is intended to:

a) Intercept a lightning flash to the structure (with an air-termination system),

b) Conduct the lightning current safely towards earth (using a down-conductor system), and,

c) Disperse the lightning current into the earth (using an earth-termination system).

Accordingly a standard lighting protection system will be provided in all the buildings as per NBC 2016 Standards, using single prone finials, horizontal and down comer Copper earthing strips of suitable size, terminating in the Copper Plate Earth Pits. Aviation Obstruction Light (AOL) shall be provided in various buildings as per Civil Aviation regulations, NBC norms & CPWD Specifications as applicable.

All Aviation Obstruction Lights shall be fed with UPS supply only.

8. INTERNAL ELECTRIFICATION, LV & ALLIED WORKS

a. Following works shall be carried out in coordination with the civil work within the buildings complete in all respects as per latest IS Codes and CPWD Specifications.
   i. Wiring & Conduiting (MS/PVC Conduits) for internal electrification, LV & Allied works, Cable & MATV.
   ii. LED Light fixtures, Fan (Ceiling & Wall) & Exhaust Fans.
   iii. 6A Light Point /UPS Modular Switch & Socket Outlets.

iv. 16A/ 20A Power/UPS Modular Switch & Socket Outlets

v. L.T. Cables and Sub main wiring, circuit wiring.

vi. GI perforated Cable Trays

vii. Raceways

viii. Sandwich Type Rising Mains

ix. Floor Panels, Distribution Boards & VTPN DBs.

x. Earthing

xi. Extra Low Voltage system like Telephone/IPBAX, LAN & Wi-Fi, Fire Detection & Alarm System, CCTV System, MATV System, Public Address System, Access Control System etc.

xii. Audio Visual System & Stage Lighting for Auditorium.

xiii. Audio Visual system for conference Room, Seminar Hall, Lecture Theaters etc.

xiv. Nurse Call System.

xv. Information Display System.

xvi. Any other system as required.

b. Following points shall be generally followed for internal and external electrification of various areas:

i. Internal areas like rooms, corridors, lobbies, staircases, terraces, washrooms etc. of all buildings and blocks shall be adequately illuminated conforming to provisions stipulated in NBC 2016, ECBC and CPWD technical specifications maintaining the indicated Lux levels and Light Power Density.

ii. The Internal Electrification work shall be carried out in recessed/surface mounted MS or PVC conduits in accordance with CPWD General Specifications for Electrical Works Part-I (Internal)-2013 and Part-II (External)-1994 with up to date amendments.

iii. MS/ PVC Conduits shall be surface mounted or laid on GI angle/channels with suitable hanging GI supports in areas wherever there is false ceiling provision. In case there is no provision for false ceiling, MS/PVC Conduits shall be concealed in concrete during slab casting. Wiring for lighting/power shall be generally done in MS Conduits whereas wiring for LV works except Fire evacuation System shall be generally done in PVC conduits unless stated otherwise.

iv. FRLS PVC insulated Copper conductor wires will be used for points, circuit & sub-main wiring conforming to relevant IS-Codes. Wiring shall be carried out with following sizes of PVC insulated FRLS multiple stranded single core copper conductor wire/cable.

a. Light Point - 1.5 sq.mm
b. Ceiling /Cabin/Exhaust Fan Point - 1.5 sq.mm
c. Call Bell Point - 1.5 sq.mm

d. 6A Plug Point/ UPS Computer outlets (up to 3 outlets on one ckt.) - 2.5 sq.mm
e. Circuit Wiring - 2.5 sq.mm
f. General Power Point – 4 sq.mm
g. Industrial Socket with 20A DP MCB for Geysers – 6 Sqmm
h. 20A Industrial Socket Outlet – 6 Sqmm
i. Special Power Point – 6 Sqmm
j. Industrial/ Modular Type A/C Socket with 32A DP MCB - 6 Sqmm
k. Sub Main wiring from VTPNDB/ Floor Panel to DB:-

i. For DB Incomer Size 25 A DP – 2RX6 Sqmm + 1R X6 Sqmm
ii. For DB Incomer Size 32/40 A DP – 2RX10 Sqmm + 1R X10 Sqmm
iii. For DB Incomer Size 63 A DP – 2RX16 Sqmm + 1R X16 Sqmm
iv. For DB Incomer Size 25 A 4 Pole – 3RX6 Sqmm + 2R X6 Sqmm
v. For DB Incomer Size 32/40 A 4 Pole – 3RX10 Sqmm +2R X10 Sqmm
vi. For DB Incomer Size 63 A 4 Pole – 3RX16 Sqmm + 2R X16 Sqmm

v. Agency shall execute the work after obtaining necessary approval of the layout for internal electrification of all buildings, Residential Blocks, common areas and staircases. The staircase lighting shall be in group control system.

vi. Modular type switches, sockets and stepped type electronic fan regulators, bell push button along with matching mounting boxes of same make shall be used.

vii. Color coding of the conduits, switches, sockets shall be provided for Normal & UPS power supply as per NBC 2016.

viii. TV Outlet point wiring shall be terminated in suitable size of G.I. box along with splitter boxes at every floor. The interconnections of all splitter boxes fixed at all floors shall be done properly with conduits to form proper distribution system with the prior approval of Engineer-in- charge.

ix. LED Type Lighting Fixtures with inbuilt harmonic suppression mechanism shall be provided. All internal and external LED Light fixtures shall have THD less than 5 %.

x. Suitable size & capacity Exhaust Fans shall be provided in Hospital & other areas.

xi. Suitable size & capacity Ceiling Fans/ Wall Fans (White/Off White color) shall be provided in all the rooms and areas of all the buildings /all blocks except OT /ICU /MRI /CT and other critical areas of Hospital as required and as directed by Engineer In Charge.

xii. Separate shafts shall be provided for laying of pipes for Electrical, ELV, Mechanical and Fire Services.

xiii. Laying of DWC HDPE / Hume pipes/Poles /Overhead structure for road crossing or in pucca portion & CC path etc. for electric / telephone / LAN/ street lighting cables complete with adequate number of cable chambers shall be provided by the agency.

xiv. After completing the work, necessary test results as envisaged in latest CPWD General Specifications Part-I (Internal) & Indian Electricity Rules, shall be recorded and submitted. The results shall be within the permissible limits.

xv. Aviation Lights (LED Type) shall be provided on buildings and structures as per prevalent norms & IS-Codes.

xvi. GI Raceways with all accessories shall be provided in Data Server Room, ELV Rooms of various buildings as per requirements.

xvii. Suitable illumination with LED light fixture shall be provided on terraces of all Institutional, Residential buildings, Substation buildings, HVAC Plant Room Building, all Services Buildings.

xviii. Power Points, LAN points, UPS power points, Telephone Points (with telephone instrument as required) shall be provided for all counters like registration, reception, nurse call station etc. and as directed by Engineer In-Charge.

xix. Requisite size of raceways shall be provided in slabs with fillers, wherever required for drawing the wires and cables for the work stations etc.

xx. For areas having grid type false ceiling, recessed type LED Light Fixtures of size 600 mm X 600 mm shall be provided as per directions of Engineer-In-Charge unless otherwise stated. For areas having false ceiling with Gypsum board, Down Lighter round type fixtures of suitable size shall be provided as per directions of Engineer-In-Charge unless otherwise stated. Surface mounted Light Fixtures shall be provided in the areas without False Ceiling.

xxi. Industrial weather proof sockets (single phase and three phases) shall be provided in the kitchen on the corresponding walls.

xxii. 4 No. 6/16 amps UPS power socket outlets shall be provided with each bed of General ward or in Bed Head Panel. In addition, normal raw power socket outlets shall be provided for TV/Display monitor, cleaning socket and / or laptop/mobile charging.

xxiii. 8 No. 6/16 amps UPS power socket outlets shall be provided with each bed of critical care units or in Bed Head Panel.

8.1. Lighting Design & Lighting Fixture

LED lighting fixtures shall be provided with inbuilt Harmonic suppression system to achieve harmonic distortion less than 5% in all areas and buildings to achieve the illumination levels conforming to latest IS Code, NBC 2016, ECBC latest up to date. All LED lighting Fixtures shall have luminous efficacy of more than 110 Lumens per watt including driver & accessories. Power Factor at 240 V AC shall be ≥0.95. Color Temperature shall be 5300 K to 6000 K. Color Rendering Index shall be minimum 80 for Indoor Light fixtures & minimum 70 for Outdoor Light fixtures. Lighting Power Density (LPD) shall be achieved for various buildings/ areas as per lighting simulation requirements as per GRIHA & ECBC norms. Number of Light Fixtures (not less than 10%) shall be fed with UPS power in all areas of various buildings. However, at least 1 No Light Fixture shall be fed with UPS power in all rooms and areas.

Occupancy/ Movement sensors and Light Dimmers shall be provided for automatic lighting control in Office rooms / Consultant rooms / toilets and other areas as required under NBC and latest ECBC norms.

8.2. Computer / LAN Networking/ Wi-Fi Points

RJ 45 data outlets points will be provided for Computers, Networking, Telephones, Wi-Fi, Access Control, CCTV, Information Display system, BMS etc. as per requirement in rooms and other areas at various floors in all the blocks / buildings.

The Data Outlet points shall be connected to Rack Panel/Computer hub with 4 pair CAT-6a wiring in Raceways, recessed/ surface conduit as required. UPS Power supply shall be provided to Network Rack, Servers & Computers wherever required.

The maximum length of the CAT 6a cable from end user point to the Hub or Edge switches shall not be more than 90 M. Beyond 90 M length Fibre Optic Cable shall be used.

The Rack Panel/computer hub at various floors will be connected to Main rack of the building/ block with Fiber Optic Cable through conduit or raceways on surface/ recess.

The server shall be connected to Distribution switch through Optical Fibre cable. Distribution switch shall be connected to Edge switches of each building/ block with optical fiber cable in underground DWC HDPE pipe of suitable size for outside connectivity or in cable raceway/conduit inside the buildings.

The proposed IT server shall have compatibility with the existing IT server of client. Required devices/ equipment shall be provided by EPC contractor for entire system smooth functioning.

The Server shall have Firewall protection, Bandwidth management & required client Access license.

Main Server Room shall be created and provided in the proposed Academic Block catering to all new proposed buildings. The incoming Fibre cable shall be laid from existing IT server room of Client and shall be terminated to Proposed Network Server room, situated in Academic Block. The laying and termination of Fibre optic cable within the campus will be provided.

The Rack panel comprising of jack/Patch panels, Network switches, patch cords, power supply units, Cooling Fans, Wire managers, LIUs, Trans-receivers, Fiber patch cord etc. of individual buildings/Blocks/ floors.

LAN Infrastructure at different Floors of various buildings shall be used commonly for IPABX, BMS, Access Control System, CCTV, Nurse Call System, Fire Alarm System, HMIS (Hospital Management Information System) etc. along with LAN.

For HMIS, only wire/cable network with copper cables/CAT6A/Optical Fiber Cable shall be provided as required.

Brick masonry manholes with covers shall be provided at suitable lengths to facilitate easy wire/cable pulling.

Wireless access points for Wi-Fi connectivity having data speed, 4 Mbps minimum, shall be provided in Hospital Block, Academic Block, General Hostel, Nurse Staff Apartments, Indoor Sports cum Auditorium complex, Guest House etc. All types of hostel shall have only Wi-Fi connectivity whereas all residential buildings in the complex shall be provided with wired data outlets along with the Wi-Fi connectivity.

8.3. IPABX System

RJ-45 Telephone socket outlets with suitable IP Phone instruments shall be provided in all blocks / buildings at convenient locations, as required. CAT 6a wiring shall be provided in recessed/surface conduits / raceways from each telephone point up to the Rack panel (Patch Panel & Switch) at each floor or nearest Rack Panel of all buildings /Blocks. The Maximum length of the CAT 6a cable shall be 90 Meter.

IPABX with minimum capacity of 500 Telephones & expandable up to 5000 telephones shall be located at Server Room in the Academic Block. The PRI lines for IPABX shall be terminated in the separate Rack in server room of Academic Block. This Rack will be connected to the IPABX system.

The Rack Panel (comprising of jack/Patch panels, Network switches, patch cords, power supply units, Cooling Fans, Wire managers, LIUs, Trans receivers, Fiber patch cord etc.) of individual buildings/Blocks shall be connected to the main IPABX Server Rack with optical Fiber ring main to be laid underground in DWC HDPE Pipe of suitable size or through overhead Poles/Structure.

Manholes with covers shall be provided in the underground DWC HDPE pipes at suitable lengths for easy pulling & maintenance of cables.

8.4. Fire Detection / Alarm System

Addressable Intelligent fire detection and Alarm system of latest IP based technology with Fire alarm panels, multi Sensor detectors, smoke detectors, heat detectors, beam detectors, response indicators, manual call point and hooters, light strobe etc. shall be provided.

It shall meet the requirement of NBC 2016/CPWD Specifications/ State By-laws. License/Approval of Local Fire Authorities shall be provided for the complex. There shall be the proper Zoning of the complex/buildings/floors considering the Non Critical & Critical areas (critical area like OT, ICUs Labs, sterilised zones etc.) in the Hospital Block and in all other buildings. Repeater panels shall be provided in various buildings as required.

Fire Detectors and devices of other ancillary buildings/ blocks shall be connected to building Fire alarm Panel, located in Fire alarm control room, through Fire survival copper armored cables.

The Addressable Fire alarm system shall have features as follows:

a) Addressable intelligent Fire Detectors.

b) Detector should have automatic addressing facility.

c) Detectors should be installed as per coverage defined in NBC 2016 and NFPA 72. It should include all rooms, halls, storage areas, basements, attics, lofts, and spaces above suspended ceilings including plenum areas utilized as part of the HVAC

system. In addition, coverage should include all closets, elevator/Lift shafts, enclosed stairways, dumbwaiter shafts, chutes, and other subdivisions and accessible spaces.

d) Suitable numbers of input/ output (C/M) relay modules are suggested for connecting other equipment like Electrical Panels, lifts, firefighting system, AHUs, Ventilators, PA System etc.

e) Fire Alarm control Panel shall have maximum 159 devices and 159 detectors in one loop and Spacing between two detectors shall be not more than 7 Mtr.

f) Cabling shall be with Fire Survival category Armoured copper cable as per NBC 2016 norms. In case unarmoured fire survival cable is used, it shall be laid in MS conduit.

g) At least 10% spare provision for future device connection shall be provided in each loop card.

h) Suitable addressable loop powered sounders/ hooters with strobe for minimum 90db sound level.

i) Addressable manual call boxes shall be provided near all exits, stair cases, lift lobbies etc. as per relevant Norms.

j) The Response Indicators shall be used in the waiting areas, Corridors, Common Area, conference Hall or in large room etc.

k) Microprocessor IP based fire alarm control panel (redundant CPU) for number of required loops with 24 hrs. Battery backup with LCD/ LED display, printer etc. shall be located in the fire control room.

l) Fire Alarm Panels shall be integrated with PA system and with BMS also.

m) Two Way communication Fire Fighters Telephone Jack & Handset with necessary accessories are to be provided in all the buildings as required.

A Repeater panel shall be installed in the Main Security Room of Hospital & Academic Block or in a location accessible to the operators/Fire Fighting personnel.

8.5. Public Address System (PA System):

Public Address System shall be provided in Hospital Block, Academic Block & other buildings as required as per NBC norms. Speakers in the Ceiling/Wall shall be provided in corridors, lift lobbies and other common areas as per NBC 2016/relevant IS codes.

a) Box type speaker shall be provided in the entrance lobby.

b) Horn type speaker are suggested in the basement.

c) Recessed speakers in the false ceiling areas.

d) Proper zoning are to be done considering the user requirement, critical areas & floor etc.

e) Control console shall be located in the fire control room with pre amplifiers, amplifiers, CD, DVD/Pen-drive, FM Player & gooseneck microphone.

f) System shall have the facility to make announcement on all floors simultaneously or on individual floors.

g) Wiring shall be done with twin twisted tinned copper industrial armored speaker cable.

h) The system shall be integratable with Fire alarm panel and with the BMS also.

8.6. Closed Circuit Television System (CCTV System)

The CCTV and Surveillance System shall control and monitor different buildings in the Campus as per NBC 2016/ relevant IS codes/Local by laws. All the buildings shall have IP Based Dome Cameras, Bullet Cameras and PTZ Cameras for surveillance. The types of cameras & locations of various Cameras indicated herein are minimum to be provided. However during detailed designing if required and found necessary the type / rating of the Cameras shall be upgraded.

a) Hospital Block – Dome/ Bullet Cameras (Indoor Type) + PTZ Cameras on pole or Roof top (Outdoor)

b) Academic Block – Dome/ Bullet Cameras (Indoor Type) + PTZ Cameras on pole or Roof top (Outdoor)

c) General Hostel and Nurses Hostel – Dome/ Bullet Cameras (Indoor Type) + PTZ Cameras on pole or Roof top (Outdoor)

d) Residential Blocks – Dome/ Bullet Cameras (Indoor Type) + PTZ Cameras on pole (Outdoor)

e) Guest House:- Bullet Cameras (Outdoor Type) + Dome/ Bullet Cameras (Indoor Type)

f) Entry/ Exit Gates- Bullet/Panoramic Cameras (Outdoor Type)

g) Service block/ Substation/ Plant Room/ Pump Room Building/ Parking/ Laundry/ Mortuary etc. - Bullet Cameras (Outdoor Type)/ PTZ Cameras on pole or Roof top (Outdoor)

The indoor Dome Cameras and Bullet Cameras shall be installed at Entry & Exit Points on all floors, main corridor, Lift lobbies, Reception Areas, Waiting areas and other common areas of Hospital Building, Academic Building & Other Areas.

In all other buildings like Hostels, Residential, Guest House, Service Block etc. cameras shall be provided at Ground floor Entry & Exit Points, main corridor, Lift lobbies & common areas etc.

All the outdoor cameras shall be in IP-66 Housing with Junction box, media converter etc. is proposed in weather proof housing. Outdoor PTZ cameras shall be provided for surveillance of external areas for all building. The existing LAN network switches would be used for CCTV connectivity and will be connected to central CCTV server & cameras shall have POE connectivity ports.

Network connectivity for outdoor cameras having distance more than 75 meters, shall be on optical fiber. Suitable provision shall be provided to connect with existing LAN infrastructure. The power supply to LAN switches and all Monitors will be on UPS. The video recording shall be non-embedded based recording server with video management software.

a. **Bullet/Dome camera: -** These cameras shall be Full HD IR Camera suitable for Day and night operations. All the cameras shall be operative on automotive manual & scheduled mode. The cameras shall be UL/FM Listed. RJ- 45 Cable connectors will be used for Network/POE connectivity.

b. **PTZ outdoor cameras: -** The true IP day and night viewing PTZ cameras proposed are 20 x optical zoom, Auto iris & auto focus lens with focal length 4.7 mm to 94 mm or better. The PTZ camera shall automatically track the object to use its Pan/Tilt/Zoom feature and record 30 frames/ sec. The cameras shall be UL/FM Listed. RJ- 45 Cable connectors will be used for Network/POE connectivity.

c. **Central Core & Recording Server:-** The main servers will be Intel Xeon processor E5-2600, minimum speed of 2.3 GHz with 6 Core, dual Gigabit Ethernet Port, USB port, Video port. The server memory will be 16 GB DDR4 RAM with operation and management Licenses to manage at least 15 Recording Servers and 300 Cameras.

d. **LED Display Monitor:** - The sufficient no. of Full HD LED Monitors with high resolutions screen size of 43" (Diagonal) is to be provided for viewing all live/ recorded camera proceedings. The resolutions of 1920 (H) x 1080 (V) pixels with comfortable viewing angle is proposed for all monitors suitable for operation on 220-240V AC 50 Hz power for the display panel should be equipped with all standard features such as video in, Audio in, HDMI/DVI, RJ 45 Port etc.

Control Room shall be located in the Security /Control Room of the Hospital block. The wiring inside the building shall be with CAT 6A cable in conduit and for Outdoor connectivity armored fiber Optic Fibre Cable/CAT 6A shall be used. Optical fiber cable shall be laid underground in HDPE pipes with suitable Manholes for easy pulling and proper Maintenance or through overhead poles/ structures. PTZ cameras will be placed on roof top and on Street light Poles/ suitable height G.I. poles with necessary mounting arrangements in external areas. The video management server should have minimum 30 days storing capacity.

8.7. Access Control System:

Access Control system will be magnetic door type controlled through Card readers and biometrically. All sensitive areas like OT's/ICUs Corridor, Laboratory, Stores, OPD Departments in Main Hospital Block, Labs & academic departments etc. shall be provided with Access Control System. IP based door controllers shall be provided as required. Existing LAN infrastructure shall be used for network connectivity of IP based door controllers. Each Controller will control four No. of Magnetic locks which can be for single or double leaf door. The centralized control will be managed through a server to be installed in main Security Control/ Server Room, located in Academic block. For Overriding purpose Push Button will be provided inside the rooms.

The system will be capable to record biometric attendance of the authorized personnel and the records will be stored in server.

8.8. Hospital Management Information System (HMIS):

For HMIS, required wire/cable network with copper cables/CAT6A/Optical fiber cable shall only be provided. Required wire/cable network for HMIS shall be provided

considering all aspects of HMIS. As HMIS is user specific tool, Software/Hardware for HMIS shall be separately dealt as the same is not being considered in this tender.

8.9. MATV System

The system shall include supply and installation of dish antenna system for all buildings and as directed by Engineer-In-Charge. The system comprises of a shared coaxial cable network that transmits analog television signals to downstream subscribers.

43" LED Monitors shall be provided as following as per functional requirements & as directed by Engineer-In-Charge.

- common reception/waiting areas of Hospital & Academic buildings,
- Entrance lobby & common areas of Indoor Sports complex cum Auditorium.
- common room in General hostel & Nurse Staff apartment,
- Dean's Chamber, Medical Superintendent's chamber, HOD Offices, Principal's chamber etc. so as to cover entire area

32" LED Monitors shall be provided in Private wards, Guest House rooms / suites, Office area in M.S. residence etc. as per functional requirements & as directed by Engineer-In-Charge.

The provision of LED monitors shall not be made in Residential apartment in complex. The scope shall be limited to supply and installation of MATV wiring with outlet sockets as per CPWD specifications.

The Master antenna/Dish shall be provided individually for all building blocks. It shall be provided at the top most convenient point in respective building with a suitable room/space on the top most floor or terrace for housing the amplifier unit.

From the amplifier rooms, conduits should be laid in recess to facilitate drawing co-axial cable to individual rooms/areas. Suitable Tap Off boxes shall be provided in every room.

The specifications of the same are listed below:

a) **Conduiting-** Conduiting for MATV system shall be carried out in M.S. Conduit.

b) **Outlets -** All MATV outlets shall be provided with modular range of cover plate, box and coaxial outlet. Cover plate shall match in shape & finish with other light and power accessories.

c) **Junction Box**: Suitable size of GI box shall be provided for termination of conduit for MATV system.

d) **MATV Line Amplifiers:** The MATV Amplifier shall be housed in a high frequency resistant Aluminum housing at the highest level (terrace level). The MATV Amplifier shall have an in built variable equalizer and Alternator for site signal condition adjustments.

e) **Coaxial Cables:** The coaxial cable RG 6/RG11 shall be of wideband type.

f) **Tap Off / Splitter:** These shall be of ultra-wide bandwidth and of hybrid type. These shall have a flat frequency response over the entire operating range. These shall have aluminum cast housing for high frequency radiation resistance. The Tap offs shall be in one way, two way and four way configurations.

8.10. UPS:

UPS units suitable for 3-phase power supply shall be provided. Suitable capacity of Centralized UPS shall be installed for computers, Operation Theatres, Medical equipment and other essential loads as required in the Hospital, academic building & Auditorium. Microprocessor Based True Online Double conversion UPS with latest IGBT technology with isolation transformer are to be provided for uninterrupted power supply for all Emergency requirements. UPS with separate Power distribution system (comprising of distribution panels, rising mains, distribution boards, incoming isolators etc.) shall be provided. The UPS System shall have minimum efficiency shall be as per ECBC.

The UPS power Supply to OT's shall be with isolation transformers. The UPS System shall be for 30 Min Backup with Maintenance Free batteries and Bypass system. The system shall have the incoming and outgoing switchgear panel. The system shall include the interconnection of UPS Input/output power supply Panels & UPS units, UPS & Batteries through flexible copper cables of suitable size. UPS shall be equipped with communication card for data monitoring on BMS System.

Proposed minimum UPS capacity details are as given below:-

Sr	**Hospital Block**	**Academic Block**	**Auditorium & Sports Complex**
1.	3 X 80 kVA	2 X 60 kVA	1 X 40kVA

8.11. SOLAR PHOTOVOLTAIC POWER SYSTEM:

Direct Online Grid connected Solar Photo Voltaic Power system of suitable capacity shall be provided in the complex as per ECBC/NBC 2016. The generated power will be directly connected to the Power grid/Distribution Panel of respective Building/ Block for load sharing during day time. The average area requirement per kWp will be 10 sq. Mtr on roof Top.

The total Capacity of Solar Power System to be provided shall be minimum 2.5 % of the Internal Lighting & HVAC Load as per prevalent GRIHA Norms. Solar cables shall be used for interconnection of various equipment like Solar PV Panels, Invertor etc. Solar cables shall be suitable for outdoor installations.

8.12. EXTERNAL/ STREET LIGHTING:

High efficiency LED lighting fixtures shall be provided for external road lighting, compound/landscape lighting/Flood lighting. The lighting control /operation for external Lighting shall be automatically controlled with digital timer control switch through outdoor type Feeder Panels.

Conventional Street Light Poles with outdoor type light fittings (IP-66) for illumination of external areas as per NBC, GRIHA & ECBC Codes.

All Street Light Poles shall be made out of Galvanized Iron (GI) Octagonal tubes. Poles will be suitable for single / double side arms or as required. Poles shall have a service window at the bottom comprising connector terminal & MCB. Poles can be mounted on foundation with Anchor bolts of suitable size & quantity. The height & spacing of the street light poles pole will be designed to achieve illumination Lux levels. The height &

spacing of pole and illumination Lux level should be as per latest CPWD Specifications, NBC 2016 and other relevant norms.

Suitable outdoor type feeder panel with digital timer controlling shall be provided for power distribution of various circuits of Street Lighting Poles / Flood Lights/ Bollard etc. Astronomical timer shall be provided in Feeder pillar with photocell sensor for seasonal variations and automatic switching of lights. This system shall facilitate energy saving as well as ensure minimum security lighting at night.

8.13. AUDIO-VIDEO & STAGE LIGHTING SYSTEM:-

8.13.1. Scope of Work:

Audio-Video & Stage Lighting System shall be provided for Auditorium. Audio-Video System shall be provided for Seminar Halls/ Conference Rooms/ Lecture Theatres/ Halls, Demonstration Rooms, Meeting Rooms (with a capacity exceeding 10 No) and other similar rooms at Complex. The facilities, as following, but not limited to, for above occupancies shall be provided:

- Audio System for Auditorium. Seminar Halls/ Conference Rooms/ Lecture Theatres/ Halls/ Demonstration Rooms/ Meeting Rooms (with a capacity exceeding 10 No.) and other similar rooms
- Video Projection & Control System for Auditorium/ Seminar Halls/ Conference Rooms/ Lecture Theatres/ Halls/ Demonstration Rooms/ Meeting Rooms (with a capacity exceeding 10 No.) and other similar rooms
- Lighting System embedded in Acoustic Interior Works for Auditorium.
- Stage Lighting & Stage Furnishing for Auditorium.

8.13.2. Audio/Sound reinforcement System for Auditorium:

Audio or Sound reinforcement system includes Line array speakers, woofers, surround loudspeakers, Passive Loudspeakers, Stage monitors loudspeakers, Control Room loudspeakers, Green Room Loudspeakers, Power amplifier, Modular digital sound Processors, Surround Pre Amplifier, Surround sound system, Digital Mixing Console, Microphones (Wired & Wireless), DVD cum USB Player, Podium, Electrical wiring, cabling, their interconnections etc. of latest technology with all accessories to complete Audio system in all respect for proper functioning of audio system. Adequate mapping, coverage, aiming & calibration of the audio system shall be carried out to mitigate echo, slap back, reverberation & speech mugginess etc.

Podium Table shall be made out of IS-710 waterproof ply with veneer finish with melamine coating with all required hardware and cutout for AV as required, Custom Design wooden of MR grade ply and century veneer with melamine polish. Podium with podium light, side extendable laptop resting drawer, should have facility to fix 17" touch Panel / writing Panel with connection to small PC along with Front design, logo with back light illumination.

The main control of Audio system will be from sound control room.

8.13.3. Electrical System in Acoustic Lining for Auditorium:

Electrical work in Acoustic lining of Auditorium includes Recess/surface mounted down lights, TRIAC dimmable LED down lights (Compliance to IEC standards),

Signage, 6A/16A Power points, wiring, cabling, earthing, cable tray/raceways of respective size etc. of latest technology with all accessories to complete the electrical system in all respect for proper functioning of system. The system of mounting these lights will be integrated with false ceiling design.

8.13.4. Video Projection and Control system & Video Switching System for Auditorium:

Video Projection and Control System includes 1 Chip DLP Projector with long throw lens, fixed frame projection screen (300" diagonal), 22" Monitor for Cameras monitoring, 55" Full HD Smart LED display for VIP room/Green room/stage monitoring/seminar Halls, VC Unit with PTZ camera with PC and Full HD MCU software, High definition PTZ cameras, remote camera Joystick Controller Unit, Speech prompter with PC and desired software, recording device, Controller, Touch Panel for wireless connectivity/controlling to all equipment, wireless routers, remote for sliding presentation, HDMI Over shielded twisted Pair Cable Digital Transmitters/Receivers, presentation, HDMI Over optical fiber Cable Digital Transmitters/Receivers, Multimode /Single mode optical fiber cable, LIUs, Network switches, HDMI Cables, VGA Cables, CAT-6a cables, their interconnection etc. of latest technology with all accessories to complete the Video Projection and Control System in all respect for proper functioning of system.

Video switching system comprises of Presentation point, Presentation switcher, HDMI over shielded twisted pair cable digital receivers complete and their interconnections etc. of latest technology with all accessories to complete entire system in all respect for proper functioning.

8.13.5. Stage Lighting & Stage Furnishing System for Auditorium:

The stage of Auditorium will be used for Video Projection, Meetings, Lectures, dance & drama performances, cultural programs etc.

For stage lighting One Set of lights shall be provided at grid level above stage. There will be two Light ladders on each side of stage. Front of Hall Light will be installed to cover front portion of the stage. The system of mounting these lights will be integrated with false ceiling design.

Stage Lighting & Stage Furnishing system comprises of Curved Motorized winch to use as Lighting bar/Frill bar/Utility bar with necessary pulley, guide pulley, compact gear box, DC Motor etc., CE Certified Self climbing motorized tele-climber hoist complete with electric motor, Grand drape track system, Mid curtain track system, Wing frame, Cyclorama with drum tight arrangement, Main valance fixing arrangement, MS lighting junction box, customized MS angles as per requirement, Power panels, Motor control panels, Halogen Fresnel spot light, Spun aluminum PARCAN lights, Halogen cyclorama light, Halogen flood light, LED lights, Stage spot light, Stage zoom profile spot light, SR Beam moving Head complete, RGY Laser for effect purpose, Dimmer pack with automatic sensor, Grid mounted Photo isolator DMX splitter unit, Lighting Console with 24 multifunctional faders, assorted metal gobos, necessary clamps arrangement, Fire retardant velvets/cotton fabric for curtains/ Grand drape/frill/Cyc tab track, Halogen lamps for light fittings, copper wires, cables, their interconnection etc. of latest

technology with all accessories to complete entire system in all respect for proper functioning.

8.13.6. Audio & Video Switching System for Seminar /Conference Rooms/ Meeting Room & Lecture Theatres:

Sound reinforcement and Conferencing system is to be provided in Seminar /Conference Rooms/ Meeting room. The conferencing system shall have complete Audio System with Audio recording facility. The system shall have flush mounted delegate units on the tables. Each delegate unit shall be shared by two delegates. Chairman unit shall have a priority unit to override the delegates.

Audio or Sound reinforcement system for Seminar /Conference room/Meeting room & Lecture theaters includes Line array speakers, surround loudspeakers, Power amplifier, Microphones, DVD cum USB Player, recorders, electrical wiring, cabling, their interconnections etc. of latest technology with all accessories to complete Sound reinforcement and Conferencing system in all respect for proper functioning.

For Seminar/Conference room facility of proceedings recording shall be provided with PTZ cameras, network recorders, microphones, LED TVs, Network switches etc. along with above mentioned video switching system for providing video conferencing facilities between chairman and max. 5 No. other delegates sitting at different remote locations.

Video switching system for other Conference rooms/Meeting room & Lecture theaters comprises of 1 Chip DLP Projector with long throw lens, fixed/ motorized screen for presentations, Presentation point, Presentation switcher, HDMI over shielded twisted pair cable digital Transmitter/receivers, HDMI cabling, Power wiring, cabling, their interconnections etc. of latest technology with all accessories to complete video switching system in all respect for proper functioning.

The wiring/cabling will be carried out with Cat-6A and HDMI cables, microphone cable with connector as required.

8.14. NURSE CALL SYSTEM

Hospital Building shall be provided with an "IP based Nurse Call System". The System shall be approved in accordance with VDE guidelines/ international guidelines. Nurse Call System shall be provided for 100 Beds plus beds provided in other healthcare areas of Hospital Buildings, with Speech and without-Speech facility as required.

The Nurse Call System shall be designed to provide most effective communication between Patient, Nursing Staff, and Doctor & management staff in the least possible time.

Nurse Call System shall be provided in the wards/ rooms where patients will stay. Some of the areas mentioned below but not limited to, are as follows:

a) IPD Wards
b) IPD Rooms (Single Bed/ Double Bed/Deluxe Suite/ Super Deluxe Suite)
c) Recovery Rooms
d) MICU/ ICU/ HDU

e) Emergency Rooms

f) Pre/ Post operation & Cath,

g) Ward (Chemo, multipurpose, observation, Triage, Day Care) etc.

h) Any other area as required.

The Nurse Call System with voice/speech facility shall be provided for Single Bed/ Double Bed/ Deluxe Suite/ Super Deluxe Suite rooms. The other wards shall be provided with nurse call system without voice/speech facility.

8.14.1. Main Controllers:

Controller shall be IP based & all the nurse station/ patient handset & other equipment shall be connected to main controller through CAT6Aa cable. Main controllers shall be networkable with other controllers through IP/ CAT6Aa. Fault in one controller shall not have the effect on working of another controller. Each controller shall be able to work independently in case there is problem in network.

8.14.2. Nurse Station:

Nurse station shall have large LC display capable of showing multiple patient call at a time with bed/ ward no., type of call, date & time. There shall be scroll down feature as well in case no. of patient call increase at a given time i.e. there shall not be any chance of missing any patient call. There shall be feature to priorities patient call depending upon patient condition, type of call & location (Bed or WC). Nurse station shall have voice facility. It shall be user friendly & have good aesthetic looks. All Nurse Stations shall be networked with other nurse station with facility of call forwarding/ diverting/ escalating calls in between nurse station. Nurse station shall be programmable so that emergency calls shall always be on top priority.

There shall be option of displaying patient call on external monitors through VGA/ HDMI/ DVI output from the nurse call system. The system shall be interfaced with IPBX to use as a telephone also.

8.14.3. Patient Handset without voice facility:

Whenever the patient needs the attention of any “Nurse”, patient just press the button provided at his/ her bedside. On pressing the button, the alarm shall be enunciated at the Nurse Station by local sounder having volume & tone adjustment informing the nursing staff about the bed no. / Room no. along with type of call (Bed call or WC call or Doctor call) for their necessary action. Patient handset shall be connected to bed head unit through plug in cable. For safety reason, handset shall have antimicrobial coating to avoid infection transfer, shall be shock & spill proof & having suitable colour & symbol for nurse call button on the handset. There shall be call cancel/ reset button either on bed head unit or separate button.

8.14.4. Patient Handset with voice facility:

Patient handset shall be connected to whenever the patient needs the attention of any “Nurse”, patient just press the button provided at his/ her bedside. On pressing the button, the alarm shall be enunciated at the Nurse Station informing the nursing staff about the bed no. / Room no. along with type of call (Bed call or WC call or Doctor call) for their necessary action. There shall be speech facility in both patient handset & nurse station with suitable inbuilt microphone & speaker. Nursing staff

shall receive the call from nurse station itself & respond to the patient queries. It will reduce the nurse staff movement to patient room. However, if required, nurse staff shall visit the patient room as & when needed by patient. Patient handset shall be connected to bed head unit through plug in cable. For safety reason, handset shall have antimicrobial coating to avoid infection transfer, shall be shock & spill proof & having suitable colour & symbol for nurse call button on the handset. There shall be call cancel/ reset button either on bed head unit or separate button.

8.14.5. Lamp Module:

Lamp module shall be installed outside the room/ ward above the door for visual indication of different type of call. There shall be different colour of indication for different type of calls.

Once the patient annunciates the alarm, the signal shall go to the nurse station. The lamp outside the patient room/ ward shall also glow simultaneously red provide a visual alarm. Lamp shall have different colours light to inform about the type of call like red light for bed call, blue light for code blue call etc.

8.14.6. Doctor Call & Cancel Button:

Each bed/ ward shall have code blue button (Doctor Call). Doctor call button shall be used only by nurse staff & programmed in such a way to avoid direct code blue call by patient. It shall be a separate programmable button with cancel button. It shall not be in patient handset with nurse call button & shall have separate cancel button. Once nurse press code blue button, call shall go to every nurse station of the hospital or as programmed as per site requirements with room no. & bed no. information so that code blue team available at any nurse station shall be informed & they can reach the patient room on immediate basis.

8.14.7. Call-Cancel Button for common toilet

There shall be nurse call & cancel button with suitable colour/ symbol in common toilet near WC to generate nurse call by patient from WC in case of any emergency. It shall be installed at waist height for easy access. The buttons shall be moisture protected.

Pull cord Button for room/ ward toilet with shower/ bath facility.

There shall be nurse call button with suitable length of pull cord with colour/ symbol for nurse call from the toilet. It shall be installed above shower head preferably in such a way to access from bath area as well as WC. Pull cord shall be detachable & replaceable without changing the unit. The buttons shall be moisture protected & suitable for bath areas.

8.14.8. Central Monitoring Station

Complete nurse call system shall be centrally connected to a PC having a software recording of all the different type of call & cancel with date & time. The software shall record the date & time of call generated by patient & call cancel by nurse with type of call. Software shall be able to generate report on daily, weekly or monthly basis as per requirement. It shall also be possible to put reminder/ highlighted on calls if nursing staff do not attend/ cancel the patient call with in specific time decided by the hospital management.

8.15. INFORMATION DISPLAY SYSTEM:

Information Display System (Digital Signage Solution) shall be provided for Hospital Building. Information display systems will achieve information sharing in order to significantly improve the hospital management and service level, and enhance the hospital's brand and core competitiveness. This system shall have centralized control over LAN with unified management of video and audio signals, pictures, text scroll and other multimedia information to be transmitted to various display terminals. Information display system shall be hooked up/interlinked with MATV System.

Information display systems will be used to display:-

- Images, scrolling texts & videos of advertisements
- To share Internal information
- Public information
- Advertisement or Promotions
- And influencing customer behaviour

System Architecture Minimum 65 inch LED Screen, Application Server will be used for Uploading & displaying movies, PPTs, Screen etc.

System advantages: Centralized control, centralized management.

Real-time: Issue Emergency information, Events, Media / Marketing Info etc.

PC based: It can play any file as per requirement of controller.

The Information Display System shall display welcome messages at reception, waiting & lobby areas, common areas of Hospital. Displays can be programmed to show videos that explain medical procedures, healthy eating tips and guidelines, medical innovations, drug information, public awareness messages etc.

43" inch LED monitors shall be provided in DEMO rooms of the Hospital Building to demonstrate real time OT procedures.

Video wall Matrix system of Minimum 9 units of 46"/43" inch ultra thin professional LED Monitors shall be provided in the Hospital block entrance area.

K. Design Basis Report- LIFTS

1. GENERAL

The EPC Contractor shall carry out Design, Engineering, Supply, Installation, and Testing & Commissioning of Lift Works. Passenger cum Bed lifts, Passenger Lifts, Service/ Goods Lifts etc. shall be provided for various buildings in the complex. IP based CCTV camera shall be provided in lift cars of all buildings for surveillance/monitoring of lift control panel. The CCTV cameras, installed in the lifts, shall be connected/ integrated with the CCTV system with suitable cabling, hardware items etc as required. The installation shall be carried out as per rules & regulation of local bodies and IS Codes that governs the requirement of installation of the lift. The voltage and frequency of the supply shall subject to variation permissible under Indian Electricity Act and Rules. Passenger cum Bed lifts, Passenger Lifts, Service/Goods Lifts for complex shall be provided, as per details given below which is indicative:-

S.No.	Building Name	Lifts	Qty.	Capacity	No. of Floors
1.	Academic Block	Passenger Lift	2	16 passenger	6
2.	Hostel Building	Passenger Lift	2	16 passenger	7
3.	Staff Nurse Apart. Building	Passenger Lift	2	10 passenger	4
4.	Resident Doctor Apart. Building	Passenger Lift	1	10 passenger	6
5.	Guest House Building	Passenger Lift	1	10 passenger	4
6.	100 Bedded Hospital Building	Bed cum Passenger Lift	2	26 Passenger	4
7.	100 Bedded Hospital Building	Bed cum Passenger Lift	2	26 passenger	5
8.	100 Bedded Hospital Building	2000 kg Goods / Service Lift	2	-	5
9	100 Bedded Hospital Building	Dirty Dumb Waiter	1	100 kg	5

Note:

1. Lift Well, Car Size, Lift Pit Depth, Overhead, and Clear Entrance Width & Height dimensions shall conform to NBC 2016 or OEM Standards/ recommendations. All lifts shall be Gearless Type with Machine room. All Bed cum Passenger Lifts shall be Side Opening type and all other lifts shall be Centre Opening type.
2. Lift Speed: For building height upto 5 floors - 1 mtr/sec
   For building height upto G+5 floors & above - 1.5 mtr/sec
3. Anti-skid granite flooring of suitable thickness shall be provided in all the lifts.

4. Car enclosure, Car & Landing doors, Car False ceiling, Handrails etc. shall be made out of SS 304 sheet of required thickness.
5. All Bed lifts shall be provided with SS Stretcher Guards at suitable height as per norms.
6. All lift shall have necessary provisions & door opening as required for physically challenged person.
7. Power supply to each elevator shall be connected with dual source. One elevator from each bank of elevators shall be key operated to be used as fireman's lift as per code.
8. Lift Car operating Panel shall be equipped with Braille buttons. Automatic rescue device and emergency lighting shall be provided in each elevator supported by independent rechargeable batteries.
9. Lifts shall be complete in all respect as per technical specifications and directions of Engineer-in-Charge.

L. Design Basis Report - HVAC System

1. Scope of Work:

The EPC Contractor shall carry out for Design, Engineering, Supply, Installation, and Testing & Commissioning of HVAC System. The scope shall include below mentioned features but not limited to: -

i. Heating, Ventilation & Air Conditioning System as per Building requirement.

ii. Centralized AC with Air Cooled Chiller System, winter heating system is proposed for Hospital & Indoor Sport Complex & Auditorium. For Hospital, AHU & Cassette units are proposed at strategic locations as per criticality of the areas.

iii. Split AC System with cooling & heating modes shall be provided for Guest House and Academic Block Buildings.

iv. Energy Efficient, preferably min. 3-star, inverter driven, heating & cooling mode (as per requirements) Split ACs are to be provided for LV Rooms, Operator/ Engineer in charge room, Warden Room, BMS Room, Fire Control room, Server Rooms other than Hospital, UPS Rooms & any other room of functional importance & as per directions of E-I-C.

v. Chilled water cassette units shall be provided for Main Server Room(s) / Data Center of Hospital along with DX type Split Units as stand by.

vi. Ventilation/ Pressurization System shall be provided for all Buildings as per relevant norms, standards & statutory bye law's provisions.

vii. Air Washer & Dry Scrubber shall be provided for main Kitchen of Hospital (if any) etc.

viii. Provision of Air Curtains shall be considered at the Main Entrance/Vestibule of the Hospital Building.

ix. The entire HVAC works should conform to specifications provided & as per directions of Engineer-in-Charge.

x. HVAC Plant Room shall be provided at Terrace of Hospital and Indoor Sports Complex Building for mounting all equipment & accessories related to Air Cooled chiller system. The HVAC Plant equipment at terraces shall be suitably covered with Polycarbonate sheets of 6 mm thickness, duly supported by GI structure.

xi. The rating and capacity of equipment indicated herein below are minimum to be provided. However, during detailed designing, if required and found necessary, the capacity/ rating of the equipment may be upgraded by the EPC Contractor.

2. Indoor Air Quality:

i. Emphasis on maintaining desirable Indoor Air Quality by setting and controlling parameters of Temperature, Air Flow, Humidity Levels and Air Changes per Hour (Total & Fresh Air) for each room/ zone/ area.

ii. Conformity of Indoor Quality parameters with ISHRAE, ASHRAE and NABH Standards.

3. Special Considerations for Critical Areas:

a. All Critical Areas shall be designed on air recirculation and outside air intake system as per standards specified by ASHRAE, ISHRAE and NABH etc.

b. Critical areas shall include but not limited to OTs, ICUs, Diagnostic Facilities, Isolation Rooms, Sterile Corridor, Labs, Observation Rooms, Surgery & Treatment Rooms etc.

c. Aluminum Ducting shall be provided for OTs, ICUs & Critical Areas such as MRI. However, as per relevant standards/ norms, if any other room is to be provided with Aluminum duct, same shall be provided.

d. HEPA Filters shall be provided for OTs. However, as per relevant standards/ norms, if any other room is to be provided with HEPA Filters, same shall be provided.

e. Septic OTs shall be designed for 100% fresh air.

f. Compartmentalizing and Zoning of Areas in Hospitals to restrict air movement and prevent cross contamination.

g. Ventilation Design and Air Filtration to dilute and remove contamination in the form of odor, airborne microorganisms and viruses, hazardous chemical and radioactive substances. To ensure the same, UVGI System /PHI may be considered. Magnehelic Gauges / Electronic Pressure Gauges to be installed for critical areas for measuring differential pressure between zones.

h. High Efficiency Filtration System shall be provided to prevent bacterial contamination whether it is from Outdoor Air or from re-circulated air within space.

i. Two-stage filtration shall be provided in all areas where AHUs are proposed. In Critical areas like OTs, AHUs static shall be sized as per Three Stage Filtration comprising of Pre, Fine and HEPA Filters.

j. Aluminum Ducting insulated separately with suitable material of suitable gauge/thickness shall be used for supplying air to aforementioned areas to reduce the risk of bacterial formation in the air handling equipment and the ducts.

k. For OTs, the Supply and Installation of HEPA Filters at Terminals, Laminar Flow Diffusers and Inside supply/return OT Ducting shall lie within the scope of EPC contractor.

l. Waiting halls (areas with high occupancy) shall have mechanical ventilation systems (Exhaust) as per relevant norms.

m. For OTs, AHUs needs to be considered dedicated for each OT. Supply & Return Ducting from AHUs till OT & inside OTs needs to be done by EPC Contractor. HEPA filters at terminal with laminar flow diffusers shall be provided. All relevant norms in this regard needs to be strictly adhered to.

4. Air Conditioning /Comfort Heating System:

a. Centralized Chilled Water Air cooled Air Conditioning System with Screw compressor Chillers (For Hospitals) & Scroll compressor chillers (for Indoor sports complex) shall be provided for Hospital Block & Indoor Sport & Auditorium in all areas except circulation spaces like corridors, toilets/staircases & non- critical stores etc. Hot Water Generators will be used for winter heating of all centrally air-conditioned areas & for monsoon reheat of critical areas like OTs/ICUs etc.

b. Split system with cooling & heating modes shall be for Guest House, Academic & Administrative block.

c. Electrical Load Provisions for DX type AC have been considered in sizing of Electrical Equipment for Resident Hostel, Hospital Staff Apartment, Medical Superintendent Residence, Resident Doctor Apartment (except office where energy efficient inverter driven – 5 star rated Split AC - with both heating & cooling modes shall be provided) etc.

d. All the equipment etc. shall be suitable for 415 V, three phases or 220 V, Single phase, 50 Hz A.C. supply.

e. The chilling machines shall be AHRI / Eurovent certified with eco-friendly refrigerant and with best possible COPs as per latest ECBC code. Fans shall be AMCA certified for fan efficiency & Noise. Fire dampers shall be UL & CBRI Roorkee certified preferably with FM certification also.

f. In case of Chilled Water System Screw Chillers with VFDs shall be provided for Summer/Monsoon Cooling. The scope shall include Plant Manager as well.

g. The Split System considered must belong to the latest Generation/Version with capability of summer and Monsoon Cooling and Winter Heating as well.

h. All pumps including Hot Water & Secondary Chilled Water Pumps, Primary Chilled Water Pumps will be with unit mounted Variable Speed Drives circulating water in the chilled/hot water circuit. Primary in pumps is meant for initial water balancing.

i. Provision of specialized equipment like Vacuum Degasser/Air and Dirt Separator in the Plant Room to ensure smoother operation, enhanced efficiency of system and longevity. An integrated system consisting features of two or more Equipment will also be accepted.

j. Chilled Water Circuit comprising of MS pipes ("C" Class) with suitable Insulation in case of Centralized Chilled Water System and hard drawn copper tubes with suitable Insulation in case of Split System.

k. GI pipes (Class B) for drain pipe with suitable insulation for chilled water system.

l. u-PVC Pipe for DX Split drain pipe to be provided.

m. Ceiling Suspended and Floor Mounted Air Handling Units, chilled water cassette unit, Fan Coil Units to Convey Chilled Air in case of Chilled Water System and Ductable/ Cassette / Hi Wall Split Units.

n. Fresh air provision for ceiling suspended AHUs/FCUs/Split units/Chilled water cassette units shall be considered as per relevant codes & standards. In outside peripheral walls, lovers shall be provided for providing fresh air to rooms adjoining outer wall. For internal rooms, inline fans of suitable capacity with ducting will be provided. Fresh air load shall be considered for sizing of ceiling suspended units while deriving actual HVAC load.

o. Pressurized Expansion Tank to adjust and regulate the pressure of water in the Chilled and Hot Water Circuit shall be provided.

p. Ducting System comprising of GI Ducting with Insulation depending upon the requirement. Duct Construction and suspension Standards must conform to SMACNA, IS 655 and ASME.

q. Chilled Water flow Modulation by means of Manual/Motorized Butterfly, Non-Return Valve, Ball Valve, Balancing Valve, 2 WAY PIBCV with insulation. All the valves must be minimum PN16 rated and suitable for Chilled Water and Hot Water applications. Insulation of valves shall be the same as that of pipe.

r. Air Flow Modulation by means of Air Distribution devices like Volume Control Duct Dampers, Collar Dampers, CAV/VAV Boxes as per requirements conforming to ASME and SMACNA Standards.

All Conference Rooms, Individual Cabins, Meeting Rooms, ICUs, waiting Areas etc. fed by common AHUs shall be provided with VAV Boxes. Alternatively, separate cassette unit/FCU/ceiling suspended AHU etc. may also be proposed for these areas for better controlling & modulation.

s. Color scheme for equipment like Chillers/Pumps/AHUs etc. shall be as per manufacturer's standard color scheme or as per directions of E-I-C.

t. The scheme of color code painting of pipe work services for AC installation shall be as per NBC/CPWD specifications.

u. Provision of trap door of suitable material & size shall be considered for easy accessibility of moving parts of the concerned equipment/dampers.

v. For Burn Patients, air conditioning shall be so designed that temperature control should be there to maintain a warm environment & high relative humidity.

w. In CSSD Areas, as it consists of cleaning area, sterilizing area & storage area, air conditioning along with ventilation arrangement needs to be considered.

x. BMS Compatibility to all Air Conditioning (3 phase equipment) High Side and Low Side Equipment.

y. Touch screen types central controller with stylus & of latest version to be provided for guest house with provision to ingrate the same on BMS.

z. For the MGPS Plant Room, Air Conditioning provision shall be considered in the Main Plant Room which houses all the equipment like Vacuum Pump, Air Receiver Tank etc. The Air Conditioning provision shall be done through the Centralized Air Conditioning System itself or suitable numbers and capacities of Hi Wall Split Units may be considered for the same. The Manifold Section of the Plant Room shall be adequately ventilated by means of Ventilation Fans or Ceiling Fans with required ACPH.

aa. Pump/ Motor placed on Terrace /open area should be weather proof type & required size of canopy also needs to be provided.

5. Ventilation System:

a. Mechanical Ventilation System to be considered for Toilets, Kitchens, Laundry, Dining and Individual Floor Smoke Extraction & HVAC Plant Room, MGPS, Fire/WTP Pump House, STP/ETP Plant, ESS & other areas as per requirements.

b. Laundry needs to be ventilated with fresh filtered air & exhausted through hoods placed over the heat generating laundry Equipment.

c. In BMW Room, in the room of integrated sterilizer & shredder, Split AC of suitable capacity to be provided. In rest all areas, ventilation arrangement will be considered.

d. In Mortuary including Post Mortem, 100% treated fresh air shall be provided with suitable capacity VRV/ VRF System along with AHU kit by the EPC Contractor.

e. Ventilation Fans for Residential Buildings/Hostels & other buildings in addition to that for Institute/Hospital & Educational buildings shall be provided of sufficient ACPH/CFM for toilet, kitchen etc. Ventilation, Smoke Extraction & Pressurization Fans (Lift Well/Lift Lobby/Staircase) as applicable needs to be provided in all buildings.

f. Emphasis on maintaining adequate Fresh Air supply, Removal/Exhaust of stale air, particulate matter, fumes and noxious gases.

g. Fan Design, selection and sizing in accordance with Provisions stated in NBC 2016, ASHRAE, ISHRAE, ECBC 2017 and Fire Bye-Laws.

h. The Fire-resistant insulation shall be applied wherever a duct passes a fire zone. This shall be applicable for basements & all floors above it. The EPC Contractor shall submit the design/details conforming to relevant norms/standards for approval.

6. Heating System:

a. Comfort heating for all areas and additional Monsoon Reheating for Critical Areas in Hospitals like OTs, ICUs is to be provided.

b. Conformity of Indoor Quality parameters pertaining to Comfort and Critical Areas Heating with ISHRAE, ASHRAE and NABH Standards.

7. Design and Layout Considerations:

The Design and Layout Considerations for HVAC System shall be done in accordance with Norms established by GRIHA for HVAC System design, provisions stated in NBC 2016, latest ECBC and conforming to the latest ISHRAE, ASHRAE and NABH and CPWD standards.

a. Objective of HVAC System Design is to ensure proper Indoor Air Quality, Energy Efficiency, Flexibility of Operation, Cost Optimization, BMS Compatibility and GRIHA Rating Compliances.

b. Heat Load is to be computed for individual rooms of required buildings which are to be air conditioned. All required parameters /factors like geographical location, orientation of building, ambient conditions, glazing factor, lighting/equipment load, occupant load, area & height of room, fresh air ACPH, CFM/person, ADP of coil, shall be considered as per ASHRAE/ISHRAE/NBC 2016/ECBC standards.

c. Equipment sizing of HVAC system shall take into account factors such as geographical location, climatic conditions, water availability & quality etc.

d. Chilled & Hot water pipes from HVAC Plant Room to various buildings shall be laid inside shaft from Terrace to individual low side Equipment as per CPWD & other relevant specs.

e. HVAC Plant Room shall be provided with safety equipment/items like suitable

elastomeric mat (as per relevant IS codes) for Panels, fire buckets, fire extinguishers, hand gloves, safety charts, framed Schematic/SLD etc.

f. Suitable size shafts, cutouts, Niche, openings etc. shall be provided to facilitate installation of Pipelines, Ducts etc. in all floor slabs of various buildings for various service areas, as required. All shafts, cutouts, Niche, openings etc. provided on floor slabs shall be suitably closed after laying of services lines asper fire safety norms as per NBC 2016.

   Doors shall be provided for all shafts at all floors as per fire safety norms as per NBC 2016.

g. All Services as required like raw/ soft/ hot water supply, drainage, plumbing, HVAC provisions, ducting etc. shall be adequately provided for all Medical Equipment, OT Rooms, CSSD, Laundry, Kitchen, MGPS etc. as required.

h. Plant Room Layout: -

   i. Plant Room placed at terrace shall be structurally designed to take loads of various equipment. Also, dimensions of plant room shall conform to CPWD norms & other relevant codes so as to have proper distance between chillers/pumps/other equipment.

   ii. The HVAC Plant Room Layout must be planned in such a manner so that it enables easy movement of personnel to conduct daily routine and maintenance procedures. Additional space for circulation shall be considered as per relevant codes. Provision shall also be kept for anticipated future requirements. Proper spacing must be ensured between the foundations of Pumps, Chillers and other equipment to enable repairs and easy replacement of parts.

   iii. Floor loading of approx. 2000 kg/sqm shall be considered for HVAC Plant Room. The Plant Room should have a fresh water connection & drain trap.

   iv. The floor shall have suitable drain with grating. Proper sloping shall be provided inside the Plant room to ensure discharge of residual water & channelize it to nearest drain. Stagnancy of water shall be avoided in every respect.

   v. Adequate level of illumination must be ensured to enable smooth maintenance and repair procedures.

i. HVAC Shaft: -

   i. Sufficient number of shafts shall be provided for piping /ducting /pressurization etc. so that length of pipe/duct is optimized.

   ii. The HVAC Shaft must be adequately sized to enable smooth passage of pipes and ducts with insulation along with its supporting arrangement through it.

   iii. The walls of the HVAC Shaft must be lined with Fire Rated Material/or of suitable material as per NBC provisions capable of withstanding 250 degree Celsius for a period of 2 hours.

   iv. Inspection Doors must be provided in HVAC Shaft wherever necessary. The door must be Fire rated capable of withstanding 250 degree Celsius for a period of 2 hours.

j. AHU Rooms: -

i. AHU Room slab shall be structurally designed to take loads of various equipment.

ii. The AHU Room Layout must be planned in such a manner so that it allows easy movement of personnel to conduct daily routine and maintenance procedures.

iii. AHU foundation shall be proper (PCC/RCC/Steel frame) in conformance to relevant standards. All measures shall be taken including providing vibration isolation pads etc. should be used to dampen noise generated at source itself.

iv. AHU Room shall be acoustically insulated with suitable material (density, K value) as per CPWD provisions & site requirements.

v. Floor loading of approx. 800 kg/sqm shall be considered for AHU Room. AHU Room should have a fresh air opening, water connection & drain trap.

vi. Fire Damper shall be provided on both supply & return duct preferably wherever duct crosses wall of AHU Room as per relevant norms & standards.

8. Design Basis

This system is designed to cater air conditioning requirement to the different areas of the building. The brief design concept report for HVAC works in the buildings is as below: -

8.1. General

The site details are as under for estimating Heat load and HVAC system design.

Site location.	Aizawl, Mizoram
Latitude	23.6°N
Longitude	93.22 °E
Altitude	1132 meters above mean sea level

The Air conditioning System shall be designed with following design parameters: -

8.1.1. Outside Conditions

The Recommended outdoor design conditions defined in ISHRAE Weather Data File 2017 (published jointly with Bureau of Energy Efficiency) for Mizoram are given below which will be based on 0.4% annual cumulative frequency of occurrence for Summer & Monsoon and 99.6 % annual cumulative frequency of occurrence for Winter. The design conditions considered are as follows: -

S. No.	Season	Outdoor Temperatures	
		DBT	WBT
1.	Summer	32 °C (90 °F)	21.7°C (71.06°F)
2.	Monsoon	21.1 °C (69.98 °F)	23.3°C (73.94°F)
3.	Winter	3.3 °C (37.94 °F)	-

8.1.2. Inside Conditions.

Central air conditioning system shall be provided to maintain the specified inside design conditions during summer, monsoon and winter for the proposed buildings.

Classification of various spaces in terms of temperature, humidity control, Occupancy, air filtration, air changes & pressurization requirements of various departments shall be as per ASHRAE Standard 170. The extracts of the relevant parameter shall be as per following: -

Annexure 1	Table 6, Clause 8.1.1 of PART 8 BUILDING SERVICES. SECTION 3 AIR CONDITIONING, HEATING AND MECHANICAL VENTILATION GUIDELINES FOR PARAMETERS TO BE CONSIDERED FOR HVAC SYSTEM DESIGN FOR HEALTH CARE FACILITIES
Annexure1.1	ISHRAE Hand BOOK - DESIGN PARAMETERS FOR AREAS AFFECTING PATIENT CARE IN HOSPITALS AND OUTPATIENT FACILLTIES
Annexure 2	Table 7 of PART 8 BUILDING SERVICES. SECTION 3 AIR CONDITIONING, HEATING AND MECHANICAL VENTILATION GUIDELINES FOR FILTER EFFICIENCY REQUIREMENT IN HEALTH CARE FACILITIES
Annexure 2.1	ASHRAE/ISHRAE Hand book - PRESSURE RELATIONSHIPS AND VENTILATION OF CRITERIA AREAS OF NURSING HOMES

Annexure 1

Table 6 Guidelines for Parameters to be Considered for HVAC System Design for Health Care Facilities (Clause 8.1.1) NBC						
Sl No.	**Area/Functional Space**	**Temperature °C**	**Relative Humidity (%)**	**Minimum Total Air Changes per Hour**	**Minimum Air Changes of Outdoor Air per Hour**	**Air Pressure in Relation to Surrounding Area**
i)	Operating theatres	18-24	45-55	25	5	Positive
ii)	Cath labs	20-22	30-60	15	3	Positive
iii)	Delivery rooms	20-22	30-60	25	5	Positive
iv)	Recovery room, ICU, Treatment rooms	20-24	30-60	6	2	Equal
v)	Endoscopy, Bronchoscopy	20-24	30-60	12	2	Negative
vi)	Patient rooms	24±1	30-60	6	2	Equal
vii)	Toilets	-	-	-	10	Negative
viii)	Protective environment rooms (Immuno suppressed patients)	24±1	30-60	12	2	Positive
ix)	Isolation room (for patients with infectious disease)	24±1	30-60	12	2	Negative
x)	Corridors	-	-	2	2	Negative
xi)	X-ray/Radiology	20-24	30-60	15	3	Positive
xii)	Laboratories (Other than biochemistry and serology)	22-24	30-60	6	2	Negative
xiii)	Biochemistry and serology labs and pharmacy	22-24	30-60	6	2	Positive
xiv)	Admission/Waiting rooms	22-24	30-60	6	2	Negative
xv)	Diagnostic/Treatment OPD	22-24	30-60	12	2	Negative
xvi)	Sterilizer room	22-26	30-60	10	-	Negative
xvii)	Sterilizer storage	22-26	30-50	4	2	Positive

	Annexure 1.1 DESIGN PARAMETERS FOR AREAS AFFECTING PATIENT CARE IN HOSPITALS AND OUTPATIENT FACILLTIES							
	Space Function	Pressure Relationship to Adjacent	Minimum outdoor Air-ACH	Minimum Total Air-ACH	ALL Room Air Exhausted Directly to	Air Recirculated by means of	Relative Humidity Rh % (k)	Design temperature (l) Deg C
								Std.
	All ante Room (u)	(e)	N/R	10	Yes	NO	N/R	N/R
	pe Anty Room (t)	(e)	N/R	10	N/R	NO	N/R	N/R
	Combination ALL/PE Ante Room	(e)	N/R	10	Yes	NO	N/R	N/R
	Labor / Delivery / Recovery /Postpartum (LDRP)(s)	N/R	2	6	N/R	N/R	Max 60	21-24
	Labor / Delivery / Recovery (LDR)	N/R	2	6	N/R	N/R	Max 60	21-24
	Patient Corridor	N/R	N/R	2	N/R	N/R	N/R	N/R
	Nursing Facility							
	Resident room	NR	2	2	NR	NR	NR	21-24
	ResidentGathering/Activity /dining	NR	4	4	NR	NR	NR	21-24
	Resident Unit Corridor	NR	N/R	4	NR	NR	NR	NR
	Physical Therapy	Negative	2	6	NR	NR	NR	21-24
	Occupational Therapy	NR	2	6	NR	NR	NR	21-24
	Bathing room	Negative	N/R	10	YES	NO		21-24
	RADIOLOGY (V)							
	X-RAY (Diagnostic and Treatment)	N/R	2	6	NR	NR	Max.60	22-26
	X-RAY (Surgrey, critical care and catherization)	Positive	3	15	NR	NO	Max.60	21-24
	Darkroom (g)	Negative	2	10	YES	NO	NR	NR
	DIAGNOSTIC AND TREATMENT							
	Bronchoscopy,Sputum collection and	Negative	2	12	YES	NO	NR	20-23
	Laboratory,general(v)	Negative	2	6	N/R	NR	NR	21-24
	Laboratory, bacteriology (v)	Negative	2	6	YES	NR	NR	21-24
	Laboratory, biochemistry (v)	Negative	2	6	YES	NR	NR	21-24
	Laboratory, cytology (v)	Negative	2	6	YES	NR	NR	21-24
	Laboratory, glasswashing	Negative	2	10	YES	NR	NR	NR
	Laboratory, histology (v)	Negative	2	6	YES	NR	NR	21-24
	Laboratory, microbiology (v)	Negative	2	6	YES	NR	NR	21-24
	Laboratory, nuclear medcine (v)	Negative	2	6	YES	NR	NR	21-24

	Annexure 1.1 DESIGN PARAMETERS FOR AREAS AFFECTING PATIENT CARE IN HOSPITALS AND OUTPATIENT FACILLTIES							
	Space Function	Pressure Relationship to Adjacent Areas (n)	Minimum outdoor Air-ACH	Minimum Total Air-ACH	ALL Room Air Exhausted Directly to Outdoors(j)	Air Recirculated by means of Room units(a)	Relative Humidity Rh % (k)	Design temperature (l) Deg C
								Std.
	Laboratory, pathology (v)	Negative	2	6	YES	NR	NR	21-24
	Laboratory, secrology (v)	Negative	2	6	YES	NR	NR	21-24
	Laboratory,sterillzing (v)	Negative	2	10	YES	NR	NR	21-24
	Laboratory,media transfer (v)	Positive	2	4	N/R	NR	NR	21-24
	Non-refrigerated body-holding rooms	Negative	NR	10	YES	NO	NR	21-24
	Autopsy Room	Negative	2	12	YES	NO	NR	20-24
	Pharmacy	Positive	2	4	NR	NR	NR	NR
	Exmaination Room	NR	2	6	NR	NR	Max.60	21-24
	Medication room	NR	2	4	NR	NR	Max.60	21-24
	Gastrointestinal endoscopy procdure room (x)	NR	2	6	NR	NO	20-60	20-24
	Endoscope cleaning	Negative	2	10	YES	NO	NR	NR
	Treatment Room	NR	2	6	NR	NR	MaX 60	21-24
	Hydrotherapy	Negative	2	6	NR	NR	N/R	22-27
	Physical Therapy	Negative	2	6	NR	NR	Max 65	22-27
	STERLIZING							
	STERLIZING Equipment Room	Negative	NR	YES	10	NO	N/R	N/R
	CENTRAL MEDICAL AND SURICAL SUPPLY							
	Solied or decontamination Room	Negative	2	6	YES	NO	NR	22-26
	Clean workroom	Positive	2	4	NR	NO	Max.60	22-26
	Sterille Storage	Positive	2	4	NR	NR	Max.60	22-26
	SERVICE							
	Food preparation Center (i)	NR	2	10	NR	NO	NR	22-26
	Warewashing	Negative	NR	10	YES	NO	NR	NR
	Dietary Storage	NR	NR	2	NR	NO	NR	22-26
	Laundry, General	Nagative	2	10	YES	NO	NR	NR
	Solied Linen Sporting and storage	Negative	NR	10	YES	NO	NR	NR
	Clean Line storage	Positive	NR	2	NR	NR	NR	22-26
	Linen and trash Chute Room	Nagative	NR	10	YES	NO	NR	NR

	Annexure 1.1 DESIGN PARAMETERS FOR AREAS AFFECTING PATIENT CARE IN HOSPITALS AND OUTPATIENT FACILLTIES							
	Space Function	Pressure Relationship to Adjacent Areas (n)	Minimum outdoor Air-ACH	Minimum Total Air-ACH	ALL Room Air Exhausted Directly to Outdoors(j)	Air Recirculated by means of Room units(a)	Relative Humidity Rh % (k)	Design temperature (l) Deg C
								Std.
	Bedpad Room	Nagative	NR	10	YES	NO	NR	NR
	Bathroom	Nagative	NR	10	YES	NO	NR	22-26
	Janitor's Closet	Nagative	NR	10	YES	NO	NR	NR
	SUPPORT SPACE							
	Soiled workroom or soiled holding	Negative	2	10	YES	NO	NR	NR
	Clean workroom or clean holding	Positive	2	4	NR	NR	NR	NR
	Hazardous Material Storage	Positive	2	10	YES	NO	NR	NR
OTES								
a	Exepct where indicatesd by a "No" in this column, recirculating room HVAC units (with heating or cooling coils) are acceptable for providing that portion of the minimum total air changes per hour that is parmitted by section 701 ASHRAE STD 170-2013 (subparagraph [a][5]. Because of the cleaning difficulty and potential for bulidup of contamination, recirculating room units shall not be used in areas marked "No. "Recirculating devices with HEPA filters shall be parmited in existing facillties as interim, supplemental environmental contols to meet requirements for the control of the airborne infectious agents. The desgin of either portable or fixed systems should prevent stagnation and short circuiting of airflow. The sdesign of such systems shall also allow or easy access for scheduled prevenative maintenance and cleaning.							
b	Pharmacy compounding ares may have additional air change, differntial pressure, and filterning requirements beyond the minimum of this table depending on the type of pharmacy , the regulatory requirements which may include adoption of USP 797), the associated lavel of the risk of the work (see USP [2013] in informative Appendix B), and the equipment utillzed in the spaces.							
c	The term trauma room as used herein is a first-aid room and/or emergency room used for general initial treatment of of acedent victims. The operating within the trauma centre that is routinely used for emergency surgrey is considered to be an operating room standred.							
d	Pressure relationships need not be maintainted when the troom is unoccupied.							
e	All air air need to be exhausted in dark room equipment has a scavenging exhaust duct attached and meets ventilation standard regarding NIOSH,OSHA, and local employe exposure limits $_{2\text{-}3}$ h. A nonrefrigerated body-holding room is applicable only to facillties that do not perform autopsies on-site and use the space for short periods while wating for the body to be transferred.							
f	Minimum total air change per hour (ach) shall be that requried tp provide proper makeup air to kitchen exhausted systems as specifled in ANSI/ASHRAE standard 154.$_4$ in some cases , excess exffiltration or infiltration to or from exit corridors restrictions of NEPA 90a, $_5$ the pressure requirments of NEPA 96, $_6$ or the maximum defined in the table . during operation , a redcution to the number of air changes to any extent required for odor control shall be permitted when the space not in use.							

g	In some areas with potential contamination and/or problems, Exhaust air shall be discharged directly to the outdoors and not re circulated to other areas. Individual circumstances may require special consideration for all the exhausted to the outdoors. To satisfy exhaust needs, constant replacement air from the outdoors in necessary when the system is in operation .
h	The RH ranges listed are the minimum and/or maximum allowable at any point within the design temperature range required for that space.
i	Systems shall be capable of maintaining the rooms within the range during normal operation. Lower or higher temperature hall be permitted when patients ' comfort and/or medical conditions require those condition.
j	National institute for occupational safety and health (NIOSH) criteria documents regarding occupational exposure to waste anesthetic gases and vapors, and control of occupational exposure to nitrous oxide[7] indicate a need for both local exhaust (scavenging) systems and general ventilation of the areas in which the respective gases are utilized. Refer to NEPA 99 for other requirements. [8]
k	If pressure-monitoring devices alarm are installed, allowances shall be made to prevent nuisance alarms. Short-term excursions from required pressure relationships shall be allowed while door is moving or temporarily open. Simple visual methods such as smoke trails, ball-in-tube, or flutter strip shall be permitted for verification of air flow direction.
l	Surgeons or surgical procedures may require room temperatures, ventilations rates humidity range, and/or air distribution method the exceed the minimum indicates ranges.
m	Treatment room used for bronchoscopy rooms. Treatment room used for procedure with nitrous

	oxide shall contain provisions for exhausting anesthetic waste gases.
n	In are circulating ventilation system, HEPA filters shall be permitted instead of exhausting the air from these space to the outdoors provided that the return air passes through the HEPA filter before it is introduced in to any other spaces. The entire minimum total be air change per hour of re circulating airflow HEPA filters. When these areas are open to larger, non-waiting spaces the exhaust air volume shall be calculated based on the seating area of the waiting area. (Note: The intent here is not require the volume calculation to include a very large space [e.g.an atrium] just because a waiting area open on to it.)
o	See NEPA 99 for further requirements. [8]
p	For intermediate care, labor/delivery/recovery rooms, and labor/delivery/recovery /postpartum rooms, for total as shall be permitted when supplemental heating and/or cooling systems(radiant heating and cooling , baseboard heating , etc.) are used
q	The protective environment airflow design specifications protect the patient from common environmental airborne infectious microbes Recirculation HEPA filters shall be permitted to increase the equivalent room air exchanges; however, the outdoors air changes are still required. Constant-volume air flow is required for consistent ventilation for the protected environment. The pressure relationship to adjacent areas shall remain unchanged if the PE room is utilized as normal patient room. Rooms with reversible airflow provisions for the purpose of switching between protective environment and all function shall not be permitted.
r	The all room described in this standard shall be used for isolating the airborne spread of infectious diseases, such as measles varicella , or tuberculosis. Supplemental re circulating devices using HEPA filters shall be permitted in the All room to increase the equivalent room air exchanges; however, the minimum outdoor air changes of tables are still required. All rooms that are retrofitted from standard patient rooms from which it is impractical to exhaust directly outdoors may be re circulated with air from the all room, provided that air first passes through a HEPA filters. When the all room is not utilized for airborne infection isolation, the pressure relationship to adjacent areas, when measured with the door closed, shall remain unchanged and the minimum total air changes rates shall be 6 ach. Switching controls for reversible air flow provisions shall not be permitted.
s	when required, appropriate hoods and exhaust devices for the removal of noxious gases for chemical vapors shall be provided in accordance with NFPA 99.[8]
t	The requirements that all rooms air is exhausted directly to outdoors applies only to radiology waiting rooms programmed to hold patients who are waiting for chest X-rays for diagnosis of respiratory disease.
u	If the planted space is designated in the organization's operational plan to be utilized for both bronchoscopy and gastrointestinal endoscopy, the design parameters for "bronchoscopy, sputum collection, and administration" shall be used.
v	For single-bed patient rooms using Group D diffusers, a minimum of six total ach shall be provided and calculated based on the volume for the finished floor to 6ft.(1.83 m) above the floor.
Source: ASHRAE std 170-2013	

Annexure 2.1

PRESSURE RELATIONSHIPS AND VENTILATION OF CRITERIA AREAS OF NURSING HOMES					
Function Area	**Pressure Relationship to Adjacent Areas**	**Minimum areas Changes of Outside air per Hour Supplied To Room**	**Minimum total air Changes per Hour Supplied to room**	**All Air Exhausted Directly To Outside**	**Air Recirculated within room units**
	Std	**Std**		**Std**	**Std**
Patient Care					
Patient Room (Holding room)	*	2	6	Optional	Optional
Patient area corridor	*	Optional	2	Optional	Optional
Toilet Room	Negative	Optional	10	Yes	No
Diagnostic and Treatment					
Exanination room	*	2	6	Optional	Optional
Physical therapy	Negative	2	6	Optional	Optional
occupational therapy	Negative	2	6	Optional	Optional
Soiled workroom or solied Holding	Negative	2	10	Yes	No
clean workroom or clean holding	Positive	2	4	Optional	Optional
Sterillizing and Supply					
Srerillizing exhaust room	Negative	Optional	10	Yes	No
Linen and trash chute room	Negative	Optional	10	Yes	No
Laundry,general	*	2	10	Yes	No
Solied linen sorting and storage	Negative	Optional	10	Yes	No
clean linen storage	Positive	Optional	2	Yes	No
Service					
Food Preparation center	*	2	10	Yes	Yes
Ware washing room	Negative	Optional	10	Yes	Yes
Dietary day storage	*	Optional	2	Yes	No
Janitor closet	Negative	Optional	10	Yes	No
Bathroom	Negative	Optional	10	Yes	No
*Continuous directional cantrol not requried				Source:ASHRAE Handbook	

8.1.3. The following are the indoor design conditions which are not suggested in ASHRAE Standard 170:-

S. No.	Description	Temperature °C	Relative Humidity	Remarks
A.	**Academic Building/Guest House/Mortuary**			
1.	Corridors & Reception	Non-Air Conditioned		
2.	Staff Room	24 ± 1	< 60%	
3.	Autopsy Room	21 ± 1	< 60%	100% Exhaust Provision
4.	Office	24 ± 1	< 60%	
5.	Reading Area	23 ± 1	< 60%	
6.	Auditorium	22 ± 1	< 60%	
7.	Guest House	22 ± 1	< 60%	

8.1.4. Lighting Load: As per NBC 2016

8.1.5. Equipment Load: As per Actual

8.1.6. Acceptable Indoor Noise Levels for Hospital: 35-40 dBA

8.1.7. Fibrous acoustic insulating material shall not be used as duct lining for critical spaces unless downstream terminal filters are provided. Supply air ducts shall be externally insulated as required.

8.1.8. Non critical spaces not having downstream terminal filters will have internal acoustic lining till first bend or 5-7 M length of duct from inside in the Air Handling Units and Treated Fresh Air Units.

8.2. Building Construction Data

The building shall be designed for GRIHA Version 2015, for ECBC compliance following are the details

a. Climate Zone : as per ECBC latest version

b. All U value, SHGC, VLT etc. of Glazing, Roof/ Wall Insulation etc. shall conform to ECBC norms.

c. Active smoke control systems shall be used along with fire and smoke partitions to limit the spread of smoke in the event of fire. Smoke and fire management shall be done in accordance with Part 4 Fire and Life Safety as per NBC.

d. Exhaust outlets shall be located at a minimum height of 3 m away from ground level and away from doors, occupied areas and openable windows.

8.3. Mechanical Ventilation: (Air Changes Per Hour) – Lift well /Lobby/Smoke extraction/staircase pressurization system shall be designed as per specific Building requirement.

S. No.	Space	Air Changes Per Hours (ACPH)
1.	Toilet (Private)	6 ACPH exhaust with equivalent draw of air from adjacent areas
2.	Toilet (Public)	10-12 ACPH exhaust with equivalent draw of air from adjacent areas
3.	Pantry	6 ACPH exhaust, with equivalent draw of air from adjacent areas
4.	Kitchen	Recommended 40 ACPH exhaust with equivalent (Supply air will be less than Exhaust), Fresh Air through air washer unit (same shall be in conformance to relevant norms).
5.	Lift well pressurization	Mechanically pressurized for maintaining 50 Pa differential pressures.
6.	Lift lobby pressurization	Mechanically pressurized for maintaining 25 Pa differential pressures.
7.	Staircase pressurization	All enclosed staircases shall be mechanically pressurized for maintaining 50 Pa pressure and external staircase to be naturally ventilated.
8.	Plant Rooms/Utility Rooms/Electrical LT Panel Room	15 ACPH exhaust with equivalent draw of make-up Air
9.	STP Plant room	30 ACPH exhaust with equivalent (Supply air will be less than Exhaust) draw of make-up Air Exhaust will be let out at higher level to prevent smell in vicinity. Necessary provision to be considered for odor control.
10.	DG Room	DG's are open to atmosphere and hence no mechanical ventilation, 35-37 CFM /KVA or as per OEM when it is kept inside Room.
11.	Smoke Extraction	12 ACPH supply +12 ACPH exhaust meeting NBC norms
12.	Basement Car Park Ventilation	12 ACPH supply +12 ACPH exhaust meeting NBC norms
13.	Waste Management	25 ACPH Exhaust

	Room	
14.	Lift Machine Room	Min 10 ACPH Exhaust provision or as per requirement
15	Electrical Rooms (with Rising Mains/ D.Bs etc.)	Min 6 ACPH Exhaust provision or as per requirement

Note: Separate: Exhaust duct shall be provided for toilets, pantries, and dirty utility areas. These shall not be combined with each other or with any other exhaust ducts of AC System. UPS Battery Room also needs to be suitably ventilated as per requirements.

Sl. No.	Description	Fan type
1.	Lift well pressurization	Long casing Tube / Vane Axial fans/Fan Sections with Class H motor insulation
2.	Lift lobby pressurization	Long casing Tube / Vane Axial fans/Fan Sections with Class H motor insulation.
3.	Stair well pressurization	Long casing Tube / Vane Axial fans/Fan Sections with Class H motor insulation
4.	Smoke Extraction System	Axial Fans for both Supply & Exhaust System with Class H Motor insulation.

Note: Basement Ventilation (Fresh Air/exhaust) Fans shall be with IE-3 Rating. Pressurization Fans (Lift Well, Lift Lobby, Stairwells etc.), Floor Smoke Extraction Fans shall be with IE-2 Rating. Adequate Static shall be considered for Fans. All statutory/ functional requirements in this regard to be met with.

Sl. No.	Description	Fan type
1.	Auditorium Fresh Air & Exhaust (Smoke Extraction System)	Long casing Tube / Vane Axial fans with Class H motor insulation
2.	Toilet Exhaust	Centrifugal Inline/Propeller as per requirement
3.	DU / Isolation Room Exhaust	Centrifugal Inline/PROPELLER
4.	Service / Utility area	Wall mounted propeller type/ Inline Fans
5.	Air Washer /Dry Scrubber	Plug Fan/Centrifugal Fan /SISW Fans
6.	Waste Management Room	Cabinet Type with SISW Blower
7.	Plant Room/Pump Room/ STP/ETP etc.	Long casing Tube / Vane Axial fans with Class H motor insulation

Waste Room Fans, Air washer, Scrubber, Pump Room fans shall be preferably with IE-3 motors & Pressurization Fans /Auditorium Exhaust shall be preferably with IE-3 rated motors. DU Isolation Rooms shall be with energy efficient motors.

9. Estimated Refrigeration Load

Detailed heat load estimation sheet shall be prepared during detailed engineering stage for all the seasons (Summer/Monsoon/winter) in which, the specified conditions are to be maintained based on above design parameters.

Based on ASHRAE GRP 158, Load Calculation Manual (Heating & Cooling), Table A1.1- Estimated Heat load summary is derived as under: -

10. Estimated Air-Conditioned Load :

10.1 Academic & Administrative Block

S. No.	Details	Area in Sq.ft	Tonnage (TR)
	Level-1		
1	Control Room/LV Room	150	1
2	Server Room	258	1.5
3	UPS Room	161	1
	Total	**559**	**3.5**
	Level-2		
1	Faculty Room	258	1
	Total	**258**	**1**
	Level-5		
1	Library	700	3
2	Faculty Room	700	3
3	Canteen	463	2
4	Dept. Office	258	1
5	H.O.D-1	323	1.5
6	H.O.D-2	323	1.5
	Total	**2767**	**12**
	Level-4		
9	Faculty Room	247	2
	Total	**247**	**2**
	Level-3		
8	Faculty Room	700	3
9	Dept. Office	323	1.5
10	H.O.D-3	323	1.5
11	H.O.D-4	323	1.5
	Total	**1669**	**7.5**
	Level-6		
7	Museum	904	3
	Total	**904**	**3**
	Grand Total	**5845**	**29**
	Hi Wall Split A/C System with Ceiling Fans shall be provided for above mentioned areas.		
	Classrooms will be provided with ceiling fans and in Labs, in addition to ceiling fans, exhaust shall be provided at appropriate places.		

10.2 Guest House

S. No.	Details	Area in Sq.ft	Total Tonnage (TR)
	Level-1		
1	Dining hall	393	1.5
2	Reception & Waiting Area	322	1.5
	Total	**715**	**3.0**
	Level-2		
1	Guest Room -1	225	1.0
2	Guest Room -2	225	1.0
3	Guest Room -3	255	1.0
4	Guest Room -4	255	1.0
	Total	**960**	**4.0**
	Level-3		
1	Guest Room -5	225	1.0
2	Guest Room -6	225	1.0
3	Guest Room -7	255	1.0
4	Guest Room -8	255	1.0
	Total	**960**	**4.0**
	Level-4		
1	Suite-1	205	1.0
2	Living room-1	205	1.0
4	Suite-2	205	1.0
5	Living room-2	205	1.0
	Total	**820**	**4.0**
	Grand Total	**3455**	**15.0**

Hi Wall Split A/C System with Ceiling fans shall be provided in above areas. Ceiling fans shall also be provided in Foyer & other areas as directed by Engineer-In-Charge.

10.3 Indoor Sports Complex & Auditorium

S. NO.	SPACE	AREA (SQ.FT)	PROPOSED (TR)
I	**LEVEL-1**		
1	COACH ROOM, EQUIPMENT ROOM, OFFICE, SNACKS BAR	624	4
	TOTAL	**624**	**4**
II	**LEVEL-2**		
1	ACTIVITY GALLERY, COMMUNICATION ROOM, GALLERY, GREEN ROOM 1& 2, LOBBY & PASSAGE	3863	14
	TOTAL	**3863**	**14**
III	**LEVEL-3**		
1	AUDITORIUM	11470	78.0
2	GREEN ROOM 1	226	1.0

3	GREEN ROOM 2	226	1.0
4	LOBBY & PASSAGE	753	3
5	LOBBY	646	2.0
6	COMMUNICATION/ LV ROOM	97	1
7	LOUNGE+ OFFICE	2506	9
	TOTAL	**15924**	**94**
IV	**LEVEL-4**		
	LOUNGE-2	1560	6.0
	TOTAL	**1560**	**6.0**
	SUBTOTAL	**21971**	**118**
	TOTAL A/C Area = 21971 Sqft Total Tonnage = 118 TR Tonnage after diversity (85%) – 100.3 TR, SAY 100 TR	**3 No. 50 TR Air Cooled Scroll Chillers (2 W + 1S) with VFD**	

10.4 **Hostels**

General Hostel Block: No Provision shall be made for air conditioning. Ceiling fans shall be provided in various areas/locations as directed by Engineer-In-Charge.

10.5 **100 Bedded Hospital**

S. NO.	SPACE	AREA	PROPOSED
		(SQ.FT)	(TR)
I	**LEVEL-1**		
1	BACK OFFICE -1	194	1.0
2	BACK OFFICE 2	344	1.5
3	BEDS	118	0.8
4	BUFFER	204	1.0
5	CARDIAC	194	2.0
6	DNS & PLASTER	91	0.8
7	DOCTOR ON DUTY	161	1.0
8	ECG 1	129	0.8
9	ECG 2	86	0.8
10	MINOR OT	409	4.0
11	PHARMACY	194	1.5
12	PHARMACY STORE	269	1.0
13	PORTABLE X RAY	65	0.8
14	RESUSCITATION	65	0.8
15	TRAUMA CARE	161	1.5
16	TREATMENT	183	1.0
22	SERVER ROOM		2.0
	TOTAL	**2868**	**22.3**
	LEVEL-2		
1	AYUSH-1, AYUSH, AYUSH-1	97	0.8
2	AYUSH-2, AYUSH,AYUSH-1	97	0.8
3	MRI SCAN	291	6.0
4	CONSOLE (MRI)	129	1.5
5	EQUIPMENT ROOM (MRI)	118	1.0

6	CT-SCAN	291	6.0
7	CONSOLE (CT)	113	1.0
8	DOCTORS ROOM	258	1.0
9	ENDOSCOPY	215	1.5
10	ENT MINOR PROCEDURE	118	0.8
11	ENT	140	0.8
12	GENERAL MEDICINE - 1	129	1.0
13	GENERAL MEDICINE - 2	129	1.0
14	GENERAL SURGERY-1	161	1.0
15	GENERAL SURGERY-2	161	1.0
16	GYNECOLOGY -1	226	1.0
17	GYNECOLOGY -2	226	1.0
18	INTEGRATED COUNSELING & TESTING	473	2.5
19	COUNSELING ROOM	161	1.5
20	NRHM OFFICE	108	0.8
21	OPHTHALMOLOGY & TREATMENT RM	194	1.0
22	ORTHOPEDIC	194	1.0
23	PEDIATRICS	226	1.0
24	PHYSIOTHERAPY	194	1.5
25	PROCEDURE ROOM	237	1.5
26	PUBLIC CANTEEN	592	4.0
27	ROGI KALYAN SAMITY	108	0.8
28	SAMPLE COLLECTION ROOM	172	1.0
29	STAFF CANTEEN	344	2.5
30	STAFF ROOM-1	65	0.8
31	STAFF ROOM-2	65	0.8
32	TRAINING AND GROUP COUNSELING	393	2.5
33	TREATMENT-1	81	0.8
34	TREATMENT-2	81	0.8
35	USG	194	1.0
36	X RAY 1	264	3.0
37	X RAY 2	264	3.0
38	CONTROL ROOM	108	1.0
47	UPS ROOM		1.0
	TOTEL	**7414**	**61.0**
	LEVEL-3		
1	DOD	301	1.5
2	GENERAL WARD	506	2.5
3	ISOLATION ROOM-1	183	12.0
4	ISOLATION ROOM-2	183	
5	ISOLATION ROOM-3	183	
6	ISOLATION ROOM-4	183	
7	MEDICINE WARD FEMALE	689	4.5
8	MEDICINE WARD MALE	732	4.0
9	NOD	183	1.5
10	SURGERY POST OPERATIVE FEMALE-1	269	1.5
11	SURGERY POST OPERATIVE FEMALE-2	269	1.5
12	SURGERY POST OPERATIVE FEMALE-3	269	2.0
13	SURGERY POST OPERATIVE FEMALE-4	269	1.5
14	SURGERY POST OPERATIVE MALE-1	247	1.0
15	SURGERY POST OPERATIVE MALE-2	247	1.0
16	SURGERY POST OPERATIVE MALE-3	247	1.0

17	SURGERY POST OPERATIVE MALE-4	247	1.0
18	SURGERY POST OPERATIVE MALE-5	247	1.0
19	SURGERY POST OPERATIVE WARD FEMALE	699	3.0
20	SURGERY POST OPERATIVE WARD MALE	699	3.0
21	SURGERY WARD FEMALE	796	4.5
22	SURGERY WARD MALE	732	4.0
29	UPS ROOM		3.0
	TOTAL	**8382**	**55.0**
	LEVEL-4		
1	ACCOUNTANT	140	1.0
2	ANTENATAL WARD	882	4.5
3	ASSISTANT SUPERINTEND	151	0.8
4	BLEEDING & RECOVERY	151	0.8
5	BLOOD BANK	151	0.8
6	BOARD ROOM	570	2.5
7	CHIEF OF LAB	183	0.8
8	COMPONENT SEPARATION	377	1.5
9	CONSULTATION	97	0.8
10	CYTOLOGY	140	0.8
11	DEMO ROOM	344	2.0
12	DESIGNATED MICROSCOPY	108	0.8
13	DOCTOR'S ROOM	312	2.0
14	DOTS CENTER	151	0.8
15	GENERAL WARD-1	484	2.5
16	GENERAL WARD-2	603	3.0
17	GYNECOLOGY	161	1.0
18	HISTO PATHOLOGY	151	1.0
19	IMMUNOLOGY	140	0.8
20	LABOUR COMPLEX	398	2.0
21	LABOUR ROOM ECLAMPSIA	753	4.0
22	MEDIA-PREP	226	1.0
23	MEDICAL RECORDS ROOM	140	0.8
24	MEDICAL SUPERINTEND	269	1.5
25	MICROBIOLOGY	140	0.8
26	NEW BORN WARD	291	2.0
27	NURSING SUPERINTEND	258	1.0
28	OBSERVATION STAGE	237	1.0
29	PEDIATRICS WARD	452	2.5
30	PUBLIC HEALTH MANAGER	301	1.5
31	SEROLOGY	129	0.8
32	STAFF ROOM	54	0.8
	TOTAL	**8942**	**47.9**
	LEVEL-5		
1	CSSD	1356	10.0
2	DOCTORS LOUNGE	172	1.0
3	ICU	495	3.0
4	OPERATION THEATRE 1	398	18.0
5	OPERATION THEATRE 2	398	8.0
6	OPERATION THEATRE 3	398	8.0
7	POST NATAL	269	2.0
8	PRE NATAL	269	2.0
9	POST OP	785	4.0

10	PRE OP	721	4.0
11	STAFF LOUNGE	204	1.0
12	STERILE CORRIDOR	1011	3.0
	TOTAL	**6478**	**64.0**

S. NO	**SPACE**	**AREA**	**Air Conditioning Load**
		(SQ.FT)	**(TR)**
1	LEVEL-1	2868	22.3
2	LEVEL-2	7414	61.0
3	LEVEL-3	8382	55.0
4	LEVEL-4	8942	47.9
5	LEVEL-5	6478	64.0
	TOTAL	34082	250.2
Considering Diversity@ 80%			**200**
PLANT PROPOSAL with 80% Diversity (200 TR)		**3 X 100 TR AIR COOLED SCREW CHILLERS (2W+1S) with VFD**	
Ceiling fans shall be provided in Waiting Areas, Reception lobbies, corridors etc. and other areas except Critical areas as directed by Engineer-In-Charge.			

1. **Hospital Staff Apartment: -** No Provision shall be made for air-conditioning. Ceiling fans shall be provided in various areas/locations as directed by Engineer-In-Charge.
2. **Medical Superintendent Residence:** No Provision shall be made for air-conditioning. Ceiling fans shall be provided in various areas/locations as directed by Engineer-In-Charge.
3. **Resident Doctor Apartment:** No Provision shall be made for air-conditioning. Ceiling fans shall be provided in various areas/locations as directed by Engineer-In-Charge.
4. The HVAC System shall be provided in miscellaneous areas as below:
   a) For UPS Rooms, LV Rooms, Fire Control Rooms, BMS Rooms, Warden Rooms, Office in Hostels, Server Rooms except Hospital, Operator Room in Substation/HVAC Plant Room etc. or any other room where it is required as per functional requirements and directions of E-I-C, energy efficient split ACs shall also be provided in various buildings. Precision ACs shall be considered for Server Rooms of Hospital Building. In LV Rooms including Fire Control Room, BMS Rooms, UPS/Batteries Room, one standby Split AC to be provided in addition to desired Nos. of working ACs if it is not connected to centrally air conditioned system. Also, for Batteries Room, required Ventilation provision needs to be considered.
   b) Toilet, Pantry, Kitchen, Tandoor area etc. of all buildings needs to be ventilated.
   c) Smoke Extraction /Pressurization scheme as per requirement / NBC norms to be provided for all required buildings.
   d) The Equipment Details, Tonnage, Air conditioned areas, Application of Equipment given in the above table is minimum to be provided. During detailed designing, if required

and found necessary, the capacity / rating of the equipment may be upgraded/ revised subject to concurrence of Engineer-In-Charge.

10.1 Proposed Chilled Water Plant Selection & Equipment Addition Scheme

Sl. No.	Description	Cumulative Load (TR)	Equipment
1.	Central Plant For Indoor Sport & Auditorium	100	3 No. 50 TR Air Cooled Scroll Chillers with VFD (2 Working + 1 Standby) 3 No. 3 H.P Primary Pump (2 Working + 1 Standby) 2 No. 10 H.P Secondary Pump with VFD (1 Working + 1 Standby) 2 No. 45 kW Hot Water Generator (1Working + 1 Standby) 2 No. 5 H.P Hot Water Pump (1 Working + 1 Standby)
2.	Central Plant For 100 Bedded Hospital	200	3 No. 100 TR Air Cooled Screw Chillers with VFD (2 Working + 1 Standby) 3 No. 5 H.P Primary Pump (2 Working + 1 Standby) 2 No. 15 H.P Secondary Pump with VFD (1 Working + 1 Standby) 2 No. 150 kW Hot Water Generator (1Working + 1 Standby) 2No. 7.5 H.P Hot Water Pump with VFD (1 Working + 1 Standby)

The Equipment Details, Layout scheme, Position and Application of Equipment given in the above table is indicative only. The rating and capacity of all equipment indicated herein below are minimum to be provided. However during detailed designing, if required and found necessary, the capacity / rating of the equipment may be upgraded by the EPC Contractor subject to concurrence of Engineer-In-Charge.
Discharge & head of pumps shall be furnished by EPC Contractor during detailed engineering along with submission of pump head loss calculation.
H.P of pumps shall be as per discharge & head of pump.

11. System Description

11.1. Air Conditioning:

Air conditioning system installed in a common Utility Block is proposed to be provided for the buildings as tabulated above. The system will comprise of Air cooled Chilling machines along with associated equipment like, pumps, air handling units, fan coil units, cassette units and piping/ducting etc. The equipment shall be installed sequentially as per development of Phases and infrastructure comprising of Header, equipment spaces & plant room sizing shall be considered accordingly.

As per preliminary assessment, the peak diversified load for all buildings is anticipated. Thus, the proposed system shall provide sufficient capacity to meet peak cooling loads and also operate efficiently at part-load conditions without excessive spare capacity.

Chilled water from Chillers and hot water from Hot Water Generators shall be pumped through insulated chilled/hot water pipes installed within plant room to required areas.

Four pipe systems shall be provided for critical areas of the Hospital like OTs, ICUs etc. The four pipe arrangement will help in reheat of air to maintain a precise control of relative humidity during monsoon season in critical areas.

Chilled and Hot water system shall be designed with 2 Way PID valves which will help to avoid reverse return piping and ensure balancing of water flows. Expansion/ Contraction in hydronic circuit (chilled/ hot water) shall be handled through expansion tank along with air separator provided in the plant room.

For comfort heating during winter for critical area shall be done by Hot Water Generators, these shall be in alternation to chillers. It is assumed that the Heating load for the complex shall show in above table.

All mechanical equipment with larger capacity motors such as chilling units, pumps, AHU's and larger ventilation fans shall be provided with energy efficient IE 3 motors in order to maximize energy savings. Mechanical Plant rooms such as HVAC plant room, Pump room, STP room, Filtration plant room etc. shall be provided with air cooling system and exhaust.

All centrally air conditioned areas shall be provided with 4 pipe system till AHUs. For chilled water cassette units, 2 pipe shall be connected to the main header through proper valve arrangement. All Hot Water Generators & Hot Water Pumps shall be of suitable size & capacity & shall be located in HVAC Plant Room. Hot Water Generators shall be sized taking into account winter heating load of all areas & monsoon reheat load of critical areas like OTs/ICUs/Labs etc.

All pipes should be placed at fixed support. Pedestals at suitable distance to be provided as per requirements & directions of E-I-C.

Butterfly valve in supply line of riser & balancing valve in return line of riser for each centrally air conditioned building shall be provided.

11.2. Protective Isolation rooms

The protective isolation rooms meant for immuno-suppressed patients (as identified) shall be kept at (+) 2.5 Pa pressure w.r.t surrounding. These rooms shall be provided with total air quantity not less than 12 ACPH.

11.3. Infectious Disease Isolation rooms

The negative pressure isolation room shall have airflow rates similar to the protective isolation room. Separate AHU is not required for these isolation rooms. Supply air shall be tapped from nearest AHU and all the air shall be exhausted to the atmosphere. Pressure differential of (-) 2.5 Pa shall be maintained with respect to adjacent spaces. In addition, exhaust through Bronchoscopy, Burn patient units and nuclear medicine shall be HEPA filtered. Exhaust point shall be at least 25 ft away from all fresh air intakes.

11.4. Imaging

Imaging or Radiology department consisting of CT scan, MRI, and X-ray etc. shall be provided with two stage filtration AHU. The indoor areas shall be kept at positive pressure with respect to surrounding.

Air distribution system for MRI shall be through aluminum construction duct & accessories If MRI machine is equipped with nozzle connections for supply and return air, flexible

aluminum ducting shall be used to connect these nozzles with ducting headers. Standby arrangement (DX split/Chilled water unit etc.) needs to be provided for MRI Equipment room for 24 hrs. Cooling.

11.5. Auditorium

Air handling units (AHU) shall be variable volume type, double skin (for noise control) construction, comprising centrifugal fans, cooling coil section, stainless steel sloping drain pan (for zero water retention) and filter section. These shall be floor-standing type with ducted arrangement for supply and return air. Fresh air shall be injected as per the operator guideline.

All fans shall have sound level not exceeding 60 dB(A) at a distance of 1 m from the air handling unit in both supply and return air stream. AHU's shall be provided with proportionate pressure independent cum modulating valves in chilled water coils.

11.6. Ventilation System:-

11.6.1. **Kitchen Ventilation**

The Kitchen shall be non-air-conditioned. Air washer unit shall be provided for supplying make-up air around the hoods. Kitchen hoods over cooking area shall be compensating type and provided with UV filters inbuilt in hoods the exhaust should be collected from the kitchen hoods and connected to dry scrubber. Kitchens shall be maintained at slight negative pressure to prevent spread of food odor in occupied areas.

S. No.	Description	Normal Operation	Fire Operation
1.	Supply air damper	NO, Open	NC
2.	Exhaust air damper	NC, Closed	NO
3.	Supply air fan	On	Off
4.	Smoke Extract Fan	Off	On
5.	Make up air Fan Or Motorized louvers	Off	On

11.6.2. **Plant Room Ventilation**

Plant rooms shall be provided with mechanical ventilation system. The system shall consist of make air fan (as described in matrix below), fresh air grille with filters, air distribution system with grilles, electrical panel, power cabling, control wiring and earth. Fresh air shall be drawn from outside & shall be supplied to these areas by means of ducts and grilles. Ventilation fan & duct shall be provided for exhausting equivalent amount of air.

Pantry and Toilet Exhaust

Pantries and toilets shall be connected to the mechanical ventilation system consisting of in-line fan or propeller fan in exhaust duct.

11.6.3. **Staircase Pressurization**

All the staircases open to the external façade shall be naturally ventilated as per the latest amendment of NBC. Whereas, all the internal/fire staircases shall be provided with Pressurization system @ 50 Pa, consisting of supply air fans installed on roof level. These fans shall be connected to ducts installed in vertical risers for supplying

air at each staircase landing in order to achieve effective pressurization. Supply air fans serving stairwell shall be provided with gravity louvers to prevent humid fresh air entering into staircase well.

11.6.4. **Lift Lobby Pressurization**

All fire escape Lift lobbies shall be provided with Pressurization system @ 25 Pa, consisting of supply air fans installed on roof. These fans shall be connected to ducts installed in vertical risers for supplying air at each lift lobby landing in order to achieve effective pressurization.

11.6.5. **Lift well Pressurization**

Lift wells shall also be provided with pressurization by supplying the air through fans installed on roof level. Fans shall be sized to maintain minimum positive pressure of 50 Pa across the door. The pressurization fans shall get activated upon sensing of smoke in corridors / common passengers / lift lobby.

12. Brief Equipment Specifications (High Side):

i. Chillers

- Chillers shall be Screw/Scroll type.
- Chiller Motors must be equipped with VFDs.
- Air cooled Chillers shall be with hermetic/semi hermetic, single compressors, Flooded/ Falling Film type chillers.
- Chiller shall be Factory Assembled and Tested – Eurovent / AHRI certified.
- Equipment shall meet or exceed minimum efficiency requirements of COP/ IPLV/ IKW per TR as per latest ASHRAE/ ISHRAE/ ECBC Standards (ECBC+).
  - For Indoor Sports Complex:- COP- min.3 & IPLV min.4 & For Hospital:- COP- min.3.2 & IPLV min.5 under ANSI/ AHRI 550/ 590 conditions needs to be strictly met with.
- Minimum requirement of both COP and IPLV requirement of ECBC /NBC provisions shall be met. The chiller capacity shall be as per following parameters:
  - Chilled Water Leaving Temperature: 6.67 Deg. C
  - Chilled Water Entering Temperature: 12.2 Deg. C
  - Chiller Fouling Factor: 0.0005 FPS
  - Chiller Water Flow Rate: @2.4GPM / TR
- Motors shall be energy efficient must conform to minimum IE-3 Class Efficiency.
- Full compatibility with BMS System.
- The scope shall include plant manager for optimizing plant room operation.
- Both Working and Stand-by provisions for Chillers has to be considered. Minimum One Chiller shall be considered in addition to the no. of chillers as per requirements.
- Refrigerant of chiller shall be CFC free & low ODP (preferably zero ODP), low GWP and preferably should be R-134 a/ R-514a/ R1233zd (E) or as per NBC 2016.

ii. Refrigerant

- Refrigerant selected must possess the following properties:
  - Low to zero Global Warming Potential (GWP) & ODP
  - Low to zero Flammability
  - Low to zero Toxicity
  - Low to zero Flame Propagation
- Depending upon the specific suitability and applicability, a desirable refrigerant may be selected for Split Unit.

iii. **Pumps**

- Chilled/Hot water pumps shall be Horizontal/Vertical Split Casing/Inline Centrifugal type for ease of maintenance and rugged usage.
- Suitable Pump Head shall be selected while sizing of pump depending upon the piping length, fittings, friction factor etc. and other requirements.
- Both Working and Stand-by provisions for Pumps has to be considered. Minimum. One standby pump shall be considered in addition to the no. of working pumps as per requirements.
- Pump casing shall be cast iron, impeller shall be bronze/gunmetal, shaft shall be of Stainless steel with S.S mechanical seal.
- The thermal insulation of Chilled/hot Water Pumps shall be with same material & thickness as that of pipe.
- Pump shall be complete with all accessories like pressure gauge, valves (butterfly, NRV etc.), reducers (if reqd.), Strainers, flexible bellows (double arch PN-16 rating min.) etc.
- All pumps including hot water & secondary chilled water pumps, primary chilled water pumps water pumps will be with unit mounted variable speed drives circulating water in the chilled/hot water circuit.
- Suitable Foundation (PCC/RCC) or as per OEM standards needs to be constructed for mounting of these pumps along with anti-vibration pads.
- Efficiency of Pumps (Chilled Water Primary & Secondary Pumps) shall be preferably 70% as per ECBC norms or best efficiency as per OEM standards. Motor shall be TEFC Type, with Class F insulation.
- Operating speed shall not exceed 1500 RPM.
- Pumps must be Energy Efficient and the Motor shall be rated preferably for IE-3 Class Efficiency.

13. Brief Equipment Specifications (Low Side):-

Air handling unit may be floor mounted/ceiling suspended based on functional requirement & space availability. Dedicated AHUs are required to be provided for areas like OTs, Microbiology, and Critical Labs etc.

i. Air Handling Units (For Comfort Areas) – Waiting Areas, Wards, Auditorium etc.

- Factory fabricated Double skinned construction with Thermal Break Profile with GI Sheet of Suitable thickness (0.8 mm) pre plasticized outside & plain GI (0.8 mm) on inside with PUF Insulation of suitable thickness (25mm for indoor applications/40 mm for outdoor applications) and density (min. 40 kg/cum) between them.

  AHU may be floor mounted/ceiling suspended & should be of sufficient Tonnage, CFM & static pressure as per requirements.

- Maximum flow velocity across filters/Fans/Coils, motor /fan speed etc. shall be in conformance to relevant standards.
- Velocity & friction factor for Pipe Sizing shall be in conformance to relevant standards.
- Volume control dampers to be provided in ducts as per requirements.
- Fire Damper must be provided at the Supply and Return of AHUs room fire walls.
- Motor must conform to preferably IE-3 Class Efficiency and must be Squirrel cage induction type / BLDC type.
- Selected AHUs shall be equipped with VFDs.
- Fan Blower should be DIDW backward/forward Curved blade (Belt driven)/ Plug fan (Direct driven) for supply/exhaust. Fans must be selected for suitable Static Pressure & CFM & shall be AMCA Certified for sound & performance.
- All AHUs shall be with pre and fine filters & will be equipped with UVGI lamps.
- Cooling/Heating Coil of required OD & thickness preferably made of Copper with Fins preferably made of Aluminum with suitable fins/inch. Cooling/Heating Coils Row deep should be considered meeting the functional requirements.
- Drain Pan of AHUs must be made of Stainless Steel of Suitable thickness (18 G) duly insulated with required thickness & density of insulating material & drain slope on both sides.
- Suitable number of modulating valves like Butterfly/ Ball/ PICB/Drain etc. must be positioned at the inlet and Outlet along with other accessories like Thermometer, Pressure Gauge, Thermostat, and Humidistat (as required) etc. Strainers shall also be considered at the inlet of AHUs.
- Suitable Foundation for Floor Mounted AHUs /Hanging Arrangement for Ceiling Mounted AHUs should be considered with anti-vibration pads.
- Water Supply provision must be considered for AHUs with Built-in Humidifier wherever required.
- Fireproof double canvass connection should be considered.
- The air handling units shall be powder coated in approved color as per OEM standards or as per directions of Engineer-in-Charge.

ii. Air Handling Units (For Critical Areas) –ICU, OTs, Sterile Corridor, Labs, CSSD etc.

- Factory fabricated Double skinned construction with Thermal Break Profile with Aluminum Sheet of Suitable thickness (0.8 mm) pre plasticized outside & Aluminum

Sheet (1mm) on inside with PUF Insulation of suitable thickness (50 mm) and density (min. 40 kg/cum) between them. AHU may be floor mounted & should be of sufficient Tonnage, CFM & static pressure as per requirements.

- All OT/ICU AHUs shall be with separate fans for supply & return.
- All OT/ICU AHUs shall have 3 damper arrangements for – one for by passing return air to recirculation, second for exhausting return air and the third for fresh air intake.
- Maximum flow velocity across filters/Fans/Coils, motor /fan speed etc. shall be in conformance to relevant standards.
- Velocity & friction factor for Pipe Sizing shall be in conformance to relevant standards.
- Volume control dampers to be provided in ducts as per requirements.
- Fire Damper must be provided at the Supply and Return of AHUs.
- Motor must conform to preferably IE-3 Class Efficiency and must be Squirrel cage induction type / BLDC motor.
- All AHUs shall be equipped with VFDs (Separately for supply & exhaust fans).
- Fan Blower should be Plug Type for supply/exhaust. Fans must be selected for suitable Static Pressure & CFM & shall be AMCA Certified for sound & performance.
- All AHUs shall be with pre and fine filters & will be equipped with UVGI lamps and at-least pre filters in exhaust.
- Cooling/Heating Coil of required OD & thickness preferably made of Copper with Fins preferably made of Aluminum with suitable fins/inch. Cooling/ Heating Coils Row deep should be considered meeting the functional requirements.
- Drain Pan of AHUs must be made of Stainless Steel of Suitable thickness(18 G) duly insulated with required thickness & density of insulating material & drain slope on both sides.
- Suitable number of modulating valves like Butterfly/ Ball/ PICB/Drain etc. must be positioned at the inlet and Outlet along with other accessories like Thermometer, Pressure Gauge, Thermostat, and Humidistat etc. Strainers shall also be considered at the inlet of AHUs.
- Suitable Foundation for Floor Mounted AHUs /Hanging Arrangement for Ceiling Mounted AHUs should be considered with anti-vibration pads.
- Water Supply provision must be considered for AHUs with Built-in Humidifier wherever required.
- Fireproof double canvass connection should be considered.
- The air handling units shall be powder coated in approved color as per OEM standards or as per directions of E-I-C.
- ICU & other critical areas shall be designed for re-circulatory system with minimum 4 air changes fresh air.

- Heat recovery units (HRU) will be provided for AHUs for 100% fresh air units to be considered for septic OTs & ICUs.
- Pressure differential operating rooms where highly infectious patients are treated and isolation is required, all air from operating rooms and from all airborne infection isolation rooms, shall be exhausted directly to outdoors and if this is not possible, the room shall be ventilated with re-circulated air supplied through High-Efficiency Particulate resistance (HEPA) filters. Such rooms shall be maintained at a minimum negative pressure with respect to surrounding areas.
- Protective environment rooms, such as, bone marrow transplants and organ transplants, shall be maintained at a positive pressure with respect to surrounding spaces.
- All operation theatres shall have independent air handling unit to prevent cross contamination.
- The laminar flow air distribution system shall be followed. Air shall be supplied from ceiling level to flow unidirectional upto the operation table. The return air shall be collected from four corners of the room to prevent the contamination from re-circulation in space.
- Return to be collected near floor level approximately 200 mm above the floor level for OTs.
- The area of laminar flow grid shall extend by a minimum of 450 mm beyond the foot print of the operating table on all sides.
- Both supply and return air shall be ducted.
- Three level filtration (OTs) shall be adopted with pre-filters, fine filters and HEPA filters of following filtration efficiency :

HEPA Filters	99.97% down to o.3 μ
Fine Filters	99% down to 5 μ
Pre Filters	90% down to 10 μ

- All these filters shall be with aluminum frame to prevent formation of bacterial colonies. Epoxy resin shall be used to seal filter media with the framework.
- OTs shall be maintained at positive pressure by supplying about 15% more air than return air to prevent any contamination from entering OT space.
- AHUs with HEPA filters shall be designed for high static pressure to overcome high pressure drops.
- All AHUs will have cooling & heating coil (for reheat) (4 pipe system).
- A unidirectional air flow pattern at a velocity of 0.45 ± 0.10 m/s should be maintained.
- Magnehelic gauge to be provided in each OT between OT & Corridor and across filter bank.

- HEPA Filters to be provided preferably at terminals of OTs. However, if not, then same needs to be provided in the AHUs.
- Ducting for Operation theatre (OT) shall be aluminum with silicon sealants at all joints. Return air will be collected in four corners with return air risers sized for min. 800 FPM velocity. Return risers will have grilles at 200 mm height above floor level. Risers will be cleanable. Each AHU shall be capable of operating at variable fresh air quantity depending on procedure and heat recovery wheel shall ensure waste heat is recovered.
- Operation theatre shall be maintained at 2.5 Pa positive pressures compared to adjacent clean corridor.

iii. Fan Coil Units

- Must be preferably of GI powder coated construction of suitable thickness.
- Fans must be selected for suitable Static Pressure. Motors shall be preferably BLDC type.
- Coil of required OD & thickness preferably made of Copper with Fins preferably made of Aluminum with suitable fins/inch. Cooling/Heating Coils Row deep should be considered meeting the functional requirements.
- Motor must be energy efficient and must be 3 speed type. This shall consist of two lightweight aluminum impellers of forward curved type, both statically and dynamically balanced. The two impellers shall be directly mounted on to a double shaft, single phase multiple winding motor capable of running at three speeds.
- Drain Pan of FCUs must be made of Stainless Steel (18 G) of Suitable thickness duly insulated with required thickness & density of insulating material.
- The PREFILTER shall be cleanable type &of suitable thickness AL./HDPE wire mesh and mounted behind the pan in a filter plenum of GI sheet.
- The fan coil units shall be powder coated in approved colour as per OEM standards or as per directions of E-I-C.
- It should consists of 2-Way Modulating type valve, Y strainers, Ball valves, wall mounted BMS compatible thermostat containing three speed and on/off control for fan, speed and temperature control for summer/ Monsoon/winter air conditioning.

iv. Split Air Conditioner Units

- Air cooled split air conditioner Unit comprising of an Indoor unit and outdoor Unit.
- It should have both Heating & Cooling Modes.
- Must be Energy Efficient & refrigerant used should be CFC free & low, preferably zero ODP.
- Refrigerant piping and fittings interconnecting compressor shall be all copper and valves shall be brass / gunmetal construction.
- Fan motor shall be suitable for 415 ± 10% volts or 230±10% volts, 50 Hz, A.C. Supply, Single phase, motors shall be provided with permanent capacitor. Motors

shall be especially designed for quite operation and motor speed shall not exceed 1440 rpm.

- Fan speed shall not exceed 1000 rpm and maximum fan outlet velocity shall be 550 meters per minute.
- Cooling coils shall be of fin and tube type having aluminum fins firmly bonded to copper tubes assembled in zinc coated steel frame / Multi channel.
- Inverter Driven Compressor Air Conditioner depending upon suitability and applicability. Non Inverter driven AC must conform to preferably 3 Star Rating.
- EER shall be as per ECBC requirements.

v. Pressurized Closed Type Expansion Tank

- Pressurized Cold Water Closed Type Expansion Tank must be equipped with Air Separator & should be preferably mounted in the plant room.
- The tank and air separator must be constructed in accordance with relevant standards.
- The tank shall be preferably pre charged steel expansion tank with replaceable heavy duty butyl rubber bladder.
- The expansion tank will be complete with safety relief valve, pressure reducing valve, pressure gauge& other accessories.

vi. Chilled Water piping

- The Pipes of sizes 150mm & below shall be M.S. 'C' class as per IS : 1239 and pipes size above 150mm shall be welded black steel pipe heavy class as per IS: 3589, from minimum 6.35mm thick M.S. Sheet for pipes upto 350 mm dia. and from minimum 7mm thick MS sheet for pipes of 400 mm dia. and above.
- For cooling and heating applications, the pipe may be sized accordingly in conformance with relevant ASME and CPWD Codes for the same.
- Pipe insulation for Plant Room/Terrace pipe shall be with EPS (Expanded Polystyrene –TF Quality) molded pipe section of density min. 20 Kg/cum after thick coat of cold setting adhesive (CPRX compound) , wire mesh, wrapped with 500 g polythene faced hessian cloth & finally applying 0.63 mm Al sheet cladding complete as per relevant standards.

  Alternatively pre insulated chilled water pipes as per CPWD specifications may be considered during detailed designing for smooth installation at site.
- The pipe within the building (in shafts, inside building etc.) shall be insulated with Nitrile insulation with glass cloth with min. 45 kg/cum density, K – 0.037 W/Mk or better at 20 degree C mean temperature, Class O Insulation applied with suitable adhesive & as per CPWD specifications.
- Riser for each building will have a butterfly valve in supply line of riser & a balancing valve return line of riser for isolating the building.
- Vacuum Degasser - Installed in a bypass line to CHW header. It shall be able to degas a minimum of 1CMH of water at system working pressure. Vacuum degasser

shall be complete with Vacuum tube with high capacity automatic air vent with ingress preventer, Multistage centrifugal pump, Make-up water and system inlet water connections with motorized valves to enable degasser operation even at low system pressure. (Manual preset flow control valves at inlet and outlet are not acceptable), Pressure transmitter to regulate pressure / vacuum in the vacuum tube, Built in flow meter to measure degassed and make-up water volumes, Microprocessor based, BMS compatible, control panel with IP54 protection, All Components, i.e. pump, vacuum tube, valves, interconnecting piping and control panel mounted on a compact steel frame. The unit shall be selected as per system's highest working pressure.

- R Value/ K value of insulation of pipe shall be in conformance with ECBC codes.

vii. Refrigerant Piping

- The refrigerant piping arrangements shall be in accordance with good practice within the air conditioning industry, and are to include expansion valves, charging connections, suction line insulation and all other items normally forming part of proper refrigerant circuits.
- The Pipe diameter and thickness shall be based on quantity and flow rate of refrigerant passing through the circuits.

viii. Valves

- All the Valves like Butterfly, Ball, Balancing, PICB must conform to PN-16 Pressure Rating.
- Valves must be duly insulated with suitable Insulation of suitable thickness and density.

ix. Thermostat

- Proportional type for AHUs and for FCUs
- Should be Microprocessor based with LED display
- Should have Fan Speed and Heat/Cool Change Over Switch options
- Automatic Heat / Cool Changeover option through external temperature sensor
- Should have high accuracy, fast response, Long Life and must be easy to operate
- Thermostat and digital programmable Humidistat, both BMS compatible to set the desired temperature and relative humidity as per the table given below.
- Followings shall be the logics of operation where both shall be installed.

x. Control Philosophy

Both Thermostat & Humidistat shall enable the user to define the set points for Temperature & Humidity in absence / breakdown of BMS System. Thermostat considered shall be suitable for 4 Pipe system with dual Analog Outputs for Cooling& Heating. However humidistat shall be having single On/Off output. Outputs of these thermostat & humidistat will go to controller which in turn shall modulate chilled water control valve, hot water control valve & switch on / off the Humidifier for maintaining Temperature & Humidity.

Following shall be the conditions possible:

- When both Temperature & RH are high with respect to Set Point: Chilled water valve shall be modulated.
- When Temperature is high & RH is low with respect to Set Point: Chilled water valve shall be modulated & Humidifier shall be switched on/ off.
- When Temperature is low & RH is High with respect to Set Point: Both Chilled Water & Hot Water valve shall be modulated.
- When both Temperature & RH are low with respect to Set Point: Hot water valve shall be modulated & Humidifier shall be switched on / off.

xi. Drain Piping

- GI medium class Drain Piping/High Strength uPVC /PVC Pipe to be considered as per requirements.
- The pipes shall be insulated with suitable material depending upon the requirement.
- The pipe material properties like density, thickness, K-Value and R-Value must be in conformity with relevant IS Codes, NBC, ISHRAE, ASHRAE& ASME.

xii. Air Distribution (Ducting)-Air Conditioning

- All ducts shall be fabricated either from galvanized sheet steel (GSS) confirming to IS 277 or Al sheets confirming to IS 737. The steel sheet shall be hot dipped galvanized with matt finish with coating of min. 120 GSM of zinc, GI sheet shall be lead free, eco-friendly &RoHS compliant. The sheet thickness shall be as per CPWD specifications.
- Ducting shall be selected factory pre-fabricated to achieve the high quality workman ship and specifications, end pieces can be site fabricated.
- Supply & Return Aluminum Ducting of required thickness (20 G in return duct& 18 G in supply duct) to be considered for OTs/ICUs & other critical areas.
- All non-critical areas supply & return ducting shall be with GSS Ducting of suitable gauge thickness & pressure rating as per requirements.
- Duct Construction and suspension Standards must conform to IS655 / SMACNA and ASME.
- All ducts are proposed to be insulated by use of crossed linked polyethylene, 19/25 mm thick or closed cell Elastomeric Nitrile Rubber. The material will adhere to ducts, since this is a flexible material. Further since this has closed cells it cannot help in germinating or supporting Bacteria colonies, which may otherwise form in the return air flowing above the false ceiling.
- The exposed duct shall have 26 G Aluminum cladding as weather protection for the insulation.
- Acoustic Duct Lining of suitable thickness and required length shall be provided at the commencement of ductwork from the respective Indoor Unit.
- Fire proof double canvass connection of suitable thickness and required length shall be provided at the outlet of the Indoor Equipment connecting it with the plenum.

- GSS Duct Construction standards must conform to SMACNA Standards.
- Threaded Rod (M.S/G.I) of sufficient dia. should be considered for hanging of fans and preferably G.I Channel of suitable dimensions shall be used for duct support. The sizing, suspension/hanging arrangement must conform to standards and specifications stated in relevant ASME/SMACNA/ CPWD/NBC 2016 Codes.
- GSS ducting shall be complete with all relevant accessories like splitters, vanes etc. complete in all respect as per directions of engineer-in-charge. Proper jointing (EPDM lining/cleats etc.) shall be done to prevent air leakages.
- R /K Value of duct insulation shall be in conformance of ECBC code.

xiii. Supply / Return Air Grilles

- Preferably powder coated extruded aluminum construction with preferably aluminum volume control dampers.

xiv. VCD/Fire Damper with Actuators

- VCDs to be provided at ducts at suitable places. Fire Dampers with actuators to be considered for floor mounted AHUs at supply/return duct.
- The material of VCDs & dampers shall be MS enamel painted.
- Fire Dampers shall be CBRI tested & certified for at least 90 min. rating against collapse & flame penetration as per UL 555 & 555S. Fire dampers shall be compatible with fire detection system.
- For fire safety motorised fire dampers with electrical actuators interlocked with the air blowers shall be provided in supply and return air paths. All materials used for insulation shall be fire proof type. The air handling unit's motors shall also be interlocked with the central fire alarm system such that in case of detection of smoke or fire by the fire alarm system, the air handling units shall automatically shut off.

14. Brief Equipment Specifications (Ventilation/Pressurization) :-

Ventilation system should be considered for Toilets, Kitchen/Pantry, Basement, floor smoke extraction, plant room & other utility areas etc. as required. Pressurization system for lift well/staircase/lift lobby etc. should be considered.

i. Axial Fans

- Axial Fans for Fresh / Exhaust air suitable for installing in any position in Horizontal or vertical, and must be AMCA certified.
- Casing of Fans shall be constructed of heavy gauge sheet steel and preferably be powder coated. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Threaded Rod of sufficient dia. /channel should be considered for hanging of fans.
- Fan Sizing (CFM & Static Pressure) for Ventilation (Fresh Air/Normal Exhaust / Smoke Exhaust) must be done considering the required ACPH levels in the Basement as specified in NBC 2016/ECBC or relevant codes.
- The plenum of the fans must be lined with Acoustic Lining to ensure proper sound absorption.

- Axial Fans for Basement Smoke Exhaust and Smoke Extraction purpose must be Fire Rated (H Class), able to withstand a temperature of 250 degree Celsius for a period of 2 hours.
- Fan-motor assembly (as whole) shall be statically & dynamically balanced, conforming to ISO and AMCA Standards.
- Should be suitable for 415 V ± 10% volts three phase 50cycle, AC supply.
- The speed of Fan shall not exceed 1000 RPM for Fans with impeller diameter above 450mm and 1450 RPM for fans with impeller diameter of 450mm and less.
- Provision of all necessary accessories such as Wire Guard on inlet side and bird screen on outlet, Gravity operated louver shutters, Canvass Connection for connecting Fan assembly and Plenum should be considered.
- Sizing of Fans must be done in accordance with provisions sated in ISHRAE/ ASHRAE/ NBC 2016 and relevant IS Codes.
- Noise Level of Fan (in decibel) should conform to NBC 2016/ASHRAE/ ISHRAE/ CPWD and relevant IS Codes.

ii. Fan Section

- Utility of Fan Section preferably for Pressurization of Lift Lobbies, Lift Well, Staircase. Fan must be AMCA certified.
- Fan Sections for Pressurization purpose must be H/F Class as per requirement.
- Fan-motor assembly (as whole) shall be statically & dynamically balanced, conforming to ISO and AMCA Standards.
- Should be suitable for 415 V ± 10% volts three phase 50cycle, AC supply.
- Provision of all necessary accessories such as Canvass Connection for connecting Fan assembly and Plenum must be considered.
- Sizing of Fans must be done in accordance with provisions sated in ISHRAE/ASHRAE/NBC 2016
- Noise Level of Fan (in decibel) should conform to latest NBC 2016/ ASHRAE/ISHRAE/CPWD and relevant IS Codes.

iii. Propeller & Inline Fans

- Propeller and Inline fans AMCA Certified with its construction standards conforming to CPWD, NBC 2016/ ISHRAE/ ASHRAE and relevant IS Codes.
- Propeller Fans shall be direct-driven, three or four blade type. It should be of Steel/GI/PVC construction as per CFM requirement & dia. Of fan.
- Fan-motor assembly (as whole) shall be statically & dynamically balanced, conforming to ISO and AMCA Standards.
- Should be suitable for 415 V ± 10% volts three phase 50cycle, AC supply.
- The speed of Fan shall not exceed 1000 RPM for Fans with impeller diameter above 310mm and 1440 RPM for fans with impeller diameter of 310mm and less.

- Provision of all necessary accessories such as Wire Guard on inlet side and bird screen on outlet, Gravity operated louver shutters, Canvass Connection for connecting Fan assembly and Plenum should be considered.
- Noise Level of Fan (in decibel) should conform to latest NBC 2016/ ASHRAE/ISHRAE/CPWD and relevant IS Codes.

iv. Air washer & Scrubber:

- It should be generally considered for kitchen ventilation. Air washer to be considered for fresh air supply & Scrubber to be considered for exhaust.
- Capacity of air washer/scrubber to be decided considering negative pressure inside kitchen all through out.
- Air Washer shall be of double skin construction with suitable thickness impregnated cellulose paper media (Celdek pads) of minimum 90% efficiency, factory assembled, distribution header, GI 'B' class piping, makeup, quick fill and drain connections, Butterfly/Gate valves for Pumps, make up, drain & quick fill connections of Sump, 2 Nos. pumps of suitable capacity (1W +1 S), Y strainers and necessary fittings, GI frame and supporting structure for Celdek pads, washable synthetic fiber filters (of 90% efficiency down to 10 micron) and SS(18 gauge) sump, TEFC Motor (IP:55) Control panel complete with necessary Switchgear, Starters, metering, power and control wiring between Control panel and Motor/Pump etc. & drive unit complete with Pulley, Belts, Fresh air Louvers with bird screen (GI Construction) etc. as per specification & as directed by Engineer- in-charge.
- Scrubber shall comprise of extract air intake section, electrostatic precipitation technology, dry type air cleaner to remove oil, smoke and fumes from exhaust air, washable type aluminium mesh filters, stainless steel spiked ionizers to create high voltage DC field, aluminium collector plates which should be alternatively charged positive and negative with large collecting area to work as magnet for charged smoke and oil particles. The system should allow connection to a fan section to achieve 500 FPM velocity across the air cleaner.
- Suitable PCC/RCC foundation with plaster, Anti-vibration arrangement of cushy foot mountings etc. shall be provided.

v. Ventilation Duct:-

GSS Duct Construction standards must conform to SMACNA Standards.

- Threaded Rod (M.S/G.I) of sufficient dia. should be considered for hanging of fans and preferably G.I Channel of suitable dimensions shall be used for duct support. The sizing, suspension/hanging arrangement must conform to standards and specifications stated in relevant ASME/SMACNA/ CPWD/NBC 2016 Codes.
- GSS ducting shall be complete with all relevant accessories like splitters, vanes etc. complete in all respect as per directions of engineer-in-charge. Proper jointing (EPDM lining/cleats etc.) shall be done to prevent air leakages.
- Acoustic Duct Lining of suitable thickness and required length shall be provided at the commencement of ductwork from the respective Indoor Unit.

- Fire proof double canvass connection of suitable thickness and required length shall be provided at the outlet of the Indoor Equipment connecting it with the plenum.

vi. Air Distribution Products (ADP) -Louvers / Grills with or without Dampers

- Sizing of Ventilation Louvers should be done considering the capacity of Fans. The Ventilation Louver for Fresh Air shall have manually operated dampers along with bird screen wire mesh and Ventilation Louver for exhaust air shall only have bird screen wire mesh. Material Of Construction of louvers shall be preferably extruded aluminum with powder coated finish or as per OEM requirements complying codes & standards.
- Grills with dampers for supply/fresh air & grills without dampers to be considered exhaust/return air. MOC of grills shall be preferably extruded aluminium with powder coated finish or as per OEM requirements complying codes & standards.
- **Air Ionizers: (STP cum ETP Plant & STP Plant -Indoor Air quality):**

  Air Ionizers of suitable CFM & adequate No. shall be provided as per relevant standards & norms by the EPC Contractor as per ACPH requirement of Plant Room of STP cum ETP to control the odor to acceptable level & maintain desirable indoor air quality inside the plant room. Ionizers will be placed after the fresh air fan & air will be supplied uniformly through perforated duct. It shall target the obnoxious /toxic/pungent smell gases & convert it into non-harmful gases. It should also target microorganisms & particle counts, VOC, static charges, mold growth, outside air contaminants etc.

15. Brief Equipment Specifications (HVAC Electrical):

i. Main HVAC Panel

- Panel shall be fabricated out of suitable gauge thickness of preferably CRCA Sheet Steel with reinforcement, channels and angles etc. HVAC Panel shall conform to norms and standards of IEC-61439.
- The main electrical panel, distribution board & Air Cooled Chiller at Site Level
- Pumps will be located in the respective plant rooms.
- Panels shall be treated with all anticorrosive process before painting with 2 coats of red oxide primer and final shade of powder coated paint.
- All outgoing & incoming shall be provided with Stop/Manual/ Auto/selector switch to facilitate operation through BAS. All starters shall be provided with potential free Contact for Connections to Building Automation System.
- A separate set of CTs to be provided for BAS and wiring from CT's and voltage transducers to be brought on to separate set of terminals.
- Panel should have sufficient number of Incoming and Outgoing feeders. 20% Spare Feeders shall be provided for all sizes of Outgoing Feeders.

ii. Main HVAC Panel should cater to Chiller Motors, Primary and Secondary Chilled Water Pump Motors, Hot Water Generators and Pump Motors etc.

iii. Control Panels For OT & Isolation Room With Heat Recovery Unit

- Should be preferably cubicle type, wall mounted control panels including anchoring into the wall
- All outgoing shall be provided with Stop / Manual /Auto selector switch to facilitate operation through BAS. All starters shall be provided with potential free Contact for Connections to Building Automation System.
- MCB with over-load relay, suitable for motor duty and able to withstand suitable fault level .Sufficient number of incomers and Outgoings depending upon the load and requirement.
- Suitable exhaust arrangement within electrical panel shall be provided to avoid overheating.
- Control Panel catering to VFD operated Motors. Suitable rating starter required as a bypass arrangement in case of VFD failure.

iv. Control Panel In Air Handling Unit With VFD

- Should be preferably cubicle type, wall mounted control panels including anchoring into the wall
- All outgoing shall be provided with Stop / Manual /Auto selector switch to facilitate operation through BAS. All starters shall be provided with potential free Contact for Connections to Building Automation System
- Phase indicating lights and indicating light for ON/OFF/TRIP status phase sequence relay shall also be provided.
- Digital voltmeter and ammeter with selector switches.
- Suitable rating starter required as a bypass arrangement in case of VFD failure.
- Time delay relay for delayed automatic restart of air handling unit motor.
- Wiring for micro switch for starting / stopping the fan when fire damper closes / Power supply for fire damper control panel.
- For on/off/remote and local operation, 3 pole single throw switch shall be provided in each AHU panel to facilitate override of the automatic operation.
- All starters shall be provided with suitable potential free contract for connections to the Building Automation System.
- Catering to Three phase Motor with VFD. Each of these compartments shall contain indicating lamp with ON/ OFF/ TRIP status of motors.

v. Control Panels For Fan Sections, Inline Fans & Axial Fans /Air Scrubbers/ Air Washers

- Should be preferably cubicle type, wall mounted control panels including anchoring into the wall
- All outgoing shall be provided with Stop / Manual /Auto selector switch to facilitate operation through BAS. All starters shall be provided with potential free Contact for Connections to Building Automation System. DOL/Star delta starters to be provided depending upon H.P rating of fans.

- Over-load relay, suitable for motor duty and able to withstand fault level of suitable kA rating.
- Single Phase Preventer (Electronics type)
- Terminal block for power distribution.
- Power Contactor.
- Phase indicating lights and indicating light for ON/OFF/TRIP status phase sequence relay shall also be provided.
- Digital Voltmeter and Ammeter of suitable range.
- Time delay relay for delayed automatic restart of motor
- Wiring for micro switch for starting / stopping the fan (in case of fire) / Power supply for damper control panel.
- For on/off/remote and local operation, 3 pole single throw switch shall be provided in each panel to facilitate override of the automatic operation.
- All starters shall be provided with suitable potential free contract for connections to the Building Automation System.
- Three phase star delta starter with overload relay and single phase preventer. Each of these compartments shall contain indicating lamp with ON/ OFF/ TRIP status for fan sections/axial fans.

vi. Cables

- Power and Control Cables should be XLPE insulated and PVC sheathedAluminum/Copper conductor armored/un-armored depending upon need and requirement, 1.1 KV grade conforming to IS : 7098:1988

vii. Glands and Lugs

- Glands and Lugs suitable for Power and Control Cables XLPE insulated and PVC sheathed Aluminum/Copper conductor armored/ un-armored (depending upon need and requirement), of 1.1 KV grade confirming to IS : 7098:1988.

viii. Cable Tray

- Perforated G.I cable trays with perforation not more than 17.5%, in convenient sections, joined with connectors, suspended from the ceiling with G.I. suspenders including bolts & nuts, painting suspenders etc. complete with bends, reducers, Tees, cross members etc. as required.

ix. Earthing

- Earthing for all equipment shall be provided in conformity with IS -3043 (latest).

16. DESIGN PARAMETERS:

i. Design parameter for selection of Air Handling Unit and its components shall be:

Maximum face velocity across pre/fine filters	1.78 m/sec (350 fpm)
Maximum face velocity across cooling coils	2.54 m/sec (500 fpm)
Maximum fan outlet velocity	9.14 m/sec (1800 fpm)
Maximum fan speed	
a. Fan above 450 mm dia.	1000 RPM
b. Fan up to and including 450 mm dia.	1450 RPM
Maximum fan motor speed	1450 RPM

ii. Design parameter for Duct design shall be:

Maximum flow velocity in ducts for air conditioning	1800 fpm.
Maximum flow velocity in ducts for ventilation in pump room, boiler room, generator room, toilet exhaust & Kitchen exhaust.	7.5 m / sec – 12.5 m / Sec (1500 – 2500 FPM)
Maximum friction	0.65 Pa / M run (0.08 inch WG/100 ft run)

iii. Ventilation Fan:

Maximum fan outlet velocity for fan upto 450 mm dia.	9.14 m/sec (1800 fpm)
Maximum fan outlet velocity for fan above 450 mm dia.	12 m/sec (2400 fpm)
Maximum fan speed for fans.	1440 RPM

iv. Filtration:

Re circulated air (mixed fresh & return air) at air handling units.	Pre-filtration shall be through washable synthetic type air filters having 90% efficiency down to 10 microns (MERV 8) Further filtration shall be through MERV 13 filters having 99% efficiency down to 3 microns

HEPA filters where ever required shall be as relevant standard

v. Piping shall be sized for the following design parameters :

Maximum velocity	:	2.5 M/Sec
Maximum friction	:	5 M/100 M Run

During detailed engineering, design parameters as tabulated above if required may be altered/changed as per relevant norms / standards meeting functional requirements & as per direction of E-I-C.

M. Design Basis Report-
Building Management System

1. General

The EPC Contractor shall carry out Design, Engineering, Supply, Installation; Testing & Commissioning of IP based BMS Works. BMS System shall be provided for Hospital Building & Indoor Sports & Auditorium complex.

Hospital Building & Indoor Sports & Auditorium complex shall be provided with IP based BMS system with Chiller Plant Manager in HVAC plant room with proper integration. Proposed BMS system shall be logically structured into three distinctive levels, which are Management Level, Automation Level and Field Level. Each level shall be autonomous from the other. Peer to peer communication shall be possible on all system levels and the system design shall be modular in structure to allow straight forward extensions.

HVAC System of Hospital Building and Indoor Sports & Auditorium complex along with AHU shall be hooked on to BMS system.

BMS room will be located in Hospital Building which will cater to both Hospital & Indoor Sports Complex.

IP based Building Management System (BMS) will integrate multiple building functions including equipment supervision and control, alarm management, energy management, information management and historical data collection and archiving. The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of field devices / programming. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

2. Scope of Work

The BMS System shall consist of the following:

- Central control station for monitoring, control and alarm through operator interface station (OIS)
- Software for Building Management System and Energy Management System.
- System integration unit consisting of gateways, interface units etc.
- Portable operator terminals, Sensors and field devices consisting of but not limited to the following:
  - Immersion type temperature sensors
  - Duct type temperature sensors
  - Outside Air and Humidity Sensors
  - Water Flow Meter
  - Differential Pressure Switch across the AHU
  - Level Switches for indicating water level in tanks etc.
  - Water Flow Switches
  - pH Sensor
  - TDS Sensor

- Differential Pressure Transmitters
- Current Transducers
- Voltage Transducers

Stand-alone intelligent 32 bit Direct Digital Controller (DDC), Line/Field Devices etc. for but not limited to the following:

- HVAC System
- Air Handing Unit
- Integration of other systems as required as per GRIHA provisions & directions of E-I-C.

The plant will operate automatically as per programmed schedule the controllers will estimate the actual requirement on any particular day depending on outside temperature and accordingly decide the lead time required to achieve design inside conditions, in all areas, at the start of offices.

The BMS system shall consists of computer system with LED monitor, printer, mouse, switches, software, system integration units, field instruments, cabling etc. All shall be of latest version.

All standby pumps can be rotated to provide equal wear and tear and reduce fatigue.

The water supply system is controlled and operated as per requirement without any wastage.

All other services are monitored as per requirement. Comprehensive I/O summary with relevant A/I, A/O, D/I, D/O details for all equipment and systems covered under BMS shall be prepared during detailed engineering & as per directions of E-I-C.

PARAMETERS TO BE CONTROLLED/MONITORED WITH IBMS										
		R stands for "Required"								
S. No.	**Description**	**AI**	**DI**	**AO**	**DO**	**Monitor**	**Control**	**Alarm**	**Type Sensors**	**OTHER CONTROLS**
A	HVAC Equipment (HIGH SIDE)									
1	Chilling Machines									
a	Chiller On/Off				R		R		Relay Output	Potential Free Contact in Chiller Panel
b	Chiller Run Status		R			R		R		Potential Free Contact in Chiller Panel
c	Chiller Auto/Manual Status		R							Potential Free Contact in Chiller Panel
d	Chiller -Water Temp Reset			R			R			0-10VDC signal from chiller panel
e	Chiller trip / Fault		R			R				Potential Free Contact in Chiller Panel
f	Chiller- Chilled water supply Temp In (1) + Out	R				R			Immersion Type Sensor	Suitable Insertion Provision
g	Chilled Water Flow Status		R			R			Water Flow switch	Suitable Insertion Provision
h	Motorized valve on evaporator				R					
i	Motorized valve on evaporator status			R						Potential Free Contact in B/F Valve limit switch
j	Chilled water Return Flow rate	R				R			Flow meter	Suitable Insertion Provision
k	Integrator for chiller machines								Integrator	Integrator interface card
n	Ambient Temp sensor	R				R				Suitable Insertion Provision
o	Ambient RH sensor	R				R				Suitable Insertion Provision
p	Chilling machine microprocessor (software integration)	-	-	-	-					Integrator unit/ software connectivity

q	Vacuum degasser & pressurization unit integration			R	R	R	R			Integrator unit/ software connectivity
	Total									

S. No.	Description	AI	DI	AO	DO	Monitor	Control	Alarm	TYPE SENSORS	OTHER CONTROLS
2	Chilled Water Pumps (Primary, Secondary & Hot Water pumps)									
a	Primary Chilled Water Pump On/Off				R		R		Relay Output	Potential Free Contact in Pump Starter Panel
b	Primary Chilled Water Pump Run Status		R			R		R		Potential Free Contact in Pump Starter Panel
c	Primary Chilled Water Pump Flow Status		R			R			Differential Pressure Switch (Water)	Suitable Insertion Provision
d	Secondary Chilled Water Pump On/Off				R		R		Relay Output	Potential Free Contact in Pump Starter Panel
f	Secondary Chilled Water Pump Run Status		R			R		R	Potential Free Contact in Pump Starter Panel	
g	Secondary CHW Pump Flow Status		R			R			Differential Pressure Switch (Water)	Suitable Insertion Provision
h	Secondary Chilled Water Pump VFD integration						R		0-10VDC Signal from controller	Acceptance of BMS signal.
I	HOT Water Pump On/Off				R		R		Relay Output	Potential Free Contact in Pump Starter Panel
J	HOT Water Pump Run Status		R			R		R		Potential Free Contact in Pump Starter Panel
K	HOT Water Pump Flow Status		R			R			Differential Pressure Switch (Water)	Suitable Insertion Provision
	HOT WATER GENERATOR									
	HWG									
L	HWG On/Off				R		R		Relay Output	Potential Free Contact in Chiller Panel
M	HWG Run Status		R			R		R		Potential Free Contact in Chiller Panel
N	HWG Auto/Manual Status		R							Potential Free Contact in Chiller Panel
O	HWG Water Temp Reset			R			R			0-10VDC signal from chiller panel
P	HWG trip / Fault		R			R				Potential Free Contact in Chiller Panel
Q	HWG- water supply Temp In (1) + Out	R				R			Immersion Type Sensor	Suitable Insertion Provision
R	HOT Water Flow Status		R			R			Water Flow switch	Suitable Insertion Provision
	Total									
3	Electrical Panels of HVAC									
a	Incoming breaker ON/OFF status		R			R				Potential Free Contact in the electrical Panel
b	Bus coupler ON/OFF status		R			R				Potential Free Contact in the electrical Panel
c	Multi-function meter integration	R							Integration	
d	Incoming breaker trip		R			R				Potential Free

	status									Contact in the electrical Panel
e	Bus coupler trip status		R			R				Potential Free Contact in the electrical Panel
	Total									

S. No.	Description	AI	DI	AO	DO	Monitor	Control	Alarm	TYPE SENSORS	OTHER CONTROLS
4	LOW SIDE									
	Air Handling units									
a	AHU On/Off				R		R		Relay Output	Potential Free Contact in the AHU Panel
b	AHU Air flow Status		R			R			Differential Pressure Switch (Air)	Suitable Insertion Provision
c	AHU Filter Status		R			R			Differential Pressure Switch(Filter)	Suitable Insertion Provision
d	AHU motor trip status		R			R			Relay Output	Potential Free Contact in the AHU Panel
e	Return Temperature Sensors	R				R			Room Temperature Sensor	Suitable Insertion Provision
f	Motorized valve controlling			R			R		Connectivity to BMS	Motorised Valves
g	AHU Auto/Manual Status		R			R				Potential Free contact from the Auto/Manual switch
h	Ambient Enthalpy Sensor	R				R			Temp & humidity Sensor(outside air)	Suitable Installation Provision
i	CO2 level monitoring in office areas	R				R			Connectivity to BMS	CO2 sensors
j	Fresh air volume control damper (Operated with CO2 Sensor)	R		R			R		Connectivity to BMS	Modulating Damper
k	Return air volume control damper	R		R			R		Connectivity to BMS	Modulating Damper
l	Exhaust air damper	R		R			R		Connectivity to BMS	Modulating Damper
m	Return air damper	R		R			R		Connectivity to BMS	Modulating Damper
n	AHU VFD Frequency Modulation			R			R		Connectivity to BMS	VFD in AHU
o	Vane Axial fans ON / OFF - free air cooling				R		R		Relay output	Potential Free Contact in panel.
p	Vane Axial fans ON / OFF - free air cooling		R			R			Differential pressure switch (air)	Suitable Insertion Provision
q	Vane Axial fans Auto Manual Status		R			R				Potential Free Contact in the Blower Starter Panel
	Total									

S. No.	Description	AI	DI	AO	DO	Monitor	Control	Alarm	TYPE SENSORS	OTHER CONTROLS
5	Pressurization Fans									
a	Pressurization Fans for supply ON/OFF				R		R		Relay Output	Potential Free Contact in the

										Blower Starter Panel
b	Pressurization Fans on/off status		R			R			Relay Output	Potential Free Contact in the Blower Starter Panel
c	Pressurization Fans Auto/Manual Status		R			R			Relay Output	Potential Free Contact in the Blower Starter Panel
d	Pressurization Fans Air Flow Status		R			R		R	Differential Pressure Switch (Air)	Suitable Insertion Provision
	Total									
4	Energy Meters of Electrical Distribution Panels located at various buildings					R			Integration	

The table given above is tentative. EPC Contractor shall prepare detailed I/O Summary while preparing shop drawings & TDS approval as per site conditions. The same may be modified as per project requirements & tender provisions.

N. Design Basis Report-

Solid Waste & Bio Medical Waste Disposal

The EPC Contractor shall carry out Design, Engineering, Supply, Installation, Testing & Commissioning for Solid Waste Generation and Management System.

The Solid waste generated from the project will be collected and managed as per Solid Waste Management Rules, 2016. The project will adopt a systematic approach for solid waste collection and disposal. The domestic solid waste will be generated by the occupants of the Hostel, Visitors, Patients, and Staff; pertains to the two categories, Bio-degradable and Non-biodegradable. These solid wastes will be collected separately by putting different types of separate bins at the source of generation.

The arrangements & space for collection of solid waste and also separate dedicated space for collection of Bio Medical waste generated from various buildings shall be provided. All necessary equipment for treatment of Solid Waste including Bio Medical Waste shall be provided by the EPC Contractor as per prevalent norms & Bye-laws.

Equipment like organic waste converter for treating solid waste & Integrated sterilized shredder for treating bio medical waste of suitable capacity shall be provided as per GRIHA/relevant norms as required with concurrence of Engineer-In-Charge. Any other Equipment required for this purpose shall also be provided within the scope of the Contract.

Non bio degradable solid waste like glass, e-wastes, bulbs etc. shall be collected at one place & handed over to the designated authorized vendor for final disposal as per norms.

Equipment capacity shall be worked out by EPC Contractor based on quantity of Solid Waste & Bio Medical Waste generated in different buildings as per norms.

O. Design Basis Report-

Medical Gas Pipeline System

	The MGPS comprises of:
1	Oxygen Manifold and Emergency oxygen manifold with automatic control panels
2	Nitrous Oxide Manifold and Emergency NO2 Manifold with automatic control panel
3	CO2 Manifold and Emergency CO2 Manifold with automatic control panel
4	Medical Air Supply System (4 Bar & 7 Bar) complete.
5	Medical Vacuum (suction) Supply System Complete.
6	Distribution Piping Complete with Accessories.
7	Area Valve Service System.
8	AGSS system Complete
9	Alarm Systems (Master & Area)
10	Gas Outlets with Probes
11	Bed Head Panels
12	Other associated & Optional works
	RESPONSIBILITY OF BIDDER
1	EPC Contractor shall be responsible for complete design, supply, installation, testing and commissioning including **Civil Modification** works, demolition and construction as applicable .The bidders are required to survey the site before furnishing the quotations.
2	EPC Contractor shall execute all required civil, electrical, plumbing, lighting, fire safety, exhaust systems, **false ceiling trap door/ cutout and repair(if any)** and other works as maybe required for complete installation and trouble-free functioning as a part of the **'Civil Modification'.**
3	Hospital will provide one point electrical supply with isolator in the plant room. The wiring, lighting, fans, exhaust etc have to be done by the bidder.
4	Control panel for Vacuum system and Air plant system has to be supplied by the bidder.
5	EPC Contractor will be responsible for trenching or other associated work related to installation and commissioning of complete MGPS system.
6	The EPC Contractor has to provide medical gases inside the OT
7	Installation and commissioning of area valve service unit and alarm unit for the operation theatre shall be done by the EPC Contractor .
8	Medical gas pipe line inside the minor operation theatre has to be done by the EPC Contractor .
9	The EPC Contractor shall be responsible for the complete works including the submission of working drawings, and isometric views, detailed work schedule and materials. EPC Contractor shall be responsible for design, supply, installation, testing and commissioning of medical gas supply system in coordination with Engineer-In charge .

10	EPC Contractor shall be responsible for free maintenance of all component of Gas pipeline system during warranty period including all filters & consumables.
11	EPC Contractor shall provide factory test certificates for the materials used. EPC Contractor shall supply complete set of part manuals, service manuals and user manuals for all the systems and subsystems supplied. Final electrical safety test, system test, leakage and calibration should be done by authorized persons using calibrated test equipment as per standards.
12	The Medical Gas Pipe Line System must follow Single Standard any one only from: NFPA 99c/HTM 02-01/ ISO 7396-1/DIN/EN. For AGSS Ventury type is not acceptable.
13	All Gas Outlets in MOT (i.e. O2, N2O, MA4, MA7, Vacuum, CO2(if required), etc.) will come with OT Pendants(Under MOT Tender) EPC Contractor has to provide pipe lines upto all MOTs.
14	EPC Contractor shall co-ordinate with respective Departments Head for their final Gas Outlets requirement per bed in their wards and should incorporate the same in drawing.
15	**The following systems/Items must be from the same principal company/Manufacturer**
a	**Control Panels & Manifold for O2, N2O & CO2**
b	**Medical Air Plant**
c	**Medical Vacuum Plant**
d	**AGSS Plant**
e	**Area & Master Alarm**
f	**All types Outlets**
g	**AVSU**
h	**Line Isolation Valves**
i	**High Pressure Tubes**
16	The third party compliance certification after installation to be done for the standard followed i.e HTM 02-01/NFPA 99C/DIN/EN/ISO-7396-1 .The cost for the same will be borne by the EPC Contractor .
17	EPC Contractor must have a satisfactory installation of complete MGPS as per any International standard as asked in tender and demo may be taken for the same.
18	EPC Contractor will be provided after award either AutoCAD or PDF or hard Copy of building Layout drawing for preparation of MGPS drawings.
19	EPC Contractor shall be responsible for suitable arrangement of heat dissipation and Air-Conditioning as per offered MGPS plant requirement / recommendations from the Manufacturer and as per local site condition. EPC Contractor should also take care of backup arrangement for AC and Exhausts as the MGPS Plant may run 24x7 as per the requirement.
20	**Gas outlet configuration location wise as below:**
	General Ward Bed (on Wall) : O2-1 & Vc-1 for each bed
	Super Specialty General Bed (On Wall): O2-1 & Vc-1 for each bed and MA4-1 for each Cubicle

	Private Room & Isolation Room/Special Ward(like- Dialysis,etc) (On BHP): O2-1, Vc-1 and MA4-1 for each bed
	ICU/CCU Bed (on BHP) : O2-2, Vc-2 & MA4-2 for each bed
	Pre-Op Bed/Emergency (on BHP) : O2-1, Vc-1 & MA4-1 for each bed
	HDU/Post-Op Bed (on BHP) : O2-2, Vc-2 & MA4-1 for each bed
	Treatment/Procedure Room (On Wall): O2-1, Vc-1 and MA4-1 for each bed
	Endoscopy/Etc : O2-1, Vc-1 , MA4-1, CO2-1, N2O-1
	Minor OT/Cath Lab/CT/LINAC/Etc (On BHP): O2-2, Vc-2, MA4-1, N2O-1 for each Room (For MRI/LINAC/ETC Pipe line of same services should be provide upto/outside of the room)
	OT (on BHP/Pendant): O2-2, Vc-2, MA4-2, N2O-2,SA-1,C02-1,AGSS-1
	The Configuration may change as per special request from consignee/institute specific requirements, if any.
21	EPC Contractor should be responsible for dedicated earthing (Chemical type) for MGPS Plant room (if required)
22	EPC Contractor shall design the MGPS system as per DBR & specification mentioned in the tender, any clarification/suggestion's regarding the design of MGPS system should be submitted before pre-bid meeting.
23	EPC Contractor has to clarify their doubts or prerequisites during prebid meeting. Bidder has to submit the list of prerequisites along with bid. No further pre-requisite/requirement after placement of NOA will be addressed.
24	Zoning of MGPS should be done to meet the peak flow requirement with suitable backup arrangements for all services, if required.
25	All tanks (Air, Vac and AGSS(if applicable) should be installed outside the MGPS Plant room on dedicated platform near MGPS Plant room and this platform shall be in work scope of EPC Contractor with shed as per requirement.
26	EPC Contractor shall submit the MGPS Plant and Manifold equipment loading design with foot print of all component as per their offered plant along with bid within the area of 120 sq m. bidder may keep the tanks inside, only when their offered plant and manifold are coming within the 120 sq m area along with proper sitting space for technicians, cylinder storage space for filled and empty, also height of tanks should be maximum 3.5m in case of installation within the MGPS plant room.

ANNEXURE-I

TENTATIVE LIST OF MEDICAL EQUIPMENT-RIPANS

SL.NO.	DEPARTMENT/ DESCRIPTION	QTY
1	**BIOCHEMISTRY DEPARTMENT**	
1	Fully automatic random access biochemistry analyzer (300 samples/hr)	1
2	Fully automatic random access immuno analyzer (200 samples/hr)	1
3	Blood gas analyzer with ISE	1
4	Semi auto analyzer	1
5	Bilirubinometer	1
6	Kahn shaker	2
7	Magnetic stirrer with hot plate	2
8	Centrifuges	4
9	Pipettes of various sizes, test tubes, funnels, glass measuring flask etc	LS
10	Spectrophotometer (double beam)	1
11	Vortex mixer	2
12	PC with LIS (data manager)	1
13	Lab Refrigerator	2
14	Water bath	2
15	Distillation plant	1
16	Laboratory furnitures	LS
2	**DEPARTMENT OF HEMATOLOGY**	
1	Fully automatic five part Hematology analyzer	1
2	Hematology analyzer-3 part	1
3	Electrophoresis analyzer	1
4	Coagulation analyzer	1
5	Colorimeter (single cell)	1
6	Haemocytometer	2
7	HbAIC analyzer	1
8	Hot air oven	1
9	HPLC System	1
10	Incubator	1
11	Table top centrifuge	3
12	Micro hematocrit centrifuge	1
13	Lab Refrigerator	1
14	Microscope Binocular with illumination & photography	1
15	Hot plate	1
16	Neuberger Chamber	1
17	ESR Analyser	1
18	Slide cabinet	1
19	Spectrophotometer	1
20	Automated urine analyzer	1
21	Stop watch	3
22	Water bath	1
23	Auto pipettes	1
24	Glucometer	1
25	PC with LIS (data manager)	1
26	Laboratory furnitures	LS
3	**DEPARTMENT OF MICROBIOLOGY & SEROLOGY**	
1	Biological safety cabinet	2

SL.NO.	DEPARTMENT/ DESCRIPTION	QTY
2	Fully automatic ELISA analyzer	1
3	Mycobacterium culture system	1
4	Centrifuges	2
5	Incubator	2
6	Merkel Burner	1
7	Microscope Binocular	2
8	Plate Reader for agglutination	1
9	Refrigerator	1
10	Stop Watches	4
11	VDRL shaker	1
12	Lyophilser (Freeze dryer)	1
13	Vortex mixer	1
14	Water Bath	1
15	Burner with gas cylinder	2
16	Autoclaves	2
17	Computer	1
18	Florescent microscope	1
19	Glassware, bottles, raegents etc	LS
20	Media preprator	2
21	Balance Electrical 1 to 10mg	1
22	BOD Incubator 600x900x600mm	1
23	Rotary Incubator shaker	1
24	Freezer -20 Degree C	1
25	Tissue Homogenizer	2
26	Multi-Channel Micro Pipette	2
27	Single Channel Micro pipette	2
28	Laboratory furnitures	LS
4	**DEPARTMENT OF HISTOPATHOLOGY**	
1	Automated Microtome	1
2	Automated Tissue Processor	1
3	Cryostat	1
4	Automated Stainer	1
5	Incubator	1
6	Hot air oven	1
7	PH meter	1
8	Hot plate	2
9	Manual Microtome	1
10	Automated ESR Analyzer (50 tests/hour)	1
11	QBC – Malaria and blood parasite detection system	1
12	Paraffin Embedding station	1
13	Tissue Floatation Bath	1
14	Lab Refrigerator	1
15	Electronic weighing balance	1
16	Filing cabinet: Slide filing, vertical type. Capacity: 10,000 slides	1
17	Block filing-capacity: 50000 blocks	4
18	Slide labeling machine	1
19	Electronic Timer	4
20	Staining Rack	1
21	Table top centrifuge	1
22	PC with LIS (data manager)	1
23	Tissue storage facilities	LS

SL.NO.	DEPARTMENT/ DESCRIPTION	QTY
24	Binocular microscope	2
25	Microscope with camera	1
26	Analytical balances	2
27	Laboratory furnitures	LS
5	**DEPARTMENT OF PATHOLOGY**	
1	Microscope with attached photography equipment	1
2	Binocular microscope	4
3	Cell counter - 3 part	1
4	Elisa Reader	1
5	Electrophoresis Apparatus	1
6	Refrigerator	1
7	Deep Freezer -20 Degree C	1
8	Cytospin	1
9	Fluorescent Microscope	1
10	Laboratory furnitures	LS
6	**DEPARTMENT OF IMMUNOLOGY**	
1	Automated Immunostaining system	1
2	Electronic Analytical Balance	1
3	Deionizer	1
4	pH Meter	1
5	Ultra low temperature Deep Freezer	1
6	Bench Top Flowcytometer (4 Color Sorter System)	1
7	Water Bath	1
8	Fully Automated Microplate ELISA System	1
9	Cryostat	1
10	Advance Fluorescence Research Microscope with Accessories	1
11	Pressure Cooker for heat induced Antigen Retrieval in Immuno Histochemistry	1
12	Semi Automated ELISA reader with printer	1
13	Automated Chemluminscence System	1
14	Microplate Shaker	1
15	ELISA Microplate Washer	1
16	CD4/CD8 T Lymphocyte Count Machine	1
17	Refrigerator	1
18	Laboratory furnitures	LS
7	**DEPARTMENT OF PHYSIOTHERAPY**	
1	Hydrocollator unit	1
2	Wax Bath	1
3	Shortwave diathermy with electrodes	1
4	Interferential Therapy with vacuum electrodes	1
5	Ultrasonic Therapy	1
6	Traction unit with traction bed	1
7	Muscle Stimulator	1
8	TENS Unit portable	1
9	CPM (knee unit)	1
10	Infrared Lamp	1
11	Parallel Bar Adult	1
12	Static cycle (Adult)	1
13	Examination couch high couch 6,low couch 2	4
14	Treadmill motorized imported	1

SL.NO.	DEPARTMENT/ DESCRIPTION	QTY
15	Hand Evaluation kit	1
16	Vacuum/compression therapy unit	1
17	Other Small Value Equipemnt	LP
18	Furniture for the Department	LP
8	**DEPARTMENT OF BLOOD BANK**	
1	Blood donor couch	2
2	Automated ELISA analyzer	1
3	Blood collection monitor	2
4	Binocular Microscope	2
5	Di-electric tube sealer	1
6	Automated blood grouping system	1
7	Blood transportation box	1
8	Deep freezer-40 deg	1
9	Deep freezer-80 deg	1
10	Ultra High speed centrifuge	1
11	Plasma thawing bath	1
12	Blood bag weighting balance	1
13	Blood bank refrigerator (2-6° C)	2
14	Centrifuge bench top	2
15	Incubator	1
16	Water bath	1
17	Stop watch	4
18	Weighting balance -	2
19	BP apparatus	2
20	Patient weighing machine-digital	2
21	Computer	1
22	Laboratory furniture's	LS
9	**DEPARTMENT OF MEDICINE**	
1	B.P. Apparatus	20
2	Weighing machine adult	20
3	Stethoscope	20
4	Ophthalmoscope	20
5	X-ray viewing box	20
6	Upper GI endoscope, Colonoscope, Sigmoid scope, Endoscopy processor with recording system, Endoscopy washer	1
7	Ultra sound machine -Medium end	1
8	Fiber optic bronchoscope	1
9	Spirometer	1
10	Multi parameter Monitors	10
11	Vital sign monitors	5
12	Defibrillator	5
13	Pulse oxymeter	5
14	Syringe Pumps	20
15	Infusion Pumps	10
16	Intensive care ventilators	5
17	Portable ventilator	2
18	Portable Monitor	2
19	Cardiac pacemaker	3
20	Ambu bag	20
21	Laryngoscope	20
22	ECG Machine -12 channel	3

SL.NO.	DEPARTMENT/ DESCRIPTION	QTY
23	ECG Machine -Single channel	3
24	Echocardiography machine -Ultrasound	1
25	Tread mill test system	1
26	Ambulatory BP	1
27	Holter analyzer	1
28	ABG Analyzer with ISE	1
29	Refrigerator	5
30	Glucometer	10
31	Electro Encephalogram (EEG) machine	1
32	EMG machine	1
33	BERA system	1
34	Computer	5
35	Printer	5
36	Furniture for general medicine	LS
10	**DEPARTMENT OF PAEDIATRICS & NEONATOLOGY**	
1	Open care system	3
2	Neonatal incubator	1
3	Portable incubator	1
4	Phototherapy unit	5
5	Syringe Pumps	5
6	Infusion Pumps	5
7	Pediatric & Neonatal ventilator	1
8	Multi parameter Monitors	5
10	Defibrillator	1
11	Pulse oxymeter	2
12	Portable ultrasound machine	1
13	High frequency ventilator with oscillator	2
14	Bilirubinometer	1
15	Ambu bag-infant	5
16	Ambu bag-children	5
17	Face mask	5
18	Nasal prongs	LS
19	Nasal catheters	LS
20	Endotracheal tubes	LS
21	Electrical Suction apparatus	4
22	Laryngoscope - Infant	5
23	Laryngoscope - Children	5
24	Oxygen head box (of each size)	1
25	Nebulisers	8
26	Weighing machine-Pediatrics	2
27	Weighing machine- Neonates	2
28	Infantometer	2
29	B.P. Apparatus	5
30	Stethoscope	5
31	Ophthalmoscope	5
32	X-ray viewing box	5
33	ABG Analyzer with ISE	1
34	Computer	5
35	Printer	5
36	Furniture for Pediatrics and Neonatology	LS
11	**DEPARTMENT OF SURGERY**	

SL.NO.	DEPARTMENT/ DESCRIPTION	QTY
1	B.P. Apparatus	5
2	Weighing machine adult	5
3	Stethoscope	5
4	Ophthalmoscope	2
5	X-ray viewing box	2
6	Flexible Endoscope, Upper GI,Colonoscope (one set in Main O.T.	1
7	Diagnostic Crystoscope	1
8	Ultrasound-High end	1
9	Uroflowmetry	1
11	Operation Theatre Ceiling light-Minor	1
12	OT LIGHT with camera and monitor	3
14	Electrosurgical Unit	3
24	Anesthesia machine - High end	3
25	Anesthesia machine - Low end	1
26	Resuscitation kit	3
27	Assorted surgical instrument for major operation sets	3
28	Assorted surgical instrument for minor operation sets	1
29	Flash autoclave	2
30	Incubators/Transport incubators	2
31	Neonatal Bassinet	5
32	Ultrasound	1
33	ABG analyzer with ISE	1
34	Esophageal/Gastric pH & pressure recorder	1
35	Surgery camera system with recorder	1
36	Crysto scope and Resectoscope	1
37	Bronchoscope	1
38	Endoscopy System complete	1
39	C-arm image intensifier	1
41	Operative ultrasound	1
42	Computer with laser Printer	5
43	Portable x-ray-20kW	1
44	Electro hydraulic OT table	2
45	Hydraulic OT table	1
46	Operating Table-Electro Hydraulic-ortho	1
47	Furniture for surgery	LS
12	**DEPARTMENT OF ORTHOPEDICS**	
1	Spot light	2
2	Doctors Diagnostic kit-Ortho	2
3	Plaster Cutter	2
4	Portable Suction Apparatus	1
5	X ray Viewer	2
6	Assorted Instruments	2
7	Operating Table-Electro Hydraulic-ortho	1
8	Electronic Tourniquette	1
9	Battery Operated Drill	1
10	Arthroscopy System Complete	1
11	Carm	1
12	Surgical Instrument Set-Ortho	2
13	Furniture for orthopedics	LS

SL.NO.	DEPARTMENT/ DESCRIPTION	QTY
13	**DEPARTMENT OF OPTHALMOLOGY**	
1	Snellen Chart/Drum with remote	1
2	Trial Lens set with frames	1
3	Log Mar Vision charts	1
4	Farnsworth Munsel 100 Hue Test	1
5	Wall mounted ophthalmoscope and streak retinoscope	1
6	Slit lamp with applanation tonometer	1
7	Digital Lensometer	1
8	Keratometer/Ophthamlometer Manual	1
9	Indirect Ophthalmoscope	1
10	Synoptophore	1
11	Frenzel prism Bar	1
12	Tonopen	1
13	Auto Refractometor	1
14	Ultrasound Biomicroscopy System	1
15	Non-contact Tonometer	1
16	Humphrey Field Analyzer	1
17	Videokerato Topography System	1
18	Ophthalmology Diagnostic Kit	1
19	Diagnostic lenses	1
31	Furniture for Ophthalmology	LS
14	**DEPARTMENT OF ENT**	
1	Nasal Endoscope (diagnostic) with video system complete.	1
2	Temporal Bone Lab (complete) with boneholder, microscope and drill	1
3	Audiometer	1
4	Electro Nystagmography Unit –4 CH computerized	1
5	OAE tester	1
6	ENT Examination chair	1
7	Diagnostic kit	2
22	Furniture for ENT	LS
15	**DEPARTMENT OF OBSTETRICS AND GYNAECOLOGY**	
1	BP Apparatus	5
2	Stethoscope	5
3	Portable Suction Apparatus	2
4	Pulse Oximeter	2
5	Foetal Monitor	2
6	Vacuum Extractor with cups	1
7	Video Colposcope with Camera	1
8	Spot light	1
9	Vaginal Hystrectomy set	1
10	Cryo Cautery Machine	2
11	Assorted Surgical Instrument	2
12	Resuscitation Kit	4
13	Diagnostic Set	4
14	Insufflator	1
15	PCA Pumps	2
16	Intra uterine pressure monitoring system	2
17	Co2 Laser	1
18	Assorted surgical instrument set	LS
19	Furniture for OBG	LS
16	**DEPARTMENT OF RADIODIAGNOSIS**	

SL.NO.	DEPARTMENT/ DESCRIPTION	QTY
1	X ray - 1000 mA	1
2	CR system	1
3	Portable X ray machine	2
4	CT Scan-16 slice	1
5	MRI -1.5 tesla	1
6	Ultrasound Machine-Medium end	1
7	Furniture for Radiology	LS
17	**DEPARTMENT OF EMERGENCY AND TRAUMA**	
1	Vital sign Monitor	2
2	ECG Machine-12 channel	1
3	Defibrillator	1
4	BP Apparatus	2
5	Stethoscope	2
6	Nebulizer	2
7	Portable Suction Apparatus	2
8	Syringe Pumps	4
9	Infusion Pumps	2
10	Portable Ventilator	1
11	Portable Patient Monitor	1
12	Weighing Machine	2
13	X ray Viewer	2
14	Spot light	2
15	Diagnostic kit	1
16	Resuscitation kit	1
17	Plater Saw with suction	1
18	Furniture for emergency and trauma	LS
18	**CSSD**	
1	Horizondal Steam Sterilizer-500 L	3
2	Flash Sterilizer-100 L	2
3	Heat Sealing Machine	2
4	ETO Sterilizer	1
5	Ultrasonic Cleaner	2
6	Washer Disinfector	1
7	Spray Rinser	2
8	Hand Dryer	1
9	Lamp with Magnifier	1
10	Furniture for CSSD	LS
19	**LAUNDRY**	
1	Washer Extractor-50 Kg	3
2	Sluice Machine-30Kg	1
3	Drying Tumbler-50 Kg	3
4	Flat work ironer	1
5	Body press	1
6	Sewing Machine	2
7	Compressor	1
8	Furniture for Laundry	LS

ANNEXURE-II

(FINISHING SCHEDULE -ATTACHED)

ANNEXURE-III

(Matrix for MGPS-ATTACHED)

END OF DBR

REGIONAL INSTITUTE OF PARAMEDICAL AND NURSING SCIENCES (RIPANS)

FINISHING SCHEDULE

S No.	LEGENDS	DETAILS
	Wall Finishes	
1	WF -P1	Oil Bound Distemper (OBD)/Acrylic Washabvle Distemper+ (with Primer coat(s) & Cement based Putty)
2	WF-P2	Premium Acrylic Emulsion Paint (with Primer coat(s) & Putty)
3	WF-P3	Plastic Emulsion Matt Finish (with Primer coat(s) & Putty)
4	WF-P4	Weather Coat Paint External Grade(with Primer coat(s) & Putty)
5	WF-P5	Acrylic Emulsion (with Primer coat(s) & cement based Putty)
6	WF-P6	Anti Bacterial Paint (with Primer coat(s) & Cement based Putty)
7	WF -LP	Laminate Paneling (with all finish detail)
8	WF -G	18 mm thick Granite cladding as per approved pattern
9	WF-VT	Vitrified Tiles Skirting
10	WF-V	Vinyl 2mm thick anti static, anti conductive with seam less joints
11	WF -G+P	Granite + Laminate Paneling
12	WF -T1	Glazed Ceramic Tile (300mmX450mm)
13	External Paint	Wheather proof Paint or As per detail
	Floor Finishes & 150 mm Skriting same as flooring	
1	FF-K	25mm thk Kota Stone Flooring (Size 550Mm X 550Mm or as required) including Polishing
2	FF-K1	Polished Kota Stone In Single Piece In Tread(25mm thk), Riser (20mm thk) And Landing (25mm thk)
3	FF-VT	Vitrified Tiles (600mmx600mm or size as specified in drawing) (double / multi charged/ full body)
4	FF-AVT	Antiskid Vitrified Tiles (600mmx600mm or size as specified in drawing) (double / multi charged/ full body)
5	FF-AT	Antiskid Ceramic Tiles (first quality) (300mmx300m)
6	FF-AR	Acid Resistant Tiles (600mm X 600 mm)
7	FF-G	Polished Granite(18mm thk) Flooring with pattern dark colour granite(18mm thk) in two or more colours
8	FF-C	Carpet Flooring
9	FF-V	Vinyl 2 mm thk anti static, anti conductive with seam less joints, skirting with coving. Vinyl Flooring laid over cement concrete flooring (IPS)
10	FF-HT	Heat Reflective Tile Flooring
11	FF-WL	LaminateWooden Flooring
12	FF- CT	22 mm thk Chequerd Tiles
	Ceiling Finishes	
1	CF -P1	Putty + OBD
2	CF - GYP	Gypsum + Mineral Fibre Tiles
3	CF - GYP+C	Gypsum Ceiling With Cove
4	CF - MET	Powder Coated Metallic Tiles 600 X 600
5	CF - AT / CF-MF	Acoustic Tiles 600x600 Mineral Fiber NRC-0.8, Grid Ceiling
6	CF - MT	GI Metal Seamless Tiles 600x600 Grid
7	CF - PEP	Plastic Emulsion Paint
8	CF - AMT	Aluminum Metal Seamless Tiles 600x600 Grid
9	CF - PP+C	Pop + Paint Finish With Cove
11	CF - P+P	Pop + Paint Finish
12	CF-GYP + M	Gypsum + Mineral Fibre-Grid Ceiling
	Railing	All staircase railing shall be in S.S. as per CPWD Specification
	Doors and Windows	1) All doors size in Hospital shall be as per door legends (as given in door window schedule) given in the architecture drawings with 1mm thick laminate factory pressed on both sides of flush shutter (35mm) and 25mm minimum thk second class teak wood lipping all around. Vision panel of size as specified/required shall be provided, in shutters wherever directed, frames shall be powder coated Aluminum with unanodised aluminum sleeve inside (on hinge side only). with rough ground frame. 2) X-ray rooms shall have lead lined door shutters and frame and lipping all around (as per Specs) 3 In residential buildings door frame shall be of Powder Coated Aluminum with 35mm thk flush door shutter both side laminated and windows shall be in aluminium with wiremesh and grill whereever required as per CPWD specification. 4) All electrical and communication niche's will be fire proof doors as per NBC 2016. 5) All cupboards (in M.S. Residence and Guest House) shall be Box type cupboards with 18mm marine ply/ Block board box, back will be 8mmPly, shelves will be 18mm pre-laminated exterior grade particle boards, Shutters shall be 25 mm thk Block Board with 1mm thk laminate on both sides and 15 mm thk teak wood lipping. 6) 2 hour fire rated doors shall be provided as per approved fire scheme and NBC 2016 7) The above door specifications shall be read in conjunction with the approved detail drawings. 8) Contractor will submit Architectural & shop drawings for approval as specified in the tender document before execution. 9) Aluminum work as per manufacturer specification/ CPWD specifications. 10) All windows shall be powder coated aluminium section.double shutter in all building except hospital. 11) Etching Film on Glazing to be provided as per requirement.
	NOTE:	
	1) Grooves of size 3mmX 3mm, shall be made in the treads of the staircases	
	2) All above listed items shall conform to relevant latest CPWD Specifications/ Scheduled Items of CPWD,VOL-4,Design Basis Report,VOL-5,Technical Specification &VOL-6,Tender Drawings	
	3) Thickness, Size, Shape, Shade and quality of Kota Stone, Granite Stone, Ceramic Tiles, Vitrified Tiles, Vinyl Flooring, Wooden Flooring, False Ceiling work, Crash Guard etc. as specified in the tender document/drawings shall conform to CPWD Specifications, Design Basis Report, Technical Specifications (Vol-5), Tender Drawings and as directed by Engineer-in-charge.	
	4) Paints finish as listed above shall be of only first quality of approved make and shade and shall conform to CPWD Specifications, Design Basis Report, Technical Specifications (Vol-5), Tender Drawings , GRIHA norms with low VOC and as directed by Engineer-in-charge.	

HOSPITAL FINISHING SCHEDULE

DESCRIPTIONS	WALL FINISHES (DESIGN AS PER DRAWING)							FLOOR FINISHES / 150MM SKIRTING SAME AS FLOORING									CEILING FINISHES (DESIGN AS PER DRAWING + WOODEN TRAP DOOR)						DOOR	WINDOW
	WF-F1	WF-F2	WF-F3	WF-T1	WF-G	WF-G+F	WF-UF	FF-F1	FF-F2	FF-F3	FF-F4	FF-F5	FF-AE	FF-FS	FF-G	FF-T	CF -F1	CF - CFF+W	CF - CFF+C	CF - F1	CF - AM1	CF - HF	Shutter :	Shutter :
MAIN ENTRANCE																							1) Main Door-1 2mm thick toughened glass door with patch fitting 2) Toilet, pantry ,store ,office,demo room, internal door - 35 mm thk flush door both side laminate finish. 3) In patient wards & ICU,operation - 35mm thk commercial door half glazed with laminate & ss guard sheet on both side. 4)Single room ,inpatient room,opt & consultant room,counselling room - 35 mm thk flush door with vision panel both side laminate finish. 5)X-RAY ,ECP,MENOGRAPHY,CT,MRI CT,SPEC CT, Ultrasoft+Remote ,- LEAD CLADDED DOOR LAMINATE FINISH. 6) CPT'S - Hermetically sheld sliding door. 7)mbh -MRF sheld door. 8)Shaft Door - laminate finish door 9)Lift Lobby, Staircase, & Compartment Door. - 2 hour Fire rated doors - GI frame & shutter powder coated with vision panel paint bar & latch. 10) Corridor, ICU,Nurse post,recovery, endoscopy ward, daycare wards, wards, isolation room, department entry doors - half glazed both side laminate finish with sa kick plate cladded up to 900mm both side of shutter.	Powder coated Aluminium Frame
OPD - Entrance Lobby		wtf-#3 (above 150 mm granite skirting band and 1350mm high tiles								FF-G							CF - CFF+W							**External Windows**-Fixed glass/ Openable External windows with Powder coated Aluminium Frame with 6+12+6 mm TH DGU as per GRIHA requirement
Reception/Registration cum Waiting		wtf-#3 (above 150 mm granite skirting band and 1350mm high tiles								FF-G							CF - CFF+W							
Admin Office		wtf-#2						FF-VT									CF - CFF+W							**internal windows** : 8 mm thk float fixed/openable glass as specified in tender drawings
Back Office & Store		wtf-#2						FF-VT									CF - CFF+W							
Pharmacy		wtf-#2						FF-VT									CF - CFF+W							
OUT PATIENT DEPARTMENT																	CF - CFF+W							
OPD - Waiting Areas		wtf-#3 (above 150 mm granite skirting band and 1350mm high tiles								FF-G							CF - CFF+W							
OPD Consultation room/Doctor/Minor OT,Cardiac/Treatment		wtf-#2 (above 130 mm skirting band and 1350mm high tiles						FF-VT									CF - CFF+W							
Ayush/HRHM Office/Rogi Kalyan/Etc.								FF-VT									CF - CFF+W							
Sample Collection (counter top granite finish with under & O/H storage)		wtf-#2 (above 130 mm skirting band and 1350mm high tiles		wtf-T1 (Serveses O/H Tecnicon)				FF-VT									CF - CFF+W							
DIAGNOSTIC BLOCK																	CF - CFF+W							
RADIOLOGY																								
Back wall+(counter top polished granite finish with under &				wtf-T1				FF-VT									CF - CFF+W							
X-Ray Rooms		wtf-#2						FF-VT									CF - CFF+W							
Ultrasound Rooms, Mammogy, ECG/TPT/TMT/BSG/EMG, Bone Densometer,		wtf-#2						FF-VT									CF - CFF+W							
Consultation/Technician/Doctor Room		wtf-#2		wtf-T1 (up to 1350mm HT with granite beading)				FF-VT									CF - CFF+W							
MRI Room		wtf-#2											FF-V							CF - AM1				
CT Scan Room		wtf-#2											FF-V							CF - AM1				
Reporting Room, Console Room		wtf-#2											FF-V				CF - CFF+W							
Change Room		wtf-#2											FF-V				CF - CFF+W							
																	CF - CFF+W							
BLOOD BANK																								
Nurse Station - back wall+(counter top polished granite finish with under & O/Fstorage)		wtf-#2		wtf-T1 (up to 1350mm HT with granite beading)				FF-VT									CF - CFF+W							
Waiting Area		wtf-#3 (above 150 mm granite skirting band and 1350mm high tiles						FF-VT (Anti-skid full body)									CF - CFF+W							
Refreshment, Pre Donor Screening		wtf-#2						FF-VT									CF - CFF+W							
Aphaeresis, Serology		wtf-#2						FF-VT									CF - CFF+W							
Component Lab				wtf-T1							FF-AE						CF - CFF+W							
Doctor's Room, Consultant Room		wtf-#2						FF-VT									CF - CFF+W							
EMERGENCY DEPARTMENT																								
Waiting Area		wtf-#3 (above 150 mm granite skirting band and 1350mm high tiles								FF-G							CF - CFF+W							
Triage /Observation Beds		wtf-#3 (above 150 mm granite skirting band and 1350mm high tiles						FF-VT									CF - CFF+W							
Doctor's Room, Duty Doctor's Room, Nurse office		wtf-#3 (above 150 mm granite skirting band and 1350mm high tiles						FF-VT									CF - CFF+W							
OT Rooms			wtf-#2																					
Sterile Store, Medicine Store		wtf-#2						FF-VT									CF - CFF+W							
Thatage Room, Plaster Room		wtf-#2						FF-VT									CF - CFF+W							
LABORATORY																								
Reception & Waiting		wtf-#2						FF-VT									CF - CFF+W							
Histo Area, Pathologist		wtf-#2						FF-VT									CF - CFF+W							
BCG Area, Phlebotomist		wtf-#2		wtf-T1				FF-VT									CF - CFF+W							
Laboratories				wtf-T1									FF-AE				CF - CFF+W							
Media Prep,				wtf-T1									FF-AE				CF - CFF+W							
Technician		wtf-#2						FF-VT									CF - CFF+W							
Physiotherapy Room		wtf-#2		wtf-T1				FF-VT									CF - CFF+W							
Dyness Complex																								
Pre & Post Delivery Beds		wtf-#2		wtf-T1 (between counter and over head)				FF-VT									CF - CFF+W							
		wtf-#2		wtf-T1 (up to 1350mm HT with granite beading)				FF-VT									CF - CFF+W							
Sterile Room, Equip. Sterile, Sterile store, Sterile Station				wtf-T1				FF-VT																
Doctor /Nurse/Staff Change room		wtf-#2						FF-VT									CF - CFF+W							
Labour & Delivery Room			wtf-#2	wtf-T1 (up to 1350mm HT with granite beading)											FF-V									
Operating Room			wtf-#2	wtf-T1 (up to 1350mm HT with granite beading)											FF-V									
Baby Resus			wtf-#2	wtf-T1 (up to 1350mm HT with granite beading)											FF-V									
																	CF - CFF+W							
IN PATIENT DEPARTMENT																	CF - CFF+W							
Nurse Station - back wall+(counter top polished granite finish with under & O/Fstorage)		wtf-#2		wtf-T1 (between counter & over head)				FF-VT									CF - CFF+W							
Treatment Room			wtf-#2 (1.2m					FF-VT									CF - CFF+W							
Isolation Bed			wtf-#2 (1.2m					VT							FF-V		CF - CFF+W							
Nurse Office, Doctor's Room		wtf-#2						FF-VT									CF - CFF+W							
PD Beds Area		wtf-#2		wtf-T1 (Cladding up to 1350mm)				FF-VT									CF - CFF+W							
ICU																	CF - CFF+W							
Nurse Station - back wall+(counter top polished granite finish with under & O/Fstorage)		wtf-#2		wtf-T1 (between counter & overhead storage)											FF-V		CF - CFF+W							
ICU Beds Area		wtf-#2		wtf-T1 (Cladding up to 1350mm)											FF-V					CF - AM1				
Isolation Room		wtf-#2						FF-VT							FF-V		CF - CFF+W			CF - AM1				
Doctor's Duty Room		wtf-#2						FF-VT									CF - CFF+W							
OT COMPLEX																								
Pre & Post Operative Beds		wtf-#6		wtf-T1 (Cladding up to 1350mm)											FF-V					CF - AM1				
OT Rooms			wtf-#6												FF-V						CF - AC			
Counselling Room		wtf-#2						FF-VT									CF - CFF+W							
Pharmacy Store, Equipment Store		wtf-#2						FF-VT									CF - CFF+W							
Doctor, Nurse, CDA, Student Change Room				wtf-T1				FF-VT									CF - CFF+W							
OT Office		wtf-#2													FF-V		CF - CFF+W							
Anesthetist Office		wtf-#2													FF-V		CF - CFF+W							
OT Store, TSSU				wtf-T1				FF-VT									CF - CFF+W							
OT Lab				wtf-T1									FF-AE				CF - CFF+W							
Doctor, Tech & Staff lounge,		wtf-#2						FF-VT									CF - CFF+W							
ADMIN OFFICE																								
Waiting & Reception		wtf-#2		wtf-T1				FF-VT										CF - CFF+C	CF - #2					
Work Station		wtf-#2						FF-VT										CF - CFF+C	CF - #2					
Cabins, Cubicles		wtf-#2						FF-VT										CF - CFF+C	CF - #2					
Board Room		wtf-#2				wtf-GF 50% GF +WF4		FF-VT										CF - CFF+C						
HQ Room		wtf-#2						FF-VT										CF - CFF+C	CF - #2					
Pantry				wtf-T1									FF-AE								CF - HF			
Cafeteria		wtf-#2		wtf-T1				FF-VT										CF - CFF+C						
Pantry				wtf-T1				FF-VT													CF - HF			
STAFF DINNING AREA																								
Pantry/Serving Counter				wtf-T1				FF-VT													CF - HF			
Hand Wash,Drinking Water				wtf-T1				FF-VT													CF - HF			
Doctor & Staff Dinning Area		wtf-#2						FF-VT										CF - CFF+C						
CENTRAL STERILE SUPPLY DEPARTMENT																								
Dirty Receiving				wtf-T1				FF-VT													CF - HF			
Trolly Area				wtf-T1									FF-AC								CF - HF			
Dirty Area				wtf-T1									FF-AC								CF - HF			
Clean Area				wtf-T1									FF-AC								CF - HF			
Change ROOM, Air Lock				wtf-T1				FF-VT													CF - HF			
HHG Room,		wtf-#2						FF-VT									CF - CFF+W							
Clean issue				wtf-T1				FF-VT													CF - HF			
IT Room		wtf-#2						FF-VT									CF - CFF+W							
MEDICAL RECORD DEPARTMENT																								
Medical Record Room		wtf-#2						FF-VT									CF -F2							
Stores		wtf-#2						FF-VT									CF -F2							
TOILETS																								
Public Toilets				wtf-T1									FF-AT								CF - HF			
Staff Toilets				wtf-T1									FF-AT								CF - HF			
CIRCULATION AND SUPPORT SERVICES																								
Staircase - All Internal		wtf-#3 (above 900mm up to ceiling)		wtf-T1 ceramic tiles (150 Skirting and up to 900mm with granite moulding)						FF-G			CF -F1										
Fire Staircase		wtf-#3 (above 900mm up to ceiling)		wtf-T1 ceramic tiles (150 Skirting up to 900mm with granite moulding)			FF-C						CF -F1										
Lift Lobby (granite cladding up to 1500mm in ceiling)					wtf-G					FF-G								CF - CFF+C						
Corridor		wtf-#3 (above 900mm up to ceiling)		wtf-T1 ceramic tiles up to 900mm with granite moulding				FF-VT (Anti-skid full body)									CF - CFF+W							
AHU/Electrical/Service Room/ UPS room/Stores/Utility Rooms	wtf-F1						FF-C																	
Server Room		wtf-#2						FF-Weayle ±50mm Raised floor									CF -F1							
Hospital Ramp												FF-CT					CF -F1							
Entry Ramp												FF-CT												

Railing	
Entry & External Ramps	Stainless Steel Railing (Both Baluster and hand Rail)
Hospital Ramp	RCC Parapet wall 1.1 ft ht with stainless steel grab rail on top
Staircase	Stainless Steel Railing (Both Baluster and hand Rail)
Fire Staircase	Stainless Steel Railing (Both Baluster and hand Rail)
Miscellaneous Items	
Window Pelmets for curtain/blinds	150x150mm Concealed pelmet in false ceiling to be made of commercial board 19mm thk finished with enamel paint to match ceiling paint color. All inpatient Rooms, wards, ICU, Pre and Post OP, Offices, Director rooms, Consultant rooms & Faculty .
Patient room wardrobe	All inpatient Rooms & wards- Wardrobes to be consider 2100mm ht and 600mm deep and length as per tender drawing and hanger rail. Complete in all respect. 1) Inbuilt Wardrobe-12mm thk both side 1mm thk laminate finish shutter with Stainless steel Handle and Locks (as per approved sample) and ms shelve finished with white paint 2)Free standing wardrobe in rooms should be constructed with 19mm thk Board finished with 1mm thk laminate on back, sides, base and top with shelves and shutter. 25mm thk Shutter finished with laminate both side 1mm thk with Stainless Steel locks and Handle (as per approved sample) and all inside surface and shelves finished with white paint
Storage -Office and cabins Full Ht Storage, Over Head and Sa	19mm thk board finished with all sides laminate with shelves with Stainless Steel locks and Handles (as per approved sample) Complete all around
Counters with Under counter and overhead Storage as per drav	All stores, Utility, OT, OG, Pantry - 20mm thk RCC counter finished with Granite top and 100mm facia with 19mmthk BWP commercial board under counter and overhead storage all inside finished with paint and out side with laminate finish 1mm thk. Shutters 19mm thk BWP Board finished with both side laminate finish as per tender drawing.
Toilet Accessories (All in Stainless Steel) (As per approved sample)	Soap Dispenser, Towel Rail, Towel Ring, Health Faucet, Alkaline Tap, Basin Mixer, Shower, Drain, Angle valves, P-Trap, Concealed Cistern with Flush valves, Disorder Mixer Tap, Grab Rail (for Patient Room toilets and Handicap toilets)
Washroom Mirror in Toilets	6mm thk Clear looking Mirror with 12mm thk BWP g/s paint finish fixed SS flat batten studs
Toilet & Pantry Fittings	Kitchen Stainless steel sink,WC, Washbasin, U/rinal of approved design and make. For attached Toilets Wall-Mounted EWC is to be provided, in other Toilets Floor Mounted EWC to be provided
Chair rail	Modular 1.90mm wide PVC chair rail fixed at 900mm/ht in corridors or specified areas
Nurse station/ Registration counters	Granite and laminate finish in two levels made out of 19mm BWP board and rough seasoned wood as per tender drawing and detail with provision of all electrical and data systems as required.
Tile cladding	Tile cladding up to false ceiling level in kitchen,pantries,clean utilities, dirty utilities, stores etc.

AUDITORIUM FINISHING SCHEDULE							
DESCRIPTIONS	**WALL FINISHES**	**FLOOR FINISHES / 100MM SKRITING SAME AS FLOORING**	**CEILING FINISHES**	**DOOR**		**WINDOW**	
LOBBY AREA	Ceramic Tiles upto 1500 MM+Acrlyic emulsion paint with primer coat(s) /putty above dado	Granite	Combination of CAL.SILICATE Board & white mineral fibre tiles 600X600 tegular joints	**Frame** :	2nd class Seasoned teak wood frame termite treated	**Frame** :	Aluminum frame powder coated
				Shutter :	**1) Main Entry Door**: 12mm thk toughened glass door on floor spring & patch fittings	**Shutter :**	Powder coated Aluminum Frame
							External Windows:- Fixed glass external windows with Powder coated Aluminum Frame with 6-12-6 mm Thk DGU as per GRIHA requirement
AUDITORIUM AREA	Wall Panel made of fibre glass substrate wrapped with accoustically transparent fire retardent fabric (Dimension 600x1200x25mm)	Carpet Flooring over IPS flooring as per specifications	Tegular Edge 8 mm thick fully perforated calcium silicate Board		**3) Auditorium Door**:- Fire rated Acoustic wooden door		
		Stage wooden flooring - wood of 20MM thick & stage front as per specifications			**4)Toilet Pantry and Utility Doors** : 30 mm thk flush commercial door finish with both side 1mm thk laminate and edges finished with 25 mm thk 2nd class teak wood lipping polish finish.		**internal windows** : - 8 mm thk float fixed/openable glass as specified in tender drawings
Pantry (COUNTER TOP GRANITE FINISH)	Ceramic tile up to ceiling	Anti skid vitrified tiles	putty + obd		5) **Staircase Corridor, Ahu door** -Fire rated wooden door with vision panel finish with both side 1mm thk laminate and edges finished with 6mm wooden lipping polish finish. flush door with vision panel		
Female & male Green Rooms	Plastic emulsion paint up to ceiling	Kota Flooring	putty + obd				
Toilet							
Toilets	Ceramic tile up to ceiling	Anti skid ceramic tiles	Metal seamless Tile				
VIP TOILET	Ceramic tile up to ceiling	Anti skid ceramic tiles	Metal seamless Tile				
CIRCULATION AND SUPPORT SERVICES							
Staircase	Ceramic tile up to 900mm ht. with granite beading & acrylic paint up to ceiling	Granite flooring	putty + obd				
Ramp		Inside auditorium carpet flooring, outside ramps Chequered tiles					
Corridor	Ceramic tile up to 900mm ht. with granite beading & acrylic paint up to ceiling	granite	Combination of CAL.SILICATE Board & white mineral fibre tiles 600X600 tegular joints				
AHU Room/Electrical/ Service Rooms /Niche's/Stores Control room	OBD	Kota Flooring	putty + obd				
Railing							
Ramps	Stainless Steel Railing (Both Baluster and hand Rail)						
Staircase	Stainless Steel Railing (Both Baluster and hand Rail)						
Fire Staircase	Stainless Steel Railing (Both Baluster and hand Rail)						
Miscellaneous Items							
Window Pelmets for curtain and blinds	150x150mm Concealed or Exposed pelmet in false ceiling to be made of commercial board 19mm thk finished with enamel paint to match ceiling paint color. All Offices, Rooms Lobby, lounge and waiting areas						
Counters (as per drawing)	Bathroom Counters,, Hand Wash,Tray Drop- 50mm thk RCC cantilevered slab counter finished with 19mm thk Granite top and 100mm facia						
Toilet Accessories (All in Stainless Steel) (As per approved sample)	Soap Dispenser, Towel Rod, Towel Ring, Health Faucet, Ablution Tap, Basin Mixer, Shower, Drain, Angle valves, P-Trap, Concealed Cistern with Flush valves, Diverter Mixer Tap, Grab Rail (for Patient Room toilets and Handicap toilets)						
Wash basin Mirror In Toilets	6mm thk Clear looking Mirror with 12mm thk BWP ply paint finish fixed SS flat button studs						
Toilet Fittings	WC, Washbasin, Urinal of approved design and make. For VIP area Toilets Wall Mounted EWC is to be provided.						
NOTE:- REFER DETAILED SPECIFICATIONS FOR ACOUSTIC PANELLING, STAGING ETC. GIVEN IN DBR/TECHNICAL SPECIFICATIONS/TENDER DRAWINGS.							

ACADEMIC BLOCK -IV FINISHING SCHEDULE

DESCRIPTION	WALL FINISHES								FLOOR FINISHES / 150MM SKRITING SAME AS FLOORING								CEILING FINISHES					DOOR		WINDOW	
	WF-P1	WF-P2	WF-P5/VT	WF-P6	WF-LP	WF-T1	WF-G	WF-G+P	FF-K	FF-K1	FF-VT	FF-AR	FF-AT	FF-CT	FF-G	FF-V	CF -P1	CF - CBS	CF-GYP+C	CF - AT	CF - MT	Frame :	Aluminum frame powder coated	Frame :	Aluminum frame powder coated
Entrance Lobby			WF-P5					WF-G (up to 1200mm)							FF-G			CF - CS				Shutter :	35mm thk Flush Shutter with vision panel both side laminated with 1mm thk laminate (factory pressed) with 2nd class Teak Wood Lipping & Polish etc. All Toilet WC Doors- 30mm thk Laminated Flush door shutters	Shutter:	Aluminum glazed & Wire mesh shutter with Grill.
HOD Room		WF-P2									FF-VT						CF -P1					Main Door	Main Entrance - Aluminium Frame & Aluminium Door shutter		
Faculty Room			WF-P5								FF-VT						CF -P1								
Deptt. Office			WF-P5								FF-VT						CF -P1								
Record Room	WF-P1										FF-VT						CF -P1								
Museum			WF-P5													FF-V			CF-GYP+C						
Kitchen	WF-P1 (above dado up to ceiling)					WF-T1 (Dado up to lintel level)							FF-AT				CF -P1								
Labs			WF-P5			WF-T1 (1200mm Dado)in coloured pattern					FF-AR										CF - MT				
Class Room			WF-P5								FF-VT									CF - AT					
Library			WF-P5			WF-T1 (1050mm Dado)in coloured pattern					FF-VT								CF-GYP+C						
Cafeteria			WF-P5								FF-VT (Anti-Skid)								CF-GYP+C						
TOILETS																									
Public Toilets(M/F)	WF-P1 (above lintel level up to ceiling					WF-T1 (up to lintel level)							FF-AT								CF -MT				
Staff Toilets(M/F)	WF-P1 (above lintel level up to ceiling					WF-T1 (up to lintel level)							FF-AT								CF -MT				
Handicaped toilet	WF-P1 (above lintel level up to ceiling					WF-T1 (up to lintel level)							FF-AT								CF -MT				
CIRCULATION AND SUPPORT SERVICES																									
Staircase	WF-P2 (above dado level up to ceiling					WF-T1 (dado up to 900mm with granite moulding)									FF-G		CF -P1								
Fire Staircase	WF-P1 (above dado level up to ceiling									FF-K1															
Ramps														FF-CT											
Lift Lobby (cladding up to false ceiling)							WF-G								FF-G				CF-GYP+C						
Stilt Area	WF-P1									Vaccum Dewatered concrete floor							CF -P1								
Corridor			WF-P5 (Above skirting)								Green Marble						CF -P1								
AHU/ Electrical/Service Rooms/stores/Record	WF-P1								FF-K								CF -P1								

Railing	
Entrance Ramps	Stainless Steel Railing (Both Baluster and hand Rail)
Staircase	Stainless Steel Railing (Both Baluster and hand Rail)
Fire Staircase	Stainless Steel Railing (Both Baluster and hand Rail)
Miscellaneous Items	
kitchen Counter	Counter top finish with polished Granite with moulding
Window sill	top finish with Granite
Storages -Stores, Office and cabins Full Ht Storage, Over Head and low ht units	19mm thk board finished with all sides laminate with shelves with Stainless Steel locks and Handles (as per approved sample) Complete all respect
Lab Counters	50mm thk RCC counter finished with 18mm thk Granite top and 100mm facia with 19mmthk BWP commercial board undercounter and overhead (only where counter is against wall) storage all inside finished with paint and out side with 1mm thk finish 1mm thk. Shutters 19mm thk BWP Board finished with both side 1mm thk finish.
Toilet Accessories (All in Stainless Steel) (As per approved sample)	Soap Dispenser, Towel Rod, Towel Ring, Health Faucet, Ablution Tap, Basin Mixer, Shower, Drain, Angle valves, P-Trap, Concealed Cistern with Flush valves, Diverter Mixer Tap, Grab Rail (for Patient Room toilets and Handicap toilets)
Wash basin Mirror In Toilets	6mm thk Clear looking Mirror with 12mm thk BWP ply paint finish fixed SS flat button studs
Toilet & Pantry Fittings	Kitchen Stainless steel sink,WC, Washbasin, Urinal of approved design and make. For attached Toilets Wall Mounted EWC is to be provided, in other Toilets Floor Mounted
OBD paint above false ceiling	
Tile cladding	Tile cladding up to lintel level toilet & kitchen ,

GENERAL HOSTEL FINISHING SCHEDULE

DESCRIPTIONS	WALL FINISHES					FLOOR FINISHES / 150MM SKRITING SAME AS FLOORING						CEILING FINISHES	DOOR		WINDOW	
	WF-P1	WF-P4	WF-P5	WF-G	WF-T1	FF-K	FF-VT	FF-AVT	FF-M	FF-AT	FF-G	CF -P1				
Main Entrance													**Frame** :	**Main Entry Door Frame:** Aluminium Extruded powder coated tubular box section without rebate **All room door Frames** : Powder Coated Aluminium Frame **WC & Sh Door Frame**: Powder Coated Aluminium Framesection Single rebate **Balcony Door Frame:** Powder Coated Aluminium Frame	**Frame** :	Aluminium Extruded powder coated tubular box section with double rebate
Entrance Area/Porch			WF-P5								FF-G	CF -P1	**Shutter :**	**1) Main Entry Door**:Door with Aluminium style & rail powder coated fully glazed shutter on floor spring	**Shutter :**	Double shutter with Aluminium powder coated security coated grill between both shutters fixed on frame
Reception /waiting area			WF-P5								FF-G	CF -P1		**2) Entrance Lobby and Visitor room**:- 35 mm thk factory made flushed commercial shutter with vision panel (150mmx1200mm) lamiante finish on bth surfaces with wooden lippingmalamine polish		**Out side Shutter** : - Aluminium style powder coated shutters with stainless steel grade 304 fly mesh
Dinning Room			WF-P5		WF-T1		FF-VT					CF -P1		**3) Lift Lobby, Corridor, Ramp, Staircase, Electrical room**: GI powder coated with fire glass vision panel 300x300 **fire rated** door		**Room side Shutter** : - Aluminium style powder coated shutters with 6mm thk clear glass fixed with Al beading.
Store / Security Room			WF-P5				FF-VT					CF -P1				
Warden Room			WF-P5				FF-VT					CF -P1		**4)Toilet WC and SH Doors** : 30mm thk Factory made flush door with laminate on both faces wooden lipping malamine polish.		
Single Room			WF-P5				FF-VT					CF -P1				
Common Room			WF-P5				FF-VT					CF -P1				
CIRCULATION AND SUPPORT SERVICES																
Staircase	WF-P1+Ceramic Tiles cladding/ Skirting										FF-G	CF -P1				
Lift Lobby (facai of lift wall is granite cladding till 2400mm lvl)			WF-P5	WF-G							FF-G	CF -P1				
Corridor			WF-P5					GREEN Marble				CF -P1				
Toilets	WF-P1				WF-T1(up to 2100mm ht.)					FF-AT		CF -P1				
Kitchen	WF-P1				WF-T1(up to 2100mm ht.)			FF-AVT				CF -P1				
Balcony		WF-P4						FF-AVT				CF -P1				
Electrical room	WF-P1					FF-K						CF -P1				
Railing																
Ramps	Stainless steel Baluster and Handrail															
Staircase and Balcony	Stainless steel Baluster and Handrail															
Fire Staircase	Stainless steel Baluster and Handrail															
Miscellaneous Items																
Counters (as per drawing)	Bathroom Counters- 50mm thk RCC cantilevered slab counter finished with 19mm thk Granite top and 100mm facia															
Wardrobe	All Rooms - Wardrobes to be 2100mm ht and 600mm deep and length as per drawing and hanger rod. Complete in all respect. 19mm thk Board finished with 1mm thk laminate on back, sides, base and top with shelves and shutter. 25mm thk Shutter finished with laminate both side 1mm thk with Stainless Steel locks and Handle (as per approved sample) and all inside surface and shelves finished with white paint															
Toilet Accessories (All in Stainless Steel) (As per approved sample)	Towel Rod, Towel Ring, Health Faucet, Ablution Tap, Basin Mixer, Shower, Drain, Angle valves, P-Trap, Concealed Cistern with Flush valves, Diverter Mixer Tap, Grab Rail (for Patient Room toilets and Handicap toilets)															
Wash basin Mirror In Toilets	6mm thk Clear looking Mirror with 12mm thk BWP ply paint finish fixed SS flat button studs															
Toilet Fittings	WC, Washbasin, Urinal of approved design and make															
External Paint finshied of building	Weather Coat Exterior Paint															

GUEST HOUSE FINISHING SCHEDULE

DESCRIPTIONS	WALL FINISHES					FLOOR FINISHES / 150MM SKRITING SAME AS FLOORING									CEILING						DOOR		WINDOW	
	WF-P1	WF-P4	WF-P5	WF-LP	WF-T1	FF-K	FF-K1	FF-VT		FF-AT	FF-CT	FF-G	FF-WL	FF-V	CF -P1	CF - GYP	CF-GYP+C	CF - MT	CF -P+ P	CF -PP+C	Frame :	**Main Entry Door Frame:** Aluminium Extruded powder coated tubular box section without rebate **All room door Frames** : Powder Coated Aluminium Frame **WC & Sh Door Frame**: Powder Coated Aluminium Frame section Single rebate **Balcony Door Frame:** Powder Coated Aluminium Frame	**Frame** :	Powder coated Aluminum frame
Reception & Waiting			WF-P5									FF-G					CF-GYP+C					**Kitchen Door**: - 35mm thk flushed shutter both side 1mm thk laminate finish with vision panel		**Room side Shutter** : - Powder coated Aluminum style and rail shutter with stainless steel fly mesh
Dinning			WF-P5		WF-T1 (Dado up to 1500 mm)			FF-VT									CF-GYP+C					**Room Door**: - 35mm thk flush commercial door finish with both side 1mm thk laminate and edges finished with 25 mm 2nd class teak wood lipping with polish finish.		**Outside Shutter** : - Powder coated Aluminum style and rail shutter Fully glazed (8mm SGU)
Kitchen	WF-P1 (Above Tile Dado UP TO Ceiling)				WF-T1 (Dado up to lintel level)	FF-K												CF - MT				**4) Balcony Doors :** Double Door-Aluminium Frame one shutter with SS fly mesh		
Toilets					WF-T1 (Dado up to lintel level)					FF-AT								CF - MT				**Toilet Doors:**		
Store/General Store	WF-P1					FF-K									CF -P1							**Room side Door**: - 35mm thk flush commercial door finish with both side 1mm thk laminate and edges finished with 25 mm 2nd class teak wood lipping with polish finish.		
Pantry	WF-P1 (above tile Dado up to ceiling level)				WF-T1 (Dado up to lintel level)					FF-K								CF - MT						
Suite Room			WF-P5					FF-VT									CF-GYP+C							
Guest Rooms			WF-P5					FF-VT									CF-GYP+C							
Dresser			WF-P5					FF-VT									CF-GYP+C							
Toilets					WF-T1 (up to lintel level					FF-AT								CF - MT						
Toilets					WF-T1 (up to lintel level					FF-AT								CF - MT						
Toilets					WF-T1 (up to lintel level					FF-AT								CF - MT						
CIRCULATION AND SUPPORT SERVICES																								
Staircase			WF-P5									FF-G			CF -P1									
Ramps											FF-CT													
Lift Lobby (cladding up to 2400mm is granite)			WF-P5									FF-G					CF-GYP+C							
Corridor			WF-P5									FF-G					CF-GYP+C							
Electrical Rooms	WF-P1					FF-K									CF -P1									
Balcony		WF-P4							FF-AVT						CF -P1									

Railing		
Ramps	Stainless Steel Railing (Both Baluster and hand Rail)	Stainless steel Baluster and Handrail
Staircase	Stainless Steel Railing (Both Baluster and hand Rail)	Stainless steel Baluster and Handrail
Miscellaneous Items		
Window Covering -Venatian Blind (of approved sample	All Guest rooms, suite rooms & dining	
Wardrobe	All Guest Rooms including Suites - Wardrobes to be 2100mm ht and 600mm deep and length as per drawing and hanger rod. Complete in all respect. 19mm thk Board finished with 1mm thk laminate on back, sides, base and top with shelves and shutter. 25mm thk Shutter finished with laminate both side 1mm thk with Stainless Steel locks and Handle (as per approved sample) and all inside surface and shelves finished with white paint	
Cabinet/Cupboard -Office, Kitchen Full Ht Storage, Over Head and low ht units	19mm thk board finished with all sides 1mm thk with shelves with Stainless Steel locks and Handles (as per approved sample) Complete all respect	
Counters	Bathroom Counters- 50mm thk RCC cantilevered slab counter finished with 19mm thk Granite top and 100mm facia	
	Kitchen Counters- 50mm thk RCC counter top support with brick base finished with tiles and counter top and 100mm thk facia in 19mm thk Granite with 19mmthk BWP commercial board shutters laminate finish with BWP board shelves, All inside finished with paint	
Toilet Accessories (All in Stainless Steel) (As per approved sample)	Soap Dispenser, Towel Rod, Towel Ring, Health Faucet, Ablution Tap, Basin Mixer, Shower, Drain, Angle valves, P-Trap, Concealed Cistern with Flush valves, Diverter Mixer Tap, Grab Rail (for Patient Room toilets and Handicap toilets)	
Wash basin Mirror In Toilets	6mm thk Clear looking Mirror with 12mm thk BWP ply paint finish fixed SS flat button studs	
Toilet Fittings	WC to be wall mounted, Washbasin, Urinal of approved design and make are to be provided.	

STAFF & NURSE APARTMENT APARTMENT FINISHING SCHEDULE

DESCRIPTIONS	WALL FINISHES			FLOOR FINISHES / 150MM SKRITING SAME AS FLOORING							CEILING FINISHES	Door & Window Frames, Shutters and Hardware Fittings			
	WF-P1(Acrylic Washabvle Distemper)	WF-G	WF-T1	FF-K	FF-K1	FF-VT	FF-AVT	FF-AT	FF-CT	FF-G	CF -P1	**Main Entrance/ Balcony Door Frame**	Powder coated Aluminium extruded/ tubular section must have double rebates for fixing of mosquito proof SS Wire Mesh shutters	**Hardware & Fittings for Doors**	Mortise Lock cum handle/ Sliding door bolts, two tower bolts (250x10mm) and handles (125mm) of SS grade 316 of approved make
Bed Room	WF-P1(Acrylic Washabvle Distemper)					FF-VT					CF -P1	**Internal Door Frame**	Powder coated Aluminium extruded/ tubular section	**Hardware & Fittings for Windows**	Two tower bolts (150x10mm) and handles (125mm) of Aluminium powder coated of approved make.
Living/Dining Room	WF-P1(Acrylic Washabvle					FF-VT					CF -P1	**Window Frame**	Powder coated Aluminium extruded/ tubular section must have double rebates for fixing of mosquito proof SS Wire Mesh	**Note:-** **• Aluminium Sections for Door / Windows to be Powder Coated (min 50 micron) as per CPWD Specification** **• Rubberised door flashing at the bottom rails of all external doors shall be provided for protection from insects &**	
Kitchen	WF-P1 (Above beam bottom lvl.)		WF-T1 (dado up-to Beam bottom level)				FF-AVT				CF -P1	**Toilet Door Frame**	Powder coated Aluminium extruded/ tubular section		
Toilets	WF-P1 (Above lintel lvl.)		WF-T1 (up to lintel)					FF-AT			CF -P1	**Main Entrance/ Balcony-shutter**	Double shutters One of MS Box frame shutter (Powder Coated) with SS Wire Mesh (SS grade-304) & MS Grill & other 35mm thick laminated Flush (Factory Pressed)		
Staircase	WF-P1(Acrylic Washabvle Distemper)			FF-K (landing)	FF-K						CF -P1	**Room-shutters**	35mm thick Flush door Shutters (Factory Pressed)		
Lift Lobby	WF-P1(Acrylic Washabvle Distemper)	WF-G(cladding up to 2400mm level)								FF-G	CF -P1	**Toilets**	35 mm thick both side laminated Factory Pressed Flush shutters (one side decorative & other side balancing)		
Lobby	WF-P1(Acrylic Washabvle Distemper)									FF-G	CF -P1	**Kitchen doors**	35mm thick shutter having 12mm thick pre-laminated (one side decorative & other side balancing) particle board panel at the bottom part and stainless steel wire mesh at upper part		
Corridor	WF-P1(Acrylic Washabvle Distemper)			FF-K							CF -P1	**Window Shutter**	Double shutter with Aluminium powder coated security powder coated grill between both shutters fixed on frame. One: - Aluminum frame with stainless steel fly mesh. Other Shutter : - Aluminum Glazed Shutter		
Electrical room	WF-P1(Acrylic Washabvle Distemper)			FF-K							CF -P1	**Note: TO BE READ WITH SCALE OF AMENITIES FOR CIVIL WORKS GIVEN IN DBR**			
Balcony (150 high skirting + 1050mm high railing)								FF-AT			CF -P1				
Railing															
Staircase	Stainless steel Baluster and Handrail														
Miscellaneous Items															
Railing															
Ramps	Stainless steel Baluster and Handrail														
Staircase	Stainless steel Baluster and Handrail														
Fire Staircase	Stainless steel Baluster and Handrail														
Miscellaneous Items															
curtain rods with required accessaries of SS grade 316.	In all windows/doors in all rooms except kitchen & toilets.														
Wardrobe /Kitchen Cabinet	As per scale of amenities given in DBR														
Toilet Accessories	As per scale of amenities given in DBR														
Note:Refer Scale of amenities given in Design Basis Report															

RESIDENT DOCTOR APARTMENT FINISHING SCHEDULE

DESCRIPTIONS	WALL FINISHES			FLOOR FINISHES / 150MM SKRITING SAME AS FLOORING								CEILING FINISHES	Door & Window Frames, Shutters and Hardware Fittings				
	WF-P1	WF-G	WF-T1	FF-K	FF-K1	FF-VT	FF-AVT	FF-AT	FF-CT	FF-G	FF-C	CF -P1	**External Frame :**	**Main Entrance/ Balcony Door Frame**	Powder coated Aluminium extruded/ tubular section must have double rebates for fixing of mosquito proof SS Wire Mesh shutters	**Hardware & Fittings for Doors**	Mortise Lock cum handle/ Sliding door bolts, two tower bolts (250x10mm) and handles (125mm) of SS grade 316 of approved make
Bed Room	WF-P1(Acrylic Washable Distemper)					FF-VT						CF -P1	**Internal frame :-**	**Internal Door Frame**	Powder coated Aluminium extruded/ tubular section	**Hardware & Fittings for Windows**	Two tower bolts (150x10mm) and handles (125mm) of Aluminium powder coated of approved make.
Living/Dining Room	WF-P1(Acrylic Washabvle					FF-VT						CF -P1	**Room doors shutter:**	**Window Frame**	Powder coated Aluminium extruded/ tubular section must have double rebates for fixing of mosquito proof SS Wire	**Note:-**	
Kitchen	WF-P1 (Above beam bottom lvl.)		WF-T1 (dado up-to Beam bottom level)				FF-AVT					CF -P1	**Toilets doors shutter:**	**Toilet Door Frame**	Powder coated Aluminium extruded/ tubular section	**• Aluminium Sections for Door / Windows to be Powder Coated (min 50 micron) as per CPWD Specification**	
Toilets	WF-P1 (Above lintel lvl.)		WF-T1 (up to lintel)					FF-AT				CF -P1	**Main door and balcony door shutter :**	**Main Entrance/ Balcony-shutter**	Double shutters One of MS Box frame shutter (Powder Coated) with SS Wire Mesh (SS grade-304) & MS Grill & other 35mm thick laminated Flush (Factory Pressed)	**• Rubberised door flashing at the bottom rails of all external doors shall be provided for protection from insects &**	
Staircase	WF-P1(Acrylic Washabvle Distemper)			FF-K (landing)	FF-K							CF -P1		**Room-shutters**	35mm thick Flush door Shutters (Factory Pressed)		
Lift Lobby	WF-P1(Acrylic Washabvle Distemper)	WF-G(cladding up to 2400mm level)								FF-G		CF -P1		**Toilets**	35 mm thick both side laminated Factory Pressed Flush shutters (one side decorative & other side balancing)		
Lobby	WF-P1(Acrylic Washabvle Distemper)									FF-G		CF -P1		**Kitchen doors**	35mm thick shutter having 12mm thick pre-laminated (one side decorative & other side balancing) particle board panel at the bottom part and stainless steel wire mesh at upper part		
Corridor	WF-P1(Acrylic Washabvle Distemper)			FF-K								CF -P1		**Window Shutter**	Double shutter with Aluminium powder coated security powder coated grill between both shutters fixed on frame. One: - Aluminum frame with stainless steel fly mesh. Other Shutter : - Aluminum Glazed Shutter		
Electrical room	WF-P1			FF-K								CF -P1					
Balcony (150 high skirting + 1050mm high railing)								FF-AT				CF -P1					
Railing																	
Staircase	Stainless steel Baluster and Handrail																
Miscellaneous Items																	
Railing																	
Ramps	Stainless steel Baluster and Handrail																
Staircase	Stainless steel Baluster and Handrail																
Fire Staircase	Stainless steel Baluster and Handrail																
Miscellaneous Items																	
curtain rods with required accessaries of SS grade 316.	In all windows/doors in all rooms except kitchen & toilets.																
Wardrobe /Kitchen Cabinet	As per scale of amenities given in DBR																
Toilet Accessories	As per scale of amenities given in DBR																
Note:Refer Scale of amenities given in Design Basis Report																	

MEDICAL SUPERINTENDENT APARTMENT FINISHING SCHEDULE

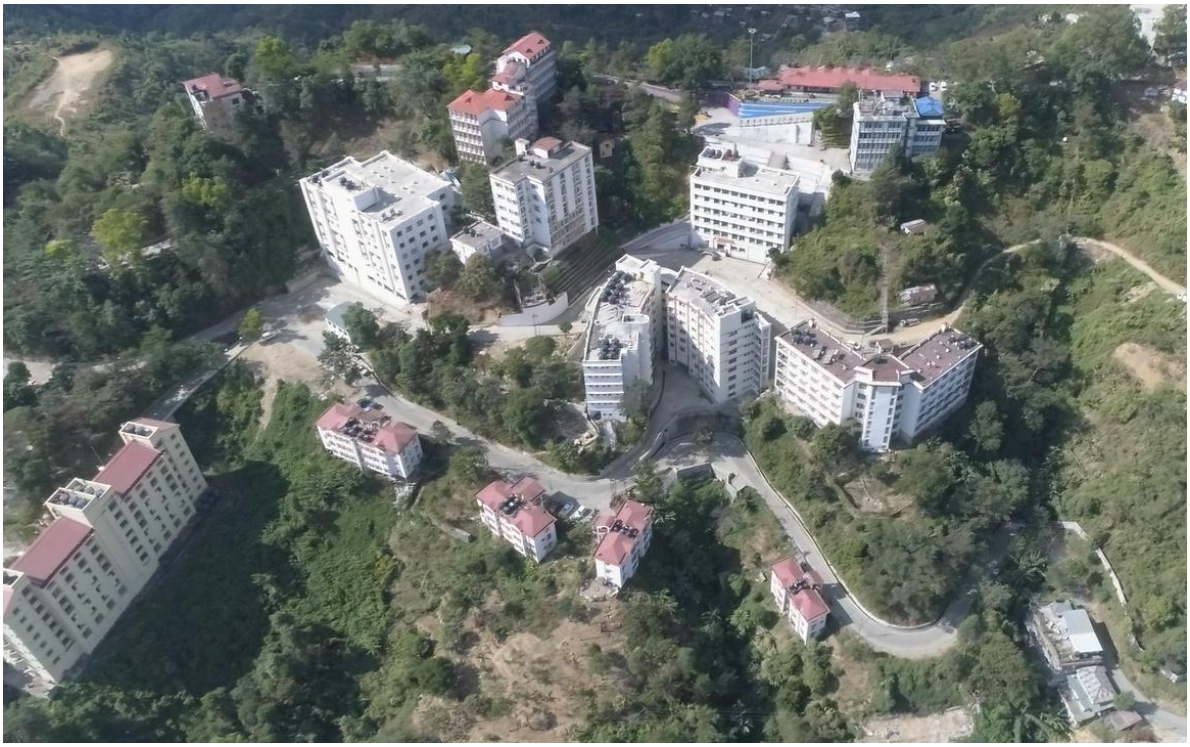
DESCRIPTIONS	WALL FINISHES			FLOOR FINISHES / 150MM SKRITING SAME AS FLOORING					CEILING FINISHES	Door & Window Frames, Shutters and Hardware Fittings			
	WF-P1	WF-P2	WF-T1	FF-K	FF-K1	FF-VT	FF-AVT	FF-AT	CF -P1(Acrylic Washable Distemper)	Main Entrance/ Balcony Door Frame	Powder coated Aluminium extruded/ tubular section must have double rebates for fixing of mosquito proof SS Wire Mesh shutters	**Hardware & Fittings for Doors**	Mortise Lock cum handle/ Sliding door bolts, two tower bolts (250x10mm) and handles (125mm) of SS grade 316 of approved make
Bed Room/Dress		WF-P2				FF-VT (In Master Bedroom-Laminate Wooden Flooring)			CF -P1(Acrylic Washable Distemper)	Internal Door Frame	Powder coated Aluminium extruded/ tubular section	**Hardware & Fittings for Windows**	Two tower bolts (150x10mm) and handles (125mm) of Aluminium powder coated of approved make.
Living/Dining Room		WF-P2				FF-VT			CF -P1(Acrylic Washable Distemper)	Window Frame	Powder coated Aluminium extruded/ tubular section must have double rebates for fixing of mosquito proof SS Wire Mesh shutters	**Note:-** **• Aluminium Sections for Door / Windows to be Powder Coated (min 50 micron) as per CPWD Specification** **• Rubberised door flashing at the bottom rails of all external doors shall be provided for protection from insects & rainwater etc.**	
Kitchen	WF-P1(Acrylic Washable Distemper)		WF-T1 (dado up-to Beam Bottom level)				FF-AVT		CF -P1(Acrylic Washable Distemper)	Toilet Door Frame	Powder coated Aluminium extruded/ tubular section		
Toilets	WF-P1(Acrylic Washable Distemper)		WF-T1 (up to lintel level)					FF-AT	CF -P1(Acrylic Washable Distemper)	Main Entrance/ Balcony-shutter	Main Door: Safety door in stainless frame with mosquito proof SS 304 grade wire mesh and SS fittings Room side Door: - 35mm thick 2nd class teak wood framed panelled with decorative veneered both side with melamine polish finish		
Staircase	WF-P1(Acrylic Washable Distemper)								CF -P1(Acrylic Washable Distemper)	Room-shutters	35mm thick 2nd class teakwood styles & rails paneled of 12 mm thick both side natural wood veneer finish paneled/ glazed paneled shutter with 55 mm thick float glass panes and finished in melamine polish.		
Varandah	WF-P2								CF -P1(Acrylic Washable Distemper)	Toilets	35 mm thick both side laminated Factory Pressed Flush shutters (one side decorative & other side balancing)		
Servant's room	WF-P1					FF-VT			CF -P1(Acrylic Washable Distemper)	Kitchen doors	35mm thick shutter having 12mm thick pre-laminated(both side decorative) particle board panel at the bottom part and stainless steel wire mesh at upper part		
Balcony (150 high skirting + 1050mm high railing)								FF-AT	CF -P1(Acrylic Washable Distemper)	Window Shutter	Double shutter with SS grill between both shutters. One: - 2nd class teakwood framed glazed panel and other with SS wire mesh Glazed/paneled shutter fixed with wooden beading & melamine polish finish		

Railing	
Staircase	Stainless steel B¿ Vitrified Tiles cladding/ Skirting
Miscellaneous Items	
Railing	
Ramps	Stainless steel Baluster and Handrail
Staircase	Stainless steel Baluster and Handrail
Fire Staircase	Stainless steel Baluster and Handrail
Miscellaneous Items	
curtain rods with required accessaries of SS grade 316.	In all windows/doors in all rooms except kitchen & toilets.
Wardrobe /Kitchen Cabinet	As per scale of amenities given in DBR
Toilet Accessories	As per scale of amenities given in DBR
Note:Refer Scale of amenities given in Design Basis Report	

			Gas Outlet Point (Nos)								Vacuum Units			Bed Head Panel	Alarm Panels					AVSU				
FLOOR	LOCATION	BEDS	OXYGEN	MEDICAL AIR 4 BAR	SURGICAL AIR 7 BAR	VACUUM	N2O	AGSS	CO2	OXYGEN FLOW METER	WARD VACUUM UNIT 1000ML JAR WITH METAL BASKET	WARD VACUUM UNIT Low Flow 1000ML JAR WITH METAL BASKET	THEATRE HIGH FLOW VACUUM UNIT WITH 2 Nos. 4000ML JAR & one ragulator on trolley mounted	Bed head panel	Alarm Panel - 2 Gas	Alarm Panel - 3 Gas	Alarm Panel - 4 Gas	Alarm Panel - 5 Gas	Alarm Panel - 6 Gas	AVSU - 2 Gas	AVSU - 3 Gas	AVSU - 4 Gas	AVSU - 5 Gas	AVSU - 6 Gas
Level -01	Gas Manifold		1	1	1	1	1		1															
	Minor OT	1	2	2		2	1						1	1			1					1		
	Triage /Resuscitation	5	5	5		5				5		5				1					1			
	ECG	1	1			1				1		1												
Level -02	CT	1	2	1		2	1			1		1		1										
	MRI	1	2	1		2	1			1		1		1										
	X Ray	2	2			2				2		2					1					1		
	USG	1	1			1				1		1												
	Endoscopy	1	2	1		2	1			1		1		1										
	Treatment Room	3	3			3				3		3			1					1				
	Procedure Room	2	2			2				2		2												
Level -03	Surgery Ward-Male	16	16	4		16				16		16				1					1			
	Surgery Post operative ward - Male	5	5	1		5				5		5												
	Surgery Post operative	5	5	5		5				5		5				1					1			
	General Ward	4	4			4				4		4				1					1			
	Isolation Ward	4	8	4		8				4		4		4										
	Medicine Ward	8	8			8				8		8				1					1			
	Surgery Post operative-Female	4	4	1		4				4		4												
	Surgery Post operative ward Female -5 bed	5	5	1		5				5		5				1					1			
	Surgery Ward - female - 5 bed	8	8	2		8				8		8												
Level -04	Labour Complex -4 bed	4	8	4		8				4		4		4		1					1			
	New Born Ward-	3	3	3		3				3		3												
	Paeditatric Ward	3	3			3				3		3				1					1			
	Gneral Ward-	8	8			8				8		8												
	Labor Room	5	10	5		10				5		5				1					1			
	Antenatal Ward-5 bed	5	5			5				5		5				1					1			
	ICU-	5	10	10		10				5		5		5		1					1			
	Pre-Natal	3	3			3				3		3				1					1			
	Post Natal	3	3	3		3				3		3		3										
	Pre-OP	5	5	5		5				5		5				1					1			
	Post _OP	5	10	10		10				5		5		5										
	OT	3	6	6	3	6	6	3	3				3	3					3					3

Vol.-5: Technical Specifications

UP-GRADATION AND DEVELOPMENT OF REGIONAL INSTITUTE OF PARAMEDICAL & NURSING SCIENCES,AIZAWL, MIZORAM



CLIENT
Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram
(Ministry of Health and Family Welfare, Govt. of India)

PROJECT CONSULTANT
HLL Lifecare Limited
(A Government of India Enterprise)

HLL Lifecare Ltd. (HLL)

(A Govt. of India Enterprise)

on behalf of

Regional Institute of Paramedical & Nursing Sciences, (RIPANS) Aizawl, Mizoram

Invites

e-Tender

For

Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram

on EPC Basis

Tender No. HLL/RIPANS-Aizawl/2019

Volume - 5

TECHNICAL SPECIFICATIONS

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Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram on EPC Basis

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TECHNICAL SPECIFICATIONS

Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram

on EPC Basis

TECHNICAL SPECIFICATIONS (GENERAL)

CHAPTER A

BRIEF OF REQUIREMENT OF THE WORK:

1. Introduction:

The scope of work relates to Up-Gradation and Development of Regional Institute of Paramedical & Nursing Sciences, Aizawl, Mizoram on EPC Basis. The work is to be executed Design, Engineering, Procurement & Construction (EPC) basis as laid down in the Site Plan, Concept plans , Design Basis Report and tender drawings including Operation & Maintenance of buildings/services for 3 years after completion and handing over of complete project.

The scope of work shall also include Electrical works, Mechanical works, Electronic works, Plumbing, Sanitary, Sewerage, Storm water drainage, & Fire-Fighting works etc. including maintenance during defect liability period including & preparation of all detailed shop drawings, obtaining approval from all local authorities, electrical inspector, water, sewer, drainage, electricity connection from local bodies, permission / approval for tree replantation etc. to be executed as integral part of the project. As CLIENT/ HLL aims at getting GRIHA 3-Star rating for the building, prospective bidders are required to provide adequate documentation & all other requirements relevant to enable CLIENT/HLL in achieving these objectives as referred above. The following are the salient features of the Works:

a. Foundations & other works like underground water tanks.
b. Super structure
c. Water proofing treatment works
d. Aluminum door and windows, aluminum partition etc.
e. Structural glazing work.
f. Anti-termite chemical treatment
g. Internal and External water supply, Sewerage, Storm water drainage
h. Infrastructure Development i.e. Roads, Parking, Pathways etc.
i. Electrical Installation (Internal & External)
j. Fire Fighting System
k. HT & LT Installation, Substation, DG Sets
l. HVAC & BMS
m. Lifts
n. LV Systems like Fire Alarm, PA, CCTV, IPABX/Telephone, LAN Systems etc.
o. Nurse Call System
p. WTP, ETP, STP, R.O System
q. Solar PV, Solar Street Light & Solar Hot Water Systems
r. Signage
s. Landscape & Horticulture Works, Hard Landscaping in Courtyards etc.

2. General

i. The work shall in general conform to the **Latest CPWD Specifications** (corrected up to the last date of submission/uploading of bid) as mentioned in Schedule 'F' of the General Conditions of

Contract (GCC). Work under this Contract shall consist of furnishing all labour, materials, equipment, tools & plants and appliances necessary and required.

ii. These Technical Specifications are to be read with the Technical Specifications mentioned in Schedule –F of the General Conditions of Contract. In case of any discrepancy, these technical specifications shall prevail.

iii. The Contractor shall conduct his work, so as not to interfere with or hinder the progress or completion of the work being performed by other Contractor(s) or by the Engineer-in-Charge and shall as far as possible arrange his work and shall place and dispose of the materials being used or removed, so as not to interfere with the operations of other Contractor simultaneously working or he shall arrange his work with that of the others in an acceptable and coordinated manner and shall perform it in proper sequence to the complete satisfaction of others,

iv. Regarding testing of civil & electrical & other materials, the testing of materials shall be conducted in Govt. Laboratory/ Govt. Engineering Colleges/ IITs/ NITs or from the laboratory approved by Engineer-in-charge. The charges of testing of materials in approved laboratory shall be borne by the Contractor.

v. No payment shall be made for any damage caused by rain, snowfall, flood or any other natural calamity, whatsoever during the execution of the work. The Contractor shall be fully responsible for any damage to the govt. property and work for which the payment has been advanced to him under the contract and he shall make good the same at his risk and cost. The Contractor shall be fully responsible for safety and security of his material, T&P, Machinery brought to the site by him.

vi. The Contractor shall comply with the safety procedures, norms and guidelines (as applicable) as outlined in the document Part 7 Constructional practices and safety- 2016, National Building code of India, Bureau of Indian Standards. A copy of all pertinent regulations and notices concerning accidents, injury and first-aid shall be prominently exhibited at the work site. Depending upon the scope & nature of work, a person qualified in first-aid shall be available at work site to render and direct first-aid to causalities. A telephone may be provided to first-aid assistant with telephone numbers of the hospitals displayed. Complete reports of all accidents and action taken thereon shall be forwarded to the competent authorities

vii. The Contractor shall ensure the following activities for construction workers safety, among other measures:

a. Guarding all parts of dangerous machinery.

b. Precautionary signs for working on machinery

c. Maintaining hoists and lifts, lifting machines, chains, ropes, and other lifting tackles in good condition.

d. Durable and reusable formwork systems to replace timber formwork and ensure that formwork where used is properly maintained.

e. Ensuring that walking surfaces or boards at height are of sound construction and are provided with safety rails or belts.

f. Provide protective equipment; helmets etc.

g. Provide measures to prevent fires. Fire extinguishers and buckets of sand to be provided in the fire-prone area and elsewhere.

h. Provide sufficient and suitable light for working during night time.

viii. The Contractor shall provide for adequate number of garbage bins around the construction site and the workers facilities and will be responsible for the proper utilization of these bins for any solid waste generated during the construction. The Contractor shall ensure that the site and the workers facilities are kept litter free. Separate bins should be provided for plastic, glass, metal, biological and paper waste and labeled in both Hindi and English with suitable symbols.

ix. Contractor should spray curing water on concrete structure and shall not allow free flow of water. Concrete structures should be kept covered with thick cloth/gunny bags and water should be sprayed on them. Contractor shall do water ponding on all sunken slabs using cement and sand mortar.

x. The Contractor shall remove from site all rubbish and debris generated by the Works and keep Works clean and tidy throughout the Contract Period. All the serviceable and non-serviceable (malba) material shall be segregated and stored separately. Malba, rubbish & other waste materials shall be disposed off as directed/ approved by Engineer in Charge and necessary documentations shall be submitted to Engineer-in-charge. In this regard directives of National Green Tribunal or any other authority shall be a binding on Contractor.

xi. Approved Makes:

Specification/brands names of materials to be used as per the scope of work are listed in the bid documents. The efforts should be made by the Contractor to use indigenous products. The Contractor should also consider the availability of spares parts/ components for maintenance purposes while proposing any brand/ manufacturer. The materials of any other brand/manufacturer may be proposed for use by the Contractor in case the brands specified below are not available in the market and/or Contractor intends to use some other brand better than the brands mentioned in this list. The alternate brand can be used only after the approval of Engineer-in-Charge. The list of approved makes is appended to this document.

xii. Method Statement:

The Contractor shall submit a 'Methods statement' for each important activity for the approval of the Engineer-in-charge soon after the award of work to him. The 'Methods statement' is a statement by which the construction procedures for any activity of construction are formulated and stated in chronological order. The 'Methods statement', should have a description of the item with elaborate procedures in steps to implement the same, the specifications of the materials involved, their testing and acceptance criteria, equipment to be used, Precautions to be taken, etc.

3. Setting Out

i. The Contractor shall carry out survey of the whole work area, setting out the layout of building in consultation with the Engineer -in-Charge & proceed further. Any discrepancy between the Engineer-in-charge, architectural drawings and actual layout at site shall be brought to the notice of the Engineer -in-charge. It shall be responsibility of the Contractor to ensure correct setting out of alignment. Total station survey instruments only shall be used for layout, fixing boundaries, and centre lines, etc.

ii. The Contractor shall establish, maintain and assume responsibility for grades, lines, levels and benchmarks. He shall report any errors or inconsistencies regarding grades, lines, levels, dimensions etc. to the Engineer -in-Charge before commencing work. Commencement of work shall be regarded as the Contractor's acceptance of such grades, lines, levels, and dimensions and no claim shall be entertained at a later date for any errors found.

iii. If at any time, any error appears due to grades, lines, levels and benchmarks during the progress of the work, the Contractor shall, rectify such error, if so required, to the satisfaction of the Engineer -in-Charge.

iv. Though the site levels are indicated in the drawings the Contractor shall ascertain and confirm the site levels with respect to benchmark from the concerned authorities. The Contractor shall protect and maintain temporary/ permanent benchmarks at the site of work throughout the execution of work. These benchmarks shall be got checked by the Engineer-in-Charge or his authorized representatives. The work at different stages shall be checked with reference to bench marks maintained for the said purpose.

v. The approval by the Engineer-in-Charge, of the setting out by the Contractor, shall not relieve the Contractor of any of his responsibilities and obligation to rectify the errors/ defects, if any, which may be found at any stage during the progress of the work or after the completion of the work.

vi. The Contractor shall be entirely and exclusively responsible for the horizontal, vertical and other alignments, the level and correctness of every part of the work and shall rectify effectively any errors or imperfections therein. Such rectifications shall be carried out by the Contractor to the entire satisfaction of the Engineer - in-Charge.

vii. The contractor(s) shall carry out soil/geotechnical investigation and should satisfy himself about complete characteristics of soil and other parameters at site. The details w.r.t soil strata, bearing capacity etc. given in the DBR are indicative and no claim on the alleged inadequacy or

incorrectness of the soil data supplied by the department shall be entertained. The intending Contractor shall conduct soil investigations on their own, and shall be responsible for the adequacy of the design.

4. Coordinated Drawings

i. Before taking up the work, the contractor shall prepare shop drawings for the works listed below for various civil and electrical & other services showing details of lay out in plan including sections & elevations & large scale details and contractor shall plan and mobilize his resources as per these drawings and as per actual site conditions to facilitate convenient execution, installation as well as maintenance of these items.

ii. Shop Drawings:

The scope of work, technical specifications and drawings together shall be considered as a tender requirement and the work shall be carried out as per Good for Construction (GFC) drawings, prepared & submitted by the Contractor and duly approved by Engineer-in-charge. The contractor shall study the GFC drawings and taking into account actual site conditions and selected material and requirements, shall prepare shop drawings as fully coordinated drawings. Such drawings shall be prepared for the works, not limited to the following works:

a. Aluminium work & Structural glazing.
b. Expansion joint work
c. Stone cladding work
d. Suspended ceiling work, coordinated with all ceiling related services.
e. Marble, granite, vitreous, ceramic, tile work
f. All Electrical work
g. All Sanitary work
h. All HVAC work
i. Lifts
j. Horticulture
k. Electric Sub-station
l. DG sets
m. STP & ETP
n. CCTV & Access Control
o. Audio Visual
p. Boilers & Pumps
q. Solar panels.
r. Signages

The shop drawings shall be prepared and submitted for approval well in advance to achieve the milestones provided.

iii. Within the time frame agreed with the Engineer-in-charge, the contractor shall prepare shop drawings using latest version of Auto CAD. Shop drawings shall show all layouts, details in plans & sections showing all connections, junctions, bends, supports, clearances. Fixing arrangements with dimensions room, etc. shall be prepared by the contractor on Auto-CAD based on the architectural drawings and site measurements. All measurable items quantities shall be mentioned on each shop drawing being submitted for approval by the contractor. 3 sets of shop drawings (soft copy also) shall be submitted for approval and Seven sets of final shop drawings after approval by Engineer-in-charge shall be submitted by the contractor along with the soft copy. The shop drawings shall be prepared as per agreed schedule.

iv. Technical submittals of manufacturer's catalogues and technical data shall be submitted for approval. The contractor shall designate an Engineer responsible for issue and preparation of shop drawings and control of GFC drawings.

5. Scale of Amenities:-

The doors and windows/flooring shall be provided as per the requirements indicated in the finishing schedules/tender drawings/ MOUD Norms for residential buildings and technical specifications. In case of variance, the decision of Engineer incharge shall prevail.

A Chart Listing various Scale of Amenities to be provided in Residential Units shall be as given in the Vol-4, DBR, of tender document.

CHAPTER B

TECHNICAL SPECIFICATIONS- CIVIL WORKS

1 GENERAL

1.1. The work shall be carried out in accordance with the Design Basis Report, Architectural drawings and structural drawings (proof checked/vetted by the approved Institute) and approved by the Engineer-in-Charge. The Technical Specifications are to be read with and in general conforming to the Latest CPWD Specifications.

1.2. Contractor(s) shall provide permanent bench marks, flag tops and other reference points for the proper execution of work and these shall be preserved till the end of the work. All such reference points shall be in relation to the levels and locations, given in the Architectural and plumbing drawings. On completion of work, the Contractor(s) shall submit required number of prints of "as built" drawings to the Engineer-in-Charge.

1.3. Before commencement of any item of work the Contractor shall correlate all the relevant architectural and structural drawings, and specifications etc. and satisfy himself that the information available is complete and unambiguous. The Contractor alone shall be responsible for any loss or damage occurring by the commencement of work based on any erroneous and or incomplete information and no claim whatsoever shall be entertained on this account.

1.4. The Contractor (s) should engage approved, licensed plumbers for the work and get the materials (fixtures/fittings) tested, by the municipal Body /Corporation authorities wherever required, at his own cost. The Contractor(s) shall submit for the approval of the Engineer-in-Charge, the name of the plumbing Contractor proposed to be engaged by him.

1.5. The Contractor shall give performance test of the entire installation(s) as per the specifications in the presence of the Engineer-in-charge or his authorized representative before the work is finally accepted and nothing extra what-so-ever shall be payable to the Contractor for the test.

1.6. The work of services will be executed simultaneously. The Contractor shall minimize the scope of making recesses, holes, opening etc. as the same shall be planned in advance and necessary grooves/niches shall be provided in shuttering of RCC.

1.7. Sample of building materials, fittings and other articles required for execution of work shall be got approved from the Engineer-in-Charge before use in the work. The quality of samples brought by the Contractor shall be judged by standards laid down in the relevant CPWD/ BIS specifications. All materials and articles brought by the Contractor to the site for use shall conform to the samples approved by the Engineer-in-Charge which shall be preserved till the completion of the work.

1.8. BIS marked materials except otherwise specified shall be subjected to quality test at the discretion of the Engineer-in-Charge besides testing of other materials as per the specifications described for the item/material. Wherever BIS marked materials are brought to the site of work, the Contractor shall, if required, by the Engineer-in-Charge, furnish manufacturer's test certificate or test certificate from approved testing laboratory to establish that the material / procured by the Contractor for incorporation in the work satisfies the provisions of specifications / BIS codes relevant to the material and / or the work done.

1.9. The Contractor shall procure the required materials in advance so that there is sufficient time to testing of the materials and clearance of the same before use in the work. The Contractor shall provide at his own cost suitable weighing and measuring arrangements at site for checking the weight / dimensions as may be necessary for execution of work.

1.10. Contractor shall submit minimum "Quality Assurance" plan (in conformity to Clause 1.7 of SCC, Vol-4) which shall consist of:

a. Lot size, number of required tests and frequency of testing. While deciding these criteria CPWD Specifications & provisions of BIS Code and standard practices may be referred. The mandatory test shall be in conformity with the requirements details

in the latest CPWD specifications. For testing of other materials/work, the requirements as per provisions of BIS Code and standard practices shall be applicable.

b. It should clearly indicate the Machinery and other Tool & Plants required to be deployed at site by the Contractor. Entire Machinery and T&P may not be required at the start of work, therefore, a proper time schedule by which each Machinery & T&P is to be brought at site should also be indicated.

c. The Contractor shall maintain record of Receipt of Materials, testing of the same & Maintenance of Register of Tests.

d. All the registers of tests carried out at Construction Site or in outside laboratories shall be maintained by the Contractor, which may be inspected by Engineer-in-charge or his/her designee at any point of time.

e. The Contractor shall allow access to Third Party Quality Assurance Agency (TPQAA) engaged by HLL/ Client to have a control on quality and methodology of execution. Requisite number of Samples of materials including Cement Concrete Cubes shall be taken jointly by Contractor, TPQAA and Engineer-in-charge or their authorized representative. All arrangements for transporting and getting them tested shall be made by the Contractor.

f. All the test in field lab setup at Construction Site shall be carried out by the Quality control team to be engaged by the Contractor which can be witnessed by Engineer-in-charge or his/her designee. A daily report of Tests to be conducted on a day shall be submitted to Engineer-in-charge or his authorized representative.

g. All the entries in the registers will be made by the designated Engineering Staff of the Contractor.

h. The Contractor shall be responsible for safe custody of all the test registers.

i. Submission of copy of all test registers, Material at Site Register and hindrance register along with each alternate Running Account Bill and Final Bill shall be mandatory.

j. All material received at site shall be entered in MAS Register and copy of Supply order, MTC & Bill-invoice shall be maintained in order. The MAS Registers including Cement and Steel Registers shall be maintained by a qualified staff of Contractor which shall be inspected by Engineer-in-charge or his authorized representative at any time. The daily report of receipt of material shall be sent to Engineer-in-charge or his authorized representative.

1.11. The Contractor shall ensure that no construction leachate (e.g. cement slurry etc.), is allowed to percolate into the ground. Adequate precautions are to be taken to safeguard against this including, reduction of wasteful curing processes, collection, basic filtering and reuse. The Contractor shall follow requisite measures for collecting drainage water run-off from construction areas and material storage sites and diverting water flow away from such polluted areas. Temporary drainage channels, perimeter dike/swale, etc. shall be constructed to carry the pollutant-laden water directly to the treatment device or facility (municipal sewer line).

2 POUR CARD, CHECK-LIST FOR EXECUTION OF WORK

i. As and when any important item is taken up for execution, the Contractor shall submit the specifications and develop a checklist and Pour card. This sample checklist should be got approved from the Engineer-in-charge and should be used at site. This check list should be shown to the Engineer-in-charge or his authorized representative during inspection. This procedure is to be followed for all hidden items, CC/RCC work, Steel-reinforcement, shuttering, cast-in-situ mosaic flooring, doors & windows, plumbing, including water supply pipe lines, roof treatment, earth filling etc.

ii. The Contractor shall render all help and assistance in documenting the total sequence of this project by way of photography, slides, audio-video recording etc. nothing extra shall be payable to the Contractor on this account.

3 EARTH WORK:

i. For all excavation operations executed manually or by mechanical means, irrespective of the stipulations in the relevant CPWD Specifications or elsewhere in the Contract. the excavated earth shall be put to use in the areas related to the work and thereafter the extra earth shall be used in filling up the low-lying areas of the total plot, at his own cost. If there is any surplus surplus excavated earth thereafter, the same shall be disposed off by the contractor at his own cost to the place as directed by Engineer – in-charge and/or permitted by the local authority after obtaining written permission of the Engineer – in-charge and no payment will be made by the HLL for disposal of this excavated earth.

ii. The Contractor shall, at his own expense and without extra charges, make provision for all shoring, pumping, dredging or bailing out water, encountered from any sources such as rains, floods, springs, subsoil water table being high or due to any other cause whatsoever. The foundation trenches shall be kept free from water while all the works below ground level are in progress without any extra payment.

iii. Filling in plinth shall be in layers and consolidated with water and compacted with pneumatic rammers, to achieve 90% relative density on testing. One test is to be carried out for 1000 sqm. of compacted area.

iv. Handling of C&D Waste :-The debris / building rubbish waste and the like (Construction & Demolition waste commonly known as C & D waste) generated from the work, should be taken out to be disposed it off the campus in a legal and environmental friendly way to the "declared dumping/Land fill sites" where the facility of re-cycling of C&D waste are available. The documentary proof with respect to disposal of all C&D waste generated out of work shall be submitted to Engineer-in-charge on weekly basis.

3.1 Site Clearance:

Before the earth work is started, the area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth up to 30cm measured at a height of one metre above ground level and rubbish removed /disposed off by the contractor at his own cost to the place as directed by Engineer – in-charge and/or permitted by the local authority after obtaining written permission of the Engineer – in-charge and no payment will be made by the HLL for disposal of this rubbish. The roots of trees and saplings shall be removed to a depth of 60cm below ground level or 30 cm below formation level or 15 cm below sub grade level, whichever is lower, and the holes or hollows filled up with the earth, rammed and levelled.

3.2 Anti-termite treatment:

Anti-termite treatment shall be got done through approved specialized agencies only with prior approval of the Engineer-in-charge or his representative. During the execution of work, if any damage shall occur to the treatment already done, either due to rain or any other circumstances, the same shall be rectified and made good to the entire satisfaction of the CLIENT/ HLL or his representative by the contractor at his costs and risks.

The contractor shall submit a guarantee bond for the anti-termite work executed under the contract in the specified format.

4 PLAIN CEMENT CONCRETE AND REINFORCED CEMENT CONCRETE WORK:

4.1 Stone Aggregate:

Stone aggregate used in the work shall be of hard broken stone to be obtained from approved source (Quarries to be approved by the Engineer in charge) and shall conform to relevant provision in the Latest CPWD Specifications for works.

4.2 Sand

Sand to be used for the work shall be of as specified in CPWD Specifications 2009. Sand shall be obtained from the source to be got approved by the Engineer in charge and washed if required, with appropriate equipment to bring down the chemical, inorganic and

organic impurities within the permissible limits as per the direction of the Engineer in charge. The same shall consist of hard siliceous materials.

Note: Where only one variety of sand is available the sand will be sieved for use in finishing work as directed by the Engineer – in – charge in order to obtain smooth surface and nothing extra will be paid on this account.

4.3 Cement

i. The contractor shall procure 43 grade Ordinary Portland cement conforming to IS 8112 / Portland Pozzolana Cement conforming to IS 1489 (Part I) as required in the work, from manufacturers as per list of approved makes or from any other reputed cement manufacturer having a production capacity not less than one million tons per annum, in case the cement is not available from manufacturers as per list of approved makes. The bidders may also submit a list of names of cement manufacturers which they propose to use in the work. The bid accepting authority reserves right to accept or reject name(s) of cement manufacturer(s) which the bidder proposes to use in the work.

ii. The supply of cement shall be taken in 50 kg. bags/silos bearing manufacturer's name and ISI marking. Samples of cement arranged by the Contractor shall be taken by the Engineer-in-charge and got tested in accordance with provisions of relevant BIS codes. In case the test results indicate that the cement arranged by the Contractor does not conform to the relevant BIS codes, the same shall stand rejected, and it shall be removed from the site by the Contractor at his own cost within a week's time of written order from the Engineer- in-charge to do so.Supply of cement shall be taken in 50-kg bags bearing manufacturer's name, or his registered trademarks if any and grade and type of cement as well as ISI marking. The packing of the cement bags shall be as per CPWD specifications 2009.

iii. The cement shall be brought at site in bulk supply of approximately 50 tons or more as decided by the Engineer-in-charge. The cement godown of adequate capacity to store the cement shall be constructed by the Contractor at site of work.

iv. The cement godown shall always be accessible for the Engineer-in-Charge or his representative.

v. The cement shall be got tested by the Engineer-in-charge and shall be used on the work only after satisfactory test results have been received. The Contractor shall supply free of charge the cement required for testing including its transportation cost to testing laboratories. The cost of tests shall be borne by the Contractor/Department in the manner indicated below:

   a. By the Contractor, if the results show that the cement does not conform to relevant BIS codes.

   b. By the Department, if the results show that the cement conforms to relevant BIS codes.

vi. The actual issue and consumption of cement on work shall be regulated and proper accounts maintained as provided in clause 10 of the contract. The theoretical consumption of cement shall be worked out as per procedure prescribed in Clause 42 of the GCC and shall be governed by conditions laid therein. In case the cement consumption is less than theoretical consumption including permissible variation, recovery at the rate so prescribed shall be made. In case of excess consumption, no adjustment shall be made.

vii. The cement brought to the site and the cement remaining unused after completion of the work shall not be removed from site without the written permission of the Engineer-in-charge.

viii. The damaged cement shall be removed from the site immediately by the Contractor on receipt of a notice in writing from the Engineer-in-charge. If he does not do so within 3 days of receipt of such notice, the Engineer-in-charge shall get it removed at the cost of the Contractor.

4.4 Fly-ash

Fly-ash conforming to grade 1 of IS 3812 (Part 1) may be used as part replacement of OPC provided uniform blending with cement is ensured in accordance with clauses 5.2 and

5.2.1 of I.S.456-2000 in the items of BMC. However this shall not override the provisions of the respective items.

4.5 Centering Shuttering and Scaffolding:

All Scaffolding centering for RCC shall be properly designed system and brought to site in sufficient quantity well in advance so that the progress of the work is not hampered for non-availability of the same.

4.6 Reinforcement:

i. The Contractor shall procure TMT bars conforming to IS: 1786 pertaining of Fe500D or Fe 550D Grade from primary steel producers from the list of "Approved make for Civil Works provided in the agreement. The manufacturer has to give a certificate that the material supplied is not a re-rolled product. Relevant vouchers & test certificates will be produced by the contractor. The Contractor shall have to obtain and furnish manufacturer Test Report /test certificates for each dia and each lot Tests to the Engineer-in-charge in respect of all supplies of steel brought by him to the site of work. Re-rolled sections will not be allowed. Reinforcement steel, structural steel shall be stored and stacked in such manner so as to facilitate easy identification, removal etc. The contractor shall take proper care to prevent direct contact between the steel and the ground/ water for which he shall provide necessary arrangement at his own cost including ensuring proper drainage of area to prevent water logging as per direction of the Engineer-in- charge. Steel shall also be protected, by applying a coat of neat cement slurry over the bars for which no extra payment shall be made. Test certificates for each consignment of steel shall be furnished and further tests shall be got carried out from the authorized laboratory as per the directions of Engineer-in-charge, before incorporating the materials in the work

ii. Nothing extra will be paid for "straightening of bars" received from market in coils or with bends. All incidental charges of any kind whatsoever including cartage, storage, safe custody of materials, cutting and wastage etc. shall be borne by the contractor.

iii. The actual average sectional weight for dia up to 10 mm shall be arrived at from one meter long samples (minimum 3 from each dia) taken from each lot of steel. The discretion of the Engineer – in – charge shall be final for the procedure to be followed for determining the average sectional weight of each lot. Quantity of each diameter of steel received at site of work each day will constitute the single lot for this purpose.

iv. The weight of each lot of a particular diameter of 10mm and below shall be reckoned as the weight as per actual issue multiplied by a factor equal to the standard sectional weight of the particular diameter divided by the average sectional weight of the particular dia in a particular lot worked out as per above para. Adjustment for the steel shall be effected on the basis of the weight as modified above .

v. Measurement of all diameters of steel be on linear basis and will be converted into weight on the basis of standard sectional weight coefficients given in relevant CPWD specifications mentioned in schedule 'F' of General Conditions of Contract.

vi. Samples shall also be taken and got tested by the Engineer-in-Charge as per the provisions in this regard in relevant BIS codes. In case the test results indicate that the steel arranged by the Contractor does not conform to the specifications as defined the same shall stand rejected, and it shall be removed from the site of work by the Contractor at his cost within a week time or written orders from the Engineer-in-Charge to do so.

vii. For checking nominal mass, tensile strength, bend test & re-bend test etc. specimen of sufficient length shall be cut from each size of the bar at random at frequency not less than the specified below:

Size of bar	For consignment below 100 tones	For consignment above 100 tonnes
Under 10 mm dia bars	One sample for each 25 tonnes or part thereof	One sample for each 40 tonnes part thereof
10 mm to 16mm dia bars	One sample for each 35 tonnes or part thereof	One sample for each 45 tonnes part thereof

Over 16mm dia bars	One sample for each 45 tonnes or part thereof	One sample for each 50 tonnes part thereof

viii. The Contractor shall supply free of cost the required steel bars for testing. The cost of tests shall be borne by the Contractor.

ix. The actual issue and consumption of steel on work shall be regulated and proper accounts shall be maintained. The theoretical consumption of steel shall be worked out as per procedure prescribed in clause 42 of the GCC and shall be governed by conditions laid therein.

x. Steel brought to site and remaining unused shall not be removed from site without the written permission of Engineer-in-Charge.

xi. Bar Bending Schedule: - Contractor shall prepare bar bending schedules and shall get them approved from the Engineer-in-charge or his authorized representative.

xii. Records of Consumption of Cement & Steel:–

a. For the purpose of keeping a record of cement and steel received at site and consumed in works, the contractor shall maintain a properly bound register in the form approved by the Engineer-in-charge, showing columns like quantity received and used in work and balance in hand etc. The contractor's representative shall sign this register daily.

b. The register of cement & steel shall be kept at site in the safe custody of Engineer-in-charge during progress of the work. This provision will not, however, absolve the contractor from the quality of the final product.

4.7 Concrete Work

All concrete work will be strictly done by automatic computerized batching plant of suitable capacity installed at site or as per approval of HLL / Engineer-in-Charge. No concrete work will be permitted without automatic batching plant unless specifically approved in writing by HLL/ Engineer-in-Charge. All operation required for continuing concreting work at the construction joints for better bond are deemed to be included in the cost and nothing extra shall be payable on this account.

4.8 Transportation, Placing and Compaction of Concrete

i. Transportation of the mix concrete shall be done through transit mixers and concrete pumped through suitable concrete pumps and pipes arrangement and vibrated by vibration machines, materials lifts shall also be provided at site as and where required.

ii. Mixed concrete from the batching plant shall be transported to the point of placement by transit mixers or through concrete pumps or steel closed bottom buckets capable of carrying 6 cum concrete. In case the concrete is proposed to be transported by transit mixer, the mixer speed shall not be less than 4 rev/ min. of the drum nor greater than a speed resulting in a peripheral velocity of the drum as 70 m / minute at its largest diameter. The agitating speed of the agitator shall be not less than 2 rev / min. nor more than 6 rev / min. of the drum. The number of revolutions of the mixing drum or blades at mixing speed shall be between 70 to 100 revolutions for a uniform mix, after all ingredients, have been charged into the drum. Unless tempering water is added, all rotation after 100 revolutions shall be at agitating speed of 2 to 6 rev / min. and the number of such rotations shall not exceed 250. The general construction of transit mixer and other requirements shall conform to IS : 5892.

iii. In case concrete is to be transported by pumping, the conduit shall be primed by pumping a batch of mortar / thick cement slurry through the line to lubricate it. Once the pumping is started, it shall not be interrupted (if at all possible) as concrete standing idle in the line is liable to cause a plug. The operator shall ensure that some concrete is always there in the pump-receiving hopper during operation. The lines shall always be maintained clean and shall be free of dents.

iv. Materials for pumped concrete shall be batched consistently and uniformly. Maximum size of aggregate shall not exceed one-third of the internal diameter of the pipe. Grading of aggregate shall be continuous and shall have sufficient ultra-fine materials (materials

finer than 0.25mm). Proportion of fine aggregates passing through 0.25mm shall be between15 & 30% and that passing through 0.125 mm sieve shall not be less than 5% of the total volume of aggregate. When pumping long distances and through hot weather, set- retarding admixtures may be used. Admixtures to improve workability can be added. Suitability of concrete shall be through pumping shall be verified by trial mixes and by performing pumping tests.

4.9 RCC Work (Concrete Mix Design)

i. The RCC work shall be done with Design Mix Concrete, unless otherwise specified. The RCC shall be as per IS: 4926 and as per CPWD Specification and guide lines. For the nominal mix in RCC, CPWD specification shall be followed. The Design Mix Concrete will be designed based on the principles given in IS: 456, 10262 and SP 23. The contractor shall carry out design mixes for each class of concrete indicating that the concrete ingredients and proportions will result in concrete mix meeting requirements specified. The cement shall be actually weighed as presumption of each bag having 50 kg shall not be allowed. In case of use of admixture, the mix shall be designed with these ingredients as well. The specification as per DBR shall be followed for Design Mix Concrete.

ii. The Engineer-in-Charge will reserve the right to inspect at any stage and reject the concrete if he is not satisfied about quality of product at the user's end.

iii. The Engineer-in-charge reserves the right to exercise control over the: -

   a. Ingredients, water and admixtures purchased, stored and to be used in the concrete including conducting of tests for checking quality of materials, recording of test results and declaring the materials fit or unfit for use in production of mix.

   b. Calibration check of the plant.

   c. Weight and quantity check on the ingredients, water and admixtures added for batch mixing.

   d. Time of mixing of concrete.

   e. Testing of fresh concrete, recordings of results and declaring the mix fit or unfit for use. This will include continuous control on the workability during production and taking corrective action, if required.

iv. For exercising such control, the Engineer-in-charge shall periodically depute his authorized representative at the Batch Mix Plant. It shall be responsibility of the Contractor to ensure that all necessary equipment, manpower & facilities are made available to Engineer-in-Charge and/or his authorized representative at Batch Mix plant.

v. All required relevant records of produced and used concrete shall be made available to the Engineer-in-Charge or his authorized representative. Engineer-in-Charge shall, as required, specify guidelines & additional procedures for quality control & other parameters in respect of materials, production & transportation of concrete mix which shall be binding on the Contractor. Only concrete as approved in design mix by Engineer-in-Charge shall be produced and transported to the site.

4.10 Concrete Batching Plant (Design Mix)

i. The Concrete Batching Plant of suitable capacity to be installed, as per requirement at site, within a period of 30 days from award of work. The contractor shall install batching plants (preferably within the site or 50 meters distance from the site of work) supplying Concrete at site. The batching plant proposed to be engaged by the contractor shall fulfill the following requirements. The Mobile Batching Plant can be used at Site of suitable capacity.

   a. It shall be fully computerized.

   b. Facility to pump concrete upto the highest point of the building.

   c. It should have facility for providing printed advice showing ingredients of concrete carried by each mixer.

   d. It should have sufficient capacity to meet the requirement as per schedule.

ii. Approved admixtures conforming to IS.9103 shall be permitted to be used. The chloride content in the admixture shall satisfy the requirement of BS 5075. The total amount of chloride content in the admixture mixed Concrete shall satisfy the requirement of IS 456-2000.

iii. The concrete mix design with and without admixture will be carried out by the contractor through the Laboratories / Test house as approved by Engineer-in-charge.

iv. The various ingredients for mix design/laboratory tests shall be sent to the lab test house through the Engineer and the sample of such ingredients sent shall be preserved at site by the department till completion of work or change in Design Mix whichever is earlier. The sample shall be taken from the approved materials which are proposed to be used in the work.

v. The batching and mixing plant shall be fully automatic.

vi. The contractor has to arrange to erect batching plant for the design mix concrete on his own.

vii. The concrete shall be transported to the site in specially made Transit Mixers & shall have suitable retarders so that it should not set before placing in position. It should have sufficient flow so that at height the concrete shall be placed by pumping only.

viii. Each Transit Mixer reaching site shall invariably have manufacturer's certificate containing details like truck number Grade of mix, time of leaving the plant, time of reaching a site etc. A copy of the same shall be handed over to E-in–C or his authorized representative.

ix. However samples for testing etc. shall be taken as per the mandatory tests prescribed in latest CPWD specifications.

x. All cubes shall be tested for 7 days and 28 days tests in conformity with the relevant CPWD specifications.

xi. In the items of RCC walls, railings and roofs etc. nothing extra shall be paid for making designs as per patterns given by Engineer-in-charges or for thickness of sections.

xii. The water will be tested with regard to its suitability for use in CC/RCC work and nothing extra will be paid for on this account.

xiii. Proportioning Concrete

xiv. In proportioning cement concrete, the quantity of both cement and aggregates shall be determined by weight. The cement shall be weighed separately from the aggregates. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean and serviceable condition. The amount of mixing water shall be adjusted to compensate for moisture content in both coarse and fine aggregates. The moisture content of aggregates shall be determined in accordance with IS : 2386 (Part III). Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weight of aggregates due to variation in moisture content.

xv. Production of Concrete

The concrete shall be Batching Plant produced in a central batching or Mobile Mini Batching Plant with, computerized printing for contents and admixture dosage. The batching plant shall be fully automatic. Automatic batcher shall be charged by devices which, when actuated by a Single starter switch will automatically start the weighing operation of each material and stop automatically, when the designated weight of each material has been reached. The batching plant shall have automatic arrangement for dispensing the admixture and shall also be capable of discharging water in more than one stage. A print out from the batching plant for every lot shall be submitted. A batching plant essentially shall consist of the following components :Separate storage bins for different sizes of aggregates, silo for cement; and water storage tank.

a. Batching equipment

b. Mixers

c. Control panels

d. Mechanical material feeding and elevating arrangements

e. The Contractor shall arrange for inspection of automatic batching plant within seven days of issue of letter of award to facilitate inspection and approval of same by Engineer-In-Charge. Nothing extra will be paid for this.

xvi. The compartments of storage bins for aggregates shall be approximately of equal size. The cement compartment shall be centrally located in the batching plant. It shall be watertight and provided with necessary air vent, aeration fittings for proper flow of cement & emergency cement cut off gate. The aggregate and sand shall be charged by power operated centrally revolving chute. The entire plant from mixer floor upward shall be enclosed and insulated. The batch bins shall be constructed so as to by self-cleansing during drawdown. The batch bins shall in general conform to the requirements of IS: 4925.

xvii. The batching equipment shall be capable of determining and controlling the prescribed amounts of various constituent materials for concrete accurately i.e. water, cement, sand, individual size of coarse aggregates etc. The accuracy of the measuring devices shall fall within the following limits.

Measurement of Cement	±2% of the quantity of cement in each batch
Measurement of Water	±3% of the quantity of water in each batch
Measurement of Aggregate	±3% of the quantity of aggregate in each batch
Measurement of Admixture	±3% of the quantity of admixture in each batch

xviii. Mixing Concrete

The mixer in the batching plant shall be so arranged that mixing action in the mixers can be observed from the operator's station. The mixer shall be equipped with a mechanically or electrically operated timing, signaling and metering device which will indicate and assure completion of the required mixing period. The mixer shall have all other components as specified in IS: 4925.

4.11 Standard for Acceptance

i. Standard of acceptance shall be same as specified in clause 16 of IS 456-2000.

ii. In order to keep the floor finish as per direction of Engineer-in-charge and as per Architectural drawings and to provide required thickness of the flooring as per specification, the level of top surface of RCC shall be accordingly adjusted at the time of its centering, shuttering and casting.

4.12 Ultrasonic Pulse Velocity Method of Test for RCC

i. The underlying principle of assessing the quality of concrete is that comparatively higher velocities are obtained when the quality of concrete in terms of density, homogeneity and uniformly is good. The consistency of the concrete as regards its general quality gets established. In case of poorer quality lower velocities are obtained. If there are cracks, voids or flaws inside the concrete which come in the way of transmission of pulse, lower velocities are obtained.

ii. The quality of concrete in terms of uniformity, incidence or absence of internal flaws, cracks and segregation etc. indicative of the level of workmanship employed, can thus be assessed using the guidance given in table below, which have been evolved for characterizing the quality concrete in structure in term of the ultrasonic pulse velocity.

Velocity criterion for Concrete Quality Grading.

Sl. No.	Pulse velocity by Cross Probing (km/sec)	Concrete Quality Grading
1	Above 4.5	Excellent
2	4.5 to 3.5	Good
3	3.5 to 3.0	Medium
4	Below 3.0	Doubtful

Note: In Case of "doubtful" quality it may be necessary to carry further tests.

iii. Pulse velocity method of test of concrete is to be conducted for CPWD works as a routine test. The acceptance criteria as per the above table will be applicable which is as per IS 13311 (part-1): 1992. From the above "Good" and "Excellent" grading are acceptable and below these grading the concrete will not be acceptable.

iv. 5% of the total number of RCC members in each category i.e. beam, column, slab and footing may be tested by UPV test method for establishing quality of concrete. It is suggested that test be conducted on RCC beam near joint with column, on RCC column near joint with beam, on RCC footings and rafts. On RCC rafts a suitable grid can be worked out for determining number of tests. In addition doubtful areas such as honeycombed locations, locations, where continuous seepage is observed, construction joints and visible loose pockets will also be tested.

v. The test results are to be examined in view of the above acceptance criteria "Good" and "Excellent" and wherever concrete is found with less than required quality as per acceptance criteria, repairs to concrete will be made. Honeycombed areas and loose pockets will be repaired by grouting using Portland Cement Mortar/Polymer Modifies Cement Mortar /Epoxy Mortar ,etc. after chipping loose concrete in appropriate manner. In areas where concrete is found below acceptance criteria and defects are not apparently visible on surface ,injecting approved grout in appropriate proportion using epoxy grout /acrylic Polymer modified cements slurry made with shrinkage compensating cement / plain cement slurry etc will be resorted to for repairs.(refer relevant chapters from CPWD Hand Book on Repairs and Rehabilitation of RCC Buildings).Repair to concrete will be done till satisfactory results are obtained as per the acceptance criteria by retesting of the repaired area. If satisfactory results are not obtained dismantling and relaying of concrete will be done.

4.13 Cover/Spacer Block

The contractor shall provide approved type of support for maintaining the bars in position and ensuring required spacing and correct cover of concrete to reinforcement as called for in the drawings, spacer blocks of required shape and size. Chairs and spacer bars shall be used in order to ensure accurate positioning of reinforcement. Spacer blocks shall be cast well in advance with approved proprietary pre-packed free flowing mortars of high early strength and same colour as surrounding concrete, Pre-cast cement mortar/concrete blocks/blocks of polymer shall not be used as spacer blocks unless specially approved by the Engineer-in-charge.

5 MASONRY WORK

Masonry work shall be carried out in conformity of Latest CPWD Specifications for works.

5.1 BRICK WORK:

Class of Bricks to be used in construction, Grade of Cement Mortar shall be as specified in DBR, Vol-4 and shall be carried out in conformity of Latest CPWD Specifications for works.

5.2 Random Rubble Masonry:

The stone shall be obtained from the quarries, approved by the Engineer-in-Charge. Stone shall be hard,sound, durable and free from weathering decay and defects like cavities, cracks, flaws, sand holes, injurious veins, patches of loose or soft materials and other similar

defects that may adversely affect its strength and appearance. As far as possible stones shall be of uniform colour, quality or texture.

Generally stone shall not contain crypst crystalline silica or chart, mica and other deleterious materials like iron-oxide organic impurities etc. Stones with round surface shall not be used. The compressive strength & water absorption shall conform to as per latest CPWD Specification.

The mortar shall be Cement mortar1:6 (1 cement: 6 Coarse sand), finished with flush/ruled cement pointing.

6 FINISHING:

Plastering, Painting, Polishing/ Varnishing to be carried out as per latest CPWD Specifications and as specified in DBR, Vol-4 (C. Design Basis Report- Civil Works) and finsishing schedule/tender drawings.

6.1 Antibacterial Paint

i. The Antibacterial Paint shall be able to provide anti-Microbial Protection:

ii. The scope of work includes providing & applying approved makes anti-Microbial Paint on wall surfaces as per manufacturer's specifications complete in all respect & as directed by Engineer-in-charge. Following are the desired characteristic of the paint:

a. The product hygiene coatings to start the biocidal action as soon as the microorganism land on the surface, and prevents the growth of mould, bacteria and yeasts for at least 5 years.

b. The unparalleled durability of hygiene coatings should help to extend the maintenance cycle and to minimize all related material, labour and shut down costs.

c. The hygiene coatings should be highly resistant to abrasives, detergents and weak acids and alkalis used in cleaning regimes. Furthermore, they can be regularly steam cleaned without any loss of performance or adhesion to the substrate.

7 DOOR & WINDOWS

The doors and windows shall be provided as per the requirements indicated in the Design Basis Report and the respective schedules appended to the Design Basis Report, Finishing Schedule appended with DBR & relevant Tender Drawings. However the typical specifications for the various types of Doors and Windows shall be as under:

7.1 Wooden:

7.1.1 Wood:

a. Timber shall be Forest Stewardship council (FSC) certified wood and it shall be seasoned and preservative treated.

b. The moisture contents of the wood used in the work shall not be more than that stipulated in the relevant clause of Latest CPWD Specifications for works. Kiln seasoning and preservative treatment of wood, if required, shall be done by the contractor. In all other respects the wood used in the work shall conform to the provision in latest CPWD specification for works.

c. The sample of species to be used shall be deposited by the contractor with the Engineer-in – charge before commencement of the work. The contractor shall produce cash voucher and certificate from standard kiln seasoning plant operator about the timber section to be used on the work having been kiln seasoned by them failing which it would not be so accepted as kiln seasoned.

7.1.2 **Glazing**:-

The glazing shall be as per CPWD specifications keeping into consideration the size of opening or panels of the glass or as specified.

7.1.3 Pre-laminated Particle Board:-

The pre-laminated particle board shall be off min. 12mm thick and shall be as per CPWD specifications keeping into consideration the size of the opening or as per tender drawings.

7.1.4 **Shutters-Wooden-Flush**:-

a. Factory made shutters, conforming to IS 2202 (Part –I) 1977, shall be obtained from factories to be approved by the Engineer – in - charge and. The contractor shall inform well in advance to the Engineer – in – charge the name address of the factory from where the contractor intends to get the shutters manufactured.

b. The contractor will place order for manufacture of shutters only after written approval of Engineer – in – charge in this regard is obtained. The contractor is bound to abide by the decision of the Engineer – in-charge. In case the factory already proposed by the contractor is not found competent to manufacture quality shutters, the contractor shall propose another name of another factory from the approved list for the approval of Engineer – in – charge.

c. The contractor will also arrange stage wise inspection of the shutters at factory with the Engineer in charge or his subordinate authorized representatives. Contractor will have no claim, if the shutters brought at site are rejected by the Engineer in charge in part or in full lot due to bad workmanship / quality or damages caused during their shifting from factory to site. Such shutters will not be measured and paid and the contractor shall remove the same from the site of work within 7 days after the written instruction in this regards are issued by the Engineer in charge or his authorized representatives.

d. The shutters shall be both side laminated with 1mm thick decorative laminated sheet of required make & shade (Factory pressed) or without lamination i.e commercial veneered or decorative veneered as per the finishing schedule & tender drawings appended to the tender document.

7.1.5 **Hardware**

a. All hardware for doors and windows shall be of stainless steel or as specified. All hardware shall be installed using routers and counter sunk screws. Panic hardware will be provided in all staircase and escape doors. Drawer slides with steel roller ball-bearings and drawer locking system with master keying option is to be provided for all built in cabinetry work and drawer units.

b. The contractor shall procure all the hardware and the fixing shall be done in the best workmanship like manner and in accordance with that employed for fixing hardware.

7.2 Aluminium Works

a. General

i. The scope of the work is the fabrication, supply and erection at site of all types of Aluminium glazed doors, windows and ventilators in accordance with the drawings and specifications.

ii. The supply and erection will include all parts such as but not restricted to frames, tracks, guides, mullions, styles, rails, couplers, transoms, rails, plates glazing bars, glass, hinges, arrangement, spring catches, cord and pulley arrangements, spring catches, cord and pulley arrangements door closers floor springs etc., required for the whole work whether the parts/ items are individually and specifically referred to in the schedules/ specifications/drawings or not provided that the supply and installation of such parts can be inferred there from and are necessary to make the work complete, unless separate provision is made in the bills of quantities for supply to such parts/items.

iii. The doors, windows, ventilators, will be fabricated to suit the finished clear openings in the building/structure which the tenderer will himself measure.

b. Materials:-

i. The members will be made out of aluminum alloy corresponding to IS:733 and will consist of extruded sections and of other shapes, and to sized gauges as shown in the drawings/ described in accordance with the relevant IS codes. The members shall be chosen to provide strength/ stability and maximum resistance to wear and tear.

ii. The Sections will be as per approved makes, extruded sections. As indicated in the drawings the tenderer should specifically mention which sections he is using.

iii. The IS specifications are to be strictly adhered.

iv. The extruder using recycled materials may be preferred.

v. The alloy of extruded aluminum should be BS or IS old HE9, Alcon 50 SWP. to this effect test certificate has to be provided for the extruder.

c. Finishing:

i. The extruded aluminum section has to be mechanically finished to remove all scratches; extrusion marks etc and subsequently thoroughly cleared in all alkali baths prior to anodizing.

ii. The polyester powder coating/powder coating, as required, as per item of work, shall be of desired shade with minimum average thickness to 50 microns or other shades as required and to this effect the tenderer must have to produce test certificate from authorized institutions Bureau of Indian Standard.

iii. The polyester powder coated/powder coated material should be properly wrapped in gummed tape before fabrication to avoid scratches during fabricated and erection shall be kept protected till handing over.

d. Fabrication:

i. Before commencing the fabrication the contractor shall submit to the Engineer – in - charge for their approval detailed shop drawings, based on the approved Architectural drawings and corresponding specification showing junctions, fittings, accessories such as hinges flush bolts, locks, latches, latching arrangements, peg stays, rotor arms, anodize pivots gaskets rubber packing door felts, mastic, sealant etc., including fixing and sealing arrangements . Type and method of scaffolding he intends to use, Fabrication is to be taken up only after approval by the Engineer – in - charge and in accordance with the approved drawings. Sections for fabrication of door/ window/ventilators etc. shall be as per architectural drawings or as approved by the Engineer – in - charge.

ii. A sample of finished door / windows/ ventilator railing etc. shall be fabricated as per the shop drawings approved by the Engineer – in - charge for final approval before under taking mass production/ fabrication,

iii. The doors, window, ventilators and partitions shall be as per thickness given in the approved shop drawings, Polyester Powder coating / Powder coating shall be as specified in the item specifications.

iv. All materials shall conform to relevant IS. Codes and in the absence of IS code, they should correspond to the best engineering practice; decision of the Engineer – in - charge shall be final and binding on the contractor.

v. Fabrication shall be done true to the drawing/ sample approved and in correspondence to the finished openings at the site. All joints shall be mitered at the corners, true right angles, and joints to be finished neatly to hairlines, with concealed fasteners, wherever possible joints shall be made in concealed locations.

vi. All fabricated/finished items shall be packed and carted properly to site to prevent any damage in transit. On receipt at site they shall be carefully stacked in protected storage to avoid distortion/damage.

vii. Site installation shall be with concealed screws, self-tapping or other approved fasteners or may be by welding, due precautions shall be taken to avoid any distortion/ discoloration /damage to the finished items.

viii. Wood work faces /parts coming in contact with masonry shall before shifting to the site be given a heavy coat of alkali resistance bitumen paint. Steel items coming in contact with other incompatible materials shall be given a thick coat of zinc chromate primer.

e. Glazing:

The glazing shall be as specified in DBR, Vol-4 & tender drawings or as per CPWD specifications keeping into consideration the size of opening or panels of the glass..

f. Hardware:

All hardware for doors and windows shall be of Powder coated aluminum or as specified in DBR / tender drawings

g. Fly proof SS wire mesh: Fly proof stainless steel grade 304 wire gauge mesh to be provided in windows and Main Doors entrance doors as specified in Finishing schedule/ tender drawings shall with average width of aperture 1.4 mm in both directions with wire of dia. 0.50 mm all complete

h. Aluminum Grills: Powder Coated Aluminium grill (minimum 50 micron) of approved design/pattern, with approved standard section shall be fixed to the window frame / Door Frame as specified in finishing schedule/ tender drawings with stainless steel screws @ 200 mm centre to centre, including cutting the grill to proper opening size for fixing and operation of handles and fixing approved aluminium standard section around the opening, all complete as per requirement and direction of Engineer-in-charge.

7.3 Fire Check Doors:-

a. <u>General</u>:-

7.3.1 The door shall be procured from approved manufacturer of CPWD / CBRI. The fire and smoke / hot gases check door shall be conforming to IS-3614 (Part-II)). The manufacturer shall have a prototype door tested and certified by CBRI Roorkee, of 120 minutes fire rating confirming to BS : 476 part 22 & IS : 3614 Part II .

7.3.2 The fire and smoke / hot gases check door shall not collapse during the rated period of the fire under the specified fire conditions.

7.3.3 The fire and smoke / hot gases check door shall not allow the passage of hot gases or the flames through the rebate of the gap between the door frame and shutter or through the holes, developed in the shutter during fire.

7.3.4 Material: **-**Door frames and shutter shall be as per DBR/tender drawings.

7.3.5 Shop drawing:- The contractor shall submit including required designing shop drawing for doorframes, shutters complete with

a. Plan, elevation with relative position of adjacent works

b. Glazing details with type size and fixing

c. Fitting and fixtures with type size, brand and fixing details.

d. Finishing details.

7.3.6 Sample Approval:- A sample of fire check door including fittings and fixtures, shall be fabricated as per the shop drawings approved by the Engineer – in - charge for final approval before under taking mass production/ fabrication

7.3.7 **Opening Width:** - Opening width of door mentioned in the drawings shall be width measured with both door shutters fully open in straight position.

7.3.8 **Testing: -** The Engineer – in - charge holds the right to get the door tested for fire rating at the cost of the contractor. In case the Engineer-in-charge desires to get the doors tested, then one door shall be selected at random out of the entire lot and shall be tested for two hour fire rating. The testing shall be got done from either CBRI, Roorkee or from any other laboratory approved by the Engineer-in-charge. The cost of material for testing and transportation / packing & other incidental testing charges shall be borne by the contractor. In case the door fails to meet the requirement, the entire lot shall be rejected.

b. Wooden Fire Doors & Frames

i. Door Frames: -

Door frame shall be manufactured from 2nd class teakwood (Ivory Coast) of requisite sections. It shall have heat activated intumescent fire seal strip of size 20mm x 4mm (for smoke seal) of approved make provided in grooves on all three sides of the frame. The frame shall be coated with one coat anti-termite fire retardant primer of approved brand. The frame shall be fixed with 8 nos. 100mm dia metal dash fasteners of approved brand and manufacture or as per direction of Engineer-in-charge.

ii. Door Shutter:-

The Door shutter shall be of thickness 50 mm minimum but not more than 55mm, suitable for mounting on the door frame. It shall comprise of two non-combustible boards 12mm to 18 mm thick sandwiching 20 mm to 25 mm fire resistant insulation filler veneered with 3mm thick commercial ply on both faces and pasting of minimum 1 mm thick laminate over wooden fire of approved brand a 100% without Asbestos, Bructile and meerschaum, having density not more than 1150 kg/m3 and thermal conductivity 0.14 W/m K with heat activated intumescent fire seal strip of size 20mm x 4mm of approved mounted in the grooves of teakwood lipping on all sides except bottom.

The intumescent sealant shall be used to fill the gaps between board and internal wooden lipping.

iii. Vision Panel:-

The Fire Rated Glass shall be minimum 11 mm thick interlayred , 120 minutes fire Rated (EW120, EI 15 minutes) Non Wired, Toughened Interlayered Glass of approved make which can also withstand thermal shock upto 800 degree centigrade shall be used as a glazing (Vision Panel Top/side fixed glazing) and is to be fixed in between the glass beading by using ceramic fiber in accordance with BS : 476 Part 22/ EN 1363 EN 1364 for stability and integrity of size 300 mm x 500mm (Clear vision) and the manufacturer should have tested the glass of similar or bigger size with any type of door framing from CBRI Roorkee . The Location of the Fr Glass will be as per the directions of Engineer-in-charge.

iv. Finish: -

The door frame and door shutter shall be finished with minimum two or more coats of thermo setting acrylic paint for scratch resistance and durability on hard wooden surface (@3.5 sq.mtr. per ltr., per coat) including preparation of base surface as per recommendation of manufacturer to make the surface fire retardant. The paint shall be of approved brand and quality.

v. Ironmongry Hinges: -

SS Ball Bearing Hinges of size 100 x 75 x 3mm complete with SS Screws of BB1953 Becker F.S / 3090F DORMA / 8011008 GEZE Make (4 Nos per panel) or equivalent approved by Engineer-incharge

c. Metal Fire Doors & Frames: - These shall conform to CPWD specifications.

i. Door Frames: -

Door frame shall be double rebate profile of minimum size 154mm X 77 mm made out of 1.60mm (16gauge) minimum thick galvanized steel sheet. NDRF 154x77 Frames shall be Butt jointed and field assembled with self bolted. The frames should be finished with Thermosetting Powder Coating in desired RAL Shade. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Frames should be provided with back plate bracket and anchor fasteners for installation on a finished plastered masonry wall opening. The frame shall be fixed with 8 nos. 100mm dia metal dash fasteners of approved brand and manufacture or as per direction of Engineer-in-charge.

ii. Door Shutter:-

The Door Shutter shall be 50 mm thick glazed fire resistant door shutters of 120 minutes fire rating conforming to IS:3614 (Part-II), tested and certified as per laboratory approved by Engineer-in-charge, with suitable mounting on door frame, consisting of vertical styles, lock rail, top rail 100 mm wide, bottom rail 200 mm wide, made out of 16 SWG G.I.sheet (zinc coating not less than 120 gm/m2) duly filled FR insulation material and fixing with necessary stainless steel ball bearing hinges of approved make, including applying a coat of approved fire resistant primer etc. all complete as per direction of Engineer-in-charge

iii. Vision Panel:-

The Fire Rated Glass shall be minimum 11 mm thick interlayred , 120 minutes fire Rated (EW120, EI 15 minutes) Non Wired, Toughened Interlayered Glass of approved make which can also withstand thermal shock upto 800 degree centigrade shall be used as a glazing (Vision Panel Top/side fixed glazing) and is to be fixed in between the glass beading by using ceramic fiber in accordance with BS : 476 Part 22/ EN 1363 EN 1364 for stability and integrity of size 300 mm x 500mm (Clear vision) and the manufacturer should have tested the glass of similar or bigger size with any type of door framing from CBRI Roorkee . The Location of the Fire Glass will be as per the directions of Engineer-in-charge.

iv. Finish: -

The door frame and door shutter shall be finished with minimum two or more coats of thermo setting acrylic paint for scratch resistance and durability on hard wooden surface (@3.5 sq.mtr. per ltr., per coat) including preparation of base surface as per recommendation of manufacturer to make the surface fire retardant. The paint shall be of approved brand and quality.

v. Ironmongry Hinges: -

SS Ball Bearing Hinges of size 100 x 75 x 3mm complete with SS Screws of BB1953 Becker F.S / 3090F DORMA / 8011008 GEZE Make (4 Nos per panel) or equivalent approved by Engineer-incharge

d. **Fire Resistant Glazed Doors, Windows & Partitions:**

i. General

The Fire resistant Glazed Doors (hereinafter termed as FRGD), Fire resistant Glazed windows (hereinafter termed as FRGW) and Fire Resistant Glazed Partition (hereinafter termed as FRGP) shall not collapse during the rated period of fire under the specified fire conditions and shall provide safe access to the escape route.

ii. **Codes & Specifications**

All materials, items, hardware etc. shall be subjected to approval by Engineer-In-Charge. Necessary documentation/ test certificates shall be furnished by the Contractor from the manufacturer before supply of material for approval by Engineer-in-charge. Each Door/Window and Partition shall be provided with a small metal identification plate in suitable location indicating Fire rating, name of the Manufacturer, date of installation and details of approved test house. Each Glazing pane shall carry a permanent stamp of the manufacturer.

The complete assembly of the doors i.e. frame, shutter, vision glass and hardware shall have fire rating as required and shall confirm to:

1	EN 1634-1	Fire resistance and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware - Part 1: Fire resistance test for door and shutter assemblies and openable windows
2	EN 1364-1	Fire resistance tests for non-load bearing elements – Part 1: Walls
3	EN 410	Determination of luminous and solar characteristics of glazing.
4	EN 12600	Glass in Buildings – Pendulum test – Impact test and classification for flat glass

iii. **Testing & Certification**

The FRGD, FRGW & FRGP shall be supplemented with appropriate certification by fire test lab, for applicable or higher dimension with complete description of the architectural components and hardware for FRGD, FRGW and FRGP for which the approval is given. Along with the material tests, the complete system along with the framing shall be tested in accordance with the criteria of EN1634-1 for door/ window and EN1364-1 for partition. The installation of the fire rated system shall confirm to requirement of test evidence. The choice of hardware and/or glazed accessories shall be as per test evidence.

iv. **Frame for Fire Resistant Glazed Door / Windows**

Frame for Door/Window of 120 min fire rating shall be made of section 50 x 60 mm on horizontal side & 35 x 60 mm on vertical sides having built in rebate made out of 1.6 mm thick GI sheet (Zinc coating not less than 120gm/m^2) suitable for mounting 120 min Fire Rated Glazed Door Shutters. The frame shall be filled with Mineral wool Insulation having density min 96Kg/m^3. The frame will have a provision of G.I. Anchor fasteners 14 nos (5 each on vertical style & 4 on horizontal style of size M10 x 80) suitable for fixing in the opening along with Factory made Template for SS Ball Bearing Hinges of Size 100x89x3mm for fixing of fire rated glazed shutter . The frame shall be finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer - in- charge. (Cost of SS ball bearing hinges is excluded).

v. **Frame for Fire Resistant Glazed Partitions**

Frame for non-load bearing fixed fire resistant glazed Partition for 120 min Fire Rating shall be made out to a profile of dimension 60mm x 70 mm of 1.6 mm thick galvanised steel sheet as per test evidence suitable for fixing fire rated glass for 120 min of both integrity & radiation control (EW120) & minimum 15 min of insulation (EI15).The profile has to be fixed to the supporting construction by means of anchor fasteners of size M10 x 80, every 150 mm from the edges and every 500 mm (approx) c/c. The frame shall be filled with mineral wool insulation of density min 96kg/m^3. and finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer - in- charge .

vi. **Shutter for Fire Resistant Doors/Windows**

Glazed fire resistant door shutters 60 mm thick of 120 min Fire Rating shall be confirming to IS:3614 (Part II) or EN1634-1:1999, tested and certified as per laboratory approved by Engineer-in-charge, with suitable mounting on door frame, consisting of vertical styles, top rail & side rail 60 mm x 60 mm wide and bottom rail of 110 mm x 60 mm made out of 1.6mm thick G.I. sheet (zinc coating not less than 120gm/m^2) duly filled mineral wool insulation having density min 96 kg/m^3

and fixing with necessary stainless steel ball bearing hinges of size 100x89x3mm of approved make, including applying a coat of approved fire resistant primer or powder coating not less than 30 micron etc all complete as per direction of Engineer-in-charge.

vii. **Fire Resistant Glass for Doors/Windows and Partitions**

Glazing to be fixed in fire resistant doors/window shutters and fixed Partitions with G.I. beading made out of 1.6 mm thick G.I. sheet (zinc coating not less than 120 gm/m²) of size 20 x 33 mm screwed with M4 x 38 mm SS screws at distance 75 mm from the edges and 150 mm c/c , including applying a coat of approved fire resistant primer/powder coating of not less than 30 micron on G.I. beading, & special ceramic tape of 5 x 20 mm size etc complete in all respect as per direction of Engineer-in-charge. The glass should be clear, toughened, interlayered, non-wired fire resistant having 11 mm minimum thickness of approved brand with 120 minutes of fire resistance both integrity & radiation control (EW120) and minimum 15 min of insulation (EI15) and having a sound reduction of more than 35dB and LT of 85%. Glass shall be compliant to class 2B2/1B1 category of Impact Resistance as per EN 12600. The glass should be manufactured in UL & TUV audited Facility and including UL-EU Certification. The maximum glazing size cannot be more than 1100 mm x 2200 mm (w x h) or 2.42 sq mts in total area. The test report for the complete system (Glazed Door or Partition) will be considered valid only if it contains the stamp and signature of the authorized signatory from the glass manufacturer..

The complete assembly shall satisfy the given criteria of fire resistance - stability, fire integrity, radiation control and insulation as per above mentioned rating required.

viii. **Vision Panel for Fire Door**

Specifications for glass for Vision panels for Fire Rated Door shall be as per para iv above. The size of glass to be used for vision panels shall be as per tender drawings.

e. Fire Doors Fittings

All work is to be carried out in accordance with relevant IS Code and specification for Fire Door & fitting as per IS: 3614 (Part I) – 1966 and direction of Engineer in charge. Door shall be fixed with fire rated hinges 5 Knuckle, 2 bearing butt hinges size 4" x 3" x 3mm, in SS 304 and in satin stainless steel, as per EN 1935, CE Marked.

i. Mortice Lock: - 2 hrs, fire rated mortice lock with lever handle tested in accordance with BS: 476 Part 22. A minimum one year warrantee shall be provided. Mortice sash lock with internal thumb turn and external key operation with lever handles shall be provided.

ii. Flush Bolts (For Double Door):- 300mm concealed extended lever action flush bolts satin finish, fixed to top and bottom of the inactive blade shall be provided.

iii. Automatic Door Closer: - Dual adjustable speed automatic door closer with rack and prinion method, in conformance with BS:476 Part 22 (for fire rating) and BS EN1154 shall be provided. The door closer shall have minimum of one year warrantee.

iv. Pull Handle: 300mm long stainless steel grade 304 D type pull handle shall be fixed with necessary screws etc. complete. A minimum one year warrantee for the product shall be provided.

v. Fire Rated Panic exit device: - It shall be suitable for door weights upto 120kgs. The Panic bar as per door leaf (SINGLE LEAF/DOUBLE LEAF) shall consist of Main Panic Latch component, End Component, Push bar, Striker Kit, end caps in Silver finish. Complete set with screws & fixing accessories, External trim, having fire rated door closer TS 71/68 rack and pinion door closer EN size 3/4, with std. arm and

with two independent closing valves and latching speed adjustable by arm. Full plastic cover. Silver finish. As per EN 1154 life cycle 500,000 with seals and door stopper. The device shall be complete in all respect and fixed as recommended by the manufacturers. A minimum one year warrantee for the product shall be provided.

vi. Smoke Seals: - Heavy duty smoke seals for smoke check doors shall be provided.

vii. Acoustic Seals: - Acoustic seals of appropriate design duly fixed in shutter as well as door frame shall be provided.

f. **Detail of Fire rated Door/Window/Partition**

i. Door frames and leaf: 1.6 mm thick GI sheet.

ii. Glazing bead: 1.6 mm thick GI sheet.

iii. Stiffeners: 1.6 mm thick GI sheet.

iv. Glass: Clear toughened interlayer fire rated glass.

v. Beading screw: M4x35 mm @ 150mm (approx.) C/C.

vi. SS ball bearing butt hinges 100x89x3 mm.

vii. Ceramic wool infill (Density – 96 kg/m3)

g. Deliverables by the Contractor

Following documentation/ drawings shall be furnished along with the Doors/ window/ partition.

1) Prototype Test Certificate by national/international test house

2) Shop drawings

3) Specification/ Manufacturer's literature, Test certificates and other documentation for materials and items intended to be used.

4) Certificate indicating that design and installation of Doors and hardware conforms to norm laid down by approved national/international test house.

5) Test report to be attested by Fire rated glass manufacturer.

6) The Fire rated glass applicator has to be approved by Fire rated Glass Manufacturer has to submit the approved applicator certificate.

7.4 Glazing with Patch Fittings

a. General

i. The contractor shall be responsible for design, fabrication, supply, installation, test and guarantee of all items including taking all measures that may be required to complete the work as per Architectural concept drawings and specifications details.

ii. The specialist agency engaged to carry out the external glazing installation and supply shall have at least 5 years of relevant experience and have completed external glazing systems of similar nature and equivalent scale of works as shown in the tender documents.

iii. The specialist contractor shall submit an outline of recent comparable works (illustrated by appropriate drawings, sketches, photographs, brochures) by the firm / its technical partner to illustrate the competence, experience and suitability of the firm.

b. The scope of work shall include:

i. Design, preparation of shop drawings, calculations, engineering data and test reports.

ii. Fabrication and installation of Glass Entrances and Glazing with Patch Fittings system.

iii. All anchors, fixings, attachments, reinforcements, steel reinforcing for mullions and transoms required for a complete installation, except those specifically indicated as being provided by other trades.

iv. Exposed Architectural mullions and other support members.

v. Finishes, protection coatings and treatments.

vi. Sealing with approved sealants within and around the perimeter.

vii. All thermal insulation, fire-safing etc. including supports and/or backing.

viii. All caulking, sealing, electrometric and metal flashing, and gaskets including sealing at junctions with roof, ground-floor waterproofing and building expansion joints between structures.

ix. Electrical bonding and ear thing of all metal cladding elements.

x. Provisions to receive electrical outlets and cutouts for conduits and other electrical work.

xi. Glass and glazing.

xii. Transportation, storage, handling, protection and cleaning.

c. Submittals

i. Product Data: Include construction details, material descriptions, dimensions of individual components, profiles and finishes.

ii. Shop Drawings

d. Fabrication and installation details, including followings

i. Plans, elevations and sections.

ii. Details of fittings and glazing.

iii. Hardware quantities, locations and installation requirements.

e. Sample for verification, for each type of exposed finish required for

i. Metal finish: 150mm long section of patch fittings, rails and other items.

ii. Glass: 150mm square, showing exposed edge finish.

f. Materials

i. Glass

- Glass shall be as specified in drawing or as per design requirement. It shall be Indian / imported hard coated reflective bronze and heat strengthened glass. It shall be of approved make.
- In toughening of Glass, rolling direction shall be parallel to the width of the glass panel such that waviness if any is parallel to the horizontal and no waviness parallel to the vertical and to ensure that such waviness is of negligible order.

ii. Components

- Patch fittings: Stainless steel clad aluminium
- Floating Transom Bar: Steel cladded in metal matching fittings and in sizes recommended by manufacturer for application indicated. Include stainless steel support rods, lateral adjustment and ceiling channel. Support fins to be metal, finished to match transom bar.
- Rails: Stainless steel clad aluminium.
- Accessory Fittings : Matching with patch fittings and rails metal and finish for overhead door stop, Centre hosing lock, glass support fin brackets and other as shown in drawing.

- Anchors and fastenings: Concealed
- Weather stripping: Sweep type

iii. Hardware

- Hardware should be heavy duty in matching finish
- Concealed Floor Closer and Top Pivots
- Centre hung; BHMA A156.4, Grade 1; including cases, bottom arm, top walking beam pivots, plates, and accessories required for complete installation.
- Swing : Double acting; Positive dead stop, concealed with hold open angle

  Delayed action closing
- Concealed Overhead Holder: Grade 1, with dead stop setting coordinated with concealed floor closer.
- Push-pull set : Stainless steel finish
- Lock set of approved make.

g. Fabrication

i. Provide holes and cutouts in glass to receive hardware, fittings, rails and accessories before tampering glass. Fully temper glass using horizontal (roller-hearth) process and fabricate so, when installed, roll wave distortion is parallel with bottom edge of door or tile.

ii. Factory assembled components and factory installed hardware to greatest extent possible.

h. Execution

i. Examine areas and condition for compliance with requirements for installation tolerances and other conditions affecting performance of work.

ii. Install all glass system and associated components according to manufacturer's written instructions.

iii. Set units in level and plumb.

iv. Maintain uniform clearances between adjacent components.

v. Lubricate hardware and other moving parts according to manufacturer's written instructions.

vi. Set, seal and grout floor closer cases as required suiting hardware and substrate indicated.

i. Cleaning

i. The Contractor shall ensure that all actions are taken during installation to eliminate the effects of corrosive substances on the finishes.

ii. The Contractor shall clean both internal and external surfaces to remove corrosive substances, dust or cement / mortar dropping during the installation as may be directed and instructed by the Engineer – in - charge.

iii. The internal surfaces of glass and aluminum frame are to be cleaned with compatible cleaning agents prior to the installation of the internal protective sheeting.

iv. The Contractor shall provide written verification that cleaning agents are compatible with aluminum, stainless steel, glass coatings, granite, glazing materials and sealants. In no case shall alkaline or abrasive agent be used to clean the surface. Care shall be taken during cleaning to avoid scratching of the surface by grit particles.

v. Prior to snagging inspections the Contractor shall, remove the internal protection sheets and carry out a thorough cleaning of all glass and aluminum.

vi. The Contractor shall also make good any physical damage to the structure including scratches, dents, abrasions, pitting, etc. to the satisfaction of the Engineer – in - charge.

vii. Manufacturer's delivery or job markings on glass and adhesive for manufacturer's labels shall be either a neutral or slightly acidic material. In no case shall such material be alkaline; any staining of glass by alkaline material will be cause for rejection of the glass.

viii. After the installation of each pane of glass all markings and labels shall be carefully and completely removed from the panes. Thereafter no markings or labels of any sort shall be placed on the glass.

ix. Glazed openings shall be identified by suitable warning tapes or flags attached with a non-staining adhesive or other suitable means to the framing of the opening. Tapes or flags shall not be in contact with glass.

x. As soon as it is practically possible after the issuance of the occupation Permit for the Building, the Contractor is to carry out a complete cleaning of the external face.

j. Performance Guarantee:

The contractor shall offer a minimum of 10 year Performance Warranty for the entire installation carried out.

7.5 Neutron Shielded Door and Frame-LINAC

a. Material and Fabrication

Borated Polyethylene: minimum of 5% boron content of homogeneous consistency and density throughout polyethylene panel, also available as High Density when fire resistance is required.

1. Sizes: Up to 48" x 96" maximum panel size, or cut to size by manufacturer or by installer.

2. Thickness: 1" thick, or in multiple layers to meet shielding requirements.

b. Door and Frame

Steel Fabrication painted with rust resistant primer finish, and borated polyethylene and lead core as required per the radiation physicist shielding report.

Door Faces: 1 /4" thick steel of prime quality cold rolled, pickled carbon steel conforming to ASTM #A366

Door Edges: 1 /2" thick steel of prime quality cold rolled, pickled carbon steel conforming to ASTM #A366

Door Core: ___" of 5% Borated Polyethylene (BPE) and ___" pure lead plate per FS QQ-L-201F Grade C.

Reference radiation physicist shielding report for required thickness of borated polyethylene and lead.

c. Hinges: Heavy Duty Full Surface Mounted Hinges of sufficient capacity for total door weight, with adjustable height feature, and bolt on installation with high strength bolts.

d. Frame: 1 /4" formed steel to required wall throat thickness single rabbit frame profile, with additional steel reinforcement at hinge locations, welded at mitered corners with internal welded anchors for high density concrete cast in place installation. Frame to be painted with rust resistant primer.

e. Installation

Neutron Shielded Door and Frame and factory pre-hung as a modular unit to be carefully formed and set inplace true, plumb, square, and level by experienced professional concrete tradesmen. Frame and door are to be cast in place with high density concrete of a density as specified by radiation physicist or a minimum 147 lbs per cubic foot dry weight per NCRP or whichever is greater, and free of any voids, butt joints or cold joints.All formed or cast concrete joints must be "keyway" overlapped or interlock type joints.

Built-In Items: Where other built-in items penetrate shielding materials, provide borated polyethylene, neutron putty, and /or lead shielding of same thickness as in surrounding wall partition around door frame as required to maintain continuity of shielding system. Install in strict accordance with manufacturer's instructions and recommendations.

Finish hardware as specified by Neutron Door Manufacturer.

Surface mounts any utilities when possible. No through penetrations are permitted. All penetrations should be baffled or staggered. Shielding material manufacturer can provide details on proper shielding solutions for various project penetration conditions meeting applicable NCRP requirements. Where recessed outlet boxes, junction boxes, ducts, conduit and similar items prevent the use of shields, provide borated polyethylene, neutron putty or lead sleeves or lead lining or backing as required per radiation physicist report to compensate for displaced concrete or other shielding materials with proper overlaps.

Provide borated shielding materials, lead lining, sleeves, shields and other products of equivalent shielding protection as used in the wall partition shielding system that each penetration occurs in.

Thoroughly HEPA vacuum, clean up and properly recycle all lead trimmings and debris carefully following MSDS instructions. Never dispose of any lead materials in general trash or refuse.

f. Certification

A. Upon completion of Radiation Shielding, the Manufacturer and Fabricator-Installer shall furnish a certificate of compliance stating that all materials provided are in accordance with this specification and the radiation physicist shielding report.

g. Testing

After the intended radiation equipment has been installed and placed in operating condition, and prior to any occupancy and use, the radiation shield

h. Quality Assurance

Standards: Comply with all applicable requirements of National Council on Radiation Protection and Measurement (NCRP) Report No. 147 titled "Structural Shielding and Design Evaluation for Medical Use of X-rays and Gamma Rays of Energies up to 10MeV" and NCRP Report No. 51 "Radiation Protection Design Guidelines for 0.1-100 MeV Particle Accelerator Facilities"

Comply with any applicable requirements of local, state or federal regulatory agencies where building or safety standards or criteria exceed NCRP Report Numbers 49,51 and 147.

i. Fabricator-Installer Qualifications: Fabricator-Installer shall be experienced in and equipped for work of fabrication and installation equal to standards specified.

7.6 HERMETICALLY SEALED SLIDING LEAD DOOR:-

Anti-Radiation Sliding doors are hermetically sealed doors with 2mm lead inside that comply with AERB requirements for X-Ray shielding Doors. Three sided wall frame consist of 2mm lead lining. These Doors should withstand up to 75 Pa Pressure. The door shall be procured from approved manufacturer and Door frames and shutter shall be made from materials specified in the bill of quantities.

a. **Door Shutter:-**

i. Core of minimum 60mm thick doors consist of approved make and shade 4mm thick high pressure compact laminate on both sides, 2mm thick lead lining (Weight:- 24.4 Kg/ m2) with 99% pure lead & 50 mm thick CFC free high density, injected polyurethane puff (Density 40 kg/m3).
ii. The door provides noise insulation up to 28 db, door core to be provided with 2.5 mm thick high grade Aluminum Extrusion profiles on the edges of the shutter with necessary Screw & Fixtures.
iii. Shutter fixed with 3-tier EPDM sealing gasket (60 degree shore) on vertical sides & top side and 2-tier EPDM sealing gasket fixed on lower part of door shutter to ensure perfect hermetic sealing.
iv. Stainless steel 304 wheel chair combined with self-lubricating rollers fitted on double ball bearings on top of shutter. The single length aluminum track to be provided and fixed for sliding door over it which can withstand the load of the door shutter.

b. **Vision Panel: -** A 10 mm thick of 305 mm x 305 mm lead glass having minimum lead capacity of equivalent to 2.2 mm thick to be fixed with 2mm thick mirror finish S.S. frame on both side of door.
c. **Door Fixtures:**- Suitable Hardware's i.e. D- Type handles, 1mm thick SS 304 Kick Plate and locking arrangement to be provided and doors can be open and closed right hand side or left hand side as per requirement. S.S. guard column to be provided.
d. **Canopy:- Canopy** over full length of the track of the door to be made up of 1mm thick galvanized sheet cover finished with powder coating. The track top should be sloping and provided with GI sheet end caps etc. complete and fixed with suitable anchors on wall.
e. The **wall** opening jamb & ceiling of door to be covered with 1mm thick high pressure laminate fixed with adhesive over 9mm thick high density particle board of and fixed with aluminum frame with suitable screws, anchors.
f. **Shop drawing**: - The contractor shall submit including required designing shop drawing for doorframes, shutters complete with

i. Plan, elevation with relative position of adjacent works
ii. Glazing details with type size and fixing
iii. Fitting and fixtures with type size, brand and fixing details.
iv. Finishing details.

g. **Sample Approval**:- A sample of Lead lined door including fittings and fixtures, shall be got approved from Engineer – in - charge for final approval before under taking mass production/ fabrication.

8 EXTERNAL FAÇADE WORKS:

8.1 Stone work-

8.1.1 Wet cladding:-

The wet cladding shall be laid as per design and in accordance with CPWD Specifications, including SS metal cramps, pins, dowels, ledges and supports, as per design and requirements. The cladding shall be fixed with 12mm thick (minimum), Cement Mortar 1:3 (1cement: 3 coarse sand). Horizontal & vertical joints shall be filled with white cement mixed with pigment of matching shade.

8.1.2 Dry cladding:-

The dry cladding shall be laid as per design with white sandstone 30mm thick gang saw cut stone with (machine cut edges) of uniform colour in sizes as approved by Engineer-Incharge and in accordance with CPWD Specifications, including SS grade 316 or as specified, metal cramps, pins, dowels, ledges and supports, as per design and requirements. The support structure shall be designed by the Contractor and approved by the Engineer-in- charge. Horizontal & vertical joints shall be filled with weather sealant mixed with pigment of matching shade. Groove width, if provided/ required, shall be uniform and in plumb of vertical surface.

The contractor shall get this work executed through a specialized agency. The Contractor shall submit the credential of the specialized agency well in advance for verification and only after written approval of Engineer-in-charge can the agency be deployed for this work. The contractor shall furnish a legal guarantee bond for ten years in prescribed proforma certifying that all the defects noticed during this period shall be rectified and made good to the satisfaction of Engineer-in-charge.

Wherever the stone slab dry cladding is provided exposed to environment, exposed surface and edge surfaces of the stone slabs shall be treated to make the surfaces hydrophobic by applying water repellant / hydrophobic clear coating of water soluble siliconate based impregnating agent of approved make. The formulation shall be prepared and applied as per the manufacturer's recommendations. Before applying the formulation the surface preparation shall be done as per the manufacturer's recommendations. The surface shall be cleaned using water and the formulation shall be applied on the damp surface.

It shall be applied before installation of stone on vertical surface has been completed and after necessary surface preparation.

8.2 Structural Glazing System

a. <u>Scope of Work</u>

The contractor shall design, engineer, test, fabricate, deliver, install, and guarantee all construction necessary to provide a complete structural glazing system to the proposed building, all in conformity with the Design Basis Report & Drawings as given. Specification and all relevant construction regulations including providing any measures that may be required to that end, notwithstanding any omissions or inadequacies of the Drawings and/or without limiting the generalities of the foregoing, the structural glazing Systems shall include, without being limited to, the followings:

- Metal frames, glass glazing, spandrels, ventilators, finish hardware, copings metal closure, windows etc.
- All anchors, attachments, reinforcement and steel reinforcing for the systems required for the complete installations.
- All thermal insulation associated with the system. All fire protection associated with the system.
- All copings, end closure and metal cladding to complete the system.
- All sealing and flushing including sealing at junctions with other trades to achieve complete water tightness in the system.
- Isolation of dissimilar metals and moving parts.
- Anticorrosive treatment on all metals used in the system. Polyester powder coating aluminium sections.

b. The contractor shall also be responsible for providing the followings:

- Engineering Proposals, Shop Drawings, Engineering data and Structural Calculations in connection with the design of the structural glazing System.
- Scheduling and Monitoring of the Work.
- Mock-ups, samples and test units.
- Performance testing of the structural glazing framing and glazing assembly.
- Co-ordination with work of other trades.
- Protection.

- All final exterior and interior cleaning and finishing of the structural glazing System
- As-built record drawings and photographs.
- Guarantees and Warranties.
- All hoisting, staging and temporary services.
- Conceptualising and design of a suitable maintenance system for structural glazing.

c. The water tightness and structural stability of the whole structural glazing System are the prime responsibility of the Contractor. Any defect or leakage found within the Guarantee Period shall be sealed and made good all at the expense of the Contractor.

d. The structural glazing system shall be designed to provide for expansion and contraction of components which will be caused by an ambient temperature range without causing buckling, stress on glass, failure of joint sealants, undue stress on structural elements or other detrimental effects. Specific details should be designed to accommodate thermal and building movements.

e. <u>Building Regulations</u>

Structural glazing shall comply with all Government Codes and Regulations including IS codes, if any.

All structural glazing, individual aluminium and glass components and all completed work shall be designed and erected to comply with the following:

i. Design load and deflection.

ii. Structural glazing construction in its entirety shall be fabricated and erected to withstand without damage or permanent deformation inward (positive) and outwards (negative) pressure, all acting normal to the construction plane with a maximum deflection of not exceeding 1/175 of the clear span between structural support or 20mm maximum whichever is less.

iii. Structural performance of all parts of structural glazing system shall conform to relevant IS codes, wind load as per IS-875 and seismic loads as per IS-1893. Deflection shall cause no permanent set in excess of 1/1000 of span nor evidence of structure failure.

iv. **Design Wind Loading**

- 850 N/m2 positive and negative to Podium.
- 1150 N/m2 positive and negative to Tower.
- 1500 N/m2 positive and negative to Crown to Tower.

No cladding element shall sustain permanent deformation of failure under loading equivalent 1.5 times the design wind pressure specified.

f. <u>Tender Drawings and Specifications</u>

The tender drawings indicate profile and configuration required together with relationship to structural frame and interior building elements.

The Specification and tender drawings is of the performance type and includes only the minimum requirements of the /structural glazing Wall System without limiting the Contractor to the method of achieving desired performance.

g. <u>Pre Execution Requirements</u>

i. <u>Design Proposals</u>

The contractor shall propose the final design in such a way that all basic

functional and architectural requirements in line with the Master Plan , Concept Plans & Design Basis Report are fulfilled and get the same approved by HLL. However, basic design requirements as described in the specification and other Architectural requirements such as the size of window, net glass area, ventilator, configuration of windows and spandrels shall be retained.

The design proposals shall be in the form of drawings, drawn to full scale as far as practical and specification shown in or describing all items of work including:

- Request details as indicated on the tender drawings.
- Metal quality, finishes and thickness.
- Glass quality, coating and thickness and proposed manufacturer's brand names.
- Sections of the mullion and transom together with structural calculations.
- Arrangement and jointing of components.
- Field connections especially mullion to mullion and transom to mullion.
- Fixing and anchorage system of typical wall unit together with structural calculations.
- Drainage system and provision in respect of water leakage in the curtain wall/structural glazing system.
- Provisions for thermal movements.
- Sealant and sealing method.
- Glazing method.
- Wind load and seismic load and any other specific load considered in the design.
- Lightning protection link-up system of the curtain wall/structural glazing for connection and incorporation into the lightning conductor system of the building. Design concept must be stated in the proposal.

The maximum permissible structural tolerances of the building that the system has been designed to accommodate in case this tolerance exceed those specified in the Specification.

Any parts of the curtain wall/structural glazing, when completed, shall be within the following tolerances:

Deviation from plumb, level or dimensioned angle must not exceed 3mm per 3.5m of length of any member, or 6mm in any total run in any line.

Deviation from theoretical position on plan or elevation, including deviation from plumb, level or dimensioned angle, must not exceed 9mm total at any location.

Change in deviation must not exceed 3mm for any 3.5m run in any direction.

ii. Samples

The contractor shall also submit samples of mullion and transom sections in lengths of 300mm with the same finish and workmanship along with the proposals and 300mmx300mm samples of glass (samples to include exposed screws and other exposed securing devices, if any).

iii. Preliminary Programme

The tenderer shall also submit a preliminary programme of the contract works showing the various stages of design sampling, testing, fabrication, delivery and installation of the works.

iv. Upon approval of the shop drawings, at least 4 copies shall be submitted by the Contractor.

v. The Contractor/Sub-contractor shall submit a maintenance manual for the curtain wall/structural glazing system inclusive of all metal parts, glass and finish etc.

vi. During detailed design and execution any details may increase as per actual requirement at site, these variations shall be executed without any extra cost implications to the HLL.

h. Execution- Performance Testing

The performance tests are to be conducted on the structural glazing system, if the area of the structural glazing system exceeds 2500 Sqm from the certified laboratories accredited by NABL (National Accreditation Board for Testing and Calibration Laboratories), Department of Science and Technology, India. The decision of the Engineer-in-charge about the necessity of testing of shall be final and binding.

i. General Requirements

Mock-up units shall be constructed by the contractor and tested to determine the structural stability as well as air and water infiltration or leakage at glazing beads and all other joints designed into the façade.

After approval of structural calculations and shop drawings for the structural glazing, one (1) Test Unit for performance testing of the structural glazing shall be constructed by the contractor at a laboratory approved by the Department.

Erect mock-up under manufacturer's/installer's direct supervision and employ workmen as they would be employed during the actual erection at the job site.

Test procedures test schedules and test locations shall be submitted to Engineer-in-charge for approval before testing.

Prior to fabrication of Test Units, the contractor shall submit shop drawings and calculations of the Test Unit for the Engineer-in-charge's approval.

Production for final job site erection shall not start until approval has been obtained as a result of the mock-up test.

ii. Test of Wind Pressure

The equivalent load of wind pressure or wind suction shall be given to the Test Unit as increasing or decreasing the inside pressure in the 'Pressure Chamber' at which the Test Unit is fixed.

The static wind pressure shall be applied up to 1.5 Kpa at maximum wind pressure. The variation of dynamic pressure shall be of any approximate sine-cure-line.

Deflection on each observational points of the Test Unit shall be observed and recorded under the Static pressure as described above.

Any damage and harmful permanent deformation on any parts except sealing materials shall not be found at maximum wind pressure.

The deflection on the main structural parts in these conditions shall not exceed:

- 1/175 of the span between supports or 20mm, whichever is the lesser for vertical elements.
- 1/250 of the span between supports for horizontal elements.

The extent of recovery of deformation 15 minutes after the removal of the test load is to be least 95%.

iii. Test of Lateral Deflection per Floor Height

Lateral deflection per floor height shall be occurred on the test unit, when the

structural frame which fixes the test unit is deflected horizontally.

The deflection of every + 2.5mm shall be increased upto + 13mmm on the Test Unit (Static Deflection Test).

The dynamic deflection shall be applied upto + 13mm.

The variation of dynamic deflection shall be of an approximate sine-curve-line, one period of 3 seconds.

The dimension of the deflection on each observational points of the Test Unit shall be measured under the condition as described above, the damage shall be observed.

Any damage and harmful permanent deformation shall not be found in any parts of the curtain wall/structural glazing except sealant at maximum deflection.

iv. Test of Water-tightness

Water shall be sprinkled to the Test Unit under the wind pressure. Pressure shall not be applied to the Test Unit.

The volume of the sprinkling water in one minute shall be 5 litres/m2 min. (0.1 gal/ sq.ft.).

All water leakage and drainage system at the joint and openable sash of the curtain wall/structural glazing system shall be observed from the outside of the chamber.

Hold the test 2 times, in sequence as described below, conforming to the above mentioned conditions.

Install the test unit.

Hold 1st water-tightness test.

Hold test of wind pressure as described above. Hold 2nd water-tightness test.

Lateral deflection test.

Water leakage at all parts of the Test Unit shall not be observed inside during the 1st water- tightness test.

v. Test Report

The Contractor is required to submit five (5) copies of test reports to the Engineer-in-Charge.

vi. Cost of Performance Test

The Contractor shall allow in his tender for the cost of the performance testing and of fabrication, erection, corrections to and demolition of the Test Units including any special provision required in the testing laboratory for the tests mentioned above.

The Contractor shall allow for amendments and adjustments to the mock-up as required by the HLL.

If the Test Unit fails to pass the initial testing, the Contractor shall make the necessary corrections to the Test Unit and shall have to get the Test Unit retested by the Testing Laboratory till it passes the tests.

Cost of corrections to the Test Unit and cost of re-testing shall be borne by the Contractor at no additional cost to the HLL.

vii. Shop Drawings and Calculations for the Performance Testing

Prior to fabrication of Test Unit, the Contractor shall submit shop drawings and calculations of the Test Unit for Engineer-in-Charge`s approval.

viii. Record Drawings

The testing laboratory shall keep copy of approved Test Unit shop drawings and calculations at testing laboratory during testing of Test Unit.

The testing laboratory shall accurately and neatly record on the above mentioned shop drawings all changes, revisions, modification etc. made to Test Unit, which shall become the record drawings.

At completion of testing and after approval of test reports the testing laboratory shall submit the marked-up record drawings to the Engineer-in-Charge.

ix. Contractor's Representatives

Full time attendance by Approved Representatives of the Contractor & subcontractor associated with the erection of curtain wall/structural glazing shall be provided for the erection of the Test Unit and for all testing of the Test Unit.

i. Performance Guarantee

The tenderer shall provide a performance guarantee as specified in the Specific Conditions of Contract for a period of five years, to provide for expenses, to cover the risk and cost of rectification of defect, noticed during the five years guarantee period. Guarantee period to start from the date of completion of the project.

9 RAILING, GRILL WORK AND FENCING:

9.1 Grill Work:

a. MS Grills shall be provided in the windows made out of mild steel sections or Aluminium Polyester powder coated sections as specified in the tender drawings/finishing schedule.

b. All steel grills shall be according to the approved detailed drawings and shall conform to Latest CPWD Specifications.

c. On MS grills an approved quality priming coat of zinc chromate shall be applied over and above a shop coat of primer and finished with two or more coats of low VOC synthetic enamel pain of approved make and shade/ powder coating as specified.

9.2 Railing :

a. **MS Railing:**

As per architectural and structural member including painting with synthetic enamel paint & primier coat complete/ powder coated as specified and as per CPWD specifications.

These shall be made from MS sections consisting of M.S. Pipes, flats, square / round bars etc. as per the detailed drawings. The work includes fixing with screws or necessary anchor bolts and flats to fix the railing rigid in position. The members shall be welded together and all the welded joints shall be filed to make smooth joints. The work includes Synthetic enamel/ powder coating/ Autocoat paint to all steel members as per manufacturers specifications after phosphating and appropriate primer coat, etc. complete. of required shade, as per the approved drawings.

i. MS Staircase Railing

Providing MS Staircase Railing with Top hand rail of 50mm dia Hollow MS pipe of 16 gauges to be welded as railing to the verticals made of 40mm dia MS tubes with 25mm dia MS Rod Mid Rails 3 Nos. welded to 40mm dia MS Tube Vertical Pipe. Verticals should be fixed to the concrete slabs with 200mm x 150mm, 10 gauge MS plate anchored with 4 Nos. of 10mm dia 75mm long Expansion bolts. All exposed MS sections to be painted with 2 coats of Synthetic Enamel paint over a coat of primer, etc., complete. all as per Architectural drawings and instructions.horizontal bars of 10mm dia MS rod of nos. as called for in the drawings to be fixed to the verticals.

ii. MS Staircase Hand Rail

Providing Staircase hand rail of 65mm dia hollow MS pipe of 16 gauge, fixed to 12mm dia MS rod bent to profile and welded to insert plates of 200mm x 125mm size and 6mm thick, anchored in the wall with 4 nos. of 10mm dia, 75mm long expansion bolts, etc., complete, as per architectural drawings. Rate to include painting all MS sections with 2 coats of Synthetic Enamel over a coat of primer.

iii. MS Handrail with Wooden Handle

Providing Staircase hand rail of 65mm dia Wooden anchored in the wall with 4 nos. of 10mm dia, 75mm long expansion bolts, etc., complete, as per architectural drawings. Rate to include painting all MS sections with 2 coats of Synthetic Enamel over a coat of primer.

b. **GI Pipe Railing**

Providing GI pipe railing as per detailed drawings above flooring with `A' class GI pipes as per design including all specials, bends, elbows, Tees and with holdfasts or clamps. If the pipe railing is to be fixed in ground or brick work it shall be with 300 x 300 x 450mm (1:2:4 PCC) and if it is to be fixed in RCC work with necessary anchor bolts and plates to fix the railing rigidly in position.

c. **Stainless Steel Railing**

- These shall be made from Stainless Steel sections of grade 304, consisting of SS. Pipes, flats, square / round bars etc. as per the detailed drawings. The work includes fixing with screws or necessary anchor bolts and flats to fix the railing rigid in position. The members shall be welded together and all the welded joints shall be filed to make smooth joints. The scope of the work includes preparation of the shop drawings (based on the tender / architectural drawings), fabrication, supply, installation and protection of the stainless steel railing till completion and handing over of the work.

- The Contractor shall procure and submit to the Engineer-in-Charge, samples of various materials for the railing work, for approval. After approval of samples, the Contractor shall prepare a mock up for approval of Engineer-in-Charge / HLL. The material shall be procured and the mass work taken up only after the approval of the mock up by the Engineer-in-Charge / HLL. The mock-up shall be dismantled and removed by the contractor as per the directions of the Engineer-in-Charge. Nothing extra shall be payable on this account.

- The stainless steel shall be of grade 304 with brushed steel satin finish and procured from the approved manufacturer. It shall be without any dents, waviness, scratches, stains etc.

- The required joints in the railing provided as per the architectural drawings, shall be welded in a workmanlike manner including grinding, polishing, buffing etc. all complete and compacted. The temporary clamps provided and fixed to hold the stainless steel railing, in position shall be removed after the concrete has set properly. The junction of the flooring and the cladding shall be neatly filled with weather silicone sealant of approved colour and shade. Nothing extra shall be payable on this account.

- The finished surface shall be free of any defects like dents, waviness, scratches, stains etc. and shall have uniform brushed steel satin finish. Any defective work shall be rejected and redone by the Contractor at his own cost. The finished surface shall therefore be protected using protective tape which shall be removed at the time of completion of the work. The surface shall then be suitably cleaned using nonabrasive approved cleaner for the material. Nothing extra shall be payable on this account.

- The railing shall be fixed in position using stainless steel pipes, stainless steel posts of required diameters and thickness as shown on drawing and polished to satin finish including cutting, welding, grinding, bending to required profile and shape, hoisting, butting, polishing etc.

a. Stainless Steel Handrail with Glass

The hand rail shall be 900mm high & made from 38mm diameter Brush finished stainless steel in position of Dline make with intermediate vertical balusters in stainless steel flats of size 52 x 12mm thick as recommended by the manufacturer adhering to the detail drawings. The 10mm thick edge polished toughened glass shall be rigidly held in position with vertical balusters with necessary interim and end adjustable brackets as per the manufacturers specifications. The balusters shall be rigidly held in granite floor with necessary anchor fasteners, sleeves and finally covered with brush finished stainless steel coupling as per the detail drawings. The fixing of anchor fasteners shall carried in close co-ordination with Civil Contractor and should be completed before finishing the Granite flooring as instructed by the Engineer-in-charge. The 75% of glass shall be fixed with 3M film for frosted/ etched effect to the pattern as indicated in the detail drawings. The Contractor to submit the shop drawing of the same including the fabrication details, calculations and stability report. The work to start only on written approval of the same by the Engineer – in-charge .

b. Stainless Steel Handrail without Glass

Fabricating, Supplying and Fixing in position SS Staircase Handrail with Top hand rail of mm dia Hollow SS pipe of to be welded as railing connected to the verticals through 8mm connecter plate with 2mm SS flat base plate below the hand rail. The Verticals shall be made of frame work of 2 Nos. 50X6 mm SS flat with 8mm spacer plate and rounded edges finish placed at 1000mm c/c as balusters as per the detail architectural drawing. Mid rails shall be 3 Nos 20mm dia SS rods connecting the verticals. Balusters should be fixed to the concrete slabs with 150mm x 100mm, 6mm SS plate anchored with 4 Nos. of 10mm dia 75mm long Expansion bolts as per the detail drawings. All SS sections will be finish as per Engineer – in-charge's instructions. All sections to be of grade 304.The Contractor to submit the shop drawing of the same including the fabrication details, calculations and stability report. The work to start only on written approval of the same by the Engineer – in-charge.

c. Stainless Steel Ramp Handrail

Fabricating, Supplying and Fixing in position SS Ramp Handrail with Top hand rail of 50mm dia Hollow SS pipe of to be welded as railing connected to the verticals through 30mm wide SS flat. The Verticals shall be made of frame work of 2 Nos. 50X6 mm SS flat and rounded edges finish placed at 1300mm c/c as balusters as per the detail architectural drawing. Mid rails shall be 2 Nos 30mm X 30mm SS flat connecting the verticals. Balusters should be fixed to the concrete slabs with 150mm x 100mm, 6mm SS plate anchored with 4 Nos. of 10mm dia 75mm long Expansion bolts as per the detail drawings. All SS sections will be finish as per Engineer – in-charge instructions. All sections to be of grade 304. The Contractor to submit the shop drawing of the same including the fabrication details, calculations and stability report. The work to start only on written approval of the same by the Engineer – in-charge.

d. Stainless Steel Wheel chair Access Railing

Fabricating, Supplying and Fixing in position Wheel chair Access Railing with Top hand rail of 50mm dia Hollow SS pipe of 16 gauge to be welded as railing to the verticals made of 2 no's 50 x 6mm SS flat section placed back to back 1200mm c/c is connected with railing by 30mm wide SS flat sections as per the detail Architectural drawing and 100mm dia SS pipes 3 no's placed equally as mid rails as per the detail architectural drawing. The verticals fixed to the concrete slabs with 100mm x 150mm, 6mm MS plate anchored with 4 Nos. of 10mm dia 75mm long Expansion bolts as per the detail drawings. All SS & MS sections will be finished as per Engineer – in-charge instructions. All SS sections will be finish as per Engineer – in-charge instructions. All sections to be of grade 304. The Contractor to submit the shop

drawing of the same including the fabrication details,calculations and stability report. The work to start only on written approval of the same by the Engineer – in-charge.

10 STRUCTURAL STEEL

a. General

i. This specification covers the fabrication and transportation to site and erection on prepared foundations and structural steel work consisting of beams, columns, purlins, vertical trusses, bracings, shear connections etc.

ii. Fabrication, erection and approval of steel structures shall be in compliance with General Specifications mentioned in CPWD specifications with up to date correction slips and IS: 800 – 1984. For the guidance on general fabrication and erection of structural steel work, Chapter 11 of IS: 800 (1984) must be followed. As far as safety is concerned guidance could be obtained from Indian safety code for structural steelwork IS: 7205(1974). Before the commencement of the erection, all the erection equipment tools, shackles, ropes etc. should be tested for their load carrying capacity. Such tests if needed may be repeated at intermediate stages also.

iii. Providing shop primer coat for steel structures. Grouting of holding-down bolt pockets and below base plates where required.

b. Scope

The fabrication and erection of the steel work consists of accomplishing of all jobs here-in enumerated including providing all labour, tools and plant all materials and consumables such as welding electrodes, bolts and nuts, oxygen and acetylene gases, oils for cleaning etc. of approved quality as per relevant IS. The work shall be executed according to the drawings, specifications, relevant codes etc. in an expeditious and workman like manner, as detailed in the specifications and the relevant Indian Standard Codes and Standard Practice and to the complete satisfaction of the Engineer-in-charge.

c. Fabrication Drawings

i. The contractor shall prepare all fabrication and erection drawings on the basis of approved design drawings and shall submit the same in triplicate to the Engineer-in-charge for review, Engineer-in-charge shall review and comment, if any, on the same. Such review, if any, by the Engineer-in-charge, does not relieve the contractor of any of his required guarantees and responsibilities. The contractor shall however be responsible to fabricate the structural strictly conforming to specifications and reviewed drawings.

ii. Fabrication drawings shall include but not limited to the following:

- Member sizes and details
- Types and dimensions of welds and bolts
- Shapes and sizes of edge preparation for welding
- Details of shop and field joints included in assemblies.
- Quality of structural steels, welding electrodes, bolts, nuts and washers etc. to be used.
- Erection assemblies, identifying all transportable parts and sub-assemblies, associated with special erection instructions, if required.
- Calculations where asked for approval.
- Connections, splices etc. other details not specifically detailed in design drawings shall be suitably given on fabrication drawings considering normal detailing practices and developing full member strengths. Where asked for calculations for the merit shall also be submitted for approval.

iii. Engineer-in-charge review shall not absolve the contractor of his responsibility for the correctness of dimensions, adequacy of details and connections. One copy will be returned reviewed with or without comments to the contractor for necessary action. In the former case further three copies of amended drawings shall be submitted by the contractor for final review.

iv. The contractor shall supply three prints each of the final reviewed drawings to the Engineer-in-charge within a week since final review.

v. If any modification is necessary in the approved drawing during the course of execution of the job, revised fabrication drawings will be prepared by the contractor, incorporating the changes and the revised fabrication drawings shall be duly got reviewed as per the above Clauses.

d. Materials

i. Rolled Sections

Structural steel will generally be of standard quality conforming to IS: 226/IS: 2062. Whenever welded construction is specified plates of more than 20 mm thickness will generally conform to IS: 2062.

ii. Welding Materials

Welding electrodes shall conform to IS: 814 and approval of welding procedures shall be as per IS: 823.

iii. Bolts, Nuts & Washers

Bolts and nuts shall be as per IS: 1367 and tested as per IS: 1608. It shall have a minimum tensile strength of 44 Kg/mm2 and minimum elongation of 23% on a gauge length of 5.65 (A- Original cross sectional area of the gauge length). Washers shall be as per IS: 2016.

iv. All materials shall conform to their respective specifications. The use of equivalent or higher grade or alternate materials will be considered only in very special cases subject to the approval of the Engineer-in-charge in writing.

v. Receipt & Storing of Materials

- Steel materials supplied by the contractor must be marked for identification and each lot should be accompanied by manufacturer's quality certificate, conforming chemical analysis and mechanical characteristics.
- All steel parts furnished by supplier shall be checked, sorted out, straightened, and arranged by grades and qualities in stores.
- Structural with surface defects such as pitting, cracks, laminations etc. shall be rejected if the defects exceed the allowable tolerances specified in relevant standards or as directed by the chief Engineer-in-charge.
- Welding wire and electrodes shall be stored separately by qualities and lots inside a dry and enclosed room, in compliance with IS: 816 - 1969 and as per instructions given by the Engineer-in-charge. Electrodes shall be perfectly dry and drawn from an electrode even, if required.

vi. Checking of quality bolts of any kind as well as storage of same shall be made conforming to relevant standards.

- Each lot of electrodes, bolts, nuts, etc. shall be accompanied by manufacturer's test certificate.
- The contractor may use alternative materials as compared to design specification only with the written approval of the Engineer-in-charge.

vii. **Material Tests**

- The contractor shall be required to produce manufacturer's quality certificates for the materials supplied by the contractor. Notwithstanding the manufacturer's

certificates, the Engineer-in-charge may ask for testing of materials in approved test houses. The test results shall satisfy the requirements of the relevant Indian Standards.

- Whenever quality certificates are missing or incomplete or when material quality differs from standard specifications the contractor shall conduct all appropriate tests as directed by the Engineer-in-charge at no extra cost.
- Materials for which test certificates are not available or for which test results do not tally with relevant standard specifications, shall not be used.

viii. Fabrication

The Contractor will submit the credential with full particulars about work completed by fabricator to be deployed for this work for approval of Engineer-in-charge. After written approval is communicated in respect of fabricator, then only the jobs should be asigned to him. Fabrication shall be in accordance with IS: 800 Section V in addition to the following:

- Fabrication shall be done as per approved fabrication drawings adhering strictly to work points and work lines on the same. The connections shall be welded or bolted as per design drawings. Work shall also include fabricating built up sections.
- Any defective material used shall be replaced by the contractor at his own expense, care being taken to prevent any damage to the structure during removal.
- All the fabricated and delivered items shall be suitably packed to be protected from any damage during transportation and handling. Any damage caused at any time shall be made good by the Contractor at his own cost.
- Any faulty fabrication pointed out at any stage of work shall be made good by the contractor at his own cost.

a. Preparation of Materials

Prior to release for fabrication, all rolled sections warped beyond allowable limit shall be pressed or rolled straight and freed from twists, taking care that an uniform pressure is applied. Minor warping, corrugations etc. in rolled sections shall be rectified by cold working. The sections shall be straightened by hot working where the Engineer-in-charge so direct and shall cooled slowly after straightening. Warped members like plates and flats may be used as such only if wave like deformation does not exceed L/1000 but limited to 10 mm (L-Length). Surface of members that are to be jointed by lap or fillet welding or bolting shall be even so that there is no gap between overlapping surfaces.

b. Marking

Marking of members shall be made on horizontal pads, of an appropriate racks or supports in order to ensure horizontal and straight placement of such members. Marking accuracy shall be at least + 1 mm.

c. Cutting

Members shall be cut mechanically (by saw or shear or by oxyacetylene flame). All sharp, rough, or broken edges, and all edges of joints which are subjected to tensile or oscillating stresses, shall be ground. No electric metal arc cutting shall be allowed. All edges cut by oxyacetylene process shall be cleaned of impurities prior to assembly. Cutting tolerances shall be as follows:

a) For members connected at both ends + 1 mm.

b) Elsewhere + 3 mm.

The edge preparation for welding of members more than 12 mm thick shall be done by flame cutting and grinding. Cut faces shall not have cracks or be rough. Edge preparation shall be as per IS : 823 - 1964.

d. Drilling

Bolts holes shall be drilled. Drilling shall be made to the diameter specified in drawings. No enlarging of holes filling, by mandrolling or oxyacetylene flame shall be allowed. Allowed variations for holes (out-of-roundness, eccentricity, plumb-line deviation) shall be as per IS: 800.

- Maximum deviation for spacing of two holes on the same axis shall be + 1 mm.
- Two perpendicular diameters of any oval hole shall not differ by more than 1 mm.

e. Drilling faults in holes may be rectified by reaming the holes to the next upper diameter, provided that spacing of new hole centres and distance of hole centres to the edges of members are not less than allowed and that the increase of hole diameter does not impair the structural strength. Hole reaming shall be allowed if the number of faulty holes does not exceed 15% of the total number of holes for one joint.

f. Welding:

i) Preparation of Members for Welding

- All welding in mild steel work shall be done with electrodes and / or by methods recommended by the suppliers of the metals being welded in accordance with corresponding Indian Standards. Type, *size* and spacing of welds, shall be as specified. All welding consumables shall be in accordance with the I.S. standards.
- Welds behind finished mild steel surfaces shall be so done as to eliminate distortion and / or discoloration on the finished side.
- Weld spatter and welding oxides on finished surfaces shall be removed by descaling and / or grinding. Plug, puddle or spot welding shall not be permitted. If weld beads are visible on exposed finished surfaces, the surfaces shall be ground and polished to match and blend with finish on adjacent parent metal.
- Structural welds shall be made by certified welders and shall conform to I.S. code. The welds shall be tested by the Contractor to ensure quality and integrity of the structural welds. However, welding tests shall be carried out as below: and the contractor shall maintain records for Visual testing – 100 % of the welds for size and quality. Fillet weld testing- 30 % of the welds for MPI or Dye penetration test
- Dirt grease, lubricant, or other organic material shall be removed by vapor degreasing or suitable solvent.
- Joints rejected because of welding defects may be repaired only by re welding. Defective welds shall be removed by chipping or machining. Flame cutting shall not be allowed.

ii) Assembly of structural members

Assembly of structural members shall be made with proper jigs and fixtures to ensure correct positioning of members (angles, axes nodes etc.) Sharp edges, rust of cut edges, notches, irregularities and fissures due to faulty cutting shall be chipped or ground or filled over the length of the affected area, deep enough to remove faults completely. Edge preparation for welding shall be carefully and accurately made so as to facilitate a good joint. Generally no special edge preparation shall be required for members under 8 mm thick. Edge preparation (beveling) denotes cutting of the same so as to result in V, X K or U seam shapes as per **IS: 823**. The members to be assembled shall be clean and dry on the welding edges. Under no circumstances shall wet, greasy, rust or dirt covered parts be assembled. Joints shall be kept free from

any foreign matter likely to get in to the gaps between members to be welded. Before assembly the edges to be welded as well as adjacent areas extending for at least 20 mm shall be cleaned (until metallic polish is achieved). When assembling members, proper care shall be taken of welding shrinkage and distortions, as the drawing dimensions cover finished dimensions of the structure. The elements shall be got checked and approved by the Engineer-in-charge or their authorized representative before assembly. The permissible tolerances for assembly of members preparatory to welding shall be as per IS: 823. After the assembly has been checked, temporary tack welding in position shall be done by electric welding; keeping in view finished dimensions of the structure.

iii) Welding procedures

Welding shall be carried out only by fully trained and experienced welders as tested and approved by the Engineer-in-charge. Any test carried out either by the Engineer-in-charge or their representative or the inspectors shall constitute a right by them for such tests and the cost involved thereon shall be borne by the contractor himself. Qualification tests for welders as well as tests for approval of electrodes will be carried out as per IS: 823. The nature of test for performance qualification of welders shall be commensurate with the quality of welding required on this job as judged by the Engineer-in-charge. The steel structures shall be automatically, semi-automatically or manually welded as per direction of Engineer-in-charge. Welding shall begin only after the checks mentioned in Clause herein have been carried out. The welder shall mark with his identification mark on each element welded by him. When welding is carried out in open air, steps shall be taken to protect the face of welding against wind or rain. The electrodes, wire and parts being welded shall be dry. Before beginning the welding operation, each joint shall be checked to ensure that the parts to be welded are clean and root gaps provided as per IS: 823. For continuing the welding of seems discontinued due to some reason, the end of the discontinued seem shall be melted in order to obtain a good continuity. Before resuming the welding operation, the groove as well as the adjacent parts shall be well cleaned for a length of approx. 50 mm. For single butt welds (in V, 1/2 V or U) and double butt welds (in K, double U etc.) the re-welding of the root is mandatory but only the metal deposit on the root has been cleaned by back gouging or chipping. The welding seams shall be left to cool slowly. The contractor shall not be allowed to cool the welds quickly by any other method. For multi-layer welding, before welding the following layer, the formerly welded layer shall be cleaned metal bright by light chipping and wire brushing. Backing strips shall not be allowed. The order and method of welding shall be so that -

- No unacceptable deformation appears in the welded parts.
- Due margin is provided to compensate for contraction due to welding in order to avoid any high permanent stresses.

The defects in welds must be rectified according to IS: 823 and as per instruction of Engineer-in-charge.

iv) Weld Inspection

The weld seams shall satisfy the following:

- shall correspond to design shapes and dimensions.
- shall not have any defects such as cracks, incomplete penetration and fusion, under-cuts, rough surfaces, burns, blow holes and porosity etc. beyond permissible limits.

During the welding operation and approval of finished elements, inspections and tests shall be made as shown in annexure-B. The mechanical characteristics of the welded joints shall be as in IS: 823.

v) Preparation of Members for Bolting

The members shall be assembled for bolting with proper jigs and fixtures to sustain the assemblies without deformation and bending. Before assembly, all sharp edges, shavings, rust dirt, etc. shall be removed. Before assembly, the contacting surfaces of the members shall be cleaned and given a coat of primer as per IS: 2074.The members which are bolt assembled shall be set according to drawings and temporarily fastened with erection bolts (minimum 4 pieces) to check the co-axiality of the holes. The members shall be finally bolted after the deviations have been corrected, after which there shall not be gaps. Before assembly, the members shall be checked and got approved by the Engineer-in-charge. The difference in thickness of the sections that are butt assembled shall not be more than 3% or maximum 0.8 mm whichever is less. If the difference is larger, it shall be corrected by grinding or filling. Reaming of holes to final diameter or cleaning of these shall be done only after the parts have been check assembled. As each hole is finished to final dimensions (reamed if necessary) it shall be set and bolted up. Erection bolts shall not be removed before other bolts are set.

vi) Bolting up

Final bolting of the members shall be done after the defects have been rectified and approval of joints obtained. The bolts shall be tightened starting from the centre of joint towards the edge.

vii) Planing of Ends

Planing of ends of members like column ends shall be done by grinding when so specified in the design. Planning of butt welded members shall be done after these have been assembled, the spare edges shall be removed with grinding machines or files. The following tolerances shall be permitted on member that has been planed.

- On the length of the member having both ends planed, maximum + 2 mm with respect to design.
- Level differences of planed surfaces, maximum 0.3 mm.
- Deviation between planed surface and member's axis maximum 1/1500.

viii) Holes for Field Joints

Holes for field joints shall be drilled in the shop to final diameters and tested in the shop, with trial assemblies. When three-dimensional assembly is not possible in the shop, the holes for field joints may be drilled in shop and reamed on site after erection, on approval by the Engineer-in-charge .For bolted steel structures, trial assembly in shop is mandatory. The tolerance for spacing of holes shall be + 1 mm.

ix) Marking for Identification

All elements and members prior to dispatch from the fabrication yard for erection shall be shop marked. The members shall be visibly marked with a weather proof light coloured paint. The size and thickness of the numbers shall be chosen as to facilitate the identification of members. For the small members that are delivered in bundles or crates, the required marking shall be done on small metal tags securely tied to the bundle, while the crates shall be marked directly. Each bundle or crate shall be packed with members for one and the same assembly; in the same bundle or crate, general utility members such as bolts, quests etc. may be packed. List of materials showing weight, quality and dimension of contents shall be placed in the crates.

The members shall be marked with a durable paint, in a visible location, preferably at one end of the member so that these may be easily checked during storage and erection. All members shall be marked in the shop before

inspection and acceptance. When the member is being painted, the marking area shall not be painted but bordered with white paint. The marking and job symbol shall be registered in all shop delivery documents (transportation, for erection etc.)

x) Shop Test Pre-assembly

For steel structures that have the same type of welding the shop test pre-assembly shall be performed on one out of every 10 members minimum. For bolted steel structures, shop test pre-assembly is mandatory for all elements as well as for the entire structure in conformity with previous Clause.

g. Shop Inspection and Approval

i) General

The Engineer-in-charge or their representative shall have free access at all responsible times to the contractor's fabrication shop and shall be afforded all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with drawings and specifications. Technical approval of the steel structure in the shop by the Engineer-in-charge is mandatory. The contractor shall not limit the number and kinds of tests, final as well as intermediate once, or extra tests required by the Engineer-in-charge. The contractor shall furnish necessary tools, gauges, instruments etc. and technical non-technical personnel for shop tests by the Engineer-in-charge, free of cost.

ii) Shop Acceptance

The Engineer-in-charge shall inspect and approve at the following stages:

- The following approvals may be given in shop:
  - Intermediate approvals of work that cannot be inspected later.
  - Partial approvals
  - Final approvals
- Intermediate approval of work shall be given when a part of the work is preformed later:
  - Cannot be inspected later
  - Inspection would be difficult to perform and results would not be satisfactory.
- Partial approval in the shop is given on members and assemblies of steel structures before the primer coat is applied and includes:
  - Approval of materials
  - Approval of field joints
  - Approval of parts with planed surfaces
  - Test erection
  - Approval of members
  - Approval of markings
  - Inspections and approvals of special features, like Rollers, loading platform mechanism etc.

  During the partial approval, intermediate approvals as well as all former approvals, shall be taken in to consideration.

iii) Final approval in the Shop

The final approval refers to all elements and assemblies of the steel structures, with shop primer coat, ready for delivery from shop to be loaded for transportation, or stored.

The final approval comprises of:

- Partial approvals
- Approval of shop primer coat
- Approval of mode of loading and transport
- Approval of storage (for materials stored)

h. Painting and Delivery

i) Preparation of parts for shop painting: Painting shall consist of providing at least one coat of red oxide zinc chromate primer to steel members before dispatch from shop. Primer coat shall not be applied unless:

- Surface have been wire brushed, cleaned of dust, oil, rust or sand blasted as per the requirement and direction of Engineer-in-charge etc.
- Erection gaps between members, spots that cannot be painted or where moisture or other aggressive agents may penetrate, have been filled with an approved type of oil and putty.
- The surface to be painted is completely dry.
- The parts where water of aggressive agents may collect (during transportation, storage, erection and operation) are filled with putty and provided with holes for drainage of water.
- Members and parts have been inspected and accepted
- Welds have been accepted.

The following are not to be painted or protected by any other product:

- Surface which are in the vicinity of joints to be welded at site.
- Surfaces bearing markings
- Other surfaces indicated in the design.

The following shall be given a coat of hot oil or any approved resistant lubricant only.

- Planed surfaces
- Holes for links

The surfaces that are to be embedded or in contact with the concrete shall be given a coat of cement wash. The surfaces which are in contact with the ground, gravel or brick work and subject to moisture shall be given bituminous coat. The other surfaces shall be given a primer coating.

Special attention shall be given to locations not easily accessible, where water can collect and which after assembly and erection cannot be inspected, painted and maintained. Holes shall be provided for water drainage and in accessible box type sections shall be hermetically sealed by welds.

The contractor shall paint further coats of red-oxide after erection and placing in position of the steel structures as directed by the Engineer-in-Charge.

ii) Packing, transportation, delivery

After final shop acceptance and marking, the item shall be packed and loaded for transportation. Packing must be adequate to protect item against warping during loading and unloading. Proper lifting devices shall be used for loading, in order to protect items against warping. Slender projecting parts shall be braced with additional steel bars, before loading, for protection against warping during transportation. Loading and

transportation shall be done in compliance with transportation rules. If certain parts cannot be transported in the lengths stipulated in the design, the position and type of additional splice joints shall be approved by the Engineer-in-charge. Items must be carefully loaded on platforms of transportation means to prevent warping, bending or falling during transportation. The small parts such as fish-plates, quests etc. shall be securely tied with wire to their respective parts. Bolts, nuts and washers shall be packed and transported in crates. The parts shall be delivered in the order stipulated by the Engineer-in-charge and shall be accompanied by document showing:

- Quality and quantity of structure or members
- Position of member in the structure
- Particulars of structure
- Identification number job symbol.

i. Field Erection

- The erection work shall be permitted only after the foundation or other structure over which the steel work will be erected is approved and is ready for erection.
- The contractor shall satisfy himself about the levels, alignment etc. for the foundations well in advance, before starting the erection. Minor chipping etc. shall be carried out by the contractor on his expense.
- Any faulty erection done by the contractor shall be made good at his own cost.
- Approval by the Engineer-in-charge or their representatives at any stage of work does not relieve the contractor of any of his required guarantees of the contract.
- Storage and preparation of parts prior to erection

  The storage place for steel parts shall be prepared in advance and got approved by the Engineer-in-charge before the steel structures start arriving from the hop. A platform shall be provided by the Contractor near the erection site for preliminary erection work. The contractor shall make the following verifications upon receipt of material at site.

  - For quality certificates regarding materials and workmanship according to these general specifications and drawings.
  - Whether parts received are complete without defects due to transportation, loading and unloading and defects, if any, are well within the admissible limit.

  For the above work sufficient space must be allotted in the storage area which will be arranged by the contractor without any extra cost to the department. Steps shall be taken to prevent warping of items during unloading. The parts shall be unloaded, stored and stored so as to be easily identified. The parts shall be stored according to construction symbol and markings so that these may be taken out in order or erection. The parts shall be at least 150 mm clear from ground on wooden or steel blocks for protection against direct contact with ground and to permit drainage of water. If rectification of members like straightening etc. are required, these shall be done in a special place allotted which shall be adequately equipped. The parts shall be clean when delivered for erection.

j. Erection & Tolerances

Erection in general shall be carried out as required and approved by the Engineer-in-charge. Positioning and levelling of the structure, alignment and plumbing of the stanchion and fixing every member of the structure shall be in

accordance with the relevant drawings and to the complete satisfaction of the Engineer-in-charge.

The following checks and inspection shall be carried out before during and after erection.

- damage during transportation
- accuracy of alignment of structures
- erection according to drawings and specifications
- progress and workmanship.

There may be any deviations regarding positions of foundations or anchor bolts, which would lead to erection deviations, the Engineer-in-charge shall be informed immediately. Minor rectifications in foundations, orientation of bolts holes etc. shall be carried out as part of the work, at no extra cost. The various parts of the steel structure shall be so erected so to ensure stability against inherent weight, wind and erection stresses. The structure shall be anchored and final erection joints completed after plan and elevation positions of the structural members have been verified with corresponding drawings and approved by the Engineer-in-charge. The bolted joints shall be tightened so that the entire surface of the bolt heads and nuts shall rest on the member. For parts with sloping surfaces tapered washers shall be used.

k. Final acceptance and handing over the structure

(i) At acceptance, the contractor shall submit the following documents:

- Shop and erection drawings – four sets soft copy and hard copies

4 copies of each of the following:

- Shop acceptance documents quality certificate for structurals, plates, etc. (electrodes, welding wire, bolts, nuts, washers etc.)
- List of certified welders who worked on erection of structures.
- Acceptance and intermediate control procedure of erection operations.

(ii) Approval by the Engineer-in-charge at any stage of work does not relieve the contractor of any of his required guarantees of the contract.

l. Grouting of Pockets

(i) Grouting of pockets and under base plates will be done only after the steel work has been levelled and plumbed and the bases of stranchions are supported by steel shims. The space below the base plate and pockets shall be thoroughly cleaned.

(ii) The mortar used for grouting shall not be leaner than 1:2 (1 cement: 2 sand) (grade 300 in case of concrete) or as is specified and shall be mixed to the minimum consistency required. It shall be poured under suitable head and tamped until the space has been completely filled.

m. Tolerances allowed in the erection of building without cranes

The maximum tolerances for line and level of the steel work shall be + 3.00 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10 M. section of height and not more than 7.0 mm per 30 M. section. These tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

n. Contractor to submit shop drawing for all structural steel work for approval. The work at site should commence only after getting the shop approved.

o. Contractor to get erection scheme approved before commencement of erection of trusses.

11 FLOORING:

a. The flooring in the building shall be as per the approved finishing schedule appended in DBR, Vol-4/ Tender drawings and laid in such a way that limits in floor levels would not exceed the limits provided in the latest CPWD specifications or manufactures specifications.

b. In order to keep the floor finish as per direction of Engineer-in-charge and as per Finishing Schedule/ Architectural drawings and to provide required thickness of the flooring as per specification, the level of top surface of RCC shall be accordingly adjusted at the time of its centering, shuttering and casting. Alternatively, for maintaining the floor finish, grading with cement concrete with nominal mix 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 10mm nominal size) shall be provided.

c. Wherever Vitrified Tile flooring is done, it shall be with 1st Quality multi-grade/multi-range tiles.

d. Slope in floors shall be provided as per architectural drawings, else the levels at any place when checked over a distance of one meters in any direction should not show variation in floor level more than 3 mm.

e. Protective layer to be provided of all types of flooring.

f. The grouting of the joints shall be with white cement and matching pigment.

g. The edges of steps in the staircases, counters, kitchen platform, window sills, facias and similar location shall be edge moulded as required.

11.1 Minimum Bed mortars for various types of flooring

11.1.1 Chequered tiles/stone flooring/kota stone flooring/granite flooring/ Ceramic glazed floor tile flooring/vitrified flooring - 20mm thick bed of cement mortar 1:4 (1 cement: 4 coarse sand). Anti Acid Tiles- 10 mm thick epoxy resin based adhesive.

11.1.2 For dado, skirting and risers of steps in Chequered tiles/stone /kota stone /granite / Ceramic glazed floor tile /vitrified tiles- 12mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand).

11.1.3 The vertical facia and drops shall be finished with epoxy resin based adhesive.

11.2 Granite Work

The granite stonework shall, in general, be carried out as per the CPWD Specifications and relevant specification for marble flooring, skirting, dado and tread/risers of steps under Flooring Sub Head of the CPWD Specifications shall prevail.

Granite stone slabs shall be pre polished (mirror polished), eggshell polished, flame finished or given any other surface treatment as specified, as per the Engineer-in-charge architectural drawings and as directed by the Engineer-in-Charge. Machine polishing and cutting to required size shall be done with water (as lubricant) only. Sawing shall also be done preferably with water as lubricant but as a special case, the Engineer-in-Charge may permit, at his discretion, oil or kerosene as lubricant subject to all kerosene or oil in the body and surface of tiles / slabs being thoroughly dried in ovens. Tiles / slabs with stains or patches due to the use of oil or otherwise, either before or after installation, shall be rejected and shall be replaced by the Contractor at his own cost. Nothing extra shall be payable on this account.

Before execution of the granite stone work, the contractor shall submit for the approval of the Engineer-in-Charge, the samples with following details:

a) Three representative samples for each type of granite stone specified.

b) Details of physical characteristics such as dimensional tolerances (within the specified limits), water absorption, compressive strength, Mohs Hardness, Specific gravity with reference to IS or International standards.

c) Source of supply and confirmation of availability in full quantity and uniformity of colour, tone and textures.

d) Company profile of Suppliers.

The decision of the Engineer-in-Charge as regards the approval of the samples for the various types of the granite stones shall be final and binding on the Contractor.

The entire supply for each type of granite stone slab shall be procured from one location (in one quarry), and supplied preferably, in one lot to keep variations to the minimum. The Contractor shall also segregate and sort the slabs according to colour, shade, texture and size of grains etc. to keep variation(s) in stones used at any one floor to the minimum. Any slab with variation in the colour, shade, texture and size of grains etc., not acceptable to the Engineer-in-Charge, shall not be used in the work and shall be removed and replaced by the Contractor.

The stone work may be required to be carried out in patterns, design and / or in combination with granite stones of different colour and shade with or without borders and in combination of different stone slabs / ceramic tiles for which nothing extra shall be payable. The stones shall be provided in sizes and shapes as per the approved Engineer-in-charge architectural drawings and wastages and incidental costs, if any, shall be deemed to be covered in the cost of the relevant items. Nothing extra shall be payable on this account.

The following tolerances shall be allowed in the dimension of granite stone slab:

Slabs:	**Tolerance**
a). Length	± 1mm
b). Width	± 1mm
c). Thickness	- 1mm
d). Angularity at corners	± 0.25%

The stones slabs not meeting the above tolerance limits shall be rejected and not permitted to be used in the work. Nothing extra shall be payable on this account.

Stones slabs shall have uniform thicknesses with-in the tolerance limits and linear items like treads, sills and jambs, coping, risers, urinal partitions, kitchen / wash basin platforms, vanity counters, facias and other similar locations etc. shall have edge polished calibrated thickness i.e. exposed edges shall have edge polished uniform thickness throughout the length of the work.

For the steps (risers and treads) in the linear profile, the granite stone shall be provided in single pieces up to 2.0m, unless otherwise specifically permitted by the Engineer-in-Charge. Wherever grooves are required to be provided the same is to be done, the joints shall be provided.

The granite slabs used for providing and fixing in the sills, soffits and jambs of doors, windows, ventilators and similar locations shall be in single piece unless otherwise directed by the Engineer-in-Charge.

The granite stone slab shall be fixed over low level storage cabinets using necessary adhesive as per the manufacturer's specification. The stone shall have uniform thickness and shall be provided in sizes as per architectural drawings. The stone slab shall have uniformly levelled surface after fixing. All the joints shall be finished smoothly in a workmanlike manner.

The granite work shall be adequately protected by a layer of Plaster Of Paris, which shall be maintained throughout and removed just before handing over of the works.

11.3 Vinyl Flooring:

a. Vinyl Flooring

i) Providing and fixing Vinyl Flooring of 2mm thick homogeneous flooring with veined surface pattern and non directional chip texture as per EN649. The tile size should be 615mm x 615mm. The floor should have residual indentation of 0.035mm as per EN 433, the light fastness> 6 as per ISO 105-B02 & electrical resistance should be $5x10^4<R<10^6\Omega$ as per EN 1081 for EC. The product should also

confirm to class Bfl- s1 in flammability test as per EN13501-1, slip resistance of R9 as per DIN51130, dynamic coefficient of friction with class DS as per EN 13893. The wear group of Sheet is M as per EN 660-2. Flooring should have excellent chemical resistance as per EN423.The joints to be welded with hot welding coils.

ii) Vinyl flooring as per EN 649, with a 183cm/16-25m sheet width/sheet length, a synthetic floor covering with surface protection. With a thickness of 2mm, it is homogeneous and durable which offers low maintenance. Adhesive to be used is Arobond 44 or equivalent of approved brand and manufacturer. Adhesive must be applied evenly with suitable toothed trowel. Drying time ranges from 24-48 hrs. after installation.

iii) Installation:

It is important to ensure the sub floor on which the sheet is being laid is smooth, flat & hard & free from moisture, grease, etc. In case of uneven sub floor the same should be leveled by self-leveling compound. The moisture level present in the subfloor should be less than 8% before installation of the floor.

The floor shall be laid on a copper strip/foil such that the strip is laid on the perimeter of the room and at the long diagonal of the room. Connection options for the earthing system should be provided at two points in the room, or in larger rooms (over 40 m^2) at several points.

The sheet should be laid using water based adhesive like Arobond 44 or similar. Installation should be followed by rolling the sheet with a 45kg roller. The joints should be chord welded with the same color welding rod to have a seamless finish. Post installation maintenance instructions should be followed as per company standards and regular maintenance instructions should be followed to sustain the life span of the product. The installation shall be undertaken as per the manufacturer's installation instructions.

b. <u>Conductive Vinyl Flooring</u>**:**

i) Providing and fixing Conductive Vinyl Flooring of 2mm thick homogeneous flooring with veined surface pattern and non-directional chip texture as per EN649. The tile size should be 615mm x 615mm. The floor should have residual indentation of 0.035mm as per EN 433, the light fastness> 6 as per ISO 105-B02 & electrical resistance should be $5x104<R<106\Omega$ as per EN 1081 for EC. The product should also confirm to class Bfl- s1 in flammability test as per EN13501-1, slip resistance of R9 as per DIN51130, dynamic coefficient of friction with class DS as per EN 13893. The wear group of Sheet is M as per EN 660-2. Flooring should have excellent chemical resistance as per EN423.The joints to be welded with hot welding coils.

ii) Conductive Vinyl Flooring of 2 mm layer homogeneous flooring with veined surface pattern and non-directional chip texture as per EN649 with 0.2 mm conductive foil backing. The sheet would have an overall thickness of 2.2 mm, width of 1.83 mts & length between 16 to 25mts. The sheet should have residual indentation of 0.06mm as per EN 433, the color fastness > 6 as per ISO105-B02, vertical resistance < $1X10^6$ Ohm as per EN1081 and the static electric charge < 2 kV as per EN1815. The product should also confirm to class Bfl - s1 in flammability test as per EN 13501-1, slip resistance of R10 as per BGR 181, dynamic coefficient of friction with class DS as per EN13893. The wear group of sheet is P as per EN 649.

iii) Installation:

It is important to ensure the sub floor on which the sheet is being laid is smooth, flat & hard & free from moisture, grease, etc. In case of uneven sub floor the same should be leveled by self-leveling compound. The moisture level present in the subfloor should be less than 8% before installation of the floor.

The floor shall be laid on a copper strip/foil such that the strip is laid on the perimeter of the room and at the long diagonal of the room. Connection options for

the earthing system should be provided at two points in the room, or in larger rooms (over 40 m²) at several points.

The sheet should be laid using water based adhesive like Arobond 44 or similar. Installation should be followed by rolling the sheet with a 45kg roller. The joints should be chord welded with the same color welding rod to have a seamless finish. Post installation maintenance instructions should be followed as per company standards and regular maintenance instructions should be followed to sustain the life span of the product. The installation shall be undertaken as per the manufacturer's installation instructions.

11.4 Epoxy Flooring

Epoxy floor coating with a three component solvent base, epoxy resin coating system of approved brand and manufacturer including applying two coats to achieve a total dry film thickness of 90 microns to provide a hard wearing, easily cleaned, attractive floor coating in areas where high resistance to chemical attack is required making sure the time between two coats is 6-24 hrs @ 20degree celcius and 4-16 hours at 35 degree celcius as per manufacturer specifications.

11.5 Tactile Flooring

Fully vitrified unglazed porcelain tile of size 300x300x10mm specially designed to assist the visually impaired- 'foot Braille' of approved colour. Conformance with RNIB, DETR & ADA. Very dense, durable and abrasion resistant, high chemical and stain resistant with high strength and durability. Fade proof with low water absorption (below 0.5%) and excellent slip resistance.

11.6 Flooring for SERVER/ EPABX/ Fire Control/ CCTV Room

Removable raised/ false access flooring with system and its components of approved make for 300/450 mm height with possible height adjustment conforming to CPWD Specifications.

11.7 Carpet Flooring (Auditorium)

Flocked floor covering rolls or equivalent having a density of 70 million fibers of nylon 6.6 per sqm , Appearence Retention Hexapod ISO 140-8, Friction Slip Resistance Test EN 14041 Class DS, sanitized anti-microbial treatment with resilient waterproof backing ,anti-allergic cetrtified by British allergy foundation, anti-static, thickness 6 mm and approximate weight of 1.8 k.g./sqm of roll form. The resistance to fire should be as per EN 13501-1: Bfl-s1. shade as approved by client and installed by approved applicator of manufacturer. Flocked flooring should be installed over CC flooring as per manufacturer specification and directions of Engineer in charge.

11.8 Wooden Laminated Flooring.

The wooden laminates shall be 8mm thick conforming to EN 13329, ASTM C 1028, DIN 52185, DIN 54345, EN 717-2, DIN 4102. matt finish of required shade- with inbuilt 3mm Sound Bloc - Class of use 34/23, wear resistance AC - 4, impact resistance -IC 3, (as per EN 13329), having 0.6mm MLC (Multi-Layer Composite) high pressure laminate, surface treated with (Aluminum Oxide) surface guard + and SRSG2 (Scratch resistance surface second generation) on top of Moisture Resistant High Density Fibre Board substrate specially developed core; of plank size minimum 1196 mm x 196 mm having click system joints tounge and groove to secure long lasting joint, the tounge and groove having the edges duly pre impregnated with paraffine and laid over underly of 0.2mm thick Alkali Resistant Polyethylene Sheet (Density 920-935 kg/Cum) complete as per manufacturers specifications and direction of Engineer-in-Charge.

Hardwood Flooring if specified shall be carried out as per CPWD Specifications

11.9 Wooden Cladding

Providing and fixing panelling on wall. Framing shall consist of Aluminium Section 50 mm x 40 mm (Wall Thickness 2 mm) @ 2'0" C/C. Both ways horizontally and vertically on the wall. This framing shall be covered by ¼" thk. Ply & Rose wood veneer or as approved by the Engineer-in-charge, finished with melamine polish. Alternatively framing shall be

covered by ¼" thk. Ply and finished with 1.5mm thick Laminate. Wooden moulding, lipping etc. as directed by the Engineer-in-charge shall be provided wherever required.

12 FALSE CEILING

12.1 General: -

a. The false ceiling in the buildings shall be as per the approved finishing schedule appended in DBR, Vol-4/ tender drawings as per latest CPWD specifications or manufactures specifications.

b. False ceiling items in general are carried out as per the manufacturer's specifications / as directed by the Engineer – in – Charge.

c. Location of particular type of false ceiling shall be as per relevant drawing, in its absence written approval of the Engineer – in - charge shall be obtained.

d. The false ceiling tiles from manufacturers using recycled materials shall be preferred.

e. Trap doors, as required, of approved size and design shall be provided.

12.2 Mineral Fibre Ceiling Tile

a. **16 mm Mineral Fibre ceiling Tile**

i. Material

Ceiling tiles shall be of made of mineral fibre of dimension 595x595mm with 16 mm thickness humidity resistance 99% Thermal conductivity K = 0.052-0.057 w/mK colour white, fire performance UK Class 0/Class 1 (BS 476 pt -6&7) suitable for green building application (GRIHA Criteria 17 & 29 SWAGRIHA 12) with recycled content not less than 30 % and light reflectance not less than 85%. NRC of 0.55 to 0.6. The tile and grid should carry a limited warranty of one year against sag.

ii. Frame

The frame work shall consist of G.I. ' T ' Sections for Main runners 15x38x3000mm length, Cross runners of 15x32x1200mm & 15x32x600mm size, 0.33 mm thickness as specified in the item with galvanization of 120 gsm (minimum) and perimeter wall angle of 0.40mm (minimum) thick gauge having equal flanges of size 24x24mm made from precoated G.I. Coil length of 3.0m fixed to the wall with the help of plastic rawl plugs at 450mm centre to centre with 50mm long dry wall SS screws. The frame work shall be executed in a manner so as to form a grid of 600x600mm as specified in the item.

iii. Fixing of Ceiling Tiles

The frame work shall be suspended from ceiling by L shape level adjuster hangers made of G.I. Of size 85x25x25x2mm having die cut slit for sliding into main T section, also having precut hole so that 6mm fully threaded MS rod length upto 1000mm goes through it and pierces into M6 dash fasteners (Galvanising of 80 gsm minimum) of 6 mm dia 50mm long, fixed to the slab and then tightened with check nuts, subsequently the bottom of 6 mm rod will be tightened with check nuts for adjusting the line & level. The tile shall be laid on 15x32mm wide T section flanges colour white having rotary stitching on all T sections i.e. the main runner, 1200 mm & 600 mm cross Tees with a web height of 32 mm and load carrying capacity of 7.57Kgs/m2. The fixing arrangement shall be as per CPWD specifications / Manufacturer's specifications.

b. **20mm Mineral Fibre Ceiling Tile**

General specification for providing and fixing mineral fibre false ceiling tiles item to be same as **mentioned** in para i. to v. of para a. above except the thickness of mineral fibre tile will be 20 mm and NRC value 0.7.

c. **16mm Antimicrobial Ceiling Tile**

General specification for providing and fixing 16 mm thick beveled tegular mineral fibre false ceiling tiles item to be same as **mentioned** in para i. to iii. of para a. above except the tile will be Anti-microbial false ceiling tiles.

d. **20mm Mineral Fibre Ceiling Tile**

General specification for providing and fixing mineral fibre false ceiling tiles item to be same as **mentioned** in para i. to iii. of para a. above except the thickness of mineral fibre tile will be 20 mm and NRC value 0.7.

e. **16mm Antimicrobial Ceiling Tile**

General specification for providing and fixing 16 mm thick beveled tegular mineral fibre false ceiling tiles item to be same as **mentioned** in para i. to iii. of para a. above except the tile will be Anti-microbial false ceiling tiles.

12.3 Light Weight Calcium Silicate False Ceiling Tiles

a. **15mm Tegular edged light weight calcium silicate false ceiling tiles**

i. **Material**

15 mm thick tegular edged light weight calcium silicate false ceiling tiles with integral densified calcium silicate reinforced with fibre and natural filler false ceiling tiles of Size 595x595 mm of approved texture, design and patterns having NRC (Noise Reduction coefficient) of 0.50 (minimum) as per IS 8225:1987, Light reflectance of 85% (minimum). Non-combustible as per BS: 476 (part-4), fire performance as per BS:476 (part 6 &7), humidity resistance of 100%, thermal conductivity <0.043 W/mK as per ASTM 518:1991.The tests shall have average density of 370 kg/m^3 (minimum) as per ECBC code 2007. The tile shall be primer coated on both sides and the fair surface shall be having a factory finish in two coats of white dispersion type solvent free paint.

ii. **Frame**

The frame work shall consist of G.I. 'T' Sections for Main runners 24x38x3000mm length, Cross runners of 24x32x1200mm & 24x32x600mm size, 0.33 mm thickness as specified in the item with galvanisation of 120 gsm (minimum) and perimeter wall angle of 0.40mm (minimum) thick gauge having equal flanges of size 24x24mm made from precoated G.I. Coil length of 3.0m fixed to the wall with the help of plastic rawl plugs at 450mm centre to centre with 40mm long dry wall SS screws. The frame work shall be executed in a manner so as to form a grid of 600x600mm as specified in the item.

iii. **Fixing of Ceiling Tiles**

The frame work shall be suspended from ceiling by L shape level adjuster hangers made of G.I. Of size 85x25x25x2mm having die cut slit for sliding into main T section, also having precut hole so that 6mm fully threaded MS rod length upto 1000mm goes through it and pierces into M6 dash fasteners (Galvanising of 80 gsm minimum) of 6 mm dia 50mm long, fixed to the slab and then tightened with check nuts, subsequently the bottom of 6 mm rod will be tightened with check nuts for adjusting the line & level. The tile shall be laid on 24x32mm wide T section flanges colour white having rotary stitching on all T sections i.e. the main runner, 1200 mm & 600 mm cross Tees with a web height of 32 mm and load carrying capacity of 7.57Kgs/m^2.

b. **15mm thick integral densified micro edged light weight calcium silicate false ceiling tiles**

i. **Material**

15mm thick integral densified micro edged light weight calcium silicate false ceiling tiles with integral densified calcium silicate reinforced with fibre and natural filler false ceiling tiles of Size 595x595 mm of approved texture, design and patterns having NRC (Noise Reduction coefficient) of 0.50 (minimum) as per IS 8225:1987, Light reflectance of 85% (minimum). Non combustible as per BS:

476 (part-4), fire performance as per BS:476 (part 6 &7), humidity resistance of 100%, thermal conductivity <0.043 W/mK as per ASTM 518:1991.The tests shall have average density of 370 kg/m^3 (minimum) as per ECBC code 2007. The tile shall be primer coated on both sides and the fair surface shall be having a factory finish in two coats of white dispersion type solvent free paint.

ii. **Frame**

The frame work shall consist of G.I. ' T ' Sections of 25 micron hot dipped galvanised iron section of 0.40mm thick on Silhouette profile, rotary stitched double webbed white with 6mm reveal profile (white/black) compromising of Main runners 15x42x3000mm length, Cross runners of 15x42x1200mm & 15x42x600mm size to form grid module of size 600x600mm. Galvanised iron perimeter wall angle of size 22x19x0.4mm of length 3000mm to be fixed on periphery wall/partition with the help of plastic rawl plugs at 450mm C/C and 40mm long dry wall SS screws. The work shall be carried out as per specifications, drawing and as per direction of Engineer-in-Charge.

iii. **Fixing of Ceiling Tiles**

The frame work shall be suspended from ceiling by L shape level adjuster hangers made of G.I. Of size 85x25x25x2mm having die cut slit for sliding into main T section, also having precut hole so that 6mm fully threaded MS rod length upto 1000mm goes through it and pierces into M6 dash fasteners (Galvanising of 80 gsm minimum) of 6 mm dia 50mm long, fixed to the slab and then tightened with check nuts, subsequently the bottom of 6 mm rod will be tightened with check nuts for adjusting the line & level. The tile shall be laid on 15x42mm wide T section flanges colour white having rotary stitching on all T sections i.e. the main runner, 1200mm & 600mm cross Tees with a web height of 42 mm and load carrying capacity of 7.57Kgs/m^2.

c. **15mm Tegular/integral densified micro edged Light weight calcium silicate false ceiling tiles**

12.4 Under Deck Insulation- Glass Wool Insulation Board

a. **Material:-**The under deck insulation shall be with Glass Wool Insulation Board. The Glass Wool Board shall conform to following specifications.

GLASS INSULATION WOOL BOARD (GREEN BUILDING)			
	Test Parameters	**Standard Value**	**Tolerance**
1	**Physical Test**		
a	Visual Appearance		
b	Shots Content	Free from Shot Content (Tested as per IS : 8183)	
c	Dimensions		
	Length	1200 mm	+20 mm/ -10 mm
	Width	600 mm	+10 mm/ -10 mm
	Thickness	100mm	+5 mm/ -5 mm
d	Bulk Density	48 Kg/M^3	± 15%
e	Hydrophobic / Non Hydrophobic Behavior (Tested as per Is – 8183 / 3144)		
	i. Moisture Content	2.0% Max	
	ii. Moisture Absorption	2.0% Max	
f	Incombustibility	Incombustible When Tested As Per Is 818 /	

		3144	
g	Recovery after Compression	90% Min. (Tested As Per Is -8183)	
2	**For Long Life Functionality / Dimension Retention / Rigidity**		
a	Loss on Ignition (Binder Content)	Av. 7% Minimum when evaporated at 550 ± 50 till yellow & black colourless fiber achieved	
b	Jolting Test	Height settlement not more than 3.0% in test as per IS: 8183/3144	
c	Vibration Test	Height settlement not more than 1.0% in test as per IS: 8183/3144	
d	Recycled Content	• 25% External Cullet • 10% Internal Cullet • 7% Trimmed Waste	
3	**Chemical Test :- Resistance To Corrosion Attack**		
a	Chloride Content %	0.01% max. (tested as per IS: 8183)	
b	Alkalinity	Ph- 7.0 – 10.0 (tested as per IS: 8183)	
c	Odour Emission Test	No apparent difference in odour(tested as per IS: 8183- 1993)	
4	**Type Test**		
a	Thermal Conductivity	0.3 w/m k (At 25 dg. C mean temp.)	

b. **Installation Guidelines:-**

i. The insulation board to be fixed to hold against the RCC true ceiling.

ii. For fixing drill RCC slab through the insulation at 1200 mm x 600 mm centres.

iii. Apply the Hilti make IDP- 6/8 polyamide fasteners (110 mm in length) or equivalent with the help of hammer to the drilled points.

iv. All the edges of the boards placed side by side to be sealed with 50 mm wide self-adhesive white HDP tape.

v. The above insulation system can be concealed under false ceiling system if required.

12.5 Under Deck Insulation System-Polystyrene Rigid Insulation Board

a. **Materials**

50mm thick extruded polystyrene rigid insulation board of required size for Underdeck Insulation System, complying with ISO 4898:2008 & ASTM C 578-08b-type VI, having thermal conductivity of 0.0289 W/mk as per ASTM C 578 (Measured as per IS 3346), Compressive strength of 350 KPA listed as per ASTM D 1621, density of 34-36 kg/Cum as per ASTM D 1622, Water absorption $\leq$ 1% by Volume as per ASTM D 2842, Oxygen Index of 24.1 to 28.1 listed as per ASTM D 2863, cell size 0.4mm of dia (max) as per ASTM D 3576. Fire retardant property as per DIN, Part 1 of Class B2 and as per ASTM E 84 Class A.

b. **Installation Process**

i. The specified Under Deck Insulation System shall be applied by an Authorized applicator only.

ii. The level of the slab should be checked and kept within permissible limit of variation of 3 to 5mm.

iii. The Substrate/ Roof Underdeck on which the insulation system needs to be installed must be free from all waste products such as petroleum, grease, oil, solvents, vegetable or mineral oil, animal fat etc.

iv. The Insulation board must be fixed to the concrete slab from inside with the help of water based adhesive and Fasteners with PVC Capping. This has to be ensured that the PVC screws are embedded in the concrete with a minimum distance of 50mm from the edges and have a pull out strength of 0.3 kN.

c. **Requirement for extruded polystyrene rigid insulation board**

Since this product is a performance based product, the third Party testing is Mandatory and should be done from any NABL approved laboratory or any other accreditation body which operates in accordance with test ISO/IEC 17011 and accredits labs as per ISO/IEC-17025 for testing. The pattern of laying XPS and location of fasteners shall be as directed by the Engineer-in-Charge.

Sl. No.	Requirement	Test Standard	Remarks
1	Thermal Conductivity Having 180 days aged thermal conductivity of 0.0289 W/mk.	ASTM C 578	Mandatory
2	Compressive strength of > 350 KPA.	ASTM D 1621	Mandatory
3	Density of 34-36 kg/Cum.	ASTM D 1622	Mandatory
4	Water absorption < 1% by Volume.	ASTM D 2842	Mandatory
5	Oxygen Index of 24.1 to 28.1	ASTM D 2863	Mandatory
6	Cell size 0.4mm of dia (max).	ASTM D 3576	Mandatory
7	Fire retardant property as per DIN, Part 1 of Class B2	------	Mandatory
8	Fire retardant property	ASTM E 84 CLASS A	Mandatory

13 WATER PROOFING

13.1 Water Proofing Treatment-General:

i. All the items for water proofing treatment with cement based water proofing treatment for roof slab and sunken portion shall be guaranteed for TEN YEARS, to be reckoned from the date of expiring of the Defect Liability period prescribed in the contract. The Guarantee shall be furnished by the contractor as per Performa prescribed.

ii. The treatment for water-proofing of basement, roofs, water retaining areas hall be of type and specifications as given in the tender drawings/ DBR and remain fully effective for a period of not less than 10 (Ten) years to be reckoned from the date of expiring of the Defect Liability period, prescribed in the contract. At any time during the said guarantee period if the CLIENT/HLL or his representative finds any defects in the said treatment or any evidence of re-infestation, dampness, leakage in any part of buildings or structure and notifies the contractor of the same, the contractor shall be liable to rectify the defect or give re-treatment and shall commence the work or such rectification or re-treatment within seven days from the date of issue of such letter to him. If the contractor fails to commence such work within the stipulated period, the CLIENT/ HLL or his representative may get the same done by another agency at the Contractor's cost and risk and the decision of the CLIENT/ HLL for the cost payable by the contractor shall be final and binding upon him. Re-treatment if required shall be attended to and carried out by the Contractor within seven days of the notice from the CLIENT/ HLL or his representative.

iii. The work shall be got executed from the specialized agency as approved by the Engineer-in-Charge.

iv. Total quantity of the water proofing compound required shall be arranged only after obtaining the prior approval of the make by Engineer-in-charge in writing. Materials shall be kept under double lock and key and proper account of the water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements.

v. The finished surface after water proofing treatment shall have adequate smooth slope as per the direction of the Engineer-in-charge.

vi. Before commencement of treatment on any surface, it shall be ensured that the outlet drain pipes / spouts have been fixed and the spout openings have been eased and rounded off properly for easy flow of water.

vii. The approved specialized agency for the work of water proofing will have to execute a guarantee bond in prescribed Proforma enclosed at ANNEXURE-II for removing any defects for at least 10 years. Guarantee bond shall be signed by both the specialized agency as approved by the Engineer-in-Charge and the Contractor to meet their liability under the guarantee bond. However, the sole responsibility about the efficiency of water proofing treatment shall rest with the Contractor.

viii. 10% of the assessed value/ cost of water proofing work as finalized by Engineer-In-Charge shall be retained as additional security deposit and the amount so withheld would be released after ten years from the date of issue of Fnal completion Certificate of the entire work under the agreement. If the performance of the work done is found unsatisfactory and any defects noticed during the guarantee period, they shall be rectified by the Contractor within seven days of receipt of intimation of defects in the work. If the defects pointed out are not attended to within the specified period, the same will be got done from another agency at the risk and cost of the Contractor.

13.2 Water Proofing Treatment (Pre-Construction) by Chemical Injection System

13.2.1 **Horizontal Surface (Raft Slab)**

i. Before the raft reinforcement is placed in position:

a. Laying PCC as per drawings and specifications.

b. Cement slurry (cement and approved water proofing compound) is spread on the PCC for proper bonding with subsequent water proofing treatment.

c. Water Proofing Course of 20mm thick cement mortar 1:4 (1 cement: 4 coarse sand) mixed with approved water proofing compound is laid over the slurry. Stone aggregates 12mm down is embedded at random.

d. After 24 hours, spreading cement slurry (cement and approved water proofing compound) on the 1st layer of mortar.

e. Providing and laying 2nd layer of 20mm thick cement mortar 1:4 (1 cement: 4 coarse sand) mixed with approved water proofing compound. Stone aggregate 12mm down size is embedded at random.

ii. After reinforcement of raft is placed in position:

a. Providing and fixing 25mm dia GI threaded grouting nozzles of adequate length at the specified locations @ 1.50 metres c/c or as shown in the drawing all over the slab. The grouting nozzles are tied with reinforcement in such a manner as not to choke its end during concrete operations. The top of these nozzles protrudes above the raft concrete.

b. After minimum 7 days of concreting, cement grout of cement and approved water proofing compound (non-shrinkage grouting compound) in proportion as specified is injected, through these nozzles at the pressure of 2.5 to 3.0 Kg/Sq.cm.

c. After grouting, top of the nozzles is cut and the space is filled with cement mortar 1:2 (1 cement: 2 coarse sand) mixed with approved water proofing compound.

13.2.2 **Retaining Wall**

a. The external surface is prepared and approved cement slurry is applied.

b. Providing and laying 25mm thick cement mortar in 1:4 (1 cement : 4 coarse sand) mixed with approved water proofing compound in two layers with chicken wire mesh 26 or 24 gauge 25mm size in between the two layers.

c. The G.I. pipes are placed at 1.5m c/c in both directions, and, 0.75 m C/C along construction joints and securely fastened to the reinforcement prior to shuttering and concreting or alternately by drilling holes (25mm to 32mm dia) in the concrete upto a depth as shown in the drawing all over the wall surface @ 1.50mt. C/C and as shown in the drawing. Treatment along all construction joints by providing nozzles, as above, shall also be executed.

d. Fixing 25mm dia G.I. threaded nozzles in these holes with cement mortar 1:4 (1 cement: 4 coarse sand) mixed with water proofing compound.

e. Injecting cement grout of cement and polymer based water proofing compound (non-shrinkage grouting compound) in proportion as specified in these nozzles at a pressure of 2.5 to 3.0 Kg/Sq.cm.

f. After the grout the nozzles are cut and filled with cement mortar 1:2 mixed with polymer based water proofing compound in proportion as specified and finished smooth.

Note: The proportion of approved water proofing compound to be used in respect of ordinary cement shall be as per manufacturer's specifications.

13.3 Integral Cement Based Water Proofing Treatment for Roof /Sunken Floors of W.C`S etc.

a. The proprietary water proofing compound shall conform to I.S.2645 – 1975 in cement based water proofing treatment, stone aggregate shall be used instead of brick aggregate without any extra cost wherever required by the Engineer in – charge.

b. The finished surface after water proofing treatment shall have required slope.

c. While treatment of sunken floors is done it shall be ensured that the 'S' or 'P' traps as the case may be have been fixed / eased and rounded off properly the work shall be carried out as per relevant CPWD specifications.

d. GURANTEE: The above water proofing, treatment shall be covered by a 10 years guarantee by the main contractor against leakage, seepage and dampness etc. for which necessary performance shall be furnished by the contractor.

13.4 Water Proofing Treatment Integral Crystalline Waterproofing Materials

13.4.1 **Integral Crystalline Waterproofing Admixture**

i. Materials

Integral Crystalline Admix is one part cementitious powder consisting of hydrophilic chemicals such as Portland cement, very fine treated silica sand and various active, proprietary chemicals. These active chemicals react with the moisture in fresh concrete with the by-products of cement hydration to cause a catalytic reaction, which generates a non-soluble crystalline formation throughout the pores and capillary tracts of the concrete. Thus the concrete becomes permanently sealed against the penetration of water or liquids from any direction. The concrete is also protected from deterioration due to harsh environmental conditions.

ii. Technical Specification/Parameters

The integral crystalline waterproofing admixture shall confirm to the following requirements:

a. At the manufacturers recommended dosage,

i. Material must fulfil the requirements of American concrete institute guidelines **ACI-212-3R-10**, the coefficient of permeability should be measured for penetration of water. Under hydrostatic pressure of 72.5 psi (5 bars) to 150 psi (10 bars) for 72 to 96 hours as per DIN 1048 Part V. Reduction of water penetration should be 50 to 90%.

ii. The performance of the crystalline admixture must not be restricted by water/cement ratio of the concrete mix. In other words, the crystalline admixture must perform at any water / cement ratio of the concrete mix.

b. The product has **no** corrosion effect on reinforcement steel according to test norm DIN V 18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.

c. The integral crystalline admixture must be compatible with any other concrete admixture confirming to ASTM D494 and IS 9103.

d. It will not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.

e. The recommended crystalline admixture shall be non-toxic and shall confirm to NSF 61 USA.

Note - The manufacturer shall produce relevant test certificates as per relevant code as stated above.

iii. **Recommended Uses:-** In locations such as Foundations / Rafts, Sewage and Water Treatment Plants, Parking Structures Basement Retaining Walls etc.

iv. **Direction for use Dosage** - 0.80% by weight of cement content per cubic **meter** of reinforced concrete.

v. **Preparation of mixing**

Mix integral crystalline admixture with water to form a very thin slurry (e.g. 40 lbs (18 kg) of powder mixed with 6 gallons (22.7 ltr) of water). Pour the required amount of material into the drum of the ready-mix truck and mix for at least 5 minutes to ensure even distribution of integral crystalline admixture throughout the concrete.

vi. **Application**

Concrete treated with integral crystalline admixture should be placed and finished in accordance with good concrete practices. ACI guidelines and recommendations should be observed.

vii. **Precaution / Special Consideration**

It is important to obtain a homogeneous mixture of crystalline admixture with the concrete. Therefore, do not add dry crystalline admixture powder directly to wet concrete as this may cause clumping and through dispersion will not occur.

When incorporating integral crystalline admixture, the temperature of the concrete mix should be above 40°F (4°C).

viii. **Storage / Shelf life**

Integral crystalline admixture must be stored dry at a minimum temperature of 45°F (7°C) and its shelf life is one year when stored under proper conditions.

13.4.2 Integral Crystalline Slurry

i. **Materials**

Integral crystalline slurry is a surface-applied, integral crystalline waterproofing material, which waterproofs and protects concrete in-depth. It consists of Portland cement, specially treated quartz sand and a compound of active chemicals. Integral crystalline slurry needs only to be mixed with water prior to application. When Integral crystalline slurry is applied to a concrete surface, the active chemicals react with moisture and the by-products of cement hydration to cause a catalytic reaction which generates an insoluble, crystalline structure. These crystals fill the pores and minor shrinkage cracks in the concrete to prevent any further water ingress (even under pressure). However, Integral crystalline slurry will still allow the passage of vapour through the structure (i.e. the concrete will be able to "breathe"). Even after the concrete has cured, Integral crystalline slurry remains dormant in the concrete and will reactivate in the presence of moisture to seal capillary tracts and hairline cracks. In addition to waterproofing the structure, Integral crystalline slurry protects concrete against seawater, wastewater, aggressive ground water and many other aggressive chemical solutions. Integral crystalline slurry is approved for use in contact with potable water, and is therefore suitable for use in water storage tanks, reservoirs, water treatment plants, etc. Integral crystalline slurry is not a decorative material.

ii. **Technical Specification/Parameters**

a. Material must fulfil the requirements of American concrete institute guidelines **ACI-212-3R-10**, the coefficient of permeability should be measured for penetration of water. Under hydrostatic pressure of 72.5 psi (5 bars) to 150 psi (10 bars) for 72 to 96 hours as per DIN 1048 Part V. Reduction of water penetration should be 50 to 90%.

b. Potable Water Compatibility : Nontoxic and suitable for use in potable water facilities – NSF Listed as per ANSI 61 listing.

c. Confirm to EN 1504-3 (For structural repairs – R3, Compressive strength > 25 Mpa), supplied from an approved manufacturing unit having CE approval conforming to EN 1504-3-R3.

d. The product has no corrosion effect on reinforcement steel according to test norm DIN V 18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.

Note - The manufacturer shall produce relevant test certificates as per relevant code as stated above.

iii. **Recommended Uses:-** In locations such as Foundations / Rafts, Sewage and Water Treatment Plants, Parking Structures Basement Retaining Walls etc.

iv. Surface Preparation

All concrete to be treated with Integral crystalline slurry must be clean and have an "open" capillary surface. Remove laitance, dirt, grease, etc. by means of high pressure water jetting, wet sandblasting or wire brushing. Faulty concrete in the form of cracks, honeycombing, etc. must be chased out, treated with Integral crystalline slurry and filled flush with crystalline mortar. Surfaces must be carefully prewatered prior to the Integral crystalline slurry application. The concrete surface must be damp but with no wet sheen on the surface.

v. **Preparation of Material**

Integral crystalline slurry is mechanically mixed with clean water to a creamy consistency or that resembling thick oil. Mix only as much material as can be used within 20 minutes and stir mixture frequently. If the mixture starts to set do not add more water, simply re-stir to restore workability.

vi. **Mixing ratios**

Application	Vertical Surfaces	Horizontal Surfaces
Brush Application	5 parts integral crystalline slurry to 2 parts water	3 parts integral crystalline slurry to 1 part water

Spray Application	5 parts integral crystalline slurry to 2.75-3.25 parts water	

vii. **Application**

Crystalline slurry is prepared by mixing 1.00 kg of crystalline slurry with 400 ml of water and applying the same from internal side with the help of synthetic fiber brush @0.70kg per sqm per coat in two coats after cleaning the entire concrete surface thoroughly with high pressure water jet / wire brush or by mechanical means to make it free from loose particles, dust and dirt etc. and making the surface saturated with water before application of crystalline slurry. Second coat shall be applied within 4-6 hours of first coat.

Apply integral crystalline slurry in two coats by masonry brush or appropriate power spray equipment.

The second coat is applied while the first coat is still "green".

viii. **Application Rates**

For vertical surface - Two slurry coats of Integral crystalline slurry at 0.70 kg per sqm per coat For horizontal surface – One slurry coat of Integral crystalline slurry at 1.10 kg per sqm.

ix. **Post Treatment**

The treated areas shall be kept damp for a period of five days and be protected against direct sun, wind and frost, by covering with polyethylene sheeting, damp burlap or similar.

x. **Precaution / Special Consideration**

Do not apply Integral crystalline slurry at temperatures at or below freezing or to frozen or freezing surfaces. Integral crystalline slurry cannot be used as an additive to concrete or plasters. (Integral crystalline admixture should be considered for these applications).

xi. **Storage / Shelf Life**

When properly stored in a dry place in unopened and undamaged original packaging its shelf life is 12 months.

13.4.3 Integral Crystalline Dry-Shake

i. **Materials**

Integral crystalline dry shake of hydrophilic in nature is a unique chemical treatment material for the waterproofing and protection of concrete. Integral crystalline dry shake has been specially formulated for dry-shake applications on horizontal concrete surfaces where greater impact and abrasion resistance is required. Packaged in the form of a dry powder compound, Integral crystalline dry shake consists of Portland cement, various active proprietary chemicals, and a synthetic aggregate hardener that has been crushed and graded to particle sizes suitable for concrete floors. Integral crystalline dry shake becomes an integral part of the concrete surface, thereby eliminating problems normally associated with coatings (e.g. scaling, dusting, flaking and delamination). The active chemicals react with the moisture in the fresh concrete causing a catalytic reaction, which generates a non-soluble crystalline formation within the pores and capillary tracts of the concrete.

ii. **Technical Specification/Parameters**

a. Material must fulfil the requirements of American concrete institute guidelines ACI-212-3R-10, the coefficient of permeability should be measured for penetration of water. Under hydrostatic pressure of 72.5 psi (5 bars) to 150 psi (10 bars) for 72 to 96 hours as per DIN 1048 Part V. Reduction of water penetration should be 50 to 90%.

b. Potable Water Compatibility: Nontoxic and suitable for use in potable water facilities – NSF Listed as per ANSI 61 listing.

c. Confirm to EN 1504-3 (For structural repairs – R3, Compressive strength > 25 Mpa), supplied from an approved manufacturing unit having CE approval conforming to EN 1504-3-R3.

d. The product has no corrosion effect on reinforcement steel according to test norm DIN V 18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.

iii. **Recommended Uses:-**

Raft / Foundation Slabs, Below-grade Structures Sewage and Water Treatment Plants Traffic Bearing Surfaces Warehouse Floors Parking Structures etc.

iv. **Directions for Application**

a. Application Rates

Under normal conditions, the coverage rate for Integral crystalline dry shake is 0.60 kg per sqm depending on the degree of abrasion resistance required.

b. Application Procedure

Integral crystalline dry shake is to be sprinkled @ 0.60 kg per sqm over the PCC blinding, after fixing the reinforcement bars on the cured PCC so as to achieve positive side waterproofing below the raft concrete, as per the manufactures specification.

c. Curing

Curing is important and shall begin as soon as final set has occurred but before surface starts to dry. Conventional moist curing procedures such as water spray, wet burlap or plastic covers may be used. Curing shall continue for at least 48 hours.

v. Precaution / Special Consideration

For the best results when applying dry shake materials, the air content of the concrete shall not exceed 3% (a high air content can make it difficult to achieve a proper application).

In hot, dry, or windy conditions, it is advisable to use an evaporation retardant on the fresh concrete surface to prevent premature drying of the slab.

Chronic moving cracks or joints will require a suitable flexible sealant.

vi. Storage / Shelf Life

Integral crystalline dry shake must be stored dry at a minimum temperature of 45°F (7°C) and its shelf life is one year when stored under proper conditions.

13.4.4 Crystalline Mortar

i. Materials

Crystalline mortar consists of Portland cement, specially treated quartz sand and a compound of active chemicals. The active chemicals react with moisture and the by-products of cement hydration to cause a catalytic reaction, which generates an insoluble integral crystalline complex. These crystalline complexes grow in the presence of water, block the capillaries of the concrete and minor shrinkage cracks, thus waterproofing it. Chemical activation begins when the powder is mixed with water and may take several days to completely block the capillaries depending on ambient temperature and environmental conditions.

ii. Technical Specification/Parameters

a. Material must fulfil the requirements of American concrete institute guidelines ACI-212-3R-10, the coefficient of permeability should be measured for penetration of water. Under hydrostatic pressure of 72.5 psi (5 bars) to 150

psi (10 bars) for 72 to 96 hours as per DIN 1048 Part V. Reduction of water penetration should be 50 to 90%.

b. Bond strength: ≥ 1.5 Mpa (Class – R3).

c. Potable Water Compatibility: Nontoxic and suitable for use in potable water facilities – NSF

d. Listed as per ANSI 61 listing.

e. Confirm to EN 1504-3 (For structural repairs – R4, Compressive strength > 45 Mpa), supplied from an approved manufacturing unit having CE approval conforming to EN 1504-3-R4.

f. The product has no corrosion effect on reinforcement steel according to test norm DIN V 18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.

iii. **Recommended Uses**

Applied in conjunction with integral crystalline slurry coat for:

a. Installation of seal strips, reglets and coves at joints to assure water tightness

b. Patching of tie holes and faulty construction joints

c. Patching and filling of routed out cracks

d. Repairing of spalled and honeycombed areas

iv. **Surface Preparation**

All surfaces to be patched, repaired or sealed with crystalline mortar must be clean and sound. **Cracks** shall be routed out to a U-shaped configuration, approximately (20-25 mm) wide and a minimum of (20-25 mm) deep. **Tie holes** should be roughened prior to filling. **Spalled and honeycombed areas** must be thoroughly cleaned and chiselled back to sound concrete prior to repair. Remove all dirt, cement laitance, form release agents, curing compounds, paints, coatings, etc. by means of wet or dry sandblasting, high pressure water jet or other suitable mechanical means. Surfaces must be well moistened to a dull dampness at the time of application. The concrete should be damp with no wet seen on the surface.

v. **Preparation of Material**

For routed cracks, coves and non-moving joints, add water to crystalline mortar until a medium stiff, trowelable consistency is reached. The texture of the mix should be pliable enough to be trowelled into the cracks with some pressure, but not so pliable that it would run out or sag out of the crack. Approximate mixing ratio (by volume) is 4.5 parts powder to 1 part water. Alternatively,100 ml of water to 450 gm of crystalline mortar powder. For tie holes and pointing applications, add only a small amount of water. Mixed consistency should be that of "dry earth", holding a shape when squeezed in your hand but easily crumbled when pressed between fingers. Mix only as much material as can be used within 20 minutes.

vi. **Application**

a. **For sealing cracks and faulty construction joints,** routed out/making U-shape groove size 25x25mm and then priming the surface with integral crystalline slurry @0.05 kg per running meter and while the surface is tacky filled the cavity upto surface crystalline mortar @1.50 kg per running meter. Once crystalline mortar is touch dry then finally applying two coats of integral crystalline slurry @0.05 kg per running meter per coat.

b. **For repairing spalled & honeycombed areas,** prepared the surface and chiesel back upto sound concrete and then primed the area with integral crystalline slurry @0.70 kg per sqm. and while the surface is tacky repair and level the honeycomb area with crystalline mortar @ 22.70 kg per sqm. for an

average thickness of 10mm. Once crystalline mortar is touch dry then finally two coats of integral crystalline slurry @ 0.70kg per sqm. per coat.

c. **For patching of tie rod holes**, prepared tie rod hole surface and primed the area with integral crystalline slurry @ 0.07 kg per sqm and while the surface is tacky repair and filled the tie rod holes with crystalline mortar @ 0.040 kg per hole. The crystalline mortar shall be tightly rodded into tie holes or packed tightly. For 25x25x25 mm hole, use 0.040 kg per hole to fill the tie hole.

vii. **Curing**

Provide protection against extreme weather conditions such as heavy rain or freezing conditions during the setting period. Curing is not normally required except during hot, low humidity weather. In these conditions a light mist of water approximately 24 hours after the repair is completed will help to ensure a controlled cure. In extreme dry heat, water misting may be required more frequently.

viii. **Precaution / Special Consideration**

Crystalline mortar shall not applied at temperatures below 40°F (4°C), to a frozen substrate or if temperatures will drop below freezing during the curing period (approximately 24 hours). This product is not recommended for use in expansion or construction joints. Crystalline mortar can be applied in (13 mm) layers not exceeding 2.5 inch (approximately 6.5 cm) to prevent shrinkage cracks in the mortar.

ix. **Storage / Shelf Life**

Crystalline mortar shall be stored in a dry enclosed area off the ground at a minimum temperature of 45°F (7°C). Shelf life when stored in proper conditions in unopened, undamaged packaging is 12 months.

13.5 Water proofing treatment with Spray Polyuretane System:

The water proofing of terraces with Spray Polyureathane to be carried out in following steps:

i. Surface Preparation: Cleaning of the surface, treating of construction joints, filling of honeycombs etc. of slab to be carried out before executing water proofing treatment.

ii. Applying over the cleaned surface instant setting spray polyurethane waterproofing system of 10 mm thickness with a density of minimum 55 kg /m3, having fire resistance property confirming to class B2 as per DIN 4102; having min 96% closed cell content of approved make and as per the manufacturer's recommendations.

iii. Over above layer, providing and applying, water proof membrane of liquid of pure polyurethane based, single component, low VOC, elastomeric, seamless & having solid content 90% (as per ASTM C836), elongation at break of 400%. The membrane to be applied with a brush/roller in 2 coats to achieve a DFT of 0. 70mm (consumption @ 1.0 kg/Sqm).

iv. Over the above membrane Geotextile 150 gsm (non-woven polyester) to be spread.

v. A layer of 60mm avg. thick M20 grade screed to be laid with required slope all around on the roof/terrace. At the parapet wall junction, an angular fillet of 50 mm X 50 mm to be provided of cement-sand mortar in 1:3 proportion including applying a coat of SRI Coating reinforced with glass cloth reinforcement at the joint of angle fillet and screed.

vi. The concrete shall be exposed by cutting grooves of size 6mm(W) x35mm(D) by saw cutting into panels of size 2.5x 4mtrs, the grooves formed by exposing the concrete shall be filled with Bituminous sealant.

vii. Over above the screed concrete applying fiber reinforced water based acrylic waterproofing cum high SRI value 0f 99, in two coats with a roller/brush at a consumption of 1 litre/sqm

The Water proofing treatment shall be of approved make and guaranteed for TEN YEARS, to be reckoned from the date of expiring of the Defect Liability period prescribed in the contract

14 ROOFING

14.1 Polycarbonate Sheet Roofing

a. The polycarbonate sheet roofing shall be of approved make and shall conform to manufacture's specifications. The material procured shall be free of any defects and damage to the edges, surface etc. The contractor shall ensure that the material is procured and delivered at installation site without any damage.

b. Adequate care shall be taken for protection of the material before installation as well as afterwards till handing over the building for occupation. The contractor shall ensure careful handling and storage and prevent any rough handling, to prevent any edge or surface damage. Any panel with edge damaged or damage to the finish etc. shall not be allowed to be used in the work and shall be replaced by the contractor at his own cost. The contractor shall procure the material including providing for wastages, damages etc. in one lot so as not have any color and shade variation. Atleast one sample of the polycarbonate sheets brought by the contractor to the site of work shall be tested. The test shall be got done at reputed independent laboratory as approved by the Engineer-in-Charge. However, the contractor shall obtain and submit to the Department the manufacturer's certificate for compliance of the polycarbonate sheets as per the manufacturer's specifications and also copy of the manufacturer's test report for the record.

c. The polycarbonate sheet shall be multi-wall (twin wall) section with thickness of the sheet not less than 16mm and the thickness of the walls on the two external faces not less than 0.8mm each. The sheet shall be extruded from polycarbonate material and shall have homogeneous composition of the material. The sheet shall have co-extruded UV protective layer. The sheet shall be fixed with the face treated for UV resistance, upward/exposed to sunlight. The weight of the sheets shall not be less than 2.7 Kg per sq.m. Light transmission shall be minimum 35% or as per manufacturers specifications. The sheets shall be obtained with closed edges. The sheet shall be bent (if required) to the require profile as per the architectural drawings but with radius not less than 175 times the thickness of the sheet. The sheet shall be fixed in a manner that the cells are parallel to the span of the shed.

d. The polycarbonate sheets shall be of colour and shade as approved by the Engineer-in-Charge.

e. The physical and the chemical characteristics of the polycarbonate sheets shall be as per the manufacturer's specifications and shall conform to the ASTM standards. The sheets shall conform to BS 476 part 7 for the fire rating. The contractor shall submit written guarantee to the Engineer-in-Charge for the polycarbonate sheets procured and provided by him against any defects like peeling, breakage, fading of color/ discoloration, cracking, leakage through the roofing loss of strength etc. for a period of ten years after the date of completion of the work. The contractor shall obtain similar back-to-back guarantee from the manufacturer.

f. The polycarbonate sheets shall be used in one piece along the span of the temporary sheds. The width of the sheet across the span of the shed shall not be more than 700 mm. The polycarbonate sheets shall be bent to required profile (linear or curvilinear) as per the architectural drawings and fixed in position, to the structural steel framework, using self-driving self-tapping screws with EPDM washers etc. The sheets shall be secured to the structural steel framework so as to withstand all the design dead, live, wind, other accidental loads etc. and shall be fixed in a workmanlike manner. It shall not have any sag. Therefore the fabrication work shall be got done

through experienced & reputed fabricator, to be got approved from the Engineer-in-Charge. The contractor shall submit to the Engineer-in-Charge the shop drawings giving fixing details for the polycarbonate sheets in roofing and also quality assurance and methodology statement for the item. The polycarbonate sheets shall be jointed along the length of the shed using aluminum top & bottom pressure plates having required profiles for fixing the EPDM gaskets, screws, washers etc. The aluminum pressure plates shall be color anodized or powder coated to the require shade. The joints in the sheet shall be provided only on the RHS steel sections of the framework and shall not be permitted elsewhere. The joint width of about 3-4 mm may be provided between the sheets at the junction for thermal expansion. The EPDM gaskets of the required profiles shall than be fixed in the grooves in the aluminum pressure plates on either side of the joint in the polycarbonate sheet. The bottom aluminum plate shall be fixed to the structural steel framework using self-driving self-tapping screws; washers etc. (one screw fixed to each sheet) and the screws fixed @300 mm center to center along the span of the shed.

g. The EPDM gaskets of the required profile shall be fixed in the grooves in the aluminum pressure plate on either side of the joint in the polycarbonate sheet. The top aluminum pressure plate shall than be fixed securely to the bottom aluminum plate using countersunk self-driving self-tapping screws, EPDM washers etc. All the screws shall be concealed using structural silicone sealant DC 995 of Dow Corning or equivalent approved brand. Also, wherever required (especially at the joint in the EPDM gasket etc.) the junction of the polycarbonate sheet and the sides of the pressure plates on both sides shall be sealed using structural silicone sealant DC 995 of Dow Corning or equivalent brand as approved. The item includes cost of all the operations and all inputs of the materials including Polycarbonate sheet, EPDM gaskets, anodized aluminum capping, anodized aluminum edge capping to the sheet with U-shaped EPDM gasket, all structure silicone sealant, self-driving self-tapping screws with EPDM washers, nuts, bolts, washers etc. and the like, labor, T & P, all the incidental charges, wastages etc. involved in the work. The contractor shall maintain the roofing scratch and damage free till the handling over the building for occupation, at his own cost. Tolerance shall be as per manufacturers specifications

h. The polycarbonate sheets shall be obtained with protective films on both sides. Care shall be taken while fixing to fix the sheets with UV protected side exposed to outside. The sheet shall be stored in a manner not to expose to direct sunlight. The sheet shall be cut to the required size or drilled using the toothed blade/machine. After fixing the protective film shall be removed and the sheets cleaned using non-alkaline based detergent and abrasive equipments or solvents be avoided. The silicones, gaskets, tapes etc. shall be compatible with the polycarbonate sheet.

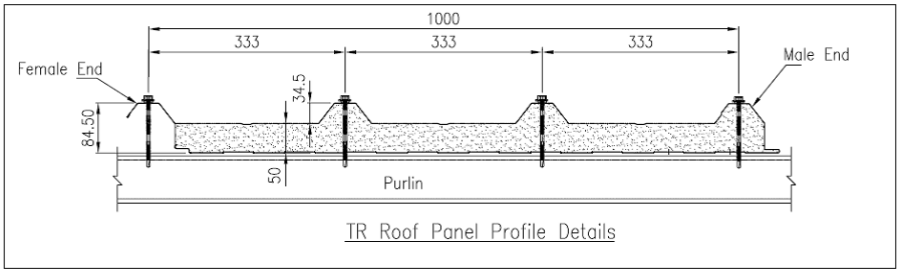
i. For joining the sheets, at least one complete channel width of each sheet shall be secured per sheet within the joining profile. Since thermal coefficient of expansion of the sheets is different from the RHS steel frames, suitable provision shall be made for accommodating differential expansions. Also any rigid jointing agent that may prevent thermal movements shall not be used. The required section aluminum profiles (upper central profile, lower central profile and top profile) for fixing the polycarbonate sheet to the structural framework as well as for joining the sheet shall be as per the manufacturer's specifications .The top capping profile shall be snap fit to the upper central profile, The EPDM gaskets and the screws shall be provided as per the manufacturer's specifications.

j. The Gaskets shall be extruded micro wave/ steam cured EPDM/ silicone of approved quality compatible with substrates, finishes and other components they are in contact with. All gaskets exposed directly on the exterior face shall be silicon gaskets, which are UV resistant. They shall not degenerate/discolor or/each on exposure to weather/ rain/pollutants etc.

14.2 Puff Insulated Roofing :-

Approved make Puff Insulated roofing sheet 40 mm thick with 38 mm High Rib, Double skin sandwiched between Pre painted Gallvalume (PPGL) sheet having outer skin 0.47mm thick Pre-coated GL Sky Blue or as approved colour Sheet with depth of crest-30-40mm,

pitch 195-200mm trapezoidal colour coated sheet & inner skin 0.47 mm thick Pre-coated GL White Sheet & minimum 40+30 mm thick layer of rigid CFC free polyurethane foam of density of 40±2 kg/m3 as insulation and PPGI sheet shall have minimum coating of 4-5 micron epoxy primer and 25 micron polyester top coat on the finish surface and 7- 8 micron primer alkyl base on reverse complete with Skirt Flashing, Corner Flashing and Rain Gutter 1.6 mm Thick G.I. Sheet.



TR Roof Panel Profile Details

15 GLASS:

a. All glass and glazing material shall be verified and coordinate with the applicable Performance requirement.

b. All glass shall be cut to required size and ready for glazing. All glass shall be accurate sizes with clear undamaged edges and surfaces which are not disfigured. Any panel which does not fit any section of the curtain wall and shop front will be rejected and a replacement made at the Contractor's expense.

c. Glass shall conform to the quality, thickness and dimensional requirement specified in US Federal specifications DD – G0415C.

d. Heat strengthened glass shall not deviate in surface flatness by more than 0.23 mm with in 260mm of leading or trailing edge, or 0.076 mm in centre. Direction of ripple shall be consistent and is acceptable to Engineer-in-charge. Distortion of glass shall be controlled as much as possible during heat strengthening. Sag distortion shall be unidirectional and surface compression shall be in the range of 320-450 Kg/cm². All glass shall be delivered to site with the manufacturer's label of identification attached.

e. The glass glazed panel / structural glazing frames for the structural glazing system shall be designed to withstand lateral imposed loads and comply with requirement of local building codes.

f. Glass shall be free from defect or impurities detrimental to its performance. Defects such as bubbles, waves, spots scratches, spalls, discoloration, visibly imperfect coating, chipping, and bubbles delaminating of opacifier film shall be limited in accordance with the Manufacturer's / trade guidelines. The glass is to be produced in such a way that the rollers will be parallel to what will be the horizontal position of the glass. Glass should be consistent in colour.

g. Double glazed units shall be procured only from approved manufacturer. Quality control tests shall be performed for mixing, curing, adhesion and dew point. The unit shall be guaranteed against condensation and dirt between the panes, failure of seal and damage to internal coating.

h. All glass breakage caused by the Contractor or his sub-contractor because of negligence or caused by the installation of faulty work by him shall be replaced by the Contractor at his own expense without delay to the project completion.

16 PANELLING

16.1 Wooden Panelling

Providing and Fixing Channeled Wooden perforated panels of width 128mm, thickness of 6mm and length 2440 mm or as required by the Engineer-In-Charge, made of a high density particle board substrate with a laminated facing as per the approved shade/ species & finish and a melamine balancing layer on the reverse side. The boards shall

have a special perforation pattern where the visible surface has a ("Helmholtz" fluted perforation of 2mm width and 14mm of visible panel / 4mm width and 28mm visible panel) each. The panels shall provide a minimum sag resistance of RH90 and a fire rating class of 1 as per Part 7 of BS 476. The edges of the panels shall be "tongue-and-grooved" to receive special clips for installation. The back of the perforated panel shall have sound absorbing non-woven acoustical fleece. The panels shall be mounted on special aluminium splines using clips approved by the Engineer-in-Charge.

16.1.1 **Installation:**

Install wooden battens (provided by others) of section 50mmx50mm or as approved by the HLL on the solid wall horizontally using screws and plugs at spacing of 600mm centre-to-centre. Screw the aluminium extruded keel for channelled wood(GTPT001) over the lowest and second wooden batten at an on-center distance of 600mm. Install the first set of wooden panels by inserting the clips for border channelled wood(GTPT002) and insert the groove of the panel into the projecting flange of the aluminium clip. Continue installing rows of panels by inserting the tongue into the groove of the earlier inserted panel and progressively installing clips for inside channelled wood (GTPT003) into the next keel till the actual height is achieved. Use clips for border channelled wood(GTPT002) to finish off the installation. Finish off the edges using wooden moulding of matching colour.

16.2 ACOUSTICAL WALL PANELLING

16.2.1 Providing and supplying Acoustical Wall Panelling of Slats made of pinewood E1 grade fiberboard, Melamine laminated finish, groove perforated slats L16-2 - (2mm Slats @16mm pitch) / L32-2 - (2mm grooves @ 32mm centers) / L64-2 - (2mm grooves @ 64mm centers), backlined with black acoustical fleece, tongue-groove edge for a seamless look, of size 75/150x2440mm with min 15mm thick having base density 800Kg/m3, weight 12Kgs/m2 installed by using GI strut system. The GI strut system includes two layers of GI Cross channel (CC50) having thickness 0.45mm, length 3600mm, knurled web 40mm, depth 50mm and equal flanges 15mm is fastened vertically/horizontally at every 600mm centers. Aluminium core cross channel (CC18) having thickness 0.5mm, length 2400mm, web 15mm & 27mm, depth 18mm and flanges of 7mm with suitable edge & centre brackets is then fixed perpendicular to the CC50 with the help of fasteners at every 400mm centers. Slats of size 75/150x2430mmx16mm in then fixed perpendicular to CC18 with suitable edge & centre brackets. Contractor to provide expansion joints of 3mm at every 5mtrs bothways.Panels shall be backlined with acoustical infill of Synth PF 5x50mm thick adhered to the wall using Stick 7 adhesive.

Technical Parameters

- Core Variants - Pinewood E1 Fibreboard
- Fire – Class 1 & P
- Acoustics – NRC upto 0.75
- Climate (OC RH) – 50, 70
- Light reflectance – 75% (beech haya)
- Green (RC %) – 25
- Hygiene (VoC, Clean room) – Low, Class 1
- Strength, Load capacity (Kg) - Ball-Impact

16.2.2 Providing and supplying Acoustical Wall Panelling of Hush burled square edge, FR grade fabric (colour choice) wrapped glassfibre core panel of size 600x1200x25mm having density 100-120Kgs/m3, weight 3.0kg/m2 installed by using impaling clip Impaling clips are attached directly to the wall/frame work with the points extending outward. The spikes are tipped with Stick S7 adhesive. Then the panels are positioned and pressed into place

Technical Parameters

- Core - Glassfibre
- Fire – Class 1 & P
- Acoustics – NRC up to 0.9
- Climate (OC RH) – 40, 90
- Termite resistance – Yes
- Light reflectance – Colour dependent
- Green (RC %) – 25
- Hygiene (VoC, Clean room) – Low, Class 3

16.2.3 Providing and supplying Acoustical Wall Panelling with square edges made of fibre glass substrate 25mm thick and wrapped on the front side with an acoustically transparent and fire-resistant fabric with an option of colours as per the choice of the Engineer-in-charge of size 2100x600 or 600x600 mm providing a minimum sound absorption level of 0.90 NRC to be affixed to wall using Wall panel impellers and construction adhesives as per the instructions laid down by the manufacturer.

16.2.4 Installation:

Wall panel impellers of adequate quantity as specified by the manufacturer shall be fixed to the wall surface using self-tapping screws. Silica based construction adhesive shall be dabbed on to the projecting elements (spikes) of the impellers. wall panels shall be pierced through the spikes of the impellers ensuring the line and level of the panels are maintained.

17 SEISMIC / MECHANICAL EXPANSION JOINTS

a. The treatment of Seismic / mechanical expansion joints shall be carried out strictly as per the specifications mentioned herein. In the absence of specifications of any material, relevant I.S. specifications shall be followed and in case any material is not covered up in the specifications; Engineer-in-charge's instructions shall be followed. No deviation shall be permissible unless specifically approved by the Engineer-in-charge.

b. The work shall be carried out as per CPWD specifications and directions of Engineer-in-charge.

c. The work shall be carried out as per site requirement. The contractor shall submit detailed drawing/shop drawing for each type of joint within three days from the date of award and shall be got approved from Engineer-in-charge before execution of the work.

d. The contractor shall make minor modification in the samples as per site requirement with the approval of Engineer-in-charge if required and nothing extra shall be paid for this modification.

e. The contractor shall submit the test reports of the product of the manufacturers.

f. Manufactures:- All seismic/mechanical expansion joints shall be designed and manufactured by the approved manufacturers.

g. Guarantee:- All the joints shall be guaranteed at least for the period of 5years when installed by the certified applicator in the prescribed performa.

h. Installation:- Installation shall be in strict accordance with manufacture's technical specifications, details and installation instructions. The work shall be carried out through the specialized agencies as approved by the Engineer-in-charge.

i. Protection:- The system and its component should be protected during construction and after work is complete, the exposed surface and adjacent areas should be cleaned by suitable cleaner to the satisfaction of Engineer-in-charge.

j. Sample for joints:-The agency shall supply sample of minimum one meter length of all types of expansion joints and the same shall be fixed at site at appropriate location and the same shall be approved by the competent authority which shall be duly intimated by Engineer–in–Charge. The agency shall place the order for procurement of mechanical expansion joint from the parent company for supply only after obtaining approval from Engineer-in-Charge.

k. Materials:-

a. EPDM (Ethylene Propylene Dinine membrane) water resistant membrane shall be as per manufacturers specifications and shall be of best quality. The EPDM membrane shall be pasted with approved adhesive to the surface.

b. S.S. screw shall be of canon or equivalent make approved by Engineer-in-charge.

c. Aluminum sheet shall be of approved make and shall generally confirm to IS: 737-1986. The powder coating on aluminum sheet shall be 50-60 microns. The slots on the aluminum sheet shall be made by lath machine with smooth and uniform finish.

l. For any discrepancy in item and corresponding drawing, the decision of Engineer- in-Charge shall be final and nothing extra shall be paid on that account.

18 BUMPER GUARD STRETCHER GUARD CRASH RAIL SYSTEM & WALL GUARD

18.1 Bumper Guard Stretcher Guard Crash Rail System

i. The scope of work includes providing & fixing Bumper Guard / Stretcher Guard Crash Rail System of approved make consisting of continuous aluminum retainer, impact absorbing strip (B-ABS), adjustable end cap / corner joint, adjustable adaptor plate and high impact vinyl acrylic cover of desired shade to withstand impact and providing a cushioned surface with its integrated rubberized absorber complete as per manufacturer's specifications.

ii. The Bumper Guard / Stretcher Guard Crash Rail System shall be able to protect walls that are susceptible to trolley traffic, preventing unsightly scuffs and costly damage.

iii. This system shall be so designed to withstand impact and provides a cushioned surface with its integrated rubberized absorber, making it ideal for areas like high traffic corridors, loading bays and light cargo lifts.

iv. Bumper Guard shall be manufactured from specially developed vinyl acrylic materials and has the following qualities:

a. Able to withstand high impact and abrasion

b. Weather resistant and fire retardant

c. Textured to provide an anti- slip surface

v. Fittings and anchorages that can withstand corrosion when exposed to normal environmental conditions

vi. Easy to install and maintain

vii. Tested to UL-94 (Underwriter's Laboratory) with a V-0 rating for fire retardance

viii. Designed and comply with static load, impact and deflection requirement in accordance with applicable applications in ASTM-E894 and ASTM-E935.

ix. It should consist of the following :

- Continuous Aluminum Retainer
- Impact Absorbing Strip (B-ABS)

- Adjustable End Cap/ Corner Joint
- Adjustable Adaptor Plate
- High Impact Vinyl Acrylic Cover as per approved colour and shade.

18.2 Wall Guard Grab Rail /Hand Rail System

i. The scope of work includes providing & fixing Wall Guard Grab Rail /Hand Rail System of approved make consisting of Continuous aluminum retainer, adjustable Rail mounting base (HRAM) adaptable to uneven wall surface, impact absorbing strip (B-ABS), end cap, corner joint, high impact vinyl acrylic snap- on cover desired shade to withstand impact and providing a cushioned surface with its integrated rubberized absorber complete as per manufacturer's specifications.

ii. The Wall Guard Grab Rail/Hand Rail System shall be developed to assist building users when ambulating along corridors and ascending or descending stairs. It is also suitable for helping physically handicapped persons to move within a building.

iii. Handrail System is applicable in the following circumstances:-

   a. Ramp- Rail System – along the sides of a ramp
   b. Stair- Rail System- along the sides of a stairway and landing
   c. Transfer- Rail System- to support and allow transfer of body weight in locations such as toilets, shower and bathtub enclosures.

iv. The Wall Guard Grab Rail/Hand Rail System shall be made from a special, high impact vinyl acrylic material, the Handrail System has the following qualities:

   a. Able to withstand abrasion
   b. Weather resistant and fire retardant
   c. Textured to provide an anti- slip surface
   d. Fitting and anchorages that can withstand corrosion when exposed to normal environment conditions
   e. Tested to UL-94 (Underwriter's Laboratory) with a V-0 rating for fire retardance

v. The Wall Guard Grab Rail/Hand Rail System shall be designed and shall comply with static load, impact and deflection requirement in accordance with applicable applications in ASTM-E894 and ASTM-E935.

   a. Continuous Aluminum Retainer
   b. Adjustable Rail Mounting Base (HRAM)- adaptable to uneven wall surface
   c. Impact Absorbing Strip (B-ABS)
   d. End Cap
   e. Corner Joint
   f. High Impact Vinyl Acrylic Snap- On Cover as per approved colour and shade

19 ROADS, PATHWAYS

The campus roads are to be constructed with cutting/filling of earth, preparation of sub-grade, two layers sub-base of WBM each of as specified and finished with RCC M-30 concrete minimum thickness 200mm . All the main RCC roads are to be constructed as per road section drawings and as per IRC code. Following are the types of roads are proposed: -

(i) RCC Road as shown in drawing.

(ii) For pedestrian movement and parking areas, paver blocks/ Grass-Crete blocks/Chequered CC tiles shall be used, as required.

(iii) Kerb stones: All roads edges shall be provided with kerb stones.

(iv) Adequate no. of hume pipes (RCC Pipes) of suitable dia. shall be laid across the roads/pathways etc. for crossing of cables, pipe etc. as per requirements.

Service roads from main RCC roads to all round the buildings are to be constructed, as per firefighting norms. The specifications for these roads shall be as subgrade with power roller, two base course 150mm each thick with WBM, 200 RCC M-30 concrete with nominal reinforcement (approx. 20 kg/sqm) with de-watering process with expansion/construction joint incl. filler joint shall be constructed as per CPWD specifications.

From Service roads, 3m wide foothpath with 80 mm thick interlocking pavers with 100m base lean concrete 1:4:8 (20% coloured pavers) upto building entrance to be constructed as per CPWD specifications.

All ramps for handicapped/disabled persons are to be provided as per norms for all buildings.

Foothpaths with above specifications are also to be provided for all SS points of the buildings

Painting and marking of the roads, parking, cycle tracks footpaths and handicapped ramps are to completed as per standard road signs & specifications.

a) Parking

(i) Provision for parking spaces has to be made on the basis of "Equivalent car space" (ECS) as laid down under "Building Bye Laws" of Aizawl Municipal Authority.

(ii) Parking space has to be planned with adequate vehicular access to a street and the area of drives, aisles and such other provisions required for adequate manoeuvring of vehicles shall be exclusive of the parking space.

b) Grass Pavers

The grass pavers shall be of size 300mm x 300mm and thickness of 70 mm should be prefab factory made cement concrete interlocking grass pavers of M-30 mix, suitably reinforced and manufactured in joint less moulds on vibrator table finished smooth as per required shape size and pattern and colour. To be laid over 50mm thk. sandbed on top of consolidated earth after proper levelling and dressing of ground surface to the requisite slopes complete in all respects as per directions and instructions of Engineer in charge.

c) Interlocking Pavers

The Interlocking pavers shall be of required size and thickness 80 mm factory made cement concrete interlocking pavers in cement concrete of mix M-30 manufactured in joint less moulds on vibrator table finished smooth as per required shape size and pattern and colour. To be laid over 50mm thk. sandbed on top of consolidated earth after proper levelling and dressing of ground surface to the requisite slopes complete in all respects as per CPWD Specifications & directions and instructions of Engineer in charge.

20 AUDITORIUM CEILING SPECIFICATIONS

Acoustical infill Ceiling Tiles of 595x1195x20/25mm, Square edge of approved make, The Ceiling Tiles to be magnesite-bonded pinewood fibre core pigmented with volume density 400Kgs/m3, weight 8/10kg/m2 and shall be suspended by using 0.3mm thick metal grid system as per manufacturer specification all complete as directed by Engineer-incharge..

Technical Parameters

Fire (Class) – 1 & P

- Acoustics – NRC 0.87 (For 15mm thk C50 Mounting)
- Thermal conductivity (W/mk)– 0.08
- Climate (°C, RH) – 50, 90

• Light reflectance (%) – Low light reflectivity

• Green (VoC, RC %) – Low, 30

21 AUDITORIUM FURNITURE

(i) Auditorium Chairs:

1. Understructure:

   MS black powder coated understructure with integrated, auto tip-up mechanism. Footprint area of base plate shall be 150mm X 230mm X 5mm thick. Backrest supporting beam width: 460mm (L) X 80 X 40 – 14 BG HR tube. Understructure should be fixed to ground by foundation expansion bolts M10 X 100 with washer and nut.

2. Seat Assembly:

   Seat assembly is made of Polyurethane foam moulded with 1.5 cm. thick plywood insert as per the following dimensions:

   * Approx. Seat size: Depth: 420.0 mm (D). Width @ rear: 440.0 mm. Width @ front: 410.0 mm.

   Effective seat width (W): 460.0 MM. •Effective seat depth (D): 450.0 MM.

3. Backrest Assembly:

   Back assembly consists of Polyurethane foam moulded with MS tubular frame insert. The insert is composed of Diameter 19mm x 16BG MS tubular frame with flexible nylon support straps running across the length and width of the frame. * Approx. Back size: Height: 540.0 mm (H). Width @ top: 340.0 mm. Width @ seat level: 460.0 mm.

4. Polyurethane Foam:

   The polyurethane foam used for seat and back is moulded with density = 45+ 2 kg/c.m.5.

5. Upholstery:

   Stitched fabric upholstery as per following specs.

Velvet finish	Std fabric (Glory shades)	
Wt.:	370 gm/running meter	320 gm/running meter
Fabric width:	1.35 M	1.2 M
Specs:	100% Polyester	100% Polyester

6. Back Cover and Mech. Cover:

   ABS Vacuum formed back & Mech. cover are provided.

7. Armrest Assembly (For Plastic Armrest):

   It is a plastic injection moulded piece with upholstered arm pad made up of 8mm thk. MDF board with 6mm U-foam over it & fabric. Armrest is covered from side with upholstered pad of 8 mm thk. MDF with 6mm U-foam & fabric.

8. Desklet Assembly (For Plastic Armrest):

   The invisible plastic quarter desklet assembly is housed within the armrest. It consists of spring loaded retractable mechanism & plastic desklet made of H.I.P.S. Material.

22 WARDROBE:

Wardrobes to be 2100mm in height and 600mm deep and specified length and or as per tender drawings/ finishing schedule/ scale of amenities mentioned in the DBR, Vol-4 complete in all respect with fixing hanger rod etc. The wardrobe shall be made of approved 19mm thick laminated Board(back, sides, base and top) with shelves and shutter. Laminated 25mm thk Shutter provided with Stainless Steel locks and Handle & other fixtures (as per approved sample). Board/ fixtures/ Hinges etc. shall be as per

approved make. Lipping etc. required shall be carried out with 2nd class Teakwood. The painting/ polishing shall be carried out as per requirement.

23 MODULAR KITCHEN

Modular Kitchen shall be provided as per tender drawings/ finishing schedule/ scale of amenities mentioned in the DBR, Vol-4 complete in all respect. The contractor shall sublit and get approved the shop drawing before installation. It shall be pre- fabricated. Following items shall be used in its fabrication.

i. 18mm thick both side pre-laminated cement bonded wood particle board as per IS: 15786:2008 of approved brand and shade with suitable full threaded steel screws etc. in partitions, boxes, shelves, racks and cupboards, kitchen cabinet under kitchen counter etc. all complete.

ii. 6mm thick both side pre-laminated cement bonded wood particle board as per IS: 15786:2008 of approved brand and shade with suitable full threaded steel screws etc. on the backing of racks, drawrers, cupboards, kitchen cabinet under kitchen counter etc. all complete.

iii. Cupboard shutter with 19mm thick one side decorative and other side balancing lamination factory pressed BWP grade marine ply as per IS 710 of approved brand including 2mm thick PVC edge banding tape with hot glue by edge bending machine etc. with auto closing spring loaded hinges (hydraulic type) etc. complete.

iv. 19mm thick both side balancing lamination factory pressed BWP grade marine ply as per IS 710 of approved brand boxes, shelves, racks, almirah, cupboard and drawer etc. including necessary nails & screws etc. complete.

v. Fixtures:

   a) Stainless steel fancy handles,

   b) SS soft closing spring hinges,

   c) SS soft closing telescopic drawer channels,

   d) Readymade SS 304 grade modular kitchen baskets & accessories, such as right angle basket (plain cup & saucer, plant, partitions, bottle rack, thali, cutlery), kitchen utensils basket, dinner set basket, kitchen grain basket, multipurpose basket as per requirement,

   e) All edges shall be provided with 2mm thick PVC edge binding tape, hot pressed to edges on binding machines.

   f) For a smoke-free kitchen, the electric chimney with Auto Clean Hood, of adequate size and capacity alongwith complete exhaust arrangement of approved make.

   g) Sink(s) and other accessories as per requirements.

24 DRY STONE PITCHING

Stones : These shall be clean, hard stones, free from decay and weathering. They shall be in block and hammer dressed on all sides. The size of the pitching stones shall be approximately 22.5 cm.in depth and not less than 15 cm. in any other direction.

Preparation of surface: The sides and bottom of earth work to be pitched, shall be brought to the required slope and gradient and shall be compacted to a firm and even surface.

Pitching: Pitching shall be of 22.5 depth unless specified otherwise. Profiles shall be put up by means of pegs and strings or by placing stones, at intervals of not more than 15 cm. Stones shall then be laid closely in position in between the profile and firmly embedded with joints staggered and with exposed faces true to line, gradient and in uniform slope throughout.

Cross bands of approximately 22.5 cm. width through bond stones equal to the full depth of pitching shall be provided at an interval of approximately 3 metres centre to centre both longitudinally and transversely.

The interestices between adjacent stones shall be filled in with stones of proper size, well driven in with crow bars to ensure tight packing and complete filling of all interstices. Such filling shall be carried on simultaneously with the placing in position of the large stones and shall in no case be permitted to fall behind. Final wedging shall be done with the largest sized chip practicable, each chip being well driven home with a hammer so that no chip is possible of being picked up or removed by hand.

25 G.I. BARBED WIRE FENCING WITH ANGLE IRON POSTS

Materials: G.I. Barbed wire shall be as per IS 278 and angle iron shall be as per CPWD Specification Vol. The angle shall be of size 40 × 40 × 6 mm or as specified in the tender drawings.

Spacing of Posts and Struts: The spacing of posts shall be 3.00 m centre to centre, unless otherwise specified or as directed by the Engineer-in-Charge to suit the dimensions of the area to be fenced. Every 15th, last but one end posts and corner post shall be strutted on both sides and end post on one side only.

Fixing of Posts and Struts Pits 45 x 45 cm and 75 cm deep or as directed shall first be excavated true to line and level to receive the posts. In the case of struts, pits 70 x 45 x 75 cm deep or as directed shall be excavated to suit the inclination of the strut so that it is surrounded by concrete by not less than 15 cm at any point.

The pits shall be filled with a layer of 15 cm thick cement concrete 1:2:4 (1 cement: 2 fine sand: 4 graded stone aggregate 20 nominal size). The posts and struts shall then be placed in the pits, the posts projecting as per specified height above ground, true to line and position. The cement concrete 1:2:4 shall be filled in upto 15 cm for posts and 25 cm for struts below ground level at the base of the concrete so that the posts are embedded in the cement concrete block of size 45 x 45 x 60 cm and strut in block of size 70 x 45 x 50 cm. The concrete in foundations shall be watered for at least 7 days to ensure proper curing. The remaining portions of pits shall be filled up with excavated earth and the surplus earth disposed off as directed by the Engineer-in-Charge and site cleared.

The angle iron post at bottom shall be split and banded at right angle in opposite direction for 10 cm length to get proper grip.

Fixing G.I. Barbed Wire : The barbed wire shall be stretched and fixed in specified number of rows and two diagonals. The bottom row should be 14 cm above ground and the rest at specified spacing. The diagonal shall be stretched between adjacent posts from the top wire of one post to the bottom wire of 2nd post. The diagonal wire will be inter woven with horizontal wires by fixing the odd rows of wires first, then the diagonal cross wires and lastly even rows of wires. The barbed wire shall be held by tearing the holes of 10 mm dia in the post and tied with G.I. wire, turn buckles and straining bolts shall be used at the end post. The Barbed Wire shall be Weighing 9.38 kg /100 m (minimum).

26 SIGNAGE & ASSOCIATED WORKS

a. The scope of the work includes preparation of the Architectural Drawings/ shop drawings based on details given in the tender drawings and as directed by Engineer-in charge. Fabrication, supply, installation and protection of the Signages shall be carried based on approved shop drawings.

b. The item of work for the respective signage shall be conforming to Specifications/ tender drawings and shall cover all operations, fabrications and their installations and materials required for finished product.

c. The signage work shall be got executed through specialized fabricator having experience of similar works. The EPC Contractor shall submit the credentials of such fabricator for the approval of the Engineer-in-Charge.

d. The EPC Contractor shall submit the Design, Size and installation procedure along with samples to Engineer-in-Charge for approval. Approved samples will be kept at site till the whole work is completed. Engineer-in-Charge has right to modify the design of the approved samples and contractor is bound to follow these written instruction/ changes in design/ size etc. from Engineer-in-Charge.

e. The typical patterns shown in the drawings are only indicative. The Contractor shall submit shop drawings, for approval of the Engineer-in-Charge, for fabricating signage with detailing of frame work, if any, along with the fixing details. The details of the signage including location, etc. shall be shown in the shop drawings.

f. The Contractor shall submit to the Engineer-in-Charge, samples of various materials for the signage work, for approval. After approval of samples of materials, the Contractor shall prepare sample(s) for approval of Engineer-in-Charge. The material shall be procured and the mass work taken up only after the approval of the mock up by the Engineer-in-Charge. The mock-up shall be dismantled and removed by the contractor as per the directions of the Engineer-in-Charge. Nothing extra shall be payable on this account.

g. The finished surface shall be free of any defects like dents, waviness, scratches, stains etc. and shall have uniform finish. Any defective work shall be rejected and redone by the Contractor at his own cost. The finished surface shall therefore be protected using protective tape which shall be removed at the time of completion of the work. The surface shall then be suitably cleaned using nonabrasive approved cleaner for the material. Nothing extra shall be payable on this account.

h. The signages shall be fixed with stainless steel anchor fasteners or other suitable arrangement for fixing the signage.

i. The entire work shall be carried out to the satisfaction of Engineer-In-Charge.

j. The Pictures shown for Internal Signages are for reference. The shape & Size of the Signages shall be as per the reference pictures. All the Internal Signages should Bilingual (English/Hindi/Assamese). The colour of the print to be finalized after having a careful study of the Building Interior which shall be constant in all the buildings. The content of the Signages will be as per Architectural Plans.

k. The fabricator will keep a liberty to choose any one of the items between "IF, IG, IV, IX and IY", wherever they are mentioned/marked without hanging The text height which shall be constant. For Example, if at any particular location "IG" is marked, but the content gets fitted in "IY", the fabricator shall use "IY"in that location instead of using "IG".Similarly, if at any particular location "IX" is marked, but the content doesn't get fitted in "IX" with the standard font size used everywhere, but gets fitted in "IV",the fabricator shall use "IV"in that location instead of using "IX

l. Way finding & Fire Exit signages suspended from Ceiling on corridors and other locations shall have content on both the two sides of the Signage for giving directions as per site requirement.

27 SAMPLES OF MATERIALS:

a. Sample of all materials/ fittings and fixture to be used in the work such as doors, windows, tiles, sanitary, water supply, drainage fittings and fixtures shall be submitted well in advance by the contractor for approval from the Engineer-in charge of work in writing before placing orders for the entire quantity required for completion of work. Samples approved by the EIC shall be kept in Sample Room under the charge of Engineer-in-Charge and shall retain till completion of work.

b. Finished items in respect of typical portion of works of repetitive nature such as typical room, toilet, railing, door, window or any other work desired by the engineer-in- charge shall be prepared by the contractor to the satisfaction of Engineer-in – charge and got approved from him in writing before the commencement of these items for the entire work.

c. The requirements for preparation of samples shall be observed and fulfilled by the contractor well in advance to avoid any detriment to the general progress of work. In other words, this will not be allowed to have any effects on the general progress of

work or on any of the terms and conditions of the contract. No claims of any kind whatsoever including the claims of extension of time will be entertained due to the incorporation of this requirement.

28 GRIHA REQUIREMENTS:

Materials shall be procured by the contractor keeping in view the recycled content to **conform** the GRIHA requirements as detailed in SCC and elsewhere.

29 VARIATION IN CONSUMPTION OF MATERIALS:

The variation in consumption of material shall be governed as per CPWD specification and clauses of the contract to the extent applicable.

30 MISCELLANCEOUS:

Materials manufacture by reputed firms and approved by Engineer – in charge shall only be used. Only articles classified as "First Quality" by the manufactures shall be used unless otherwise specified. Preference shall be given to those articles which bear ISI certification marks. In case articles bearing ISI certification marks are not available the quality of sample brought by the contractor shall be judged by the standards laid down in the latest CPWD specifications. For items not covered by the latest CPWD specification, relevant ISI standards shall apply.

31 TESTS:

a. Materials brought at site of work shall not be used in the work before getting satisfactory test results for Mandatory tests as per relevant provisions in Latest CPWD Specifications for works. These tests shall be got done from laboratories approved by Engineer-in - charge or the laboratory set up by the contractor at site as per directions of Engineer-in - charge.

b. The Engineer-in - charge of work shall check the test results and satisfy himself before allowing any payment in the running /final bill.

CHAPTER C

TECHNICAL SPECIFICATIONS- PLUMBING & SANITARY WORKS

1. Scope of work

The work shall in general conform to the Latest CPWD Specifications for works as mentioned in Schedule 'F' of the GCC. Work under this Contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialized services as described hereinafter and as specified in the general arrangement (GA) plumbing drawings. Tender drawings w.r.t plumbing & sanitary works are for reference and are indicative in nature only.

2. Plumbing Fixtures

2.1. General

i. Work under this Part shall consist of furnishing all materials & labour necessary and required to completely install all sanitary fixtures, chromium plated fittings and accessories as required for the work.

ii. Without restricting to the generality of the foregoing the sanitary fixtures shall include the following:-

a. Sanitary fixtures

b. Chromium plated fittings

c. Porcelain or stainless steel sinks

d. Accessories e.g. towel rods, toilet paper holders, soap dish etc.

e. Whether specifically mentioned or not, the installation of the fixtures, appliances and accessories shall be provided with all fixing devices, nuts, bolts, screws, hangers ,fasteners as required.

f. All exposed pipes within toilets and near fixtures shall be chromium plated brass or copper unless otherwise specified.

iii. All sanitary fixtures, CP Fittings and CP/SS accessories shall be as per manufacturers' standards / CPWD Specifications.

iv. All fixtures and fittings shall be provided with all such accessories and fixing devices as are required to complete the item in working condition, even if the same is not specifically mentioned in Specifications or shown on the GA drawings and will include all devices for proper fixing arrangement, nuts, bolts, screws and required connection pieces etc.

v. Wall caps shall be provided on all walls, floors, columns etc. wherever supply and disposal pipes pass through them. These wall caps shall be chromium plated brass snugly fittings and shall be large enough to cover the puncture properly and shall conform to IS: 4291.

vi. Fixing screws shall be half round head stainless steel wood screws or bolts with Stainless Steel washers. Iron screws rust will not be permitted.

vii. All fittings and fixtures shall be fixed in a neat workmanlike manner true to level and heights shown on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling or terrace shall be made good at Contractor's cost.

viii. Contractor shall provide poly-sulphide sealant appropriate for its use for all fixtures fixed near wall, marble core seal and edges.

2.2. Water Closets

i. European W.C. shall be any one of the following types:

a. Wall hung wash down at Guest House, MS Quarter, Hospital & Academic all HOD Rooms (attached Toilets)

b. single or double siphon type

ii. Each W.C. set shall be provided with an approved type of matching plastic seat of approved finish compatible and fitting appropriately with the WC set with rubber buffers and hinges. The WC seat shall be those approved and accepted for fixing on a particular type of WC.

iii. The seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.

iv. The edge between the fixture and the wall shall be sealed with approved type of poly-sulphide sealant.

2.3. Health faucet/spray

A chromium plated spray with integral hand control valve and connected to a flexible pipe and angle valve with wall flange and hook are fixed as directed by the Engineer-in-charge.

2.4. Wash Basins

i. Wash basins shall wall mounted type or for under over/counter installation as specified.

ii. Each basin shall be supported on MS galvanized brackets and the basin securely fixed to wall or under/above counter installation. The design of the brackets shall suit the basin selected and as recommended by the manufacturer.

iii. Each basin shall be provided with 32 mm dia. C.P. waste with overflow/ pop-up or standard waste with rubber plug and chain, 32 mm dia. C.P. brass bottle trap with CP pipe to wall and flange.

iv. Each basin shall be provided with a single tap a hot & cold Brass CP mixer with or without pop up waste fittings, 32 mm dia. CP cast brass bottle trap with outlet pipe and wall flange.

v. The edge between the fixture and the wall or the counter shall be sealed with approved type of poly-sulphide sealant

vi. Washbasins shall be fixed at proper heights as per NBC or as directed by Engineer-in-charge.

vii. Each washbasin connection (separately for hot and cold) shall be provided with angle valves with CP wall flange and CP connecting pipe and of required length.

2.5. Sinks

i. Sinks for kitchens, pantries, and designated utility rooms the sinks shall be stainless steel sinks with or without drain boards, as required.

ii. Each sink shall be supported by MS galvanized brackets and clips and the basin securely fixed to wall or on the counter. The design of the brackets shall suit the basin selected and as recommended by the manufacturer.

iii. Stainless steel sinks shall be provided with 40 mm dia. C.P. basket waste with plug (as supplied by manufacturer), 40 mm dia. C.P. brass "P" trap with CP pipe to wall and flange.

iv. Each sink shall be provided with hot & cold brass CP mixer with approved type of a neck spout or individual taps as directed by the Engineer-In-Charge.

2.6. Shower set

i. Shower set shall comprise of hot & cold water mixer, C.P. shower arm with wall flange and shower head adjustable type.

ii. Mixer shall be exposed type, single lever, concealed stop cocks with diverter and spout as selected by the Engineer-in-charge.

2.7. Accessories

i. Types of typical Accessories:

a. Towel rails
b. Towel rings
c. Coat hooks
d. Soap dispensers
e. Soap dishes

ii. Accessories shall be fixed with stainless steel half round head screws and cup washers in wall with rawl plugs or nylon sleeves and shall include cutting and making good.

iii. Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work. The flange of the recessed fixture shall cover the recess in the wall fully.

3. Soils, Waste, Vent & Rainwater Pipes & Fittings

3.1. Scope of work

i. Work shall consist of furnishing all labour, materials, equipment's and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as per requirement.

ii. Without restricting to the generality of the foregoing, the system shall include the following:-

a. Vertical and horizontal soil, waste, vent and rain water pipes, and fittings, joints, clamps and connections to fixtures.
b. CI Hubless soil, waste & Vent pipe and uPVC rainwater pipes.
c. Connection of all pipes to sewer lines at ground floor levels.
d. Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads/Khurras.
e. Testing of all pipe lines.

3.2. General requirements

i. All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-in-charge.

ii. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.

iii. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

iv. Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

v. Access doors for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

3.3. Piping System

a. Soil, Waste & Vent Pipes

i. The Soil & Waste pipe system above ground has been planned as a "two pipe system" as defined in BIS: having separate pipes for waste for kitchen sinks, showers, washbasins, AHU's condensate drains and floor drains and approved by Engineer-in-charge.

ii. All waste water from AHU's plant and pump rooms, floor channels in basements will be provided with a deep seal trap before connecting to the main drain or vertical stack.

iii. Vertical soil & waste stacks shall be connected to a common horizontal drain pipe at basement ceiling or to an external manhole directly where feasible and shown on the drawings.

iv. Hubless centrifugally cast (Span) iron pipes epoxy coated in sides and outside as per IS code 15905.& fittings shall be used for Soil, waste, anti-siphon age pipes.

a. Rainwater Pipes

i. All terraces shall be drained by providing down-takes rainwater pipes.

ii. The rainwater for all buildings shall be collected in separate underground Tank and transfer in overhead tank. The rain water shall be used for flushing for all buildings and also used for firefighting in Hospital & Indoor Sports Complex

b. uPVC pipes & fittings (For Rain Water Pipes etc.)

i. Where specified, Polythene pipes shall be uPVC pipes confirming to I.S: 4985-2000, 6kg /cm^2 .

ii. The details of the nominal outer diameter, weight and working pressure shall be as per the standards, for the respective pressure rating.

iii. Polythene pipes may be cold bending to a radius of not less than eight times of their external diameter. Pipes bent for smaller radius may be made by hot bending.

iv. Fittings used for Polythene pipes shall be compression moulded fittings matching to the above specifications.

c. Jointing

iii. All Polythene pipes shall be Drip seal/Sealant/Ring Fit and jointed as per manufacturer's specifications and relevant I.S codes.

iv. All pipes shall be tested after installation for a pressure equal to twice the maximum working pressure in the line as per manufacturer's specifications.

d. Fittings

v. Fittings shall conform to the same Indian Standard as for pipes. Pipes and fittings must be of matching IS Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.

vi. Fittings shall be of the required degree of curvature with or without access door.

vii. Access door shall be made up with 3 mm thick insertion rubber washer and white lead. The bolts shall be lubricated with grease or white lead for easy removal later. The fixing shall be air and water tight.

e. Fixing

viii. All vertical pipes shall be fixed by structural support clamps truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).

ix. Horizontal pipes running along ceiling shall be fixed on structural adjustable clamps (Clevis clamps) of required shape & design or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.

x. Contractor shall provide all sleeves, openings, hangers, inserts during the construction. All damages shall be made good to restore the surfaces.

3.4. Traps

a. Floor traps

Floor traps shall be siphon type full bore P or S type Polypropylene having a minimum 50 mm deep seal. The trap and waste pipes shall be set in cement concrete blocks firmly supported on the structural floor. The blocks shall be in 1:2:4 mix (1

cement :2 coarse sand : 4 stone aggregate 20 mm nominal size) and extended to 40 mm below finished floor level. Contractor shall provide all necessary shuttering and centring for the blocks. Size of the block shall be 30x30 cm of the required depth.

b. Urinal traps

Urinal traps/horn shall be Polypropylene P or S traps with or without vent and set in cement concrete block specified for floor traps.

c. Floor trap inlet

Bath room traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a special type inlet fitting of P.P. pipe without, with one, two or three inlet sockets on side to connect the waste pipe. Joint between waste and hopper inlet socket shall be Ring fit / Drip Seal. Inlet shall be connected to a P.P P or S trap. Floor trap inlet fitting and the traps shall be set in cement concrete blocks.

d. Gratings for traps

Floor and urinal traps shall be provided with 100-150mm square or round C.P. / Stainless steel grating / PTMT, with rim of approved design and shape.

e. Jointing

Soil, waste, vent and anti-siphonage pipes shall be jointed with Ring fit joint as per design. The following minimum procedures shall be complied with while making the pipe joints:-

i. Ensure that the pipes are clean internally and undamaged.

ii. The pipes shall be cut square with sharp tools.

iii. The cut ends of the pipes shall be filed/ reamed and finished smooth.

iv. Any deformed ends shall be re-rounded.

v. It shall be ensured that the pipe ends shall enter the fittings and sockets to full depth of the jointing area.

vi. The pipe work shall be assembled in a manner such that it does not entail making of joints in restricted locations.

vii. The jointing surfaces shall be cleaned to remove any coatings etc.

f. Floor Trap Inlet/ Inlet Fitting:

Traps and connections shall ensure free and silent flow of discharging water. Where specified, Contractor shall provide a P.P. inlet fitting without or with one or two or three inlet sockets to receive the waste pipe. Joint between P.P. waste pipe and inlet socket shall be Ring fit / Solvent joint. Inlet fitting shall be connected to a P.P. 'P' or 'S' trap with at least 50mm seal. Floor trap inlet fitting and the traps shall be set in cement concrete blocks/and supports as required for Floor trap.

3.5. Cleanout Plugs

a. Cleanout Plug on soil pipes

Clean out plug for Soil, Waste or Rainwater pipes laid under floors shall be provided near pipe junctions bends, tees, "Ys" and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor levels. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be Cast Brass suitable for the Pipe dia. With screwed to a G.I. socket. The socket shall be Drip seal caulked to the drain pipes.

b. Cleanout Plug on Drainage Pipes

i. Cleanout plugs shall be provided on starting point of each drain and in between at locations indicated on plans or directed by the Engineer-in-charge. Cleanout plugs shall be of size matching the full bore of the pipe but not exceeding 150

mm dia. Cleanout Plugs on drains of greater diameters shall be 150 mm dia. Fixed with a suitable reducing adapter.

ii. Cleanout Plug at Ceiling Pipes: - Cleanouts provided at ceiling level pipe shall be fixed to a P.P. pipe. The cleanout doors shall be of Polypropylene, gasket etc.

3.6. Cutting and making good

a. Pipes shall be fixed and tested as building proceeds.

b. Contractor shall provide all necessary holes cut outs and chases in structural members as building work proceeds. Wherever holes are cut or left originally, they shall be made good with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) or brick work in cement mortar 1:2 (1 cement: 2 coarse sand) and the surface restored as in original condition.

3.7. Testing

a. Testing procedure specified below apply to all soil, waste and vent pipes.

b. Entire drainage system shall be tested for water tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber/bellow plugs, manometers, smoke testing machines, pipe and fitting work test benches and any other equipment necessary and required to conduct the tests. All testing shall be certified for its calibration by an approved laboratory.

c. All materials obtained and used on site must have manufacturer's hydraulic test certificate for each batch of materials used on the site. All testing equipment must be calibrated and shall carry certificate from an approved laboratory.

d. Testing soil, waste and rainwater pipes

i. Apart from factory test all pipes and fittings shall be hydraulically tested for a head of 3 m preferably on a specially set up work bench. After applying pressure, strike the pipe with a wooden pallet and inspect for blow holes and cracks. Pressure may be applied for about 2 minutes. Reject and remove all defective pipes.

ii. After installation all connections from fixtures, vertical stacks and horizontal drains including Polypropylene pipes shall be tested to a hydraulic pressure not exceeding 3 m. Such tests shall be conducted for each floor separately by suitable plugs.

iii. The entire installation shall be tested by smoke testing machine. The test can be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging all inlets by bellow plugs. Apply dense smoke keeping the top of stack open an observe for leakages. Rectify or replace defective sections.

iv. After the installation is fully complete, it should be tested by flushing the toilets, running at least 20% of all taps simultaneously and ensuring that the entire system is self-draining, has no leakages, blockages etc. Rectify and replace where required.

v. Contractor shall maintain a test register identifying date and time of each area. All tests shall be conducted in presence of Engineer-in-charge and signed by both.

4. Water Supply Systems

4.1. Scope of work

Without restricting to the generality, the water supply system shall include the following:-

i. Rising main from water supply pumps to all overhead tanks.

ii. Distribution system from overhead tank to all fixtures and appliances for cold & hot water.

iii. Insulation to hot water pipes within toilets.

iv. Connections to all plumbing fixtures, and appliances.

4.2. General requirements

a. All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the Engineer-in-charge.

b. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

c. Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.

d. As far as possible all bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 25 mm dia. Bends and elbows may be used for pipe dia. greater than 32 mm.

e. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

f. Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals approved by the Engineer-In-Charge.

g. Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

4.3. Water Supply System

a. Contractor should study the site plan and water supply system diagram for overviews of the system.

b. Source

i. Municipal Lines or through Water Tankers.

ii. The rising mains will be connected to the main fire static tank and then overflow into the main domestic water tanks as per tender drawings or as specified.

c. Water supply piping for garden hydrant and sprinkler and irrigation system will be separate and independent connected to a different pumping system.

4.4. Pipes & Fittings

In the water supply system Galvanised Iron Pipes/ CPVC Pipes/ SS Pipes / UPVC Pipes / Ductile Iron Pipes shall be provided as per approved designs.

i. CPVC pipes shall be used in the internal concealed water supply if specified in the contract. The CPVC pipes shall be conforming to I.S. 15778-2007and/or ASTMF-441 Schedule 40 of Class specified and having thermal stability for hot & cold water supply and shall be heavy class. These may require to be connected to the existing/ new GI pipes. The pipe and fitting approved make solvent shall be used as per approved manufacture specification.

ii. Galvanised Iron Pipes shall be used in the external water supply for upto 80mm dia and for above 80mm dia Ductile Iron Pipes shall be used, weather concealed or exposed as per approved design. These shall conform to I.S. 1239 of Class specified and shall be heavy class. These may require to be connected to the existing/ new CPVC/ DI Pipes. The pipe and fitting approved make, solvent etc., as required shall be used as per approved manufacture specification.

iii. SS 316 pipe shall be provided in labs and specific water supply requirements. The jointing shall be press type fittings with S-C contour in accordance with DVGW regulation W-524 with fittings. A press joint is made by mechanical deformation of the tube and fitting means of special hydraulic tool and cutting of pipe shall also be carried by later cutting tools by authorized agency. An elastomer o-ring is inserted in the recess at the end of the fitting for sealing. When the joint is made, the cross section of the tube becomes hexagonal. A calibration tool is used to ensure

that the joint made is up to standard, Clearances from wall, floor and ceiling should be allowed for making the joint refer to the manual of the press tool for clearance requirements.

4.4.1. Galvanised Iron Pipes

i. Pipe and fittings shall be joined with screwed joints, after cutting a pipe with a hacksaw or a cutting machine care shall be taken to remove burr from the end of the pipe after reaming with a proper file.

ii. Pipe threaded joints will be made by applying suitable grade of TEFLON tape used for drinking water supply.(Use of red and white lead sutli will not be permitted for screwed joints)

iii. Fittings shall be malleable iron galvanized of approved make. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for CPVC pipe shall include couplings, bends tees, reducers, nipples, union and bushes. Fittings shall conform to I.S. 1879-(Section I to X).

iv. All pipes shall be fixed in accordance with approved layout and alignment. Care shall be taken to avoid air pockets. G.I. pipes inside shall be fixed in wall chases well above the floor. No floor shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as per approved drawings.

4.4.2. Ductile Iron Pipes

i. Pipe and fittings shall be joined with spigot and socket joints or flanged joints, after cutting a pipe with a hacksaw or a cutting machine care shall be taken to remove burr from the end of the pipe after reaming with a proper file.

ii. Fittings shall be ductile iron of approved make. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for CPVC pipe shall include couplings, bends tees, reducers, nipples, union and bushes. Fittings shall conform to I.S. 8329.

iii. All pipes shall be fixed in accordance with approved layout and alignment. Care shall be taken to avoid air pockets. Pipes may be run as per approved drawings.

4.4.3. Chlorinated Polyvinyl Chloride (CPVC) pipes and fittings

i. CPVC pipes of specified dia. nominal bore shall conform to I.S. 15778 – 2007 and ASTMF-441 Schedule 40. The pipe fittings, clamps, etc. required for specified dia. bore pipes shall be of best quality and make as approved by the Engineer-in- charge. Chlorinated Polyvinyl Chloride (CPVC) pipes shall be as per ASTMF-441 Schedule 40 and having thermal stability for hot & cold water supply, including all CPVC plain & brass threaded fittings, including fixing the pipe with clamps at 1.00 m spacing. This includes jointing of pipes & fittings with one step CPVC solvent cement and testing of joints complete as per direction of Engineer in Charge.

   a) 15mm

   b) 20mm

   c) 25mm

   d) 32mm

   e) 40mm

   f) 50mm

   g) 65 mm;

ii. Workmanship:- Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within a joint. Burrs and fittings should be removed from the outside and inside of pipe with a pocket knife or file. The tubing should

make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket. Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket. After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approximately) in order to allow the joint to set up. An even bead of cement should be evident around the joint and if this bead is not continues remake the joint to avoid potential leaks.

When making a transition connection to metal threads, special Brass / plastic transition fitting (Male and female adapters) should be used. Plastic threaded connections should not be over torqued Hard tight puts one half turn should be adequate.

iii. Pipe and fittings shall be joined with one step CPVC solvent cement and testing of joints complete as per direction of Engineer in Charge.

iv. Fittings shall be CPVC of approved make. Each fitting shall have manufacturer's trade mark stamped on it. Fittings for CPVC pipe shall include couplings, bends tees, reducers, nipples, union and bushes and shall be of best make as approved by the Engineer-in-charge.

v. Only CPVC solvent cement conforming to ASTMF 493 should be used for joining pipe with fittings and valves. The cement solvent should be used within 30 days after opening the company's seal and tightly close the seal after using in order to avoid its freezing. The freezed cement solvent should be discarded immediately and fresh one should be used.

vi. For Horizontal runs, support should be given at 3 foot (90 cm) intervals for diameters of one inch and below and at 4 foot (m) intervals for larger sizes. Hangers should not have rough or sharp edges which come in contact with the tubing.

vii. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets. CPVC pipes inside shall be fixed in wall chases well above the floor. No floor shall be run inside a sunken floor as far as possible. Pipes may be run under the ceiling or floors and other areas as shown on drawings.

4.4.4. PVC (Sch40) Pipes & Fittings for water distribution Network

i. The rigid PVC (Polyvinyl Chloride) compound used in the manufacture of pipes and fittings is Type 1, i.e. Grade 1 PVC 1120 as identified in ASTM D 1784. The compound contains specified amounts of pigment, stabilizers and other additives to facilitate extrusion.

ii. The system is made as per ASTM (American Society for Testing of Materials) standards. The Pipes are made as per ASTM D 1785 and Fittings are made as per ASTM D 2466 (for SCH 40 Fittings). The pipes are plain ended in lengths of 3 meters in SCH 40 pressure classes.

iii. PRESSURE RATING – PVC SCHEDULE 40

Norm Size (mm)	Max. Work Pre. at 23°C (kg/cm2)
15	42.19
20	33.75
25	31.64
32	26.01
40	23.20
50	19.69

65	21.09
80	18.28
100	15.47
150	12.66

iv. Cut pipe square. As joints are sealed at the base of the fitting socket. An angled cut result in joint failure. Acceptable tools include miter saw, mechanical cut off saw or wheel cutter. Wheel type cutters must employ a blade designed for plastics.

v. Remove all burrs from inside and outside of pipe with a knife-edge, file, or deburring tool. Chamfer(bevel) the end of the pipe 10° - 15°.

vi. Remove surface dirt, grease, or moisture with a clean dry cloth.

vii. With light pressure, pipe should go one third to one half of the way into the fitting socket. Pipes and fittings that are too tight or too loose should not be used.

viii. Use an applicator that is one half the pipe diameter. Too large an applicator will force excessive cement into the inside of small diameter fittings. Too small an applicator will not apply sufficient cement to large diameter systems.

ix. Apply a full even layer of cement to the outside of a pipe and medium layer of cement to the inside of a fitting.

x. Assemble pipe and fitting socket till it contacts socket bottom. Give pipe a quarter turn. Hold pipe and fitting together until the pipe does not back out. Remove excessive cement from the exterior. A properly made joint will show a continuous bead of cement around the perimeter.

xi. Pressure Testing

a. Conduct pressure testing with water. DO NOT USE AIR OR OTHER GASES for pressure testing.

b. The piping system should be adequately anchored to limit movement. Water under pressure exerts thrust forces in piping systems. Thrust blocking should be provided at changes of direction, change in size and at dead ends.

c. Refer tables given for initial set & cure times before pressure testing.

d. The piping system should be slowly filled with water, taking care to prevent surge and air entrapment. The flow velocity should not exceed 1 feet per second.

e. All trapped air must be slowly released. Vents must be provided at all high points of the piping system. All valves and air relief mechanisms should be opened so that the air can be vented while the system is extremely dangerous and it must be slowly and completely vented prior to testing.

f. The piping system can be pressurized to 125% of its designed working pressure. However care must be taken to ensure the pressure does not exceed the working pressure of the lowest rated component in the system (valves, unions, flanges, threaded parts etc.)

g. The pressure test should not exceed one hour. Any leaking joints or pipe must be cut out and replaced and the line recharged and retested using the same procedure.

4.4.5. Clamps

i. G.I/CPVC/SS pipes / D.I. Pipes in the shaft and other locations shall be supported by clamps of design approved by Engineer-In-Charge. Pipes in wall chases shall be anchored by hooks. Pipes at ceiling level shall be supported on structural clamps.

ii. Spacing of clamps, hooks etc. Shall be as per good engineering practice approved by the Engineer-in-charge

4.4.6. Unions

Contractor shall provide adequate number of unions on pipes 50mm and below to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve , stop clock , or check valve and go on straight runs as necessary at appropriate locations as required and /or direct by Engineer-In-Charge.

4.4.7. Flanges

i. Flanged connections shall be provided on pipes 65 mm and above as required or where shown on the drawings generally as follows:

a. On straight runs not exceeding 30 m, near bends and at connections to main branch lines.

b. On all valves ends

c. On equipment /pump connections as necessary and required or as directed by Engineer – in - charge.

ii. Flanged connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion neoprene gaskets Bolt hole dia. for flanges shall conform to match the specification for C.I. sluice valve to I.S. 780 and C.I. butterfly valve to IS: 13095.

4.4.8. Trenches

i. All water supply pipes below ground shall be laid in trenches with a minimum cover of 60 cms. The width and depth of the trenches shall be as follows:-

Dia. of pipe	Width of trench	Depth of trench
15 mm to 50 mm	30 cm	75 cm
65 mm to 100 mm	45 cm	100 cm

ii. Sand filling

All D.I. / G.I. pipes in trenches shall be protected with fine sand 15 cm all around before filling in the trenches.

4.4.9. Painting

All pipes above ground shall be painted with one coat Zinc with each coating and two coats of synthetic enamel paint of approved shade and quality. Pipes shall be painted to standard colour code specified by Engineer-in-charge.

4.4.10. Pipe protection

i. All G.I. pipes in chase or below floor shall be protected against corrosion by the application of two coats of bitumen paint covered with bitumen tape and a final coat of bitumen paint before covering up the pipe.

ii. All D.I. / G.I. / CPVC water supply pipes below ground shall be protected against corrosion by applying one layer of 4 mm thick multilayer anticorrosive polymeric mix tape applied over a coat of primer as per recommendations of the manufacturers. (Pypkote)

4.4.11. Insulation

Hot water pipes within a toilet /kitchen , shaft and terrace from hot water header shall be insulated with **nitrle rubber insulation on hot water supply o**f required size as per specifications.

i. Materials: .

Insulation material for Pipe insulation shall be Closed Cell Elastomeric Nitrile

Rubber or closed cell cross linked polyethylene foam. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.038 W/moK or 0.0313 Kcal / Mhr oC or 0.212 BTU / (Hr-ft2-oF/inch) at an average temperature of 30oC. The product shall have temperature range of –40 oC to 105oC. Density of material shall not be less than 0.06 gm/cm3. The insulation shall have fire performance such that it passes minimum CLASS 1 as per BS476 part 7 for surface spread of flame. Water vapour permeability shall not exceed 0.024 per m inch (3 x 10-14 Kgs / m.sec.Pa).

ii. Workmanship:

Insulating material in tube form shall be sleeved on the pipes. On existing piping, slit opened tube from insulating material shall be placed over the pipe and adhesive (as recommended by the manufacturer) shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre.

All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labelled (HWS / HWR / HWRR) and provided with 300 mm wide band of paint along circumference at every 1200 mm for colour coding. Direction of fluid shall also be marked. All painting shall be as per relevant BIS codes.

4.5. **Valves**

i. Ball valves

Providing and fixing ball valve (Gunmetal) of approved quality, High or low pressure, with plastic floats as per drawings/CPWD specifications and directions of Engineeer-in-charge.

Valves below 50 mm dia. shall be screwed type ball valves with stainless steel balls spindle Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm^2 and accompanying couplings and steel handles to B.S. 5351.

ii. Butterfly Valve

a. The Butterfly valve shall be of best quality as per CPWD specification with hand lever operation. Operating pressure not less than 16 Kg/Sq.cm (PN 16). The Butterfly valve shall confirm to IS:13095.

b. Valves 50 mm dia. and above shall be cast iron butterfly valve to be used for isolation and/or flow regulation. The valves shall be bubble tight, resilient seated suitable for flow in either direction and seal in both direction. Valves shall be provided with matching flanges with neoprene insertion gasket 3 mm thick .P.N 1.6. Butterfly valve shall be of best quality conforming to IS: 13095.

c. The butterfly valve shall be installed with rubber gasket, flanges, nuts, bolts, washers & painting complete as required as approved by the Engineer-in-charge and as per CPWD specifications. The Butterfly Valve shall be complete with bolts, nuts, washers and neoprene gaskets as per manufacturers specifications.

iii. Non return valve (swing check type) shall be provided through which flow can occur in one direction only, It shall be single door swing check type of best quality conforming to IS: 5312.P.N1.6

iv. Each butterfly and slim type swing check valves shall be provided with a pair of flanges screwed or welded to the main line and having the required number of galvanized nuts, bolts and double washers of correct length.

v. Sluice valve shall be of approved makes conforming to I.S.:780 of class as specified.

4.6. **Storage Tanks**

4.6.1. Overhead Tanks

Overhead water storage tanks for water supply shall be reinforced cement concrete/PVC, as specified or as per design approved by the Engineer-In-Charge.

4.6.2. Tank connection and accessories

i. Contractor shall provide the following to each tanks:

a. Inlet and outlet connections to pumps, equipment and main pipe lines.

b. Tank overflows with mosquito proof gratings

c. Scour drain and valve as per drawings

d. Water level gauge with approved type of brass gauges, plastic tube, a wooden board with level marking.

ii. Electronic level controllers, cabling, sequence controllers and all related equipment shall be provided by agency executing the pumping system work. Plumbing contractor shall provide necessary G.I. sleeves and co-operate with the contractor to ensure that the work is successfully executed.

4.7. CP Materials:-

4.7.1. CP Brass Angle Valve:-

i. The C. P. brass Angle Valve shall be 15/20mm dia. of best quality as approved by the Engineer-in- charge. The Angle Valve shall conform to I.S. 8931-1993. The CP brass Angle Valve shall be with PVC flexible connections 1.5m long or as per requirement of standard design and of approved make.

ii. Workmanship:- The C.P. brass Angle Valve shall be fixed as directed to 15/20 mm. dia. CPVC. at one end and PVC flexible connection with brass check nut on the other end.

4.7.2. CP Brass wall mixer:-

i. The Wall Mixer shall conform to I.S. 8931-1993. The CP Brass wall mixer shall be with provision of overhead shower with 115mm long bend pipes on upper side with connecting legs and wall flanges with all accessories as required and making good the walls wherever required. The C. P. brass Wall Mixer shall be 15mm dia. of best quality as approved by the Engineer-in- charge.

ii. Workmanship:- The C.P. brass wall Mixer shall be fixed as directed to 15 mm. dia. CPVC. at the inlet.

4.7.3. SS towel rail:-

i. The towel rail, 600mm long and 20 mm dia, shall be of best quality as approved by the Engineer-in- charge. The brackets shall be of SS.

ii. The towel rail shall be fixed as and where directed.

4.7.4. SS Soap Dish:-

i. The SS Soap Dish shall be of best quality as approved by the Engineer-in-charge.

ii. The towel rail shall be fixed as and where directed.

4.7.5. SS Liquid Soap Dispenser:-

i. Liquid Soap Dispenser shall be wall/counter mounted suitable for dispensing liquid soaps, lotions, detergents. The cover shall lock to body with concealed locking arrangement, opened only be key provided. Liquid soap dispenser body and shank shall be of high impact resistance material. The piston and spout shall be stainless steel with 1 litre capacity polyethylene container.

4.7.6. 32 mm dia. C.P. brass waste coupling for sink

i. The 32 mm dia. C.P. brass waste trap and unions shall be of best quality and make as approved by the Engineer-in-charge.

ii. Workmanship:- C. P. brass waste trap and union shall be connected to 32 mm. dia. waste pipe which shall be suitably bent towards the wall and which shall discharge into drain through a floor trap. The C. P. brass waste trap shall be provided for wash basin or sink as the case may be.

4.7.7. CP Brass Sink mixer

i. The C. P. brass Sink Mixer shall be 15mm dia. of best quality as approved by the Engineer-in- charge. The CP Brass Sink mixer shall be with casted swinging spout with all accessories as required and making good the walls wherever required.

ii. Workmanship:- The C.P. brass sink mixer shall be fixed as directed to 15 mm. dia. CPVC. Pipe at one end .

4.7.8. Fully automatic "NO TOUCH" durable & shock proof hand drier:-

i. The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position. The hand drier shall be fully hygienic, rated for continuous repeat use (CRU). The rating of hand drier shall be such that time required to dry a pair of hands up to wrists is approximately 30 seconds. The hand drier shall be of wall mounting type suitable for 230 V, single phase, 50 Hz, AC power supply. It shall be fully automatic "NO TOUCH" durable & shock proof hand drier of approved make & manufacture suitable to operate on 220 volts, single phase 50 hz, A.C. power supply, 1500 Watt and directly plugged to power point complete in ABS plastic body having drying time 20-30 seconds complete as per direction of Engineer in Charge.

ii. Workmanship:- The Hand Drier shall be fixed by means of C.P. brass to screws wooden plugs finely embedded in the wall with C.M. 1 : 3 (1 cement: 3 coarse sand). The towel rail shall be fixed as and where directed.

4.7.9. Health faucet with regulator

i. The Health Faucet shall be 15mm dia. of best quality as approved by the Engineer-in-charge. The Health faucet shall be with regulator with flexible pipe 1 m long, wall hooked complete as required.

ii. Workmanship:- The Health Faucet shall be fixed as directed to 15 mm. dia. CPVC. Pipe at one end, as and where directed.

4.7.10. Hand rail and grab bar

i. The C. P. brass hand rail shall be 600 x 20 mm. of best quality as approved by the Engineer-in- charge. The brackets shall be of C. P. brass. The rail shall conform to I.S. 1068-1958. hand rail size 600X100mm and grab bar 350mm long to mounted on the track (vertically and laterally) for handicap toilet complete as required.

ii. Workmanship: The brackets of the hand rail shall be fixed by means of C.P. brass to screws wooden plugs finely embedded in the wall with C.M. 1 : 3 (1 cement: 3 coarse sand), as and where directed.

4.7.11. CP Brass Robe Hook

i. The C. P. brass Robe Hook shall be of best quality as approved by the Engineer-in-charge. The CP Brass Robe Hook shall be complete with C.P brass brackets fixed to wooden plugs with and C. P. brass screws.

ii. Workmanship:- The C.P. brass Robe Hook shall be fixed by means of C.P. brass to screws wooden plugs finely embedded in the wall with C.M. 1 : 3 (1 cement: 3 coarse sand), as and where directed.

4.8. Other Materials

4.8.1. S.S. hinged grating

i. The 100 mm. dia. SS hinged gratings for Floor trap shall be of best quality and make as approved. The frame of the grating shall be minimum 6mm thick. The S.S. hinged grating, 6mm thick with frame shall be of approved make including setting in floor with cement mortar 1:3. mix

ii. Workmanship: The SS grating shall be provided to P trap as the case may be in best workman like manner.

4.8.2. Nitrle rubber insulation on hot water supply

i. Insulation material for Pipe insulation shall be Closed Cell Elastomeric Nitrile Rubber or closed cell cross linked polyethylene foam. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.038 W/moK or 0.0313 Kcal / Mhr oC or 0.212 BTU / (Hr-ft2-oF/inch) at an average temperature of 30oC. The product shall have temperature range of –40 oC to 105oC. Density of material shall not be less than 0.06 gm/cm3. The insulation shall have fire performance such that it passes minimum CLASS 1 as per BS476 part 7 for surface spread of flame. Water vapour permeability shall not exceed 0.024 perm inch (3 x 10-14 Kgs / m.sec.Pa). The nitrle rubber insulation shall be on hot water supply of the following size as per specifications. (A) 15 mm; (B) 20 MM; (C) 25 mm; (D) 32 mm; (E) 40 mm; (F) 50 mm; (G) 65 mm; (H) 80 mm.

ii. Workmanship:

Insulating material in tube form shall be sleeved on the pipes. On existing piping, slit opened tube from insulating material shall be placed over the pipe and adhesive (as recommended by the manufacturer) shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre.

All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labelled (HWS / HWR / HWRR) and provided with 300 mm wide band of paint along circumference at every 1200 mm for colour coding. Direction of fluid shall also be marked. All painting shall be as per relevant BIS codes.

4.8.3. MS pipe puddle flanges

Providing and fixing for water tanks MS pipe puddle flanges of required size with 6mm thick MS plate of required size properly fixed in RCC walls of water tanks, including necessary welding of pipe with MS plate & reinforcement as per drawings and directions of Engineeer-in-charge.

4.8.4. UPVC Rain Water pipes

i. The specified size of uPVC Spigot and socket soil or waste pipe shall conform IS 4985 – 2000 the UPVC Rain Water pipes shall be of the following normal size

(A) 160 mm. dia.

(B) 200 mm. dia.

ii. Workmanship:

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from groovings and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be laid and clamped to wooden plugs fixed above the surface of the wall. Alternatively plastic clamps of suitable designs shall be preferred. Jointing for UPVC pipes shall be made by means of solvent cement for horizontal lines and 'O' rubber ring for vertical line.

The waste from lavatories, kitchens basins, sinks, baths and other floor traps shall be separately connected to respective stacks of upper floors. The waste stack of lavatories shall be connected directly to main hole while the waste slack of other shall be separately discharged over gully trap.

4.8.5. Cast Iron grating

i. The 225 x 225 mm. Cast Iron gratings for Floor trap shall be of best quality and make as approved. The Cast Iron grating, with frame shall be of an approved make including setting in floor with cement mortar 1:3.

ii. Workmanship: The grating shall be provided to Rain Water Pipes as the case may be in best workman like manner.

4.8.6. MS grating

i. MS grating consisting of ISI marked MS frame made of angle size 25mm x 25mm x 4mm thick. The removable cover shall be made out of ISI marked MS angle size 25mm x 25mm x 4mm thick having vertically welded transverse members made out of MS flats of size 25mm x 5mm thick at a spacing of 25mm centre to centre. The MS grating, with frame shall be of an approved make including setting in floor with cement mortar 1:3.

ii. The grating to be fixed on brick / concrete with 2 nos hold fasts of size 100mm x 25mm x 4mm thick to be embedded with cement concrete block of size 150mm x 100mm x 100mm of mix 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size) on each face of wall including painting with two coats of synthetic enamel paint over a coat of primer complete as per direction of engineer - in - charge.

4.8.7. Reinforced Concrete Light Duty Non-Pressure Pipes

i. The reinforced concrete light duly non -pressure pipes of specified diameter shall conform to I.S. 458-1971. The laying to level or slopes and jointing reinforced concrete light duty non-pressure pipes I.S. class N.P. 2 of the 200mm internal diameters shall be with collars and butt-ends prepared for collar joints incl. testing of joints etc. complete

ii. Laying:

The pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Where necessary pipe shall be laid in straight lines or with easy curves and true to line and gradient as specified. The laying of pipe shall proceed upgrade of a slope. In the pipe with loose collars, the collars shall be slipped on before the next pipe is laid.

In case where the foundation conditions are unusual such as the proximity of trees or holes, under existing or proposed around in 150 mm. thick cement concrete 1 :5 :10 (1 cement: 5 fine sand : 10 graded stone aggregate 40 mm. nominal size) or compacted sand or gravel.

In case where the natural foundation is inadequate the pipe shall be laid either in concrete cradle, supported on proper foundation or on any other suitably designed structure. If concrete bedding is used, the depth of concrete below bottom of the pipe shall be at least ¼th of the internal diameter of the pipe subject to a minimum of 100 mm. and maximum 300 mm. The concrete shall be extended upto the sides of the pipe at least a distance of ¼ th of the outside diameter for pipes 300 mm. and over in diameter.

The pipes shall be laid in the concrete bedding before the concrete has set. Pipe laid in trenched in earth shall be bedded evenly and firmly and as far as upto the haunches of the pipe as to safely transmit the load expected from the back fill through the pipe to the bed. This shall be done cither bye excavating the bottom of the trenches to fit the curve of the pipe or by compacting the earth under round curve of the pipe to form an even bed. Necessary provision shall be made for joints wherever required.

iii. Jointing:

The joints shall be done by slipping the collar over and clear of the end of the pipe. The recess of the end of the pipe shall be filled with jute threading dipped in hot bitumen. The new pipe shall then be brought forwarded until the bitumen ring in recess of first pipe is set into the recess of the second pipe. This process

shall be repeated for two or three pipes which shall then be jacked up so as to thoroughly compress the bitumen. The quantity of jute and bitumen shall be just enough to fill the recess when pressed hard by jacking, care being taken that no offset of the jute braiding shall be visible either outside or inside of pipe. The collar shall then be set up over the joints covering equally both the pipe and leaving an even caulking space all round Cement and sand mortar 1 : 1½ shall then be well punched or pressed home with a caulking tool within this caulking space. Care shall be taken that the underside of the joints is properly filled with mortar.

iv. Curing:

Every joint shall be kept wet for about 10 days for maturing, the section of the pipe line laid and jointed shall be covered immediately to protect from weather effects. Minimum bore of 100 mm. is considered adequate. 2 A2. The joints shall be left exposed for observation.

v. Testing of joints: The testing of joints shall be done as per relevant specifications.

4.8.8. 455x610 mm rectangular C.I. cover with (light duty)

i. The cover for the OHT shall be 455x610 mm rectangular C.I. cover with frame (light duty), with weight not less than 15 Kg for frame and 23 Kg for cover confirming to IS:1726 -1991..

ii. Workmanship: The CI Cover shall be securely placed on the top of the overhead tank as the case may be in best workman like manner.

CHAPTER D

TECHNICAL SPECIFICATIONS - HORTICULTURE WORKS:

1. Scope of work

The work shall in general conform to the Latest CPWD Specifications for works. Work under this Contract shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialized services as described in DBR, Tender Drawings.

2. **Excavation**

The top excavated soil shall be collected, stacked, preserved for use in landscaping / horticulture works. Surplus top excavated soil may be given to the nurseries or put to use in other Horticulture works.

3. **GRASSING**

a. **Preparation**

i. During period prior to planting the ground shall be maintained free from weeds.

ii. Grading and final leveling of the lawn shall be completed at least three weeks prior to the actual sowing. Clods of excavated earth shall then be broken upto the size not more than 75mm in any direction. The area shall then be flooded with water and after 10 days and within 15 days of flooding, weeds that re-germinate shall be uprooted carefully. The rubbish arising from this operation shall be removed and disposed of in a manner directed by Engineer. Regular watering shall be continued until sowing by dividing the lawn area into portion or approx 5 mts. Square by constructing small bunds to retain water. These 'bunds' shall be level just prior to sowing of grass plants. At the time of actual planting of grass, it shall be ensured that he soil has completely settled.

iii. Slight unevenness, ups and downs and shallow depressions resulting from the settlement of the flooded ground, in drying and from the subsequent weeding operations, shall be removed by fine dressing the surface to the final levels by adding suitable quantities of good earth brought from outside, if necessary as directed by the Engineer. In fine dressing, the soil at the surface and for 40mm depth below shall be broken down to particles of size not exceeding 6mm in any direction.

b. **SOIL**: The soil itself shall be ensured to satisfaction of Engineer to be a good, fibrous loam, rich in humus.

c. **SOWING THE GRASS ROOTS** :

i. Grass roots (Cynodon dectylon or a local approved by the Engineer) shall be obtained from a grass patch, seen and approved beforehand.

ii. The grass roots stock received at site shall be manually cleaned of all weeds and water sprayed over the same after keeping the stock in a place protected from sun and dry winds.

iii. Grass stock received at site may be stored for a maximum of three days. In case grassing for some areas is scheduled for a later date fresh stock of grass roots shall be ordered and obtained.

d. EXECUTION :

i. Small roots shall be debbled about 15 cms apart into the prepared grounds. Dead grass and weeds shall not be planted.

ii. Grass areas will only be accepted as reaching practical completion when germination has proved satisfactory and all weeds have been removed.

iii. All planting is to be done in moderately dry to moist (not wet) soil and at times when wind does not exceed a velocity of 8 kilometer per hours.

e. MAINTENANCE OF LAWN

i. As soon as the grass is approximately an inch high it shall be rolled with a light wooder, roller in fine, dry weather and when it has grown to 2 to 3 inches above the ground, weeds must be removed and regular cutting with the scythe and rolling must be begun. A top dressing of announce of guano to the square yard on well decomposed well broken sludge manure will help on the young grass. The scythe must continue to be used for several months until the grass is sufficiently secure in the ground to bear the mowing machine. It should be possible to use the inch above the normal level of the first two or three cuttings. That is to day the grass should be cut so that it is from 1 to 2 inches in length, instead of the ½ to ¾ of an inch necessary for mature grass.

ii. In absence of rain the lawn shall be watered every ten days heavily, soaking the soil through to a depth of at least 25 cms.

iii. Damage failure or dying back of grass due to neglect of watering especially for seeding out of normal season shall be the responsibility of the contractor.

iv. Any shrinkage below the specified levels during the contract or defects liability period shall be rectified at the contractor's expense.

v. The contractor is to exercise care in the use of rotary cultivator and mowing machines to reduce to a minimum the hazards of flying stones and brickbats. All rotary mowing machines are to be fitted with safety guards.

f. **ROLING**: A light roller shall be used periodically, taking care that the lawn is not too wet and sodden. Rolling should not be resorted to, to correct the levels in case certain depressions are formed due to watering

g. **EDGING**: The contractor shall establish a neat edge where planting areas meet grass areas with spade or edging tool immediately after all planting, including lawn planting, is completed. Particular care shall be exercised in edging to establish good flowing curves as shown on the plans or as directed by the Engineer. Edging must be cut regularly and shall be maintained by the contractor.

h. FERTILIZING: The lawn shall be fed once a month with liquid manure prepared by dissolving 45 grams of ammonia sulphate in 5 litres of water.

i. WATERING: Water shall be applied daily during dry weather. Watering whenever done should be thorough and should wet the soil at least upto a depth of 20 cms to eliminate air pockets and settle the soil.

j. WEEDING: Prior to regular mowing the contractor shall carefully remove rank and unsightly weeds.

4. **MAINTENANCE:** The contractor shall maintain all planted area within the landscape contract boundaries until the period of one year after the completion of project. Maintenance shall include replacement of dead plants. Watering, weeding, cultivating, control of insects, fungicide and other disease by means of spraying with an approved insecticide or fungicide, pruning and other horticulture operations necessary for the proper growth of the plants and for keeping the landscape area neat in appearance.

5. **PRUNING & REPAIRS: U**pon completion of planting work on the landscape all trees should be pruned and all injuries repaired where necessary. The amount of pruning shall be limited to the minimum necessary to remove dead or injured twigs and branches and to compensate for the loss of roots and the results of transplanting operations. Pruning shall be done in such a manner as not to change the natural habit or special shape of the trees. In general, one third to one fourth branching structure of the plants to be removed to compensate the loss of roots during transplantation by thinning or shortening branches but no leaders shall be cut. All pruning shall be done with sharp tools in accordance with instructions of the HLL. Pruning cuts shall be painted with recommended paints.

6. DIGGING HOLES FOR PLANTING TREES

In ordinary soil, refilling earth after mixing with manure and Watering.

Holes of circular shape in ordinary soil shall be excavated and excavated soil broken to clods of size not exceeding 75 mm in any direction, shall be stacked outside the hole, stones, brick bats, unsuitable

earth and other rubbish, all roots and other undesirable growth met with during excavation shall be separated out and unserviceable material removed from the site as directed. Useful material, if any, shall be stacked properly and separately. Good earth in quantities as required to replace such discarded stuff shall be brought and stacked at site by the contractor. The tree holes shall be manured with powdered Neam/castor oil cake at the specified rate along with farm yard manure over sludge shall be uniformly mixed with the excavated soil after the manure has been broken down to powder, (size of particle not be exceeded 6 mm in any direction) in the specified proportion, the mixture shall be filled in to the hole up to the level of adjoining ground and then profusely watered and enable the soil to subside the refilled soil shall then be dressed evenly with its surface about 50 to 75 mm below the adjoining ground level or as directed by the Engineer-in-charge.

7. FLOODING THE GROUND WITH WATER AND MAKING KIARIES

The water for flooding shall be of soft water and free from chemical and good for growing the trees and shrubs etc. Before flooding the kiaries shall be made in required size and shape as per directions of Officer-in-charge. After uprooting weeds from the trenched area and uprooting vegetation, kiaries shall be dismantled.

8. SPECIFICATIONS OF PLANTS

The plants should be as per following specification.

i. The plants should be full of fresh and healthy foliage.

ii. The plants should be free from insect, pest and disease.

iii. Plant should be healthy and vigorous growth

iv. The height of the plants will be measured from top of the pots.

v. The plants should be well settled and should not be newly shifted.

vi. The plants should be true to the variety and named Variety should be tagged.

vii. Moss stick used should be made on plastic pipe.

viii. Moss stick should be straight and properly fixed in the pot.

ix. The rejected plants materials should be removed from the site immediately.

x. Moss stick should be covered with the plants in case of plants supplied with moss stick.

xi. The Plant should be well established and good spread.

xii. Good earth and manure used for filling the pot/poly bag free from any inert material and mixed to proper ratio.

xiii. Pot/ Poly bag used for filling the plants should be proper size good quality not damaged.

xiv. There should be proper drainage in pots for plants.

xv. The flowering plants should also have proper flowering and should be true to the variety.

xvi. All plant should have the tendency of growth and should not be stunted type.

xvii. There should be no stagnation of water in the pots.

9. **NURSERY STOCK:** Planting should be carried out as soon possible after reaching site. Where planting must, of necessity, be delayed, care should be taken to protect the plants from pilfering or damage from people or animals. Plants with bare roots should be healed in as soon as received or otherwise protected from dying out, and others set closely together and protected from the wind. If planting should be unpacked, the bundles opened up and each group of plants heeled in separately and clearly abeled. If for any reason the surface of the roots becomes dry the roots should be thoroughly soaked before planting.

10. **PROTECTIVE FENCING**: According to local environment shrubs may have to be protected adequately from vandalism until established.

11. **COMPLETION:** On completion the ground should be formed over and left tidy.

List of Approved Makes of Materials-Civil & Plumbing

S.No	Details of equipment/ material	Make/Manufacturer
A. CIVIL WORKS		
1.	Acoustical Panelling	ECOTONE/ Armstrong/ Anutone
2.	Adhesive for Ceramic tiles	Cico / Pidilite / Bal Endura / Laticrete/ Fosroc
3.	Adhesive for Wood Work	Fevicol/Vamicol/Dunlop
4.	Aluminium Accessories and Hardware	Classic/ Crown /EBCO /Earl Bihari
5.	Aluminium Composite Panels	Aludecor / Alucobond /Alstone
6.	Aluminium Die-Cast handles & two point locking kit	Giesse / Securistyle / Alu – alpha
7.	Aluminium Extrusion/ Sections	Hindalco / Jindal / Indal
8.	Aluminium Fabricator	To be approved by the Engineer-in-Charge
9.	Anchor Fastner/Dash Fastner	Hilti / Fischer /Bosch/Wurth
10.	Anti – Termite Treatment	It should be done by permanent members of IPCA as approved by Engineer-in-Charge.
11.	Back up rod	Supreme Industry or equivalant
12.	Batch Mix Concrete (BMC)	The contractor to install his own computerized batching plant of suitable capacity and arrange for Transit Mixers, pumps etc. as per approval of Engineer – In- Charge. Or arrange Mobile Mini Batching Plant
13.	Bitumen	Indian Oil, Hindustan Petoleum, Bharat Petroleum
14.	Cement	ACC / Ultra tech / JK Cement / Jaypee-Rewa / Ambuja / Lafarge / Bangur/ Shree/ Dalmia/ Amrit/ STAR/TAJ
15.	Cement: White	Birla White / JK
16.	Cement bonded particle board	Bison Panel/ Viroc/ Viva
17.	Clean Room Wall Panels with/ without return air risers, Doors/ windows etc.	CLESTRA/ NICOMAC / HEMAIR / GMP / EPACK
18.	Clear Glass / Clear Float Glass / Toughened Glass	Saint Gobain (SG) / Asahi India Safety Glass Ltd /Modiguard
19.	Concrete Additive	Pidilite / Fosroc / Fairmate / MC Bauchemie/Sika/Cico/ CHRYSO/ STP Ltd.
20.	Cover /Spacer Block	Conbextra as manufactured by M/s Fosroc Chemicals India Ltd. or equivalent
21.	Curtain Rod/ Drapery Rod/ Venetian	Vista work / Mac Décor/ Deck

	Blinds	
22.	Crash Guard/ Corner Guard	MDD/TSI/LSR/Radius
23.	Door closer / Floor spring	Hardwyn/Godrej/ Dorma/Doorking/Everite/ Doorset
24.	Door Locks	Godrej / Harrison / Dorma/Link
25.	Door Seal – Woolpile Weather Strip	Anand Reddiplex/ Enviroseal
26.	Door Shutters- Flush	Duro / Greenply/Archidply / Century / Merino/ Jayna
27.	Doors & Windows Fixtures / Fitting.	Everite / Classic/ Crown / Earl Bihari /Doorset
28.	Epoxy Flooring	Fosroc/ Dr. Beck/ Flamaflor /STP
29.	Extruded Polystyrene Board	Styrofoam by DOW Chemicals / Insuboard by Supreme Industries /STP
30.	False Ceiling - Calcium Silicate Boards & Tiles	India Gypsum/ Armstrong / Hilux / Saint Gobain (Gyproc)/Aerolite
31.	False Ceiling - Metal	Armstrong / Hunter-Douglas / USG-Boral/ Saint Gobain/ Unimet
32.	False Ceiling - Mineral fibre	Armstrong / Decosonic / USG-Boral/ AMF/ Saint Gobain (Gyproc)
33.	Fire Rated Doors & Frames	Navair / Shakti-Hormann / Pacific/Promat
34.	Fire Rated Glass	Asahi India Safety Glass Ltd./ Saint Gobain/ Pilington, Schott, Pyroguard, Glaverbel
35.	Fire Retardant Paint	Viper FRS 881/ Nullifire/ Berger
36.	Fire Seal	Sealz, Alstroflam/ Abacus
37.	Fire: Door Closures, Mortice Dead locks	Becker Fire Solution/ Inersoll Rand/ Dorma/Godrej/ Geze/ Hafele
38.	Fire: D-Type Pull Handles	Becker Fire Solution/ Dorma/ Hardwyn /Godrej
39.	Fire: Hinges,	Becker Fire Solution/ Inersoll Rand/ Dorma/Godrej/ Geze/ Hafele
40.	Fire: Panic Exit Devices	Becker Fire Solution/ Inersoll Rand LCN Series/ Dorma PHA Series/ D-line/Godrej
41.	Fire: Sealant	Birla/ 3M/ Hilti
42.	Fire: Tower Bolts	Suzu/ Nulite, Dorset/ Dorma/Godrej
43.	Floor Hardener	Pidilite / SIKA/ Fairmate / BASF/STP
44.	Glass : Float & Mirror	Modiguard / Atul / Saint Gobain/ Asahi India Safety Glass Ltd / Modi Glass
45.	Glass for Aluminum Doors/ Windows/ Structural Glazing	Modiguard / Saint Gobain / Pilkington/ Asahi India Safety Glass Ltd./Modiglass

46.	Glass Wool / Insulation Boards/Puf InsulatedRoofing	Rockwool / UP Twiga / Lloyd Insulation /Pidilite
47.	GRC Jali	Unistone/ Kuber Fibrostone/Everest Composites/ Birla white
48.	Grout: Non-Shrink	Fosroc / Sikka/Pidilite or equivalent/STP
49.	Grouting Compound	Bal Endura/ Pidilite/ Laticrete/ Unitile/STP
50.	Gypsum Board / Gypsum False Ceiling/ Gypsum Partitions	USG-Boral Gypsum / India Gypsum / Lafarge / Saint Gobain (Gyproc)
51.	Laminates/ Veneers	Century/Archidply/Greenlam/Formica/Sunmica / Merino
52.	Lead Lined Door	REBBON, Kutty's, AHALDA
53.	Modular Grab bars and Disabled Hardware	Dorma / D-line
54.	Modular SS Railing System	Metallica India / D – Line International Denmark / Mobel Hardware
55.	Modular Kitchen Chimney	Hindware, Elica, Glen, Faber
56.	Neutron Shielded Door	Ray-Ban Engg corp/A-Fabco In/A7L shielding INC/Accurate Radiation Shielding
57.	Night Latch	Godrej / Dorma/ Ozone/Harrison/Link
58.	OT: Anti-Fungal paint	Sikka by Liquid Plastic/ Viesmann/ SSK/ TRILUX
59.	OT: Conductive Tile Flooring: ESD-Control Tile Flooring	Tarkett/ Gerflor/ Armstrong/ Forbe/ Trilux
60.	Paints - Cement Based	Snowcem Plus/, Berger (Durocem Extra)/ Nerolac (Super Acrylic)/ TATA Cem, Asian
61.	Paint – Fire Retardent	Viper FRS 881/ Nullifire
62.	Paints - Epoxy paint	Akzonobel DULUX/ Nerolac / Cico / Sikka / BASF / Berger / Pidilite
63.	Paints - Oil Bound Distemper / Acrylic Washable Distemper	Akzonobel DULUX/ Asian (Tractor)/ Berger (Bison)/ Nerolac (Super Acrylic), ICI (Maxlite)
64.	Paints - Other Paints / Primer	Akzonobel DULUX/ Asian/ Berger/ Nerolac
65.	Paints - Plastic Emulsion Paint	Akzonobel DULUX/ Asian/ Berger/ Nerolac
66.	Paints - Plastic Emulsion Paint (exterior)	Asian (Apex Ultima)/ Berger (Weathercoat all Guard)/ IAkzonobel (DULUX weathershield max)
67.	Paints - Synthetic Enamel Paints	Akzonobel DULUX (Gloss), Berger (Luxol Gold), Asian (Apcolite), Goodlas Nerolac (Full gloss hard drying), Jenson & Nicholson (Borolock)
68.	Paints - Texture paint	Berger / Spectrum / Unilite Heritage /Asian / Akzonobel DULUX/STP
69.	Paver blocks / Tiles (All Types)	KK / Uni Stone Products (India) Pvt. Ltd/

		Hindustan Tiles/ NITCO
70.	Plywood/Block board/Ply board	Duroply / Greenply/ Archidply/ Century/ Kitply/ National / Anchor/ Merino /Jayna
71.	Polycarbonate Sheets	Danpanlon India/Gallina/ Sabic Lexanc/ Ultralite
72.	Pre-coated Galvanised Steel Sheet	Tata BlueScope / Llyod Insulations India Ltd / S.R.Metals
73.	Pre-Laminated Particle Board	Novapan /Century /Green Ply/ Merino
74.	PVC continuous fillet for periphery packing of glazings / Structural/ Glazing	Roop / Anand / Forex Plastic/ Nagalia/Trading Company
75.	PVC Doors	Sintex/ Polyex/ Rajshri
76.	PVC Flooring	Tarkett Floors / LG Floors / Gerflor / Premier Vinyl flooring / Regent / Armstrong
77.	Powder Coating Material pure Polyester	Jotun / Berger / Goodlass Nerolac
78.	PVC Water Stops	Prince /Supreme/ Finolex
79.	RF Shielded Door	ETS Lindgern/ Synchrony Agency/ Huaming EMC India
80.	Reinforcement Steel / Structural Steel	SAIL/ RINL/ TATA Steel Ltd./ Jindal Steel & Power Ltd./ JSW Steel Ltd./ Shyam Steel Industries Limited
81.	Restroom Cubicles	Merino/ Century/ Greemlam
82.	Sandwich Puff Panel	JSW/SINTEX or equivalent
83.	Sealant: Poly-sulphide	Pidilite / Fosroc / CICO / Sikka /STP
84.	SFRC / RCC Manhole Covers/ Perfect RCC Grating	KK Manholes / SK Precast Concrete/ Advent concreteovision / Daya concrete
85.	Silicon sealants /Weather Sealant / Structural Glazing Sealant	GE- Silicon / Pidilite / Forsoc / Cico /Dow Corning / Sikka/ Wacker/STP
86.	Stainless Steel	Salem Steel/ Jindal or equivalent
87.	Outdoor Sports Flooring	Great Sports Infra/PORPLASTIC/Sunflex
88.	Stainless Steel bolts, Screws, Nuts & Washers	Kundan / Puja / Atul
89.	Stainless Steel Clamps	Hilti /Intellotech Koncept or equivalent
90.	Stainless Steel CP Grating	Chilly / Camry/ Neer or equivalent
91.	Stainless Steel D-handles	D-line / Giesse /Dorma
92.	Stainless Steel Friction Stay	Earl Bihari / Securistyle / EBCO
93.	Stainless Steel Hinges/Handles/Door Window Fixtures	Hettich/ Godrej/ Dorma
94.	Stone Adhesives	Fosroc / Sikka/Pidilite

95.	Sunken Portion Treatment	Choksey / Sika / CICO/ MC Bouchemie / BASF
96.	Super plasticizer	CICO/ Roffes Construction Chemicals/ Pidilite /
97.	Tiles: Ceramic Tiles	Kajaria / Somany/RAK/
98.	Tiles: Glass Mosaic Tiles	MRIDUL/ BIZZARE
99.	Tiles: Glazed (Ceramic) tiles	Kajaria / Somany/RAK/
100.	Tiles: Heat Resistant Terrace Tiles	Thermatek or equivalent
101.	Tiles: Vitrified Tiles (Double / Multi Charged)/ Germ free	Kajaria / Somany/RAK
102.	Vacuum Dewatered Flooring	Tremix / Sun Build / Avcon technics
103.	Veneered Particle Board	Duro / Greenply / Century / Novapan / Action Tesa
104.	Vinyl Flooring	Wonder floor/Responsive or equivalent make
105.	Water Proofing Materials	BASF/ Fosroc / Sika / CICO / STP/ Pidilite/CHRYSO/PENETRON/ASIAN
106.	Wooden Laminated Flooring	Euro / Pergo/ Green Deco , Krono, Egger, Harro , Armstrong, Kaindl
107.	Auditorium Chairs	Godrej/Spacewood/Indo/ Wipro
108.	Expansion Joints	Sanfield (India) Ltd., MIGUA, TRISTAR
109.	Raised/ False Flooring	UNIFLOOR, UNITILE, CAMFLOR
B.	**PLUMBING & SANITARY WORKS**	
1.	Automatic variable temperature control / fixed temperature control faucets	Jaquar / AOS-Robo-U-Tec/ Parry / Angash / Euronics
2.	Central Control	Rain Bird, USA/Toro/Nelson,
3.	Ball Cock	Sant / L&T/Audco/GPA
4.	Ball valves with floats	Zoloto / Leader / Sant/ Audco/GPA
5.	Brass - Stop & Bib Cock	Zoloto / Sant / Jaquar
6.	C. I Pipes & Fittings	Electrosteel/ Kapilansh/ NECO/ RIF/ SKF/BIC
7.	Centrifugally Cast Iron Hubless Pipes & Fitting	NECO/BIC/SKF/Kapilansh
8.	C.I Sluice Valve & Non Return Valve	Kirloskar /Leader /Zoloto/ Audco/ Sant
9.	C.I Valves (Full way, Check and Globe Valves	Leader / Kirloskar / SKF / Zolto / Sant / Castle / Kartar
10.	C.I. Manhole Covers	NECO/R.I.F./B.I.C./HEPCO/SKF/ KAJECO
11.	C.P. Fittings: Mixer / Bib Cock/ Pillar taps/ Angle valve/ Valves Washers / Waste/ Urinal / Spreaders / Accessories	Jaquar /Kohler/ Grohe/Marc/ Kerovit/ Somany

	etc.	
12.	Centrifugally C.I Rainwater Intel fitting , Bronze gratings	NECO/BIC
13.	Centrifugally casted C.I. Pipes	Electrosteel/ Kapilansh/ NECO/ RIF/ SKF/BIC
14.	Chlorinator	Thermax Ltd/ Watcon, Ion exchange/ Sigma DH Combine Inc./ Siemens/ Techcon/ Jesco / Prominent Heidelberg
15.	Chlorine Dosing System	Toshcon / Chloromax
16.	Cockroach Trap	Chilly/ Player/ Camry
17.	Copper Fittings (Capillary)	Yorkshire Imperial, U.K./ Rajco Metal Works Mumbai / IBP Conex Ltd.
18.	Disc Filter	Azud, Spain/ Amaid / Arkal,
19.	Ductile Iron Fittings (IS:9523)	Electrosteel/Kesoram/Tisco/Jindal/HEPCO
20.	Ductile Iron Pipes (IS:8329)	Electrosteel/Kesoram/Tisco/Jindal/HEPCO
21.	E.P.D.M Gaskets	Anand Reddiplex / Enviro Seals / HANU
22.	Forged Steel Fittings & Flanges (For Welded joints)	Rohini /Kanwal/ Vijay Cycle & Steel (VS)
23.	Geyser	Spherehot / Racold / Usha Lexus /Bajaj
24.	Hand Drier	Kopal / Utech Systems / Euronics Automat
25.	HDPE Pipes / Moulded Fittings	Emco /Polyefins/Pioneer Plyfab/ Jain
26.	HDPE Solution tank	Watcon / Ion Exchange / Water Supply Specialist Pvt. Ltd.
27.	Inbuilt Drip Line	Azud/ Rainbrid-USA/ Netafim
28.	Insulation of Hot water pipes	Vidoflex insulation / Superion insulation Kaiflex – Kaimann/Armoflex/Thermaflex
29.	Liquid Level Controllers / Indicators	Advance Auto / Sridhan International / Minilec / Radar / Femac / Switzer / 21st Century
30.	Liquid Soap Dispenser	Euronics/Utec/Kopal
31.	MS Saddle with G.I. Riser	Harvel/Alprene/Rain Bird, USA
32.	PVC flushing cistern	Commander / Parryware / Hindware/ Cera/ Kajaria Sanitary ware/ Somany
33.	P.R.S. Dials	Rain Bird, USA/ Toro, USA/ Nelson,
34.	P.T.M.T. Fitting	Prince India / Symet/Pryag
35.	Pipe coat material (pipe protection)	RPG Raychem/Pypkote/Makphalt/Lwl
36.	Pipe Fittings: G.I.	R/Unik/Zoloto/K.S./Sun/Swastik
37.	Pipe:- G.I.	Jindal / Tata / Prakash Surya/SAIL/ Swastik
38.	Pipes & fitting: PVC for SWR Soil, Waste	Prince / Supreme / Finolex

	& Vent Pipes and fittings, Type B PVC Casing & Screen Pipes	
39.	Pipes & Fittings: CPVC	Flowguard/ Astral/ Ashrivad/ AKG/Supreme
40.	Pipes & fittings: UPVC	Finolex / Prince / Supreme / AKG / Kasta / Vector / Astral
41.	Pipes & Gully Trap: Stone ware	Perfect / S.K.F/ R.K/ Hind / Anand
42.	Pipes and Accessories: PE-AL-PE	Kitec/ Jindal/ Kissan/Vista
43.	Pipes: Copper	Rajco Metal works, Mumbai / IBP Conex Ltd.
44.	Pipes: M.S.	Jindal / Prakash – Surya /TATA
45.	Pipes: PP-R (PN – 16)	Amitex Polymers Pvt. Ltd. / Prince/ Supreme
46.	Pipes: R.C.C	Indian Hume Pipe / Pragati Concrete Udyog Daya/ KK / JSP
47.	Plastic seat cover of W.C	Commander/Hindware / Parryware
48.	Polyethylene Storage Tank	Sintex / Polycon/ Fusion
49.	Pop up Connecting Assembly	Rain Bird/Dura/Lasco,
50.	Popup Spray Head	Rain Bird/Toro, USA/Nelson,
51.	RQRC Hydrant	Harvel/Alprene/Rain Bird, USA
52.	RQRC Key	Harvel/ Aqua/ Drip& Drip
53.	Sensor Operated Auto Flushing System Urinals	Jaquar / AOS-Robo/U-tec/Angash/Euronics
54.	SS Gratings/ Soap Dish/Towel Rail etc.	Camry/Glacier/Gem/ Jaquar/ Grohe
55.	Stainless Steel Sink	Hindware / Neelkanth / Nirali / Jayna
56.	Valve Box	Rain Bird, USA/Carson Brook, USA/Dura,
57.	Valve: Air Release	Azud/ API/ Bermad/ BIR/ Kirloskar / Venus / Zoloto
58.	Valve: Butterfly	Zolato/Audco /Sant/ KSB
59.	Valve: Gun metal	Kilburn /Leader /Zoloto/ Sant/ Kartar/ AIP/ Audco
60.	Valve: Flush	Gem/ Jaquar / Marc
61.	Valve: Mainline Isolation	Sant /Leader /Zoloto,
62.	Valve: Pressure Relief	Sant/Leader/ Zolato / Audco
63.	Valve: Sluice / NRV	Kirloskar/IVC/Kilburn /Zoloto/Castle/ Leader / L&T/ Audco
64.	Valve: Solenoid	Rain Bird, USA/Toro/Nelson,
65.	Valve: Non Return	Sant/ Leader/ Zoloto / AIP / Kirloskar/ IVC/ Leader/ Audco

66.	Valves: Gunmetal / C.P brass angle	Zoloto / Leader / Kilburn / Sant / Kartar/ AIP/ Audco
67.	VFD Pump	Jyoti / Crompton/ Kirloskar/ KSB/ Grundfos/ Mather & Platt
68.	Vibration Eliminator Resisto-flex Pads & Connections	Relay Corpn./ Kanwal
69.	Vitreous China Sanitary wares	Hindware / Parryware / Cera / Kohler/ Kajaria Sanitary Ware/ Somany
70.	Water Cooler	Blue Star/ Voltas/ Usha/ Godrej
71.	Water Meter	Capstan / Kranti/ Anand/ Kant
72.	Water supply pumps	KSB/ Grunfos/ Kirloskar/ Crompton/ Mather & Platt
73.	White Glazed Fire Clay Sink	Hindware / Parryware / Cera

Note:-

1. The contractor will use one of the approved makes as approved by the Engineer -in-charge.
2. In case of different quality / pattern of same make, the pattern/ quality shall be approved Engineer – in – charge.
3. This list of makes shall be read with the list of makes provided elsewhere in the Tender Documents . In case of variance, decision of the Engineer-in – Charge shall be final.
4. For materials/equipment/ to be used in items of work for which approved makes are not given hereinor in the list of makes provided elsewhere in in the Tender Documents, the makes of such materials /equipment shall be as decided by Engineer –in-charge.
5. If any major equipment is using a small component of make other than that given as a standard component with the equipment, the same shall be accepted subject to approval of Engineer –in-charge.

CHAPTER –F

TECHNICAL SPECIFICATIONS – ELECTRICAL & LOW VOLTAGE WORKS

1. GENERAL

Certain new builds comprising of Hospital Block, Academic Block, PG Hostel, Guest House, Indoor Sports complex & Auditorium, Resident Doctor building, M.S. Residence, Nurses Staff Quarters and Service Blocks etc. are to be constructed in existing RIPANS complex, Aizwal, Mizoram.

2. SCOPE OF WORK

The scope of work shall cover internal Electrical Installations, DG Set, Main LT Panels and external electrical Installation works complete as required for Electrification of proposed **RIPANS Campus.** It shall cover designing of complete Electrical System for the entire complex, preparation of shop drawings, supply of all equipment, material, electrical Fixtures & Accessories required, installation, testing and commissioning of all electrical installations for the project for the following, but not limited to, main items/systems:

2.1 ESS & External Electrical Installation

i. LT Panel with Synchronizing Relay for auto synchronizing and Auto-load management

ii. Capacitor Panels (APFC) with Harmonic filters to improve Power factor up to 0.97 (lagging).

iii. All Associated Equipment & accessories required

iv. DG Sets including Synchronizing relay and PLC panels for Auto Start/ Stop, Auto Load Management & Load sharing etc.

v. Lightening Protection System & Earthing Network

vi. 1.1 kV LT power cables

vii. Street Lighting System

viii. Electrical distribution comprising of feeder cables from LT Two Pole structure to respective Main LT panel/ Changeover Panel. Separate distribution shall be provided for Lighting load, AC Load, Power/Medical Equipment load through Rising Mains etc. UPS power shall be distributed through suitable cabling & LT panels in all buildings. Separate LT panels at each floor shall be provided for feeding HVAC load of AHUs, FCUs, Split ACs and Ventilation Fans.

The Electrical distribution should include - Emergency power supplying distribution system as per NBC 2016 for critical requirement for functioning of fire and life safety system and equipment, shall be planned for efficient and reliable power and control supply to the following systems and equipment where provided:

i. Fire Pumps

ii. Pressurization and smoke venting; including its ancillary systems such as dampers and actuators;

iii. Fireman's Lifts (including all lifts).

iv. Exit Signage Lighting;

v. Emergency Lighting;

vi. Fire Alarm System;

vii. Public Address (PA) System (relating to emergency voice evacuation and annunciation);

viii. Access Control System

ix. Lighting in fire command centre and security room.

x. Any other system as required

2.2 Internal Electrical Installations

It shall include the following items of work to be carried out simultaneously with the civil work within the buildings:

i. Wiring for 6A Light Points and socket Outlets

ii. Wiring for Call Bell, Fan & Exhaust Points.

iii. Wiring for 16A/20A Power socket outlets.

iv. Wiring for 3 Phase Power socket Outlets

v. 1.1 KV L.T. Cables and Sub main wiring.

vi. Rising Mains

vii. MV Panels/ Floor Panels and Double Door MCB Type Distribution Boards.

viii. Supply and Installation of LED Light fittings, fans, Exhaust Fans & fixtures

ix. Earthing & Lighting Arrestor

x. Wiring for Telephone

xi. Wiring for Cable TV

xii. Wiring for LAN Networking & Hospital Management Information System (HMIS)

xiii. Wiring for CCTV & Access Control System, Boom Barriers

xiv. Testing and commissioning of all electrical installations

The scope of work shall also include any other item or item of work, equipment, material or accessories not specifically mentioned above but is required for the satisfactory completion & trouble free operation & maintenance of electrical equipment/ work. This shall also include spares required for commissioning of the equipment/work

2.3 SPECIAL CONDITIONS FOR ELECTRICAL SERVICES:

a) GENERAL:- The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The requirement offered by the contractor shall be complete in all respects.

b) The contractor shall obtain all sanctions (electrical loads, approval of drawing/ ESS/ D.G.'s estimator/ approval of meter room etc. from the concerned authorities and permits required for the electrical installation work. The actual fee payable in this regard will be reimbursed against receipt/documentary evidence. On completion of work, the contractor shall obtain NOC from SEB & Director of Safety of the concerned state/Pollution Control Board; a copy of the same shall be delivered to HLL / Engineer In Charge.

The HLL shall have full power regarding the materials or work to be got tested through independent agency at the EPC contractor's expenses in order to prove their soundness and adequacy. The contractor will rectify the defects/suggestions pointed out by HLL/ independent agency at his own expenses.

The installation shall comply in all respects with the requirements of Indian Electricity Act 1910, Indian Electricity Rules (IER) 1956 and other related Laws and Regulations as amended up to date, there under and special requirements, if any, of the State Electricity Boards etc. The bidder

is liable to furnish the list of authorized licensed persons/ employed/deputed to carry out the works/perform the assigned duties to fulfill the requirement of Rule No.3 of IER 1956 as amended up to date.

2.4 DRAWINGS

i. **Tender Drawings:**

The tender drawings are meant to give general idea to bidder regarding the nature of scope & works to be executed. Any information/data not shown in tender drawings shall not relieve the contractor of his responsibility to carry out the work as per the specifications & terms of the EPC contract. Additional information required by the bidder/tenderer for successful completing the work shall be obtained at his end.

ii. **Shop Drawings:**

The contractor shall prepare detailed coordinated electrical shop drawing indicating Light Points, Power Points, Cal Bell points, Ceiling Fan, Exhaust Fan Points, Switch Boards, Distribution Boards (Light, Power & UPS), Lighting Fixtures, Convenience outlets, Single Line Diagram for complete HT/ LT electrical scheme, DG Sets, HT Panel, Transformers, LT Panels, Capacitor Panels, RTCC Panels, PCC Panel, UPS Units, UPS Incoming/ Outgoing panels, Lift Panels, Rising Mains, HT/ LT Cable Schedules, Solar PV System, Earth Pit Layout, Earth Strip routes, HT/ LT Cable Routes, Street Light Layout & Street Cable routes, Schematic Diagrams & Floor wise Shop Drawings for all LV works namely, Telephone, LAN, Wifi, CCTV, Access Control, Fire Alarm, Public Adress System, Information Display System, Boom Barriers etc. with other relevant services and submit to the HLL for approval or the Engineer-in-Charge before commencing the work.

GA Drawings, SLD & Control wiring diagrams, Room trench details for all HT / LT Panels, Capacitor Panels, UPS panels, Floor Electrical Panels, Transformers, DG Sets, UPS Units, Rising Mains etc. shall be prepared & submitted. The shop drawings shall indicate all setting out details and physical dimensions of all equipment/items/ components with wiring and cable details, cable schedule and routes, manhole trap and fixing details as well as for conduit indicating run and size of wire/cables, outlet/pull/junction boxes etc. with fixing details etc. for the above mentioned work. All work shall be carried out on the approval of these drawings. However, approval of these drawings shall not relieve the contractor of his responsibility for providing maintenance free and fool proof system including any missing component/accessories to meet the intent of the specifications. Contractor will submit 2 prints for preliminary approval and finally six prints for distribution. The recommended location/ position of the all equipment as shown on the layout drawings will be adhered to unless stated otherwise.

iii. **As-Built Drawings:**

On completion of the work and before issue of certificate of virtual completion, the contractor shall submit to the HLL, required Sets of 'As Built' drawings (in AutoCAD & PDF format) along with soft copy of the executed works incorporating all such changes and modifications during engineering and execution along with Operation and Maintenance Manuals, Warranty & Guarantee Certificates from Original Equipment Manufacturers (OEM), authorized Suppliers & Vendors, as applicable.

These drawings must provide:

- Run and size of conduit, inspection and pull boxes including routing and locations.
- Number and size of conductor in each conduit.
- Locations and rating of sockets and switches controlling the light and power outlet.

- A complete wiring diagram as installed and schematic drawings showing all connections in the complete electrical system.
- Location of outlets of various services, junction boxes, light fixtures.
- Location of all earthing stations route and size of all earthing conductors.
- Layout and particulars of all cables.
- Location and details of Transformers, HT/ LT Panels, Feeder Pillars, capacitor control panels etc.
- UPS panel, and relay panels with description detailed control wiring diagram.
- Location of transformer and its details and control wiring diagram.
- Location of Hume pipe and manhole including HT/LT cable layout and scheduling
- Location of DG Sets, Exhaust and auxiliary equipment with schematic drawings.
- Layout of cable trays with support and their fixing details.
- Location of all earthing station, route and size of all earthing conductor.\
- Layout and particulars of rising mains with fixing details.

The contractor shall submit 2 sets of samples of each type of accessories and apparatus, proposed to be used in the installation at site for approval (drawings or samples) as required shall be submitted by contractor and the choice of selection out of the approved list lies with the HLL. For all non-specified items, approval of the HLL shall be obtained prior to procurement of the same. HLL shall in no way be liable for rejection of the any material due to poor quality, poor workmanship, poor material etc.

2.5 MANUFACTURER'S INSTRUCTIONS

Where manufacturers have furnished specific instructions, relating to the material/ equipment to be used on this job, covering points not specifically mentioned in this document, manufacturers' instructions should be followed.

2.6 MATERIALS AND EQUIPMENT

All the materials and equipment shall be of the approved make and design. Unless otherwise called for any approval by HLL's Engineer-in-Charge, only the best quality materials and equipment shall be used.

2.7 GENERAL DETAILS

a) Space Heaters & Lighting.

One of more adequately rated heaters thermostatically controlled with On-Off switch and fuse shall be provided to prevent condensation in any panel compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation. CFL lamp shall be provided in any panel compartment.

b) Fungistatic Varnish

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the

varnish.

c) Ventilation Opening

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

d) Degree of Protection

The enclosures of the Control Cabinets, Junction Boxes and Marshalling Boxes, Panels etc. to be installed shall provide degree of protection as called for in specifications / General arrangement, whenever it is not mentioned it shall be as given below:

- Installed out door: IP-55.
- Installed indoor in air-conditioned area: IP-52.
- Installed in covered area: IP-52.
- Installed indoor in non-air-conditioned area where possibility of entry of water is limited: IP-42.
- For L.T. switchgear (AC and DC distribution boards): IP-52.

The degree of protection shall be in accordance with IS: 13947 (Part-I)/IEC-947 (Part-I). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

2.8 Rating Plates, Name Plates and Labels

Rating Plates, Name Plates and Labels are to be provided & attached permanently in a conspicuous position to all equipment & items installed in various buildings. A rating plate of non-corrosive material engraved with manufacturer's name, year of manufacture, equipment name, diagram, type or serial number etc. together with details of the loading conditions of equipment. The rating plate of each equipment shall be according to relevant BIS & IEC norms, as applicable.

All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

2.9 First Fill of Consumables, Oil and Lubricants

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, welding/ soldering/ brazing material for all copper/ G.I. earthing and essential chemicals etc. which will be required to put the equipment/ scheme covered under the scope of the specifications, into successful operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

2.10 DESIGN IMPROVEMENTS / DEVIATIONS

The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. If for any reason, Contractor wishes to deviate from specification, prior permission from HLL will be sought.

If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly in the specification.

3. QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Purchaser's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Purchaser after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following:

- His organization structure for the management and implementation of the proposed quality assurance programme.
- Documentation control system.
- Qualification data for bidder's key personnel.
- The procedure for purchases of materials, parts components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.
- Control of non-conforming items and system for corrective actions.
- Inspection and test procedure both for manufacture and field activities.
- Control of calibration and testing of measuring instruments and field activities.
- System for indication and appraisal of inspection status.
- System for quality audits.
- System for authorizing release of manufactured product to the Purchaser.
- System for maintenance of records.
- System for handling storage and delivery.
- A quality plan-detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

3.1. QUALITY ASSURANCE DOCUMENTS

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after dispatch of the equipment:

- All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.
- Welder and welding operator qualification certificates.
- Welder's identification list, listing welders and welding operator's qualification procedure and welding identification symbols.
- Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.
- Stress relief time temperature charts/oil impregnation time temperature charts.
- Factory test results for testing required as per applicable codes/ mutually agreed quality plan/ standards referred in the technical specification.

- The quality plan with verification of various HLL inspection points as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactorily.

4. INSPECTION, TESTING AND INSPECTION CERTIFICATE

- The HLL or duly authorized representative shall have at all reasonable times free access to the Contractor's/ Manufacturer's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, the Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.
- All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The Contractor shall intimate the HLL the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies.
- The Contractor shall give the HLL thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account. The HLL, unless witnessing of the tests is virtually waived off, will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/ inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the presence of HLL and he shall forthwith forward to the HLL duly certified copies of tests in triplicate.
- The HLL shall within fifteen (15) days from the date of inspection as defined shall inform in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.
- When the factory tests have been completed at the Contractor's or Sub-contractor's works, the HLL shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the HLL, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the HLL. Failure of the issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the HLL to accept the equipment should, it, on further tests after erection, is found not to comply with the Specification. The equipment shall be dispatched to site only after approval of test reports and issuance of clearance by the HLL.
- The contractor shall arrange all necessary tools and testing facilities for inspection purpose including arrangement of air travel (inland as well as abroad), conveyance, lodging, boarding and other miscellaneous expenses etc. HLL shall depute its inspection engineers (2 or more as decided by HLL) after receipt of inspection call from the contractor. All such expenses incurred by the contractor towards inspection of equipment by HLL' inspection engineers shall be borne by the contractor.
- For tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by HLL or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.

- The inspection by HLL and issue of Inspection Certificate thereon shall in no way absolve the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.
- The HLL will have the right of having at his own expenses any other tests(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material comply with the specifications.
- The HLL reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the Contractor.

5. TESTS

5.1. Charging Tests

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the HLL and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. given and shall be included in the Contractor's quality assurance programme.

5.2. Commissioning Tests

- The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, unmeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Contractor will apply proper corrections in calculation, to take into account conditions, which do not correspond to the specified conditions.
- All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.
- Pre-commissioning test shall be carried out as per relevant IS and/or as specified in the relevant clause.
- The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment.

6. PACKAGING

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. HLL takes no responsibility of the availability of any special packaging/transporting arrangement.

7. PROTECTION

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

8. FINISHING OF METAL SURFACES

8.1. General

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanized. All steel conductors used for earthing/grounding (above ground level) shall be galvanized according to IS: 2629.

8.2. Hot Dip Galvanizing

- The minimum weight of the zinc coating shall be 700 gm/sq.m and minimum thickness of coating shall be 85 microns.
- The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discolored patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.
- After galvanizing drilling or welding shall be performed on the galvanized parts of the earthing materials. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.
- The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.
- Sharp edges with radii less than 2.5mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.
  - Coating thickness,
  - Uniformity of zinc,
  - Adhesion test,
  - Mass of zinc coating.
- Galvanized material must be transported properly to ensure that galvanized surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

8.3. Painting

- All sheet steel work shall be degreased, pickled, phosphate in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces which will not be easily accessible after shop assembly shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, staving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be shoved.
- Powder coating/electrostatic painting of approved shade shall be applied.

- The exterior color of the paint shall be as per shade no. 697 of IS-5 or as approved by Engineer-in-charge and inside shall be white or as approved by Engineer-in-charge. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments, if required.
- In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids for HLL's review and approval.

9. HANDLING, STORING AND INSTALLATION

- In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Purchaser or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented.
- Contractor shall follow the unloading and transporting procedure at site, as well as storing, testing and commissioning of the various equipment being procured by him separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's Engineer(s) and shall extend full co-operation to them.
- In case of any doubt/ misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the HLL. Contractor shall be held responsible for any damage to the equipment consequent for not following manufacturer's drawings/instructions correctly.
- Where assemblies are supplied in more than the one section, Contractor shall make all necessary connections between sections. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.
- The Contractor shall submit to the HLL every week, a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
- The Contractor shall be fully responsible for the equipment/material until the same is handed over to the HLL in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by HLL, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment, which require indoor storage.
- The words 'erection' and 'installation' used in the specification are synonymous.
- Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- The minimum phase to earth, phase to phase and section clearance along with other technical parameters for the various voltage levels shall be maintained as per relevant IS.

10. PROTECTIVE GUARDS

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards with necessary spares and accessories shall be designed for

easy installation and removal for maintenance purpose.

11. DESIGN CO-ORDINATION

The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

12. DESIGN COORDINATION MEETING

The Contractor will be called upon to attend design co-ordination meetings with the Engineer, and the HLL/ RIPANS/MoHFW during the period of Contract. The Contractor shall attend such meetings at his own cost at mutually agreed venue as and when required and fully co-operate with such persons and agencies involved during those discussions.

13. TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipments.

14. SAFETY CODES & PRECAUTIONS

The Contractor at his own expenses shall arrange for safety provisions as required to comply with the statuary regulations, ISI recommendations and CPWD codes.

The contractor shall provide necessary barriers, warnings, signals and other safety measures to avoid accidents. He shall indemnify HLL against any claims arising out of negligence in this respect.

15. REGULATIONS AND STANDARDS

All equipments their installation, testing and commissioning shall conform latest CPWD/ IS specifications in all respects. Indian Standard Code of Practice for Electrical Wiring Installation IS:732-1989. It shall also be in conformity with Indian Electricity Rules and the Regulations, National Electric Code, National Building Code 2016, ECBC, latest CPWD specifications amended up to date and requirements of the Local Electric Supply Authority. In general, all materials equipment and workmanship shall conform to the Indian Standards specifications and code. Some of the applicable codes/standards are as under:

a.	CPWD General specifications for electrical works	Part-I (Internal) 2013
b.	CPWD General specifications for electrical works	Part-II (External) 1994
c.	CPWD General specifications for electrical works	Part-III (Lifts & Escalators) 2005
d.	CPWD General specifications for electrical works	Part-IV (Substation) 2013
e.	CPWD General specifications for electrical works	Part VII (DG Sets) 2013
f.	CPWD Guidelines for Substation & Power Distribution Systems of Buildings	2019
g.	Guide for uniform system of marking and identification of conductor and apparatus terminals.	IS 11353 -1985
h.	Low voltage switchgear and control gear assemblies	IS/IEC 61439
i.	Specification for low voltage switchgear and control gear assemblies	IS 8623 (Part -2-1993)
j.	Code of practice for selection, Installation and maintenance of switchgear and control gear.	IS 10118 Part – 1 - 4

k.	PVC insulated (heavy duty) electric cables	IS 1554
l.	PVC insulated cables for working voltages up to and including 1100V.	IS 694
m.	Conduit for electrical installations	IS 9537
n.	Accessories for rigid steel conduits for electrical wiring	IS 3837
o.	Boxes for the enclosure of electrical accessories	IS 14772
p.	General and safety requirements for luminaries	IS 1913
q.	Code of practice for earthing	IS 3043
r.	Electrical accessories – circuit breakers for over current protection for household and similar installations.	IS 8828
s.	Low Voltage switchgear and control gear	IS 13947 Part 1 – 5
t.	Residual current operated Circuit Beakers	IS 12640
u.	Current Transformers	IS 2705
v.	Voltage Transformers	IS 3156
w.	Direct acting indicating analogue electrical measuring instruments and their accessories	IS 1248 part – 1 to 9
x.	Control Switches (switching device for control and auxiliary circuits including contactor relays) for voltages up to and including 1000V AC and 1200 V DC.	IS 13947 & IS 1336

In case of contradiction in specification the priority of the documents shall be CPWD/ IS Specifications, Drawings, Technical Specifications.

16. 11/ 0.433 kV SUBSTATIONS

16.1. 11 kV VACUUM CIRCUIT BREAKER (VCB) PANEL BOARD

16.1.1. GENERAL:

Vacuum Circuit Breaker shall be incorporated in HT Panel boards in required combination of incoming panels, coupler panel, outgoing transformer panels & outgoing feeder panels. VCB's shall conform to IEC 298 and 694, IS 3427, BS 5227 and VDE 0670, Part 6 as well as the regulations mentioned therein. VCB's shall be indoor type & suitable for operation on 11 kV, 3-Phase, 50 Hz AC supply. Metering and protection in the panels as detailed herein after. 11KV Panel board in each Substation shall be comprising of 2 Incoming Panels, One Bus coupler & Outgoing Panels with provision of at least one no. spare Breaker panels on each side.

16.1.2. TYPE AND CONSTRUCTION:

- The metal clad panel shall be fully extensible and compartmentalized to give.
    a. Circuit Breaker Compartment
    b. Busbar Compartment
    c. CT and Cable Compartment
- The compartments shall be safe to touch and compartments thus formed shall be dust proof & vermin proof. A separate metering chamber for fixing the necessary instrumentation metering and protective equipment shall be provided panel on the front.

- The VCB shall consist of three air insulated poles incorporating mechanism of interrupters. The body of interrupters shall be made of nickel chromium steel supported on insulators made out of metalised aluminum oxide. The contacts shall be of chromium copper and butt shaped.
- Vacuum Circuit Breaker shall be mounted on truck or a carriage mechanism. In case of truck mechanism, the breaker shall be on a trolley while in a carriage mechanism, shall be separate door and it shall be possible to perform all operations with front door closed. The draw out carriage shall have two positions for the circuit breaker viz isolated/test & service position. Bus bars shall be insulated type made of high conductivity copper supported on cast epoxy monobloc designed to withstand full short circuit currents and shall be provided all along the length of the HT Board.
- It shall be horizontal isolation, horizontal draw out type, fully interlocked, with dust and vermin proof construction, suitable for indoor instillation. The panel shall be supplied with the manufacturer's test certificates.
- The steel work should have undergone a rigorous rust proofing process comprising alkaline degreasing, descaling in dilute sulphuric acid and recognized phosphate process and shall then be given power coating (Electrostatic) paint of manufacturer's standard shade.
- The switchgear constructions shall be such that breaker operation and internal explosions do not endanger the operating personnel, and the front of the panel shall be specially designed to withstand these. Pressure relief flaps shall be provided for safely venting out gases produced inside the high voltage compartment, bus bar compartment and termination compartment. These flaps shall be vented upwards and cannot be opened from outside. These relief flaps shall be of such construction as not to permit ingress of dust/water in harmful quantities under normal working conditions. Enclosure shall be constructed with sheet steel of at least 2.0 mm thickness. It shall have a rigid, smooth, leveled, flawless finish.
- Voltage transformer of burden not less than 100 VA and of proper ratio as specified shall be provided. The accuracy class for the VT shall be 0.5 as per is 3156 Part 1 to III for incomer and class I for outgoing panels. The PT shall be of cast epoxy resin construction. It shall be fixed/withdraw able type. HRC fuses circuit Breaker shall be provided on both HV and LV side. Adequate space at the rear of the panel shall be provided for the termination of power & control cables. The panel shall be provided with suitable terminating arrangement for the termination of cables. Burden of PT should match with the requirement of client.
- The making contact arms (upper & lower) of the circuit breaker shall be encased in polyprolene tubes. Penetration type bushings shall be provided in the busbars & cable compartment for the fixed contacts.
- Safety shutters shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the carriage is moved to Isolated/Disconnected position. The shutters shall move automatically with the movement of the draw out carriage. It shall, however, be possible to open the shutters of busbars side and cable side individually.
- Mechanically operated circuit breaker auxiliary switches of minimum 5 NO + 5 NC ways, shall be provided for control and indication purposes. Control wiring shall be done by 1.5 sq. mm, 1.1 kV grade stranded copper PVC insulated wires. All control device shall be MCB type.
- Terminal blocks shall be clamp type suitable for connection of only 2 wires per terminal and shall be 650 V grade. The LT control circuit shall be routine tested to withstand 1.5 kV for one minute.

- Busbar compartment shall be provided at the rear. Electrolytic copper busbars shall be of rectangular cross section and insulated. Busbars shall be supported properly by cast epoxy resin insulators so as to withstand thermal and dynamic stresses during system short circuits. Busbars shall be provided with necessary color coding for phases indication. The busbars shall be designed to withstand a temperature rise of 60 deg. C above and ambient temperature of 45 deg. C.

16.1.3. BUSBAR AND REGULATORS

- All bus bars and jumper connections shall be of electrolytic copper conforming to relevant IS Standards. They shall be adequately supported on epoxy insulators to withstand electrical and mechanical stresses due to specified short circuit currents. Busbar cross section shall be uniform throughout the length of switch board.
- Contact surface at all joints shall be properly cleaned and No-oxide grease applied to ensure an efficient and trouble free connections. All bolted joints shall have necessary washers for maintaining adequate contact pressure. All connection hardware shall have high corrosion resistance.
- Bus bar insulators shall be of track-resistance, high strength, and non-hygroscopic, non-combustible type & shall be suitable to withstand stresses due to over voltages and short circuit current. Busbar shall be supported on the insulator such that the conductor expansion and contraction are allowed without straining the insulators. The temperatures of the busbars and all other equipments, when carrying the rated of relevant Indian Standards, duly considering the specified ambient temperature.

- **EARTHING AND PROTECTIVE EARTHING**

  Copper earthing bus shall be provided. It shall be bolted/ welded to the framework of each panel. The earth bus shall have sufficient cross time fault currents to earth without exceeding the allowable temperature rise. Suitable arrangement shall be provided at each end of the earth for bolting. Earthing conductors and earth bus shall run inside at the back of the panel for entire length. Facilities shall be provided for integral earthing of busbars & feeder circuit. Earthing rod consisting of 16 Sq.mm. stranded/flexible copper cable 15 Mtr. long and connectors shall be supplied. Cost of this earthing rod is deemed to be included in the cost of VCB Panel.

- **METERING AND PROTECTION**

  The VCB Panel Board shall be provided with epoxy resin current transformers for metering and protection. The protection CT's shall be of accuracy class 5P10 of 2705-Part –III- 1992. The metering CTs shall confirm to the metering ratio and accuracy class 0.5 of is 2705-1992 for the incomer and Class I for the outgoing panels. Ammeter and voltmeter to be installed on panel shall be digital type. Voltmeter transformer of burden not less than 100 VA shall be 0.5 as per IS 3156 Part-I to Part-III for incomer and class I for outgoing panels. The PT shall be fixed/withdraw able type. HRC fuses/ MCB shall be provided on both HV and LV side. All meters shall be 96mm squire pattern, flush mounting type necessary selector switches. Necessary lamps of low voltage type with built in resistors shall be provided (maximum wattage 2.5watt. Burden of CT should match with the requirement of the client.

- **Metering and Protection to be provided in Panels shall be as detailed below:**

INCOMING PANELS - 800 A 11 kV VCB BREAKER PANEL
1 Set .-11KV/110Volts , 3 phase PT Class -0.5 accuracy and 100 VA burden with 1 No. Voltmeter (0-15KV), digital type with built-in selector switch and protection MCBs for HT metering up to 12 KV on Incomer (IS-3156)

1 Set- Ammeter Digital Type with built -in selector switch.
1 Set-Microprocessor based relay with O/L, S/C and E/F protection. Relay shall be communicable on modbus protocol of IBMS.
1 Set of dual core dual ratio 3 CTs of suitable ratio 15VA burden and accuracy Class-0.5 for metering and class 5P10 for protection. (IS-2705-1992)
1 Set calibrated intelligent multi function digital panel meter of class 0.5 accuracy with communication interface port RS 485 for giving output on MOD BUS protocol of IBMS for receiving V, A, KVA, KVAh, KW, KWH, Hz, KVAR , PF, MDI individual total harmonic distortion with suitable rating CTs etc complete with wiring connections etc.
1 Set R/Y/B phase LED indication lamp
1 Set Red - ON, Green - OFF, TRIP, TRIP CIRCUIT HEALTHY, SPRING CHARGE, DC ON. (6 Nos. Ind. Lamps (LED TYPE) for each set).
1 Set of Push button for Emergency Tripping with 1 NO + 1 NC contacts & inscription plates.
1 Set Trip / Neutral / Close Breaker Control Switch.
1 Lot - Master Trip Relays / Lockout Relays / Anti pumping / Aux. Relays/ Over current/ Earth Fault/ Phase Sequence Relay for Incoming VCB Feeders as required.
OUTGOING PANELS- 630 A, 11 KV VCB BREAKER PANEL
1 set Ammeter digital type with built-in selector switch.
1 set -Microprocessor based relay with O/L, S/C and E/F protection. Relay shall be communicable on modbus for protocol of IBMS.
1 Set of dual core 3 CTs of 15VA burden and accuracy Class-1.0 for metering and class 5P10 for protection.
1 set R/Y/B phase LED indication lamp
1 set Red - ON, Green - OFF, TRIP, TRIP CIRCUIT HEALTHY, SPRING CHARGE, DC ON and AC ON. Indication LED lamps (7 Nos. Ind. Lamps for each set)
1 set of Push button for Emergency Tripping with 1 NO + 1 NC contacts & inscription plates.
1 set Trip / Neutral / Close Breaker control switch.
1set calibrated intelligent multi function digital panel meter of class- 1.0 accuracy with communication inter face port RS 485 for giving output on BACNET / MOD BUS protocol of IBMS for receiving V, A, KVA, KVAh, KW, KWH,F, KVAR & PF etc. complete with wiring.
1 Set 8 window solid state audio/ Visual Annunciators with Test/ Accept/ Reset push buttons and Electronic Hooter.
1 Lot - Master Trip Relays / Lockout Relays / Anti pumping / Aux. Relays/ Over current/ Earth Fault for Outgoing VCB feeder as required.

The Incoming & Outgoing VCBs panels shall SCADA/BMS compatible.

16.1.4. OPERATING MECHANISM

- Vacuum Circuit Breaker shall be equipped with motorized spring charge. These operating mechanisms shall be of the stored energy type. In the closed state of the breaker, the energy stored in the springs shall be suitable for O-C-O duty.
- Interlocking and Safety Arrangement- Vacuum Circuit Breaker shall be provided with the following safety and interlocking arrangements:

  i. The draw out carriage cannot be moved from either test/disconnected to service position or vice versa, when the circuit breaker is 'On'.

  ii. The circuit breaker cannot be switched 'ON' when the carriage is in any position between test & service position.

iii. The front door of the panel cannot be opened when the breaker is in service position or in an intermediated position.

iv. The low voltage plug & socket cannot be disconnected in any position except test/isolated position.

v. The door cannot be closed unless the LV plug has been fitted.

vi. It shall be possible to mechanically close and trip the circuit breaker through push buttons with the circuit breaker in service position and the door closed.

vii. Individual explosion vents shall be provided for breaker, busbar, cable chambers on the top of the panel to let out the gases under pressure generated during an unlikely event of a fault inside the panel.

viii. Circuit Breaker & sheet metal enclosure shall be fully earthed.

ix. Self locking shutters shall be provided which close automatically and shall be interlocked with the movement of the draw out carriage mechanism.

- **Rating:** The rating of the vacuum circuit breaker shall be as below

Rated current	800 A for I/C and 630 A for O/G Panels
Rated Voltage	11 KV
Rated Frequency	50 Hz
Rated Breaking capacity	18.37 kA (350 MVA)
Rated making capacity	As per relevant standards.

- **Accessories:** Circuit Breakers shall be provided with the following accessories.

i. Auxiliary Switch with minimum 5 NO + 5 NC auxiliary contacts.

ii. Tripping Coil

iii. Mechanical Operation Counter

iv. Spring Charging Handle

- **Mounting:-** Vacuum Circuit Breakers shall be mounted as per manufacturer's standard practice.

- **Auxiliary Supply**

a. The tripping shall be at 24 Volt D.C. through a power pack unit or Battery Charger

b. Space heater indication & other auxiliary supply requirement shall be at 230 V AC. Necessary termination arrangements complete with isolating switch, control fuse & link shall be provided at one place in the panel for receiving the purchaser's cable.

16.1.5. TESTS

- **Factory Tests**

The circuit breakers panel shall be subjected to routine tests at manufacturer's works in accordance with the details specified in the relevant IS specifications. These shall however necessarily comprise of the following.

a. Power frequency voltage test on the main power circuit.

b. Verification of the correct wiring/Functional Test.

c. Dielectric test at 1.5kV on the control circuit. Apart form above, the contractor shall submit the routine test certificates for the following equipment.

   i. Circuit Breakers

   ii. Current Transformers

   iii. iii.Voltage Transformers

d. Temperature rise test.

e. Impulse & power frequency voltage test

f. Short time current test on circuit breaker.

- **Site Test**

General

1. Verification for completion of equipment, physical damage/deformities.
2. Alignment of panel, interconnection of busbars & tightness of bolts & connection etc.
3. Interconnection of panel earth busbar with plant earthing grid.
4. Inter panel wiring between transport sections.
5. Cleanliness of insulators and general Cleanliness of panel to remove traces of dust, water etc.

Circuit Breaker & Panel

1. Check for free movement of circuit breaker, lubrication of moving part & other parts as per manufacturers manual.
2. Manual/Electrical operations of the breaker and Functional test as per drawings.
3. Meggar before the Hi Pot test.
4. H.T. Test - Hi Pot test (Power frequency withstand test for one minute at 28kV RMS). At site Hi Pot test is carried out at 80% of 28kV RMS value.
5. Meggar after the Hi Pot test.
6. CT/PT ratio/polarity primary injection test.
7. Secondary injection test on relays to practical characteristics.

16.2. 11 KV HT CABLES

The size & runs of the HT cables shall be decided as per the Electrical Load requirements and rated short circuit capacity of Substations & HT cable Schedule shall be got approved from Engineer-In-Charge.

16.2.1. Construction

All HT cables shall be of 11 kV grade, armored, aluminum conductor, XLPE insulated, earthed & PVC sheathed. All HT cables shall be manufactured & tested in accordance with relevant IS Code Specifications.

16.2.2. 11KV CABLE JOINTS/ TERMINATIONS

Terminal joints shall be carried out as per IS specifications. Heat shrink cable termination kit shall be used for terminations & straight through joints.

16.2.3. INSTALLATION OF CABLES

Cable laying in ground, Cable trays , Ducts or fixing on Wall shall be carried out as per CPWD specifications for Electrical works Part II as amended up to date. Cable route marker shall be provided at regular intervals as per CPWD specifications. Cost of cable route markers is deemed to be included in the cost of cables/cable laying.

16.3. LT PANELS

16.3.1. GENERAL

The scope of supply covers design, fabricate, integrate, pack, dispatch to site along with routine testing as per IEC of Low Voltage Switchgear & Controlgear Assemblies up-to 1000 V (Will be termed as ' LT Panel ' here forth) . Main LT Panel, Distribution Boards & Sub Panels shall be factory fabricated by Original Equipment Manufacturer or their authorized system intergrators/ channel partners. All LT Panels, Distribution Boards & Sub Distribution Panels shall comply with IEC-61439 & manufactured accordingly. The Panels shall be indoor type, metal clad, floor mounted, free standing, totally enclosed, extensible type, air insulated, cubicle type for use on 415 Volts, 3-phase, 50 cycles system. All LT Panels shall be designed to accommodate suitable ratings of Incoming Feeders, Outgoing Feeders, Bus Couplers etc. to cater to electrical load requirements of various buildings & facilities. All necessary wiring, cabling etc between LT Panels, Sub- Panels etc and BMS shall be carried out as per norms. Incoming Feeders from Transformers & DG Sets shall also be controlled through Sync Relay/ PLC for auto Load change over / load sharing.

Degree of protection shall be IP-42 for Indoor & IP-62 for Outdoor Panels. All Outdoor Panels shall be weather proof, Double Door with suitable canopy on top. The short circuit current rating of LT Switchgears shall be $\geq$ 50 kA.

All LT Panels shall be provided with necessary instruments for Monitoring & Metering purpose to meet ECBC & GRIHA requirements.

All incoming feeders of LT panels shall have R, Y, B, ON, OFF & Trip LED Type indication lamps. All outgoing feeders of LT panels shall have ON, OFF & Trip LED Type indication lamps.

Multifunction meters with BMS compatibility shall be provided in all incoming feeders of all LT Panels to be installed in RIPANS Campus. Suitable digital energy meter with CTs, wiring etc. shall be provided for all outgoing feeders of Main LT Panels to be installed in various buildings.

Main LT Panels in ESS buildings shall have Multifunction meters with BMS compatibility in all Incoming Feeders & all Outgoing Feeders.

Site Conditions: The LT Panel will be located indoors and shall be designed to operate satisfactory at rated load under the service conditions. This equipment will be subject to the ambient temperature conditions at the site as specified in the Project Requirements.

a.	Location	- Indoor
b.	Altitude above main sea level	- < 2000 M above sea level.
c.	Design Ambient Temperature	- 40 Deg. C
d.	Temperature Rise	- As per IEC-61439
e.	Relative Humidity Max	- 95%
f.	Relative Humidity Min	- 10%
g.	Pollution	- Up to Degree of Pollution-3
h.	Application	- Indoor

16.3.2. CONSTRUCTION-

a) Standards

The equipment covered under this specification shall conform to the latest revisions of relevant Indian and International Standards some of which are listed below:

IEC 61439 part 1 & 2: Low voltage switchgear and control Gear assemblies

IS 13947 1993 : General requirements of Switchgear and Control Gear for Voltage not exceeding 1000 / 1200V AC

IS 11353 1985 : Guide for uniform system of marking Identification of Busbar and Terminals.

IS 13703 1993 : Low voltage fuses

IS 2705 1992 : Current transformers

IS 694 1990 : PVC insulated cables for voltages including 1100 V with Copper and Aluminum Conductor.

IS 1248 1983 : Direct Acting Electrical Indicating Analog

IS 8623 1993 : Low voltage Switch gear & control gear assemblies

IS 5082 : Electrolytic Aluminum Busbar, Trunking system, Rod tubes sections for Electrical Purposes.

IS 13779 1999 : AC Electric Meters / Static Meters.

b) Main/ Sub Panels shall be:

i. Of metal enclosed, indoor, floor mounted, free standing construction (unless otherwise specified) type.

ii. ade up of the requisite vertical sections, which when coupled together shall form continuous dead front switchboards.

iii. Provide dust and damp protection.

iv. Be readily extensible on both sides by the addition of vertical sections after removal of the end covers in case of Main Panels.

v. All panels shall be front access type.

Main/ Sub Panels shall be constructed only of materials capable of withstanding the mechanical, electrical and thermal stresses, as the effects of humidity, which are likely to be encountered in normal service.

Each vertical section shall comprise of the following:

i. A front-framed structure of rolled/ folded sheet steel channel section, of minimum 2 mm thickness, rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, moulded case circuit breaker, main horizontal busbars, vertical risers and other front mounted accessories. The structure shall be mounted on a rigid base frame of 100 mm height with folded sheet steel of minimum 2 mm thickness. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.

ii. A cable chamber housing the cable end connections, and power/control cable terminations. The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in an adjacent section.

iii. A cover plate at the top of the vertical section, provided with a ventilating hood where necessary. Any aperture for ventilation shall be covered with a perforated sheet having less than 1 mm diameter perforations to prevent entry of vermin.

iv. Front and rear doors fitted with dust excluding neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

The height of the panels should not be more than 2400 mm for MV Panels. Operating handle of breaker in top most compartments shall not be higher than 1800 mm. The total depth of the panel should be adequate to cater to proper cabling space and should not be less than 350 mm.

Doors and covers shall be of minimum 2 mm thick sheet steel. Sheet steel shrouds and partitions shall be of minimum 1.6 mm thickness. All sheet panels shall be smoothly finished, leveled and free from flaws. The corners should be rounded. The apparatus and circuits in the power control centers (panels) shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

Apparatus forming part of the Main/ Sub Panels shall have the clearances more than as given below.

i.	Between phases	- 32 mm
ii.	Between phases and neutral	- 26 mm
iii.	Between phases and earth	- 26 mm
iv.	Between neutral and earth	- 26 mm

When, for any reason, the above clearances are not available, suitable insulation shall be provided. Clearances shall be maintained during normal service conditions.

Creepage distances shall comply with those specified in relevant standards.

All insulating material used in the construction of the equipment shall be of non-hygroscopic material, duly treated to withstand the effects of the high humidity, high temperature tropical ambient service conditions.

Functional units such as circuit breakers and moulded case circuit breakers shall be arranged in multi-tier formation, except that not more than two air circuit breakers shall be housed in a single vertical section. Cable entry for various feeders shall be from the rear. Panel shall be suitable for termination of bus duct for incoming breakers.

Metallic/insulated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:

i. Main busbars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.

ii. Cable termination of one functional unit, when working on those of adjacent unit /units.

All doors/ covers providing access to live power equipment/ circuits shall be provided with tool operated fasteners to prevent unauthorized access.

Provision shall also be made for permanently earthing the frames and other metal parts of the switchgear by two independent connections.

16.3.3. METAL TREATMENT & FINISH

All steel work used in the construction of the Main/Sub Panels should have undergone a rigorous metal treatment process as follows:-

i. Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.

ii. Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.

iii. A recognized phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.

iv. Passivating in de-oxalite solution to retain and augment the effects of phosphating.

v. Drying with compressed air in a dust free atmosphere.

vi. Panel shall be powder coated with epoxy based powder paint after the above process so as to render the material suitable for corrosive environment.

vii. Paint shade shall be Pebble (light) grey, shade No RAL 7032 unless otherwise specified.

16.3.4. BUSBARS

The busbars shall be air insulated and made of high conductivity, high strength aluminum alloy complying with the requirement of IS-5082.

The busbars shall be suitable braced with non-hygroscopic SMC supports to provide a through fault withstand capacity of at least 50 kA RMS symmetrical for one second. The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent busbars. Large clearances and Creepage distances shall be provided on the busbar system to minimize possibilities of fault.

The Main/Sub Panels shall be designed that the cables are not directly terminated on the terminals of breaker etc. but on cable termination links. Cross-section area/ size of aluminum busbars shall be designed considering current density as 0.8 Amp per sqmm. Likewise Cross-section area/ size of copper busbars shall be designed considering current density as 1.2 Amp per sqmm. The main busbars shall have continuous current rating throughout the length of Panels. The cross section of neutral busbars shall be same as that of phase busbar for busbars of capacity up to 200 Amp; for higher capacity the neutral busbar shall not be less than half (50%) the cross section of that the phase busbars. The busbar system shall consist of main horizontal busbar and auxillary vertical busbars run in busbar alley/chamber on either side in which the circuit could be arranged/connected with front access.

Connections from the main busbars to functional circuit shall be arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Busbars to be colour coded with PVC sleeves.

All MCCBs & ACBs shall be provide with spreader links/terminals or Bus Bar extension pieces for easy termination of cables.

Clamp or screw type control terminal blocks shall be provided for outgoing control cables.

Minimum 20% spare terminals shall be provided for future use. Control terminal block shall be separated from power terminal blocks by means of an insulating barrier.

16.3.5. SWITCHGEARS

Refer 16.4 – LT switchgears

Protection Relays:

Provision of Relays like Under Voltage & Reverse Power shall be incorporated in incoming Feeders in addition to the relays already inbuilt in the ACBs as mentioned above.

16.3.6. CABLE TERMINATIONS

Cable entries and terminals shall be provided in the Main/Sub Distribution Panels to suit the number, type and size of aluminium conductor power cables and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. A cable chamber 150 mm. high shall be provided at the bottom through out the length and depth of the MDB/SDB. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated.

Barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

16.3.7. Auxiliary wiring and terminals:

Wiring for all controls, protection, metering, signaling etc. inside the switchboard shall be done with 1100 V gray colour PVC insulated FRLS copper conductors. Minimum size of these conductors shall not be less than 1.5 mm2. However, CT circuit wiring shall be done with 2.5 mm2. Control wiring to components fixed on doors shall be flexible type.

10% spare terminals shall always be available in each terminal block. Control wiring up to these terminal blocks shall be done by supplier.

15% spare feeders of various ratings completely prewired shall be supplied in each MCC.

All conductors should be terminated using compression type cable sockets / lugs at both the ends.

Each control wiring termination shall be identified at both the ends by PVC ferrules. The identification termination numbers should match with those on drawings. Suitable size SP MCB shall be used for tapping power for control circuit wiring.

For all motor starter feeders, provision for control wiring to remote ON/OFF control is to be made. The auxiliary wiring for the same shall be brought up to terminal block in the feeder's cubicle.

16.3.8. LABELS

Labels shall be anodised aluminium with white engraving on black background shall be provided for each incoming and outgoing feeder of Main/Sub Distribution and all Panels.

16.3.9. TEST AT MANUFACTURES WORK

All routine tests specified in IS: 8623-1977 shall be carried out and test certificates submitted.

16.3.10. INSTALLATION, TESTING AND COMMISSIONING

Installations of LT Panels shall be done as per CPWD norms/Specifications.

Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/setting shall be done before commissioning in addition to routine Meggar test. Checks and tests shall include the following.

a. Operation checks and lubrication of all moving parts.

b. Interlocking function check.

c. Insulation Test:As per CPWD Specifications for Electrical Works Part-I (2013)

d. Trip tests & protection gear test.

16.4. LT SWITCHGEARS

16.4.1. AIR CIRCUIT BREAKERS

- **GENERAL**

Air Circuit Breakers shall be incorporated in Main Distribution Panels wherever specified. ACBs shall conform to IS 13947 (Part 2) & IEC 60947 (2) in all respects. ACBs shall be suitable for operation on 415 volts, 3 phase, 50 Hz, AC supply. ACB shall be provided for feeder ratings 800A and above.

All electrical panels shall be provided with BMS compatibility.

TYPE AND CONSTRUCTION

Air Circuit Breakers shall be of enclosed pattern, dead front type with 'trip free' operating mechanism. It shall have microprocessor based electronic release. Air Circuit Breakers shall be EDO type (Electrically draw out type unless otherwise specified) with horizontal draw out carriage. The ACBs shall be strong and robust in construction with suitable arrangements for anchoring when in fully engaged or fully drawn-out positions. The carriage or cradle on which the breakers are mounted shall be robust design made of fabricated steel, supported on rollers. Cradle shall also comprise of main and secondary separable contacts and all draw out mechanism in a completely fig welded assembly. There shall be no dependence upon the switchboard frame for any critical alignment. The withdrawal arrangement shall be such as to allow smooth and easy movement.

All the current carrying parts of the circuit breakers shall be silver plated, suitable arcing contacts shall be provided to protect the main contacts. The contacts shall be of spring loaded design. The sequence of operation of the contacts shall be such that arcing contacts 'make before' and break after' the main contacts. Arcing contacts shall be provided with efficient arc chutes on each pole and these shall be such suitable for being lifted out for inspection of main as well as arcing contacts. The contact tips and arc chutes shall be suitable for ready replacement. Self aligning isolating contacts shall be provided. The design of the breaker shall be such that all the components are easily accessible to inspection, maintenance and replacement. Inter phase barriers shall be provided to prevent flashover between phases.

- **OPERATING MECHANISM**

  Air Circuit Breaker shall be provided with a quick-make, trip free operating mechanism, the operating mechanism shall be 'strain-free' spring operated. The operating handle shall be in front of the panel type. The design shall be such that the circuit breaker compartment door need not be opened while moving the breaker from completely connected, through test, into the disconnected position. Electrical operated breakers shall have a motor wound spring charged closing mechanism. Breaker operation shall be independent of the motor, which shall be used solely for charging the closing spring. The operating mechanism shall be such that the breaker is at all times free to open immediately and the trip coil is energised. Mechanical operation indicator shall be provided to show open and closed position of breaker. Electrically operated breakers shall be additionally provided with mechanical indication to show charged and discharged condition of charging spring. 24 Volt DC supply through battery backup for closing and opening for tripping circuit.

  Means shall be provided for slow closing and opening of the breaker for maintenance purposes and for manual charging and closing of electrically operating breakers during emergencies.

- **INTERLOCKING AND SAFETY ARRANGEMENT**

  Air Circuit Breakers shall be provided the following safety and interlocking arrangements:

  i. It shall not be possible for breaker to be withdrawn when in "ON" position.

  ii. It shall not be possible for the breaker to be switched on until it is either in fully inserted position or for testing purposes it is in fully isolated position.

  iii. The breaker shall be capable of being racked into 'testing', 'isolated' and ‘maintenance’ positions and kept locked in any of these positions.

  iv. A safety catch to ensure that the movement of the breaker, as it is withdrawn is checked before it is completely out of the cubicle.

  v. The operating mechanism shall provide for racking the breaker into connected, test and disconnected positions without operating compartment door. When cubicle door shall be open position, the breaker can be pulled out to a fourth position, maintenance, where free access shall be possible to all parts of the breaker.

- **RATING**

  Rated service breaking capacity (Ics) of the breakers shall be 50 kA at 433 Volts unless otherwise specified. The rated making capacity shall be as per the relevant standard. Rated service, short Circuit Breaking capacity shall be equal to the Rated ultimate Short circuit breaking capacity (Icu) and short circuit withstand values (Icw) for 1 sec.

- **RELAYS & ACCESSORIES**

  All ACBs (except bus couplers) shall be provided with micro-controller based release to offer accurate and versatile protections with complete flexibility and in the following zones:

  - Overload (Phase & Neutral) protection with adjustable time delay.
  - Short time protection with intentional delay.
  - Instantaneous protection.
  - Ground fault protection with intentional time delay.

The release should provide local LED indication for identification of type of fault, without requiring using external power supply. The release shall meet the EMI / EMC requirements.

Transformer & DG set Incomer ACB releases shall have LED/LCD display showing all Power & Energy Parameters (I, Imax, %loading, Iavg, V, Freq, PF, W, VAr, VA, Wh, VArh, Vah, MD-Active, MD-Reactive, MD-Apparent, Temperature in each Phase).

The release shall draw its power from the main breaker CTs and shall require no external power supply for its operation, release shall also be connected to aux. supply for display of parameters during off or lightly loaded conditions.

The ACB should have breaker control through Modbus Breaker control.

The breaker shall be fitted with following accessories for control, signal and interlocking.

i. Auxiliary contacts 6 NO + 6 NC, of rating 16Amp at 415 volts 50Hz.

ii. Shunt release for tripping the breaker remotely and shall be suitable for 240 volt/415 volt 50Hz with range of operation from 10% to 130% of rated voltage.

iii. Micro switches shall be mounted on the cradle of draw out breaker to indicate the position of the breaker on the cradle.

   a) Kit for test/isolated indication.

   b) Kit for service position indication.

   c) Kit for shutter assembly.

iv. Accessories for following interlocking schemes shall be provided.

   a) Accessory kit for locking the breaker in isolated position. This kit is useful for interlocking scheme as well as keeping personnel and equipment safe.

   b) Door interlock kit: Panel or cubicle door cannot be opened with the ACB in Test or Service position.

   c) Lockable trip push button.

- **MOUNTING**

Circuit Breakers shall be mounted as per manufacturers' standard practice.

- **TESTING**

Testing of each circuit breaker shall be carried out at the works as per IS 2516 and the original test certificate shall be furnished in triplicate. The tests shall incorporate at least the following.

i. Impulse withstand test.

ii. Power frequency withstand test.

iii. Short circuit test.

iv. Temperature - rise test under rated conditions.

16.4.2. MOULDED CASE CIRCUIT BREAKERS.

- **GENERAL**

Moulded Case Circuit Breaker shall be incorporated in the Main/Sub Distribution Boards wherever specified. MCCBs shall conform to IS 13947 (Part 2) & IEC 60947 (2) in all respects. MCCBs shall be suitable either for single-phase AC 230 volts or three phase

433 volts. All MCCBs shall have microprocessor based over current and short circuit releases with adjustable current setting from 0.4In to 1.0 In.

- **Technical Specifications**

The MCCB should be current limiting type with trip time of less than 10 milli sec under short circuit conditions. All MCCB should be 4 poles type unless stated otherwise.

MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2 /IEC 60947-2 and should have test certificates for breaking capacities from independent test authorities CPRI / ERDA.

MCCB shall comprise of Quick Make-break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses.

The MCCBs shall be provided with following type of Relays for overload, short circuit & earth fault protection in the LT panels boards:

All incoming ACBs /MCCBs of LT Panel boards shall be with Microprocessor based release having inbuilt adjustable protections against Over Load (L), Short Circuit (S), instantaneous short-circuit protection (I) and Ground Faults (G)] with time delay (LSING).

The outgoing MCCBs shall be with Thermal Magnetic type release for with adjustable Overload and fixed short circuit protections. However, MCCBs of ratings 250A & above shall be provided with Microprocessor based release with LSING protection.

Microprocessor based Trip unit shall be suitable for 433 V voltage rating.

All MCCBs should be provided with the Rotary Operating Mechanism. The ROM should be with door interlock (with defeat feature) & padlock facility

MCCB should have Spreader links & Phase barriers as standard feature. Superior quality of engineering grade plastics confirming to glow wire Tests as Per IEC 60695-2-1 should be used for insulation purpose.

The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to disconnection as per the IS/IEC indicating the true position of all the contacts.

For Motor application, motor duty type MCCBs shall be selected with reference to Type 2 coordination chart provided by the manufacturer.

- **CONSTRUCTIONS**

The MCCB's cover and case shall be made of high strength heat treatment and flame retardant thermo-setting insulating material. Operating handle shall be quick make/quick break, trip-free type. The operating handle shall have suitable "ON", "OFF" "and" "tripped" indicators. Three-phase MCCBs shall have common operating handle for simultaneous operation and tripping of all the three phases. MCCBs shall be provided with rotary handle.

Suitable extinguishing device shall be provided for each contact. Tripping unit shall be of thermal magnetic or static release type provided in each pole & connected by a common trip bar such that tripping of any pole operates all three poles to open simultaneously. MCCB shall be current limiting type.

Contact trips shall be made of suitable air resistant, silver alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

- **BREAKING CAPACITY**

  All MCCB shall be 4 pole type and shall have following short circuit current rating/breaking-

  (i) MCCB rating below 250 A – 25 kA

  (ii) MCCB rating 250 A and above upto 630 A – 36 kA

  The rated service breaking capacity should be equal to rated ultimate breaking capacities (Ics=Icu).

- **TESTING**

  a. Original test certificate of the MCCB as per Indian Standards (IS) 315C- 8370 shall be furnished.

  b. Pre-commissioning tests on the Main Distribution/Sub Distribution Board incorporating the MCCB shall be done as per standard.

16.5. MEASURING INSTRUMENTS, METERING & PROTECTION

16.5.1. GENERAL

Direct reading electrical instruments shall be in conformity with IS 1248. The accuracy of direct reading shall be 0.5 for voltmeter and 0.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variations in temperature shall be limited to a minimum. The meter shall be suitable for continuous operation between-10 degree Centigrade to + 50 degree Centigrade. All meters shall be of flush mounting type of 96mm square or circular pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instrument glass. Instruments meters shall be sealed in such a way that access to the measuring element and to the accessories within the case shall not be possible without removal of the seal. The meters shall be provided with white dials and black scale markings.

The pointer shall be black in colour and shall have zero position adjustment device which could be operated from outside. The direction of deflection shall be from left to right.

Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three-phase supply.

The specifications herein after laid down shall also cover all the meters, instrument and protective devices required for the electrical work. The ratings type and quantity of meters, instruments and protective devices shall be as per DBR/Drawings.

16.5.2. DIGITAL AMMETERS

Ammeters shall be standard digital type. The ammeters shall be calibrated as per the latest edition of IS:1248. Ammeters shall be instrument transformer operated, and shall be suitable for 5A secondary of instrument transformer. The scales shall be calibrated to indicate primary current, unless otherwise specified. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy.

16.5.3. DIGITAL VOLTMETERS

Voltmeters shall be standard digital type. The voltmeters shall be calibrated as per the latest edition of IS:1248. The range for 415 volts, 3 phase voltmeters shall be 0 to 500 volts. Suitable selector switch shall be provided for each voltmeter to read voltage between any two lines of the system. The voltmeter shall be provided with protection fuse of suitable capacity.

16.5.4. CURRENT TRANSFORMERS

Current transformers shall be in conformity with IS: 4201 - 1983 as amended up to date in all respects. All current transformers used for medium voltage applications shall be rated for 1kV. Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated acceptable minimum class of various applications shall be as given below:

Measuring : Class 0.5 to 1

Protection : Class 5P10.

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 50KA on medium voltage system. Terminals of the current transformers shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT's shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

All Current Transformer shall be Cast resin type

16.6. MISCELLANEOUS

- Control switches shall be of the heavy-duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.
- Indicating lamps shall be of the filament type of low watt consumption, provided with series resistor where necessary, and with translucent lamp covers, bulbs & lenses shall be easily replaced from the front.
- Push buttons shall be of the momentary contact, push to actuate type fitted with self-reset contacts & provided with integral escutcheon plates marked with its functions.

16.7. LT CABLES

16.7.1. GENERAL

LT Cables shall be supplied, inspected, laid tested and commissioned in accordance with drawings, specifications, relevant Indian Standards specifications as per given below. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drums.

Total number of runs and size of LT power cables shall be designed so that the distribution losses do not exceed 3% of the total power usage in the system as per ECBC norms.

CODES OF PRACTICE GUIDE		
S. NO.	Reference	Description
1	IS 694 : 1990 IEC 60227 - 1 to 5 : 1979	PVC insulated cables for working voltages up to and including 1100 V
2	IS 694 : 2010	Polyvinyl chloride insulated sheathed and unsheathed cables with rigid and flexible conductor for rated voltages up to and including 450/750 V : Part general requirements(fourth revision)
3	IS: 7098: 1988 (Part-I)	XLPE insulated (heavy duty) electric cables. For working Voltages up to and including 1100 V (third revision)

4	IS 4288 : 1988	PVC insulated (heavy duty) electric cables with solid aluminium conductors for voltages up to and 1100 V (second revision)

16.7.2. CABLE CONDUCTOR MATERIAL

a) The LT Power cables shall be XLPE insulated, PVC sheathed, copper conductor armoured cable for sizes up to & including 16 sqmm, unless otherwise stated.

b) For LT Power cable sizes above 16 sqmm, cables shall be XLPE insulated, PVC sheathed, Aluminium conductor armoured cables, unless otherwise stated.

c) LT Control cables shall be XLPE insulated PVC sheathed type copper conductor armoured cables, unless otherwise stated.

d) All LT Power & Control cables shall conform to IS: 7098: 1988 (Part-I) with up to date amendments.

16.7.3. INSTALLATION OF CABLES

Cables shall be laid directly in ground, pipes, masonry ducts, on cable tray, surface of wall/ceiling etc. as indicated on drawings and/or as per the direction of Engineer In Charge. Cable laying shall be carried out strictly as per CPWD specifications.

16.7.4. INSPECTION

All cables shall be inspected at site and checked for any damage during transit.

16.7.5. JOINTS IN CABLES

The Contractor shall take care to see that the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoiding of cable joints. This apportioning shall be got approved from Engineer-in-Charge before the cables are cut to lengths.

16.7.6. LAYING CABLES IN GROUND

Cables shall be laid by skilled experienced workmen, using adequate rollers to minimize stretching of the cables. The cable drums shall be placed on jacks before unwinding the cable. With great care it shall be unrolled on over wooden rollers placed in trenches at intervals not exceeding 2 meter. Cables shall be laid at depth of 0.75 meters below ground level for LT Cables and 1.20 meter below ground level for HT cable. A cushion of sand total of 250 mm shall be provided both above and below the cable, joint boxes and other accessories. Cable shall not be laid in the same trench or alongside a water main.

The cable shall be laid in excavated trench over 80 mm layer of sand cushion. The relative position of the cables, laid in the same trench shall preserved. At all changes in direction in horizontal and vertical planes, the cables shall be bent smooth with a radius of bent not less than 12 times the diameter of cables. Minimum 3 meter long loop shall be provided at both ends of cable.

Distinguishing marks may be made on the cable ends for identifications of phases. Insulation, tapes of appropriate voltage and in red, yellow and blue colours shall be wrapped just below the sockets for phase identifications.

16.7.7. CABLE ROUTE MARKERS:

Cable route marker shall be provided at regular intervals as per CPWD specifications. Cost of cable route markers is deemed to be included in the cost of cables/cable laying.

16.7.8. PROTECTION OF CABLES:

The cables shall be protected by bricks laid on the top layer of the sand for the full length of underground cable. Where more than one cable is laid in the same trench, the bricks shall cover all the cables and shall project a minimum of approximately 80mm on either side of the cables. Cable under road crossings and any other places subject to heavy traffic shall be protected by running them through Hume Pipes of suitable size. Hume Pipes for road crossing of the cables the shall be laid at a depth of 1000 mm.

16.7.9. EXCAVATION & BACK FILL

All excavation and back fill required for the installation of the cables shall be carried out by the Contractor in accordance with the drawings and requirements laid down elsewhere. Trenches shall be dug true to line and grades. Back fill for trenches shall be filled in layer not exceeding 150mm. Each layer shall be properly rammed and consolidated before laying the next layer.

The Contractor shall restore all surfaces, road ways, side walks, curbs, wall or the works cut by excavation to their original condition to the satisfaction of the Engineer-in -Charge.

16.7.10. LAYING OF CABLES ON CABLE TRAY/SURFACE OF WALL/ CEILING

Cable shall be laid on perforated M.S. Cable tray/ladders. Cables shall be properly dressed before cable ties/clamps are fixed. Wherever cable tray is not proposed, cables shall be fixed on surface of wall or ceiling slab by suitable MS clamps/saddles. Care shall be taken to avoid crossing of cable.

16.7.11. CABLES ON HANGERS OR RACKS

The Contractor shall provide and install all iron hangers racks or racks with die cast cleats with all fixings, rag bolts or girder clamps or other specialist fixing as required. Where hangers or racks are to be fixed to wall sides, ceiling and other concrete structures, the Contractor shall be responsible for cutting away, fixing and grouting in rag bolts and making good.

The hangers or racks shall be designed to leave at least 25mm clearance between the cables and the face to which it is fixed. Multiple hangers shall have two or more fixing holes. All cables shall be saddled at not more than 150mm centres. These shall be designed to keep provision of some spare capacity for future development.

16.7.12. CABLES TAGS

Cable tags shall be made out of 2mm thick aluminium sheets, each tag 1-1/2 inch in dia with one hole of 2.5mm dia, 6mm below the periphery. Cable designations are to be punched with letter/number punches and the tags are to be tied inside the panels beyond the glanding as well as below the glands at cable entries. Tray tags are to be tied at all bends. On straight lengths, tags shall be provided at every 5 metres.

16.7.13. TESTING OF CABLES

Prior to installation burying of cables, following tests shall be carried out. Insulation test between phases, phase & neutral, phase & earth for each length of cable.

i. Before laying.

ii. After laying.

iii. After jointing.

Along with the test as prescribed in IS Code, cross sectional area shall also be checked. On completion of cable laying work, the following tests shall be conducted in the presence of the Engineer in Charge.

i. Insulation Resistance Test (Sectional and overall).

ii. Continuity Resistance Test.

iii. Earth Test.

All tests shall be carried out in accordance with relevant Indian Standard code of practice and Indian Electricity Rules. The Contractor shall provide necessary instruments, equipments and labour for conducting the above tests & shall bear all expenses of conducting such test

16.8. CABLE TRAY

16.8.1. Ladder Type Cable Tray

Ladder type cable tray shall be fabricated out of double bended channel section longitudinal members with single bended channel section rungs of cross members welded to the base of the longitudinal members at a centre to centre spacing of 250 mm. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These may be galvanized or painted to the desired lengths.

16.8.2. Perforated Type Cable Tray

i. The cable tray shall be fabricated out of slotted/perforated M.S. Sheet as channel section single or double bended. The channel section shall be supplied in convenient length and assembled at site to the desired lengths. All cable trays shall be hot dipped galvanized only as per relevant IS Codes.

ii. Typically, the dimensions, fabrication details etc. are shown in CPWD General Specification for Electrical Works - Part II -External, 1994 as amended up to date. The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section.

iii. Two coupler plates, each of minimum 200 mm length, shall be bolted on each of the two sides of the channel section with 8 mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

iv. The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span are as per CPWD General Specification of Electrical Work Part II -1994. The sizes shall be specified considering the same.

v. The width of the cable tray shall be chosen so as to accommodate all the cable in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100 mm. The overall width of one cable tray shall be limited to 800 mm.

vi. Dimensions of Cable Trays shall be as following:

Sr	Width	Depth	Thickness
1	100 mm to 300 mm	50 mm	2 mm
2	375 mm to 450 mm	62.5 mm	2 mm
3	600 mm to 900 mm	75 mm	2 mm

vii. Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. (Details are typically shown in figure 3 of CPWD General Specification of Electrical Work Part II -1994) or as amended up to date. The radius

of bend, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

viii. The cable tray shall be suspended from the ceiling slab with the help of 10mm dia MS rounds or 25 mm X 5 mm flats at specified spacing as per CPWD General Specification of Electrical Work Part II -1994 or as amended up to date. Flat type suspenders may be used for channels up to 450 mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50 mm x 50 mm x 5 mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the Project Consultant to take the weight of the cable tray with the cables.

ix. The entire tray (except in the case of galvanized type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

x. The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.

xi. The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross-joints, etc, and paid for accordingly.

16.9. SANDWICH BUS DUCTS/ TRUNKING, RISING MAINS

16.9.1. Scope :

These specifications are intended for design, manufacturing, Supply, Installation, testing & commissioning of 3 Phase 3 Wire / 3 Phase 4 Wire (100% Neutral) / 3 Phase 5 Wire Sandwich type Aluminum Busbar Trunking System.

16.9.2. System details :

The Busbar Trunking System shall be suitable for operational Voltage of 415V / 690V / 1000 V with supply frequency of 50Hz, minimum insulation voltage of 1100 V & impulse withstand voltage of 12 kV.

16.9.3. Standards :

The Busbar Trunking System shall be designed to comply in accordance with the following international standards,

IEC 61439 – Part 1	: Low voltage switchgear & controlgear assembly- General rules
IEC 61439 – Part 6	: Busbar Trunking Systems (busways)
IEC 60529	: Degree of protection
IS 8623 – Part 2	: Specification for Low Voltage Switchgear & Controlgear Assemblies
IS 1893 – Part 1	: Criteria for Earthquake Resistant Design of Structures
IEEE 693:2005	: High Seismic Qualification Level

Wherever required and specified, the Busbar Trunking System shall conform to Fire Rating of 600 deg C for 2 Hours.

Busbar Trunking System should also have Seismic Zone-5, Flame Propagation and Fire Resistance certification.

16.9.4. Manufacturer :

The manufacturer must have an established track record in design and manufacture of sandwich busbar trunking system.

Design & Construction requirements :

- General :

  The Busbar Trunking System shall be of sandwich construction, non-ventilated and natural cooled design. It shall be possible to mount the Busbar Trunking System in any orientation without affecting the current rating.

- Busbars :
  - The busbars should be made of high conductivity electrical grade Aluminum with conductivity >60%
  - Purity of Aluminum conductor should not be less than 99.6%
  - Aluminum busbars should be Tin plated at the joint area
  - Provision for mounting external earth strip to be provided on both side of busduct. 2 Nos. Copper earth strips of appropriate size shall be provided for the complete run of bus bars enclosure.

- Insulation :
  - Each bus bar shall be individually insulated by means of Multi-layer Class-F Insulation, Each layer shall have withstand breakdown voltage of minimum 6 kV.
  - The insulation material used shall be of minimum Class F (155 deg. C)
  - Insulation must be Halogen free & RoHS compliance

- Housing :

  The housing shall be made of minimum 1.6 mm electro-galvanized sheet steel, epoxy powder coated with RAL7032 shade. Enclosure must be dust & vermin proof IP rating of indoor busduct must be IP-54 / IP-55 & Outdoor busduct should be IP-65 / IP-66 with canopy.

- Joints :
  - The joint design shall have inbuilt provision of absorbing expansion & contraction of 12mm per joint during operation.
  - The joint insulation must be of single piece moulded design of thermoset material for longer life and higher temperature withstand & better insulation property.
  - The joint construction must allow +/- 3mm adjustment at the time of installation, for ease of adjusting to site measurement variations.
  - The joint bolt must be insulated with a bolt insulator. The bolt insulator must be of molded one piece.
  - The joint design shall have inbuilt provision to prevent excessive insertion of busduct which can damage the bolt insulator.
  - The busbar ends shall not have holes or slots at the joints to avoid reduction in cross section area which will lead to temperature increase. The electrical continuity shall be through pressure plates, achieving a high contact area of joint cross section and expansion capability.
  - It shall be possible to install and remove the joints without disturbing the adjacent feeder section
  - Joint set should have insulators with temperature withstand capacity of class-F

- Plug-in Unit / Tap off units :

- Plug in boxes will be of draw out type. Contacts will be of silver plated copper and spring loaded. Earth connection will be the first to make and last to break during insertion and with drawl. Plug in boxes will be made from 1.6 mm CRCA sheet steel powder coated.
- Each section of Bus Bar enclosure plug in ports spread at interval of approximately 600 mm for the insertion of plug in boxes.
- Inside the plug in Boxes MCCB will be located as per requirements. The operating handle will be interlocked with plug in box cover so that MCCB can be operated only with the suitable cover in closed position. The plug in box will be interlocked with bus bar trunking so that it cannot be inserted or removed with the plug in box lid open. MCCB will be of 4 pole type.
- When the MCCB in the Plug-in unit is in 'ON' position, the operator should not be able to open the door.
- The design of plug-in units shall be such that, the PE conductor shall be of 'First-Make' 'Last-Break' type.
- The Plug-in unit will be suitable for accommodating MCCBs or other accessories, as required. The Plug-in unit should allow the flexibility of accommodating different reputed MCCB makes, to be mutually agreed depending on the tender requirements.
- Plug-in unit must achieve IP-54 protection.
- Plug-in units should be plug-in type up to 400A & Bolt-on Type from 630A.

- **Routine & Type Tests :**
  - The busduct shall be type tested at a reputed test laboratory (certified by ASTA or ERDA) for the tests as per IEC-61439 Part-1 (Low voltage switchgear & controlgear assembly- General rules) & Part 6 (Bus bar trunking systems & bus ways)
  - Short circuit testing of busduct should be for duration of 1 Sec. Neutral & Earth conductor should also be tested for 60% short circuit rating of phase conductor
  - Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory as per IEC-60529
  - Dielectric test.
  - Busduct should be tested for minimum Seismic Zone-4 & High Seismic Qualification level as per IEEE:693

- **Installation:-**

  The Bus Section shall be joined together with flanges and tie bolts. Bus trunking shall be suspended at a uniform height as per site conditions above floor/Ground level with suitable MS suspenders and MS supports duly Hot dip Galvanised.

16.9.5. CAPACITOR PANEL

16.9.6. SCOPE

Supply, installation, testing and commissioning of medium voltage capacitors and Automatic Power Factor Correction Panel (APFC) for improvement in power factor of electrical system. It will be connected to main LT panel. It shall improve power factor up to 0.97 (lagging) from initial power factor of 0.85 (lagging). Capacitor panel shall be provided with Auto/ Manual selector switch.

Power factor correction shall be done through Automatic Power Factor Correction panels with passive detuned filters.

16.9.7. BASIC Design Specifications

An automatic power factor correction relay, microprocessor based, with arrangement for sensing the power factor of the inductive load (maximum 14 channels) and giving signal to the feeders of power capacitors as per the setting of P.F. and electronic circuit to ensure that once a capacitor gets cut off, it is not put on at least for a minute. The relay should automatically manage capacitor banks according to the reactive power required to correct the power factor of the load to the power factor set on the relay. The capacitors must be turned "on" and "off" to correct the power factor of the load to the power factor set on the relay. The relay should have automatic and manual mode of operation with an LED to indicate the operating mode. The auto / manual function makes it possible to turn the capacitor banks "on" and "off" manually regardless of the line value measured.

Rated System Voltage	440 V / 415 V / 380 V / 400 V
Rated Frequency	50 Hz
Short Circuit Rating	> 30 kA
Altitude	1000 m
Duty	Continuous
Ambient temperature	-5° C to 50° C
Power Supply	Three phase, four line
Relay current input signal	-- / 5A, from CT on line
Enclosures	The load bearing structure is made of 2 mm sheet steel
	The front door and partition are made of 1.6 mm sheet steel
	The internal switchgear components are accessible on opening the front door and Capacitors & Reactors shall be accessed through back door
	Ingress protection - IP42
Installation	Indoor, wall mounted (up to 100 kVAr), floor mounted (100 kVAr and above) in a well-ventilated, non-dusty environment, cable entry from bottom
Control	Auto + Manual
Incomer	3 Pole MCCBs up to 630 A (400 kVAr) , 3 Pole ACBs above 630 A (above 400kVAr)

Other important features required are:

- Various system parameter display on APFC Relay
- Fully automatic / manual setup and operation
- Minimal joining in all the connections to ensure better reliability and lower losses.
- Use of special connecting cables suitable for high temperature withstands.
- Flush mounted meter to indicate line voltage and current.

16.9.8. CAPACITOR BANK:

Capacitor voltage shall be minimum 480 V when used with 7% reactors. Capacitors shall be MPP Heavy Duty type/ Gas filled type. The capacitor element used in unit shall have metallized polypropylene film (MPP) having low loss dielectric and impregnated with such impregnate, which shall have high dielectric constant, low viscosity and high chemical stability. The impregnate should be resin filled. . The capacitor unit shall have over pressure dis-connector protection. Discharge resistance shall reduce the residual voltage to less than 50 volts within one minute

General specifications:

- 3 phase, delta connected, 50 Hz
- Overvoltage +10% (for 8h / 24h), + 15% (for 30m / 24h), + 20% (5m/24h), +30% (1m/24h)
- Overcurrent: 1.8 x In
- Peak Inrush current withstand: 250 x In
- Total watt-losses: < 0.45 W / kVAr
- 6000 switching operations per year
- IEC 60831

16.9.9. DETUNED FILTER

- 7% detuned harmonic filter reactors shall be used along with power capacitors to mitigate harmonics amplification and to avoid electrical resonance in LV electrical networks.
- The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin. The insulation shall be Class H.
- The reactors shall be made of high grade aluminum windings, having a three phase, iron core construction suitable for indoor use. The reactor shall be air cooled and the layout shall be in accordance with IEC 60289 / IS 5553.
- The permitted tolerance of inductance is ± 3% of rated inductance value.
- Reactor tuning factor shall be 7 % (189 Hz) and the current rating of the reactor shall include the effects of harmonics and other possible over-currents.
- The limit of linearity of inductance of the filter reactor is: 1.8*In with L=0.95*LN.
- The reactor shall be fitted with a temperature sensitive micro-switch in the center coil (normally open) for connection to trip circuits in case of high operating temperatures.
- Power loss in each reactor shall be less than 5 W/kVAr
- Each reactor shall have routine test certificate for the above tests.

16.9.10. Thyristor switching

All capacitor banks shall be controlled with suitable rating thyristor switches.

16.9.11. APFC Controller

The APFC controller should be microprocessor based and should correct power factor with the help of contactors by switching the required no. capacitor banks

The controller should offer power factor correction without any need for manual intervention. The controllers should decide optimum configuration of capacitor banks in

order to achieve desired power factor by taking into consideration the kVAr of each step, no of operations, total usage time, re-connection time of each step etc. Besides manual switching of capacitors should also be possible directly through the controller, The APFC controller should have the following basic features

- Backlit LCD display with multiple parameters displayed at the same time
- Auto step programmable
- Capable of measuring VTHD and ITHD values at least up to 15th order
- Automatic CT reversal sensing and correction
- Should be 1A / 5A CT selectable.
- Sensing shall be done at LT as well as HT side of the transformer
- Display of average weekly power factor
- Keypad lock feature to prevent operation by unauthorized persons
- Alarms for under/over compensation, high VTHD/ITHD, over temperature, capacitor failure, capacitor over-current, over/under voltage
- Individual capacitor's ON/OFF status and capacitor failure indication
- Temperature sensing feature with alarm in case of panel over heating
- Should have RS485 communication protocol.

16.9.12. SWITCHGEAR & PROTECTION:

Suitable capacity duty contactor for each step shall be used and must be capable of capacitor switching duty. Busbars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cable used shall have superior mechanical, electrical and thermal properties. Internal wiring between main bus bars, contactor, capacitor etc shall be made with 1100 volt grade PVC insulated FRLS copper conductor of appropriate size by using suitable copper crimping terminal ends etc suitable bus links for input supply cable termination shall be provided.

Control circuit shall be duly protected by using suitable rating MCB. An emergency stop push button shall be provided to trip the entire system (22.5 mm dia, mushroom type, press to stop and turn to reset). 440 Volt caution board shall be provided on the panel.

16.9.13. TESTS AT MANUFACTURER'S WORKS:

All routine and type tests as per IS:2834 relevant to capacitor bank s as amended up to date shall be carried out at manufacturer's works and test certificates to be submitted.

TEST AT SITE:

Insulation resistance with 500 V DC Meggar shall be carried out and test results should be recorded.

Residual voltage shall be measured after switching of the capacitors and the same shall not be more than 50 volts after one minute. Each discharge resister shall be tested for its working.

16.9.14. INSTALLATION:

Capacitor bank shall be installed at least 30 cm away from the walls on suitable frame work of welded construction. The earth terminals provided on the body of capacitor bank

shall be bonded to main capacitor panel earth bus with 2 nos 8 SWG copper or 6 SWG GI earth wire.

Contractor shall also submit four sets of installation and maintenance manual

17. EARTHING & LIGHTENING PROTECTION SYSTEM

Earthing system shall conform to CPWD General Specifications for Electrical Works (Part I-Internal), 2013. Earthing system shall comprise of suitable nos. of Earthpits with GI & Copper Plate electrodes as per IS-3043 & CPWD specifications.

Neutral Earthing with suitable size Copper strips and Copper plate earthpits for Transformer, DG Sets and other equipment as specified by OEMs shall be provided. earthing of all sus. The body earthing for transformers, DG, HV & MV panels shall be done separately (2 Nos. for Each equipment) and shall also made a common earth bus network.

Like for a single transformer, the total number of earth electrodes shall be 4 (2 for neutral and 2 for connection to a common earth bus for body earthing).

17.1. ELECTRODES

The earth electrodes shall be as per CPWD General Specifi cations for Electrical Works (Part I-Internal), 2013.

17.2. LOCATION OF EARTH ELECTRODES

Distance of earth electrode from any building and other earth electrode shall be as per CPWD specification & IS codes. Care shall be taken that the excavation of earth electrode may not affect the column footings or foundation of the building. In such cases electrodes may be farther away from the building. The location of the electrode earth will be a place where the soil has reasonable chance of remaining moist. As far as possible, entrances, pavements and road ways, are to be defi nitely avoided for locating the earth electrode.

17.3. WATERING ARRANGEMENT

Method of watering arrangement shall comply with CPWD general specifications.

17.4. SIZE OF EARTH LEAD

The recommended sizes of copper earth bus lead in case of Sub-stations shall be in accordance with General Specifications for Electrical Works (Part I-Internal), 2013 amended upto date. The minimum size of earth lead shall be 25 mm x 5 mm copper or equivalent GI strip.

17.5. INSTALLATION

All joints shall be riveted and sweated. Joints in the earth bar shall be bolted and the joints faces tinned. Where the diameter of the bolt for connecting earth bar to apparatus exceeds one quarter of the width of the earth bar, the connection to the bolt shall be made with a wider piece of fl ange of copper jointed to earth bar. These shall be tinned at the point of connection to equipment and special care taken to ensure a permanent low resistance contact to iron or steel. All steel bolts, nuts, washers etc. shall be cadmium plated, main earth bars shall be spaced suffi ciently on the surface to which they are fi xed such as walls or the side trenches to allow for ease of connections. Copper earthing shall not be fi xed by ferrous fi ttings. The earthing shall suitably be protected from mechanical injury by galvanized pipe wherever it passes through wall and fl oor. The portion within ground shall be buried at least 60 cm deep. The earthing lead shall be securely bolted and soldered to plate or pipe as the case may be. In the case of plate earthing the lead shall be connected by means of a cable socket with two bolts and nuts. All washers shall be of the same materials as the plate or pipe. All iron bolts, nuts and washers shall be galvanized.

17.6. TESTING

After installation, the tests as specifi ed in CPWD General Specifications for Electrical Work (Part I-Internal), 2013 shall be carried out and results recorded

17.7. LIGHTENING PROTECTION SYSTEM

Lightening Protection System shall be provided for all buildings, blocks and facilities constructed under this contract as per IS/IEC-62305:2010 amended up to date and NBC 2016. However, All earth pits shall be GI or copper Plate electrodes. Finial shall be of copper material and for earth grid/mes & downcomers, required size Copper strip/equivalent size G.I. strip shall be used.

18. SAFETY REQUIREMENTS

Safety provisions shall be generally in conformity with appendices (A) and (C) of CPWD General Specifi cations of Electrical Works (Part I-Internal), 2013. In particular following items shall be provided:

(i) Insulation Mats

Insulation mats conforming to IS 15652: 2006 shall be provided in front of of all HT & LT Panels as well as other control equipments as specified.

(ii) First Aid Charts and First Aid Box

Charts (one in English, one in Hindi, one in Regional language), displaying methods of giving artifi cial respiration to a recipient of electrical shock shall be prominently provided at appropriate place. Standard first aid boxes containing required materials should be provided in each sub-station.

(iii) Danger Plate

Danger Plates shall be provided on HV and MV equipments. MV danger notice plate shall be 200 mm x 150 mm made of mild steel at least 2 mm thick vitreous enameled white on both sides and with the descriptions in signal red colour on front side as required. Notice plates of other suitable materials such as stainless steel, brass or such other permanent nature material shall also be accepted with the description engraved in signal red colour.

(iv) Fire Extinguishers

Portable CO2 conforming to IS 2878: 1976/ chemical conforming to IS 2171: 1976 extinguishers, HCFC Blend A (P-IV) shall be installed in the sub-station at suitable places. Other extinguishers recommended for electric fires may also be used.

(v) Fire Buckets

Fire buckets conforming to IS 2546: 1974 shall be installed with the suitable stand for storage of water and sand.

(vi) Tool Box

A Standard tool box containing necessary tools required for operation and maintenance shall be provided in the sub-station.

(vii) Caution Board

Necessary number of caution boards such as “Man on Line” ‘Don’t Switch on’ etc. shall be available in the sub-station.

(viii) Key Board

A keyboard of required size shall be provided at a proper place containing castle keys, and all other keys of sub-station and allied areas.

19. 11/0.433 KV DRY TYPE TRANSFORMER (ON LOAD TAP CHANGER TYPE)

19.1. GENERAL

Power transformers shall be Cast Resin Dry Type for indoor use. The transformers shall be suitable for 11KV/ 433 Volts, 50 Hz and 3-phase. All the transformers shall be ON LOAD TAP CHANGER type with RTCC Panels.

The design manufacture and performance of transformer shall comply with all performance of equipment status, regulations and safety codes in the location where the transformers will be installed. Transformers shall conform to the latest applicable standards. Transformer losses at 50% & 100% loads & impedance shall be as per latest applicable ECBC Building norms. Transformers' incoming feeders in the LT Panel would be equipped with metering class current transformers (CT's) & potential transformers (PT's) so that periodic loss monitoring can be carried out.

19.2. CODES AND STANDARD

Transformers shall comply with the latest edition of Indian Standards No. IS 2026 Part I to Part V (Power Transformer) and IS-11171 for Dry Type Transformer. In case the Provision of Indian Standards are not directly applicable to dry type Transformer , the provision of latest IEC-60726 and any other relevant IEC shall apply. Latest Stadards as applicable shall be followed the Insulating materials, Bushing, Installation and Maintenance of the Transformer.

19.3. SERVICE CONDITION

Altitude	Less than 1000 meters.
Maximum Ambient Temperature	50 deg. C
Minimum Ambient Temperature	-5 deg C
Relative Humidity	100 %
Installation	Corrosive,dusty, humid and tropical.

19.4. RATING AND TYPE

The Transformer shall have core type construction, 3 phase and shall be suitable for indoor service under the climatic conditions prevailing at site. The Transformer shall be capable of withstanding thermal and mechanical effects of short circuit at terminals of any winding with full voltage maintained on other winding as per IS: 2026.

19.5. WINDING

The primary and secondary winding shall be of electrolyte copper conductors. The high and low voltage winding shall be totally encapsulated and should be cast under vaccum in moulds with fiber glass reinforce epoxy resin laminate. Both HV and LV winding of each phase shall be separately cast as arigid tubular coil with no mechanical and electrical connection between their co- axial arrangement. The Transformer shall be free of partial discharges at least up to 1.1 times the rated voltage.

The winding shall not absorb moisture under the worst tropical conditions. The collection of moisture and dust over the winding shall not in any way affect the insulation strength of the winding.

19.6. CORE

The transformer core shall be build up with high non-aging low and high permeability CRGO Silicon steel lamination. CRGO sheet shall be coated with inorganic material or equivalent insulation to reduce eddy current to minimum. After shearing, the laminations shall be treated to remove all burrs and shall be annealed to remove all the residual stresses.

Core frame work and clamps shall be arranged and tighted to securely hold lamination in order to prevent any settling or displacement in case of heavy shocks during transport, handling or short

circuits. All the Iron parts except the core shall be galvanized and treated with high temperature resistance paint. Core Fastening shall be insulated to reduce losses and avoid spots. Transformer shall be designed to witstand 10 % over fluxing corresponding to rated voltage.

Suitable lugs shall be provided for lifting the complete core and coil assembly of the transformer.

19.7. INSULATION

Interturn and inter coil insulation shall be designed such that di - electric stress is uniformly distributed throughout the winding under all operating conditions. The winding shall be provided with Class 'F' Insulation.

19.8. TEMPERATURE RISE

The temperature rise of the winding shall not exceed 90 deg C on continuous full load above maximum ambient temperature of 50 Deg C and in no case shall reach value that may damage the core itself or other adjacent part.

19.9. TAP CHANGING:

"ON LOAD" circuit tap changing with AVR arrangement on H.V side is to be provided. The tapping is to be provided for variation on high voltage side from + 5% to - 15% steps of 1.25% each. Automatically operated STEPLESS "ON LOAD Tap Changing Switch" having a position indicating lights & Locking device and complete with Automatic Voltage regulator and its Control panel shall be provided separately.

In case of transformers having OFF Load Tap Changer, the tapping is to be provided for variation on high voltage side from + 5% to - 5% in steps of 2.5% each.

19.10. VECTOR GROUP:

Transformer shall have the vector group of Dyn 11.

19.11. IMPEDANCE

The desired impedance shall be as mentioned in the IS:11171 and ECBC norms.

19.12. FLUX DENSITY

The maximum flux density at any point in the winding shall not exceed 1.6 Tesla on the normal rated tap voltage and frequency.

19.13. CURRENT DENSITY

The Maximum current density at any point in the winding shall not exceed 2.2 Amp. Per sq.mm at the rated full load, voltage and frequency.

19.14. COOLING

The Transformer shall be designed for natural cooling (AN) or forced cooling as required for smooth continuos functioning at site.

19.15. ENCLOSURE

Transformer shall be provided with a sheet steel enclosure with adequate provision for ventilation. The degree of protection of enclosure shall be IP 21 for indoor installation and IP 44 for outdoor installations. The sheet steel thickness of enclosure shall be minimum 2mm.

19.16. CABLE TERMINATION

The low voltage side of the transformer shall be suitable to receive Sandwich Aluminium Bus Duct of suitable capacities from the top of the Transformer. A suitable size of flange to be provided for connecting the suitable size overhead sandwich busducts in the LT Box.

H.T. sides of the transformers shall have cable end boxes to receive 3 C X 300 sq.mm size of 11KV HT cables with bottom entry provision.

All cable end boxes shall have bore holes to match the opening for each cable specified and shown in the single line diagram.

19.17. EARTHING

Two main earthing terminals shall be connected to the terminals provided for transformer.

19.18. FITTINGS AND ACCESSORIES

- Rating and Terminal Marking Plate of the Transformer including the details of OFF circuit changing voltage of the links.
- Earthing terminal with Lugs.
- Transformer Neutral Earthing terminal.
- Marshal Box with wiring and terminal and temperature scanner.
- PT 100 type temperature scanner and its connection with marshal box.
- Neutral CT 2000/1 Amp. And its connection with marshal box for 2000 KVA Transformer only.
- Limit Switch in all hinged door fix door and wiring till marshal box.
- HV cable end box at primary.
- LT Bus Trunking box at secondary.
- Nos. Plan bi- directional rollers.
- Inspection windows shall be provided in the cover.
- Lifting lugs for both the transformer and core shall be provided.

19.19. RTCC PANEL

RTCC Panel shall be provided to operate OLTC from control room located in substation. RTCC shall be provided with main switch, a sequence selector switch. RTCC shall be provided with lower push button & raise push button, tap change in progress & complete. A.C supply ON/OFF lamp indicator & AVR relay operated operation indication. Cubical panel shall be totally enclose, floor mounting and fabricated with a framed structure with rolled/folded sheet steel channel section of minimum 2mm thickness.

All the sheet steel work forming the exterior of RTCC panel shall be smoothly finished and all steel work used in construction of RTCC panel shall undergone a regrious metal treatment process consisting of effective cleaning by hot alkaline degreasing solution followed by the cold water rinsing, pickling in dilute sulphuric acid to remove scales and rust formation, a recognized phosphating process, passivating in deoxidize to retain & augment the effects of phosphating, drying with compressed air and dust free atmosphere, primer coating with two coats of highly corrosion resistant primer applied under strictly controlled conditions and finished coat of stoving. RTCC Panels shall be connected with respective transformers through suitable size multicore copper conductor armoured control cables.

19.20. INSTALLATION OF TRANSFORMER

Installation of transformer shall be carried out in accordance with manufacturer's instructions and/or as directed by purchaser.

All power/control connections and mechanical joints shall be completed, checked and adjusted to ensure safety and satisfactory operation of the transformer.

Transformer shall not be placed on bare ground during unloading but it shall be placed on wooden sleepers. After placing on foundation, alignment, leveling etc. shall be carried out in best workman like manner.

For the power/control cabled projecting above the ground, the termination to cable box shall be run in GI conduits of suitable cross section and the same shall be supported properly and pipe ends shall be sealed with bitumen compound.

The cable box of detachable type of the transformer shall be supported properly so as to facilitate taking out of the transformer for repair without disturbing the cables.

19.21. TEST CERTIFICATES.

Test certificate shall be furnished in required number of copies for approval. The routine, special and type test certificate of the transformer shall be furnished.

The routine and type test certificates of miscellaneous components shall be furnished or approval.

19.22. ROUTINE TESTS

During manufacture and on completion the transformer shall be subjected but not limited to the following Routine Tests as laid down in the latest revision of the IS 11171 IEC - 726

i) Applied voltage test

ii) Induced voltage test

iii) No-load loss and excitation current tests

iv) Impedance voltage and load loss tests

v) Resistance measurement

vi) Ratio tests

vii) Polarity and phase relation tests

viii) Insulation resistance tests

ix) Insulation power factor tests

19.23. TYPE TESTS

The type test certificates for the following type tests carried out on similar capacity rating shall be submitted along with the routine test certificates.

i) Heat run test

ii) Impulse test

19.24. FIELD TEST

After installation a site, the transformer shall be subjected to the following field test:

i) Construction inspection

ii) Ratio tests

iii) Polarity test

iv) Tap change operation test.

19.25. ELECTRICAL & PERFORMANCE REQUIREMENT :

a) Transformer shall operate without injurious heating at the rated KVA at any voltage within variation of +/- 10% of the rated voltage of that particular tap.

b) Transformer shall be designed for 110% continuous over fluxing withstand capability.

c) The neutral terminals of the winding with star connection shall be designed for the highest over current that can flow through the winding.

d) Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminal bushings, tap changers or other auxiliary equipment shall apply.

e) Temperature Rise for continuous full load application shall be guided by Maximum temperature rise clause of IS 2026. The temperature rise shall not exceed 45 degree C by thermometer in oil or 50 degree C for winding over an ambient of 45 degree C.

(Please note maximum ambient temperature shall be considered 50 degree C).

19.26. DRAWINGS AND O&M MANUALS:

Four copies of manual of complete instructions for the installation, operation, maintenance and repairs circuit diagrams, foundation and trenching details shall be provided with the transformers. List of spare parts shall also be indicated.

a) GA drawing showing dimension, net weight and shipping weight, quantity of insulating oil etc.

b) Crane requirements for assembly and dismantling of the transformer.

c) Drawing indicating GA of cable box and its dimension for cable entry cut out requirements etc.

The drawings in (four sets) to be furnished by the supplier for approval after acceptance of his order shall include the following.

a) GA showing front and side elevations and plan of transformer and all accessories and external features, detailed dimensions, crane lift for untanking, H.T./L.T. clearances etc.

b) Drawings of Bus duct termination arrangement.

c) HV cable box arrangement & disconnecting chamber GA drawings.

d) Name plate and terminal making and connection diagram.

e) Assembly of OLTC gear mechanism & details of mechanism parts, limits, contours of wearing parts, timing gear adjustments etc.

20. DISTRIBUTION TRANSFORMER OIL FILLED

11/ 0.433 kV OIL TYPE DISTRIBUTION TRANSFORMER WITH ON LOAD TAP CHANGER MECHANISM WITH AUTOMATIC VOLTAGE REGULATOR

20.1. GENERAL

The step down double wound core type transformers shall be suitable for Outdoor mounting with a voltage ratio of 11000/433 Volts and naturally oil cooled with a Delta/Star configuration. The transformer shall comply with the regulations of IEC 76, B.S. 171, IS: 1180 as amended up to date.

20.2. TRANSFORMER DETAILED SPECIFICATIONS

20.3. TRANSFORMER OPERATION

The transformer shall be suitable for operation on 11 kV, 3 phase 50 cycle earthed system, connected Delta on H.V. side and star on the L.V. side with neutral brought out for independent Earthing (Vector Group DYN11). The transformer shall be suitable for continuous operation at the rated capacity under Site conditions.

20.4. TRANSFORMER MATERIAL

The material used in the manufacture of the transformer shall be of the best quality of their respective kind available as per standard specifications.

20.5. CORE

The core shall be built up with high grade non-aging, low loss and high permeability CRGO lamination special silicon steel suitable for transformers. After being sheared, the lamination shall be treated to remove all burs and shall be re-annealed to remove all residual stresses. Each lamination shall be coated with a durable, insulating coating. Core assembly shall be provided with lugs suitable for lifting the complete core and coil assembly of the transformers. Core and coil shall be so fixed that there is permanent displacement of windings on other parts when the transformer is moved or during short circuit. Core frame parts shall be galvanized.

20.6. WINDINGS

The HV and LV windings shall be of copper conductors using highly densified glass fiber reinforcement. Temperature rise of winding shall not exceed 50 deg C by resistance on continuous full load above ambient of 50 deg C and temperature rise of oil shall not exceed 45 deg C above ambient of 50 deg C. Flux density at any point in winding and core shall not exceed 1.7 T on normal rated voltage and frequency.

20.7. On Load Tap Changer (OLTC)

The transformer shall be provided with an Automatic On Load Tap Changer (OLTC) with Remote Tap Changer Control (RTCC) facility. The OLTC suitable for an incoming voltage variation from +5% to -15% in 17 steps on H.V side so as to give a near constant voltage of 433 Volt on the L.V. side. The OLTC shall be provided with automatic voltage sensing relay and shall be fully automatic in operation.

The OLTC shall be supplied with the first filling of the oil, oil surge relay, shut off valve for the OLTC oil surge relay, trip contracts, access windows for OLTC connection etc. The OLTC shall be provided with motorized / manual operation alongwith handle for operating manually. Mechanical tap position indicator shall be provided.

OLTC shall be provided with remote / local operation facility with selector switch for remote/local operation. The Remote Tap Changer Control Panel (RTCC) shall have remote indicator for the position of the steps and automatic voltage regulating relays. The RTCC Panel shall have Push buttons for Raise and Lower. The RTCC shall have indicating lamps for :-

Tap in progress

Raise

Lower

Out of step indication

20.8. INSULATION CLASS

The insulation material shall be insulation class 'F'.

20.9. TRANSFORMER TAPPINGS

'ON' load tap changing links on HV side. The tappings to be provided for variation on HV side from + 5% to – 15% in steps of 1.25 % each.

In case of transformers having OFF Load Tap Changer, the tapping is to be provided for variation on high voltage side from + 5% to - 5% in steps of 2.5% each.

20.10. TRANSFORMER CHARACTERISTICS

The no load voltage ratio of the transformer shall be 11000/433 Volts and the percentage impedance be as per latest applicable ECBC building norms.

20.11. TRANSFORMER TERMINATIONS

The transformer shall have self-supporting cable boxes with suitable glands and cable sockets for receiving 11,000 Volt grade XLPE cables on the H.V. side as required.

On the LV side the transformer shall have a suitable self supporting terminal arrangement with extended busbars to receive 1100 Volt grade Aluminium Conductor Sandwich Busduct as specified.

20.12. TEMPERATURE RISE PARAMETERS

Thermistor sensors shall be embedded in the low voltage winding for warning and tripping, for temperature control. The temperature detectors shall be suitable for 24 volts D.C. The temperature rise when continuously operated of windings by resistance method shall not exceed 20 deg C over 50 deg C ambient for warning and 45 deg C over 50 deg C ambient for tripping.

20.13. TRANSFORMER FITTINGS

The transformer alongwith OLTC shall be manufactured in accordance with the requirements as specified in the Standards stated above and shall be fitted with:

1. Diagram and Rating plate
2. Lifting Lugs.
3. Two earthing terminals on either side of the tank.
4. Four bidirectional rollers on the under carriage for movement.
5. Winding Temperature Indicator with alarm contacts for alarm and trip circuits.
6. Externally operated tapping switch with position indicator & locking arrangement.
7. Terminal marking plate.
8. Jacking Lugs.
9. H.V. cable box for 3 core XLPE cable as required.
10. L.V. cable box suitable for reception of XLPE armoured cables or chamber for receiving sandwich/ air insulated bus ducts as required.
11. Oil conservator with drain plug.
12. Oil filling hole and cap.
13. Filter valve with plug.
14. Drain valve with plug or cover plate.
15. Oil level indicator with minimum marking.
16. Dehydrating breather (Silica gel breather)
17. Air release valve.
18. Explosion vent.
19. Thermometer pocket with plug.
20. 150 mm dial type contact thermometer with maximum temperature indicator and alarm and trip contacts for oil temperature.
21. Buchholz relay of double float type with alarm and trip contacts and M.S. box for terminating control cables of 4 x 2.5 sq. mm. size.
22. L. V. Neutral bushing
23. Shut-off valve between Buchholz relay and conservator.

24. The transformer shall be complete with the first filling of insulating oil as per IS 335 - 1983 including makeup fill at site.

20.14. TRANSFORMER GUARENTEED TECHNICAL PARTICULARS

The following guaranteed technical particulars of the transformer shall be furnished.

a) Core loss

b) Load loss

c) Percentage Impedance

20.15. TRANSFORMER TESTING

Prior to acceptance and dispatch of the transformer, the CLIENT/HITES reserves the right to witness the routine tests at manufacturer's works. The transformer shall be subjected to the following routine tests as per relevant Standards at the manufacturers Works. The test certificates shall be submitted to the CLIENT/HITES/Engineer-in-charges for approval prior to dispatch.

a) Measurement of Winding Resistance

b) Ratio polarity and phase relationship

c) Losses in kW at No load, 50% Load, 75% Load and 100% Load

d) Impedance Voltage

e) No load and Full load current

f) Insulation resistance

g) Induced over voltage withstand

h) Separate source voltage withstand

In addition type test certificate for following parameters shall also be submitted to CLIENT/HITES/ Engineer-in-charges for record. Any type test if specifically asked for by CLIENT/HITES, shall be carried out on the equipment covered by this contract shall be done at extra cost prior to dispatch.

a) Temperature Rise

b) Impulse Voltage withstands.

20.16. INSTALLATION

The transformer shall be installed as per the manufacturers' instruction manual and shall conform to the requirements of IS 10028: 1981.

Transformer and all other accessories shall be handled carefully in its upright position as indicated on the packing cases. Lifting lugs and jacking pads shall be use for lifting the transformer. Utmost care shall be taken in proper application of jacks. Where transformer is dragged or pulled on sleeper or rollers, the traction eyes provided at the bottom frame shall be used with suitable wire ropes and shackles.

Transformer shall be mounded on concrete plinth/foundation prepared for the purpose. Rollers shall be checked and locket to prevent movement of the transformer after being positioned after on the plinth.

The transformer cable end boxes shall be sealed to prevent entry of moisture.

The transformer neutral and body earthing shall be as per the requirements of IS 3043-1966 and the Local Inspecting Authorities.

20.17. COMMISSIONING TESTS

The following tests shall be carried out prior to commissioning at site by third party

a) Insulation resistance of the winding between phases and phase and earth on the H.T. side.

b) Winding resistance of all the windings on all tap positions.

c) Voltage ratio test shall be carried out by applying low voltage on H.T. side and measuring the voltage between phases and phase and neutral on the L.T. side for every tap setting.

d) On commissioning of the transformer the following readings shall be taken

- MV side voltages at all tap settings
- Temperature rise under no load conditions

e) Transformer Oil Test

f) If necessary, the transformer shall be heated by applying low voltage on the HT side and shorting the LT side. This shall be done for a period of 48 hours or till all the moisture has been removed from the transformer

21. INTERNAL ELECTRIFICATION OF BUILDING

21.1. SCOPE

The electrical Installation work shall be carried out in accordance with Indian Standard Code of Practice for Electrical Wiring Installation IS: 732-1989 and IS: 2274-1963. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity Supply Authority and Fire Insurance regulations, so far as these become applicable to the installation. Electrical work in general shall be carried out as per following CPWD Specifications with up to date amendment.

- ✓ Specifications for Electrical Works Part-I (Internal) by CPWD–2013 with latest revision
- ✓ Specifications for Electrical Works Part-II (External) by CPWD–1994 with latest revision

Wherever these specifications calls for a higher standard of material and or workmanship than those required by any of the above mentions regulations and specification then the specification here under shall take precedence over the said regulations and standards.

Following Light/power point Shall be provided as minimum or as per approved shop drawings in following areas and as directed by Engineer In-Charge

Consultation Room / Workstation -

- 6/16 A Raw Power points- 2 nos.
- 6/16 A UPS power points – 2 Nos.
- Data points- 1 Nos.
- Telephone Points – 1 Nos.
- Light fittings as per required Lux level (NBC-2016, ECBC)

General Wards (with Each Bed)-

- 6/16 A UPS power points – 4 Nos.
- Light fittings as per required Lux level (NBC- 2016, ECBC)

- Foot Light

ICU/ICCU with Each Bed-

- 6/16 A UPS power points – 8 Nos.
- Light fittings as per required Lux level (NBC-2016, ECBC)
- Bed Head Light (Up & Down)

Confrence Room-

- 6/16 A Raw Power points- 4 nos.
- 6/16 A UPS power points – 2 Nos. shared in Two seats (in Pop up box)
- HDMI Port – 1 Nos. shared between Two seats (in Pop up box)
- Data points – 2 Nos. shared between Two seats or Wifi connectivity
- Dimmer Lights as per requirement
- Light fittings as per required Lux level (NBC-2016, ECBC)
- Data & UPS Power points for Projector / Monitor/PC/Audio Visual system

21.2. DISTRIBUTION BOARDS

As a general practice MCB type double door DB shall be used. Provision of Vertical type MCB DBs is to be considered in areas where 3-phase outlets are also required:

Provisions in MCB DB:

i) Recess/ surface type with integral loose wire box.

ii) Phase/neutral/ earth terminal blocks for termination of incoming & outgoing wires.

iii) DIN channel for mounting MCBs.

iv) Arrangement for mounting incomer MCB/RCCB/RCBO/MCCB as required.

v) Copper Bus Bar.

vi) Earthing terminals.

vii) Interconnection between terminal block/ incoming switch/ bus bar/ neutral/ terminal block/ earth terminal connector with specified size of FRLS pre insulated copper conductor cable duly fitted with copper lugs/ thimbles.

ix) Termination block should be suitable for termination of conductor/ cable of required size but minimum rated cross section of the terminal blocks should be 6 sq. mm.

x) Terminal block shall be made of flame retardant polyamide material.

xi) Coloured terminal blocks and FRLS wires for easy identification of RYB phases, Neutral and Earth.

xii) DB shall be provided with a detachable cassette for safe removal of MCBs, RCCBs. Terminal connectors from the DB without loosening the internal cable connections of phase and neutral circuits.

xiii) The DB shall have peel able poly layer on the cover for protection from cement, plaster, paints etc during the construction period.

xiv) Detachable plate with knock out holes shall be provided at the top/ bottom of board. Complete board shall be factory fabricated /pre-wired in factory, ready for installation at site. The box and cover shall be fabricated from 1.2 mm sheet steel, properly pretreated, phosphotized with powder coated finish.

xv) DB shall be of double door construction provided with hinged cover in the front.

xvi) DB doors shall be suitably earthed.

Distribution Board shall be standard type. Distribution boards shall contain miniature circuit breakers. Miniature circuit breakers shall be quick make and quick break type with trip free mechanism. MCB shall have thermal and magnetic short circuit protection. All miniature circuit breakers shall be of minimum 10 kA, 'C' curve rated rupturing capacity unless otherwise specified.

Neutral busbars shall be provided with the same number of terminals, as there are single ways on the board, in addition to the terminals for incoming mains. An earth bar of similar size as the neutral bar shall also be provided. All live parts shall be screened from the front. Ample clearance shall be provided between all live metal and the earth case and adequate space for all incoming and outgoing cables. A circuit identification card in clear plastic cover shall be provided for each distribution board.

MCB's shall be provided on the phase of each circuit. No isolator shall be used in distribution board & panels unless stated otherwise. The individual banks of MCB's shall be detachable. There shall be ample space behind the banks of MCB's to accommodate all the wiring. All the distribution boards shall be completely factory wired, ready for connections. All the terminals shall have adequate current rating and size to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

Earth Leakage Circuit Breaker/Residual Current Circuit Breaker shall be provided in each Distribution Board as required. Earth Leakage Circuit Breaker shall be current operated type and of 30 mA sensitivity unless otherwise specified. It shall also provide over-current and short circuit protection i.e. it shall be MCB-cum-RCCB (Residual Current Circuit Breaker). In case ELCB doesn't have inbuilt short circuit protection, same rating MCB have to be provided for short circuit protection along with ELCB. Cost of this MCB is deemed to be included in the cost of ELCB. ELCB shall be housed within the Distribution Board.

Distribution Boards shall be ready for connections and shall be inspected in the factory by Electrical Engineer- In charge before dispatch.

Before procurement of Distribution Boards, MCB's, ELCB's (incomer and outgoings) etc., the contractor has to take approval of the DB Schedule/Drawings of each DB from the Electrical Engineer In Charge. The whole unit i.e. Distribution Board, MCB's, ELCB's etc. shall come from the manufactures premises/workshop. After inspection, if required, HLL representative shall provide dispatch clearance for installation at site.

METALLIC CONDUIT WIRING SYSTEM:

21.2.1. TYPE AND SIZE OF CONDUIT

All conduit pipes shall be of approved gauge (not less than 16 SWG for conduits of sizes up to 32 mm diameter and not less than 14 SWG for conduit of size above 32mm diameter) solid drawn or reamed by welding finished with black stove enameled surface. All conduit accessories shall be of threaded type and under no circumstances pin grip type accessories shall be used. The maximum number of PVC insulated 650/1100 volts grade copper conductor cable that can be drawn in conduit of various sizes shall be as per IS Code. No steel conduit less than 20 mm in diameter shall be used.

21.2.2. CONDUIT JOINTS.

Conduit pipes shall be joined by means of threaded couplers, and threaded accessories only. In long distance straight run of conduits, inspection type couplers at reasonable intervals shall be provided or running threads with couplers and jam nuts shall be provided. In the later case the bare threaded portion shall be treated with anti-corrosive preservative. Threads on conduit pipes in all cases shall be between 13 mm to 19 mm long sufficient to accommodate pipes to full threaded portion of couplers or accessories.

Cut ends of conduit pipe shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductor while pulling them through such pipes.

21.2.3. PROTECTION AGAINST CONDENSATION.

The layout of conduit should be such that any condensation or sweating inside the conduit is drained out. Suitable precaution should also be taken to prevent entry of insects inside the conduit.

21.2.4. PROTECTION OF CONDUIT AGAINST RUST.

The outer surface of conduit including all bends, unions, tees, junction boxes etc. forming part of conduit system shall be adequately protected against rust when such system is exposed to weather by being painted with two coats of oxide paint applied before they are fixed. In all cases, no bare threaded portion of conduit pipe shall be allowed. Unless such bare thread portion of conduit is treated with anticorrosive preservative or covered with approved plastic compound.

21.2.5. PAINTING OF CONDUIT AND ACCESSORIES.

After installation, all accessible surface (if any) of conduit pipes, fittings etc. shall be painted with two coats of approved enameled paint or aluminium paint as required to match the finish of surrounding wall, trusses etc.

21.2.6. SURFACE CONDUIT

Conduit pipes shall be fixed by saddles, secured to suitable approved plugs with screws in an approved manner at an interval of not more than one meter,but on either side of the couplers or bends or similar fi ttings, saddles shall be fixed at a distance of 30 cm from the center of such fittings.Where conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips or clamps asrequired by the Engineer-in-charge.In long distance straight run of conduit, inspection type couplers at reasonable intervals shall be provided, or running threads with couplers and jam nuts shall be provided.Fixing Outlet Boxes Only portion of the switch box shall be sunk in the wall, the other portion beingprojected out for suitable entry of conduit pipes into the box.

21.2.7. RECESS CONDUIT

The chase in the wall shall be neatly made and of ample dimensions to permit the conduit to be fixed in the manner desired. In the case of building under construction, conduit shall be buried in the wall before plastering and shall be finished neatly after erection of conduit. In case of exposed brick/rubble masonry work, special care shall be taken to fix the conduit and accessories in position along with the building work. Entire work of chasing the wall, fixing the conduit in chases, and burring the conduit in mortar before plastering shall form part of point wiring work.

The conduit pipe shall be fixed by means of staples or by means of saddles not more than 60cm apart or by any other approved means of fixing. Fixing of standard bends and elbows shall be avoided as far as practicable and all curves maintained by bending the conduit pipe itself with the long radius, which shall permit easy drawing in of conductors. All threaded joints of conduit pipe shall be treated with some approved preservative compound to secure

protection against rust. Suitable inspection boxes to the barest minimum requirements shall be provided to permit periodical inspection and of facilitate replacement of wires, if necessary. These shall be mounted flush with the wall. Suitable ventilating holes shall be provided in the inspection box covers. Wherever the length of conduit run is more than 10 meters, then circular junction box shall be provided.

21.2.8. METAL OUTLET BOXES & COVERS.

The switch box shall be made of modular metal boxes with suitable size modular cover plates. Modular metal box shall be made of mild steel on all sides except on the front. The metal box (other than modular type) shall be made of metal on all sides except on the front. Boxes shall be hot dip galvanized mild steel. Metal boxes up to 20 x 30 cm size M.S. box shall have wall thickness of 18 SWG and MS boxes above 20 x 30 cm size shall be of 16 SWG. The metallic boxes shall be painted with anticorrosive paint before erection. Clear depth of the box shall not be less than 60mm. All boxes shall be covered from top with Phenolic laminated sheet of approved shade. These shall be of 3 mm thick synthetic phenolic resin bonded laminated sheet as base material and conform to grade P-I of IS: 2036-1994.

21.2.9. ERECTION AND EARTHING OF CONDUITS.

The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested in presence of Engineer In Charge for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirement by means of special approved type of earthing clamp effectively fastened to conduit pipe in a workmen like manner for a perfect continuity between the earth and conduit.

21.3. NON-METALLIC CONDUIT WIRING SYSTEM

21.3.1. Scope

This chapter covers the detailed requirements for wiring work in non-metallic conduits.This chapter covers both surface and recessed types of wiring work.

21.3.2. Application

- Recessed conduit work is generally suitable for all applications. Surface conduit work may be adopted in places like workshops etc. and where recessed work may not be possible to be done. The type of work shall be as specified in individual works.
- Flexible non-metallic conduits shall be used only at terminations, wherever specified.
- **Special Precautions-**
  - i. If the pipes are liable to mechanical damages, they should be adequately protected.
  - ii. Non-metallic conduit shall not be used for the following applications:-
  - iii. In concealed/inaccessible places of combustible construction where ambient temperature exceeds 60 degrees C.
  - iv. In places where ambient temperature is less than 5 degrees C.
  - v. For suspension of fl uorescent fi ttings and other fi xtures.
  - vi. In areas exposed to sunlight.

21.3.3. Materials

a) Conduits

- All non-metallic conduit pipes and accessories shall be of suitable material complying with IS 2509 : 1973 and IS 3419 : 1989 for rigid conduits and IS 9537

(Part 5) : 2000 for fl exible conduits. The interior of the conduits shall be free from obstructions. The rigid conduit pipes shall be ISI marked.

- The conduits shall be circular in cross-section. The conduits shall be designated by their nominal outside diameter. The dimensional details of rigid non-metallic
- No non-metallic conduit less than 20 mm in diameter shall be used.
- The maximum number of PVC insulated aluminium/copper conductor cables of 650/1100 V grade conforming to IS 694 : 1990 that can be drawn in one conduit of various sizes as per CPWD specification. Conduit sizes shall beselected accordingly.

b) Conduit Accessories

- The conduit wiring system shall be complete in all respect including accessories.
- Rigid conduit accessories shall be normally of grip type.
- Flexible conduit accessories shall be of threaded type.
- Bends, couplers etc. shall be solid type in recessed type of works, and may be solid or inspection type as required, in surface type of works.
- Saddles for fi xing conduits shall be heavy gauge non-metallic type with base.
- The minimum width and the thickness of the ordinary clips or girder clips shall be as per CPWD specification
- For all sizes of conduit, the size of clamping rod shall be 4.5 mm (7 SWG) diameter.

c) Outlets

- The switch box shall be made of either rigid PVC molding, or mild steel, or cast iron on all sides except at the front. The regulator boxes shall however be made only of mild steel or cast iron.
- PVC boxes shall comply with the requirements laid down in IS 14772 : 2000. These boxes shall be free from burrs, fi ns and internal roughness.
- The thickness of the walls and base of PVC boxes shall not be less than 2 mm.
- The clear depth of PVC boxes shall not be less than 60 m.
- 3 mm thick phenolic laminated sheet covers for all types of boxes shall be as per requirements.

21.3.4. Installation

a) Common Aspects for Both Recessed and Surface Conduit Works

- The erection of conduits of each circuit shall be completed before the cables are drawn in.
- Conduit Joints
  - All joints shall be sealed/cemented with approved cement. Damaged conduit pipes/fi ttings shall not be used in the work. Cut ends of conduit pipes shall have neither sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling them through such pipes.
  - The Engineer-in-charge, with a view to ensuring that the above provision has been carried out, may require that the separate lengths of conduit etc.

- Conduit joints after preparation shall be submitted for inspection before being fixed.
- All bends in the system may be formed either by bending the pipes by an approved method of heating, or by inserting suitable accessories such as bends, elbows or similar fittings, or by fixing non-metallic inspection boxes, whichever is most suitable. Where necessary, solid type fittings shall be used.
  - Radius of bends in conduit pipes shall not be less than 7.5 cm. No length of conduit shall have more than the equivalent of four quarter bends from outlet to outlet.
  - Care shall be taken while bending the pipes to ensure that the conduit pipe is not injured, and that the internal diameter is not effectively reduced.
- Outlets
  - All switches, plugs, fan regulators etc. shall be fitted in flush pattern.

b) Additional Requirements for Surface Conduit Work

- Conduit pipes shall be fixed by heavy gauge non-metallic saddles with base, secured to suitable approved plugs with screws in an approved manner, at an interval of not more than 60 cm, but on either side of couplers or bends or similar fi ttings, saddles shall be fi xed at a closer distance from the centre of such fi ttings.
- Slotted PVC saddles may also be used where the PVC pipe can be pushed in through the slots.
- Where the conduit pipes are to be laid along the trusses, steel joists etc. the same shall be secured by means of saddles or girder clips as required by the Engineer in-charge. Where it is not possible to use these for fi xing, suitable clamps with bolts and nuts shall be used.
- If the conduit pipes are liable to mechanical damage, they shall be adequately protected.

21.3.5. Earthing Requirements

- A protective (earth) conductor shall be drawn inside the conduit in all distribution circuits to provide for earthing of non-current carrying metallic parts of the installation. These shall be terminated on the earth terminal in the switch boxes and/or earth terminal blocks at the DBs.
- Gas or water pipe shall not be used as protective conductors (earth medium).

21.4. SWITCHES.

All 6 and 16 Amp switches shall be modular type of 240 volts A.C. grade. All switches shall be fixed on modular metal boxes. All 6 Amp socket shall be 3 pin type and 16 Amp socket shall be 5/6 pin type (unless otherwise specified) suitable for 16/6 Amp. All modular switches, sockets, telephone outlets, TV outlet etc. shall be in off white finish unless otherwise specified. The switches controlling the lights or fans shall be connected to the phase wire of the circuit. Switch boards shall be located at 1200 mm above finished floor level unless otherwise indicated on drawings or directed by Engineer-In-Charge.

In case of computer power points, Data points, telephone points etc. to be fixed on laminated partition board (furniture), same shall be fixed on laminated board (portion of laminated board meant for fixing power points) with base plate/cover plate as applicable, duly fixed with screws.

One modular switch may control maximum one, two or three light points as per requirement and as directed by Engineer-In-Charge. One light point controlled by 2 switches shall be provided in the staircases as directed by Engineer-In-Charge. Depending on area of rooms, halls etc. one or more than one switchboards shall be provided as directed by Engineer-In-Charge. At least one number 6A Socket with Switch shall be provided in each switchboard as directed by Engineer-In-Charge. Suitable power points and light points shall be provided for urinal sensors and hand dryers in the toilets as directed by Engineer-In-Charge. At least 10% Light fixtures shall be provided and operated with UPS supply with switches fed from UPS Distribution Boards.

21.4.1. COVER PLATE

All modular switches, sockets, telephone outlets etc. shall be fixed on modular metal boxes with modular base plates and modular cover plates on top.

21.4.2. WALL SOCKET PLATE

Each outlet shall have a switch located beside the socket preferably on the same cover plate/modular base. The earth terminal of the socket shall be connected to the earth wire.

21.5. WIRING

All PVC insulated copper conductor wires shall conform to relevant IS Codes. All wires/ cables shall be stranded type irrespective of its size.

All internal wiring shall be carried out with PVC insulated FRLS, Copper wires of 650/1100 Volts grade. The circuit wiring for points shall be carried out in looping in system and no joint shall be allowed in the length of the conductors. Circuit wiring shall be laid in separate conduit originating from distribution board to switch board for light/fan. A light/fan switchboard may have more than one circuit but shall have to be of same phase. Looping circuit wiring shall be drawn in same conduit as for point wiring.

Each circuit shall have a separate neutral wire. Neutral looping shall be carried out from point to point or in light/fan switchboards. A separate earth wire shall be provided along with circuit wiring for each circuit. For point wiring red/yellow/blue colour wire shall be used for phase and black colour wire for neutral.

Circuit wiring shall be carried out with red, yellow or blue colour PVC insulated FRLS copper wire for RYB phase wire respectively and black colour PVC insulated FRLS Copper wire for the neutral wires. Green/Green-Yellow Colour copper wire shall be used as earth continuity conductor and shall be drawn along with other wires. No wire shall be drawn into any conduit until all work of any nature, that may cause injury to wire is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire.

Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust and dirt. Drawing and jointing of copper conductor wires and cables shall be as per CPWD specifications for Electrical works (Part - I) 2013

Maximum number of PVC insulated 650/1100 V grade aluminium/copper conductor cable conforming to IS : 694 – 1990

Conduit size	**20mm**		**25mm**		**32mm**		**40mm**		**50mm**		**60mm**	
Wire size in sq.mm.	**S**	**B**	**S**	**B**	**S**	**B**	**S**	**B**	**S**	**B**	**S**	**B**
1.50	7	5	12	10	20	14	-	-	-	-	-	-
2.50	6	5	10	8	18	12	-	-	-	-	-	-

Conduit size	20mm		25mm		32mm		40mm		50mm		60mm	
Wire size in sq.mm.	S	B	S	B	S	B	S	B	S	B	S	B
4	4	3	7	6	12	10	-	-	-	-	-	-
6	3	2	6	5	10	8	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	-	4	3	7	6	-	-	-	-
25	-	-	-	-	3	2	5	4	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

NOTE :

1. The above table shows the maximum capacity of conduits for a simultaneous drawing in of cables.
2. The columns headed `S' apply to runs of conduits which have distance not exceeding 4.25m between draw in boxes and which do not deflect from the straight by an angle of more than 15 degrees. The columns headed `B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
3. Conduit sizes are the nominal external diameters.

21.5.1. JOINTS.

All joints shall be made at main switches, distribution board socket and switch boxes only. No joint shall be made in conduits and junction boxes. Conductors shall be continuous from outlet to outlet.

21.5.2. LOAD BALANCING

Balancing of circuits in three-phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

21.5.3. COLOUR CODE FOR CIRCUIT WIRING

Colour code for circuit and sub main wiring installation shall be Red, Yellow, and Blue for three phases. Black for neutral and yellow/green or green only for earth in case of insulated earth wire.

21.5.4. CLASSIFICATION OF POINTS.

a. General

Classification of Point wiring shall be as per CPWD specification for Electrical Works (Part-I- Internal) 2013.

b. Point Wiring (Modular)

i. Definition of Point Wiring

A point (other than socket outlet point) shall include all work necessary in complete wiring to the light points/fan/exhaust fan/call bell point from the controlling switch/MCB. The scope of wiring for a point shall, however, include the wiring work necessary in tapping from another point in the same distribution circuit i.e. from first

switch board (wiring from distribution board to first switch box is covered in the circuit wiring and is not in the scope of point wiring) to subsequent switch board(s) in the same distribution circuit. The point wiring includes all materials specified below including chasing the wall (in case of recessed wiring in wall), fixing the conduit and making the wall good as it originally was. It also includes supply, drawing, testing and commissioning of wires.

c. Scope of point wiring

Following shall be deemed to be included in point wiring.

(a) Supply & fixing conduit & conduit accessories for the same and wiring cables (including supplying and drawing wires) between the switch box and the point outlet.
(b) All fixing accessories such as clips, nails, screws, phil plug, rawl plug etc. as required.
(c) Modular switches, modular base plates and modular cover plates over the same. regulators, sockets with Metal boxes etc. in recessed or surface .
(d) Outlet boxes, junction boxes, pull-through boxes etc. but excluding modular metal boxes if any, provided the switchboards for loose wires/conduit terminations.
(e) In case of recessed wiring in wall the scope includes chasing of wall, fixing the conduit and making the wall good as it originally was.
(f) Control modular switch (5/6A) as specified.
(g) Ceiling rose or connector (in case of points for ceiling/exhaust fan point, prewired light fittings and call bells).
(h) Connections to ceiling rose, connector, socket outlet, lamp holder, switch etc.
(i) Interconnecting wiring between points on the same circuit, in the same switch box or from another. Interconnecting wiring from first switchboard to subsequent switch board(s).
(j) Protective (loop earthing) conductor as required from one metallic switch box to another in the distribution circuits, and from switchboard to each point (light/fan/exhaust fan/call bell etc).
(k) Bushed conduit where wiring cables pass through wall etc.
(l) Ceiling rose (in the case of pendants except stiff pendants).
(m) Lamp holder (in the case of goose neck type wall bracket, batten holder and fittings which are not pre-wired)..
(n) Back Plate (in the case of stiff pendants).

21.5.5. Circuit and Submain Wiring

a. Circuit Wiring

Circuit wiring shall mean the wiring from the distribution board up to the tapping point for the nearest first point of that distribution circuit i.e. up to the nearest first switch box.

b. Submain Wiring

Submain wiring shall mean the wiring from one main/distribution switchboard to another.

21.5.6. Power Plug Wiring

a. 6A Plug Wiring

Wiring for all 6 A Socket Outlets shall be done with 2 X 2.5 sqmm PVC insulated FRLS copper wire in suitable size MS Conduit (including supplying and fixing MS Conduit) along with the earth wire. Up to 3 points may be connected to one circuit.

b. 16A Power Plug Wiring

Wiring for all 16 A Socket Outlets/Geyser point shall be done with 2X4 sq mm PVC insulated FRLS copper wire in suitable size MS Conduit (including supplying and fixing MS Conduit) along with the earth wire, directly from the MCB- Distribution Board or from one power socket outlet to another in case of computer power points. Looping shall not be done in general 16A power points (other than computer power points).

c. Wiring for 20A Metal Clad Socket Outlets

Wiring for all 20A Metal Clad Socket Outlets shall be done with 2X6 sqmm PVC insulated FRLS copper wire in suitable size MS Conduit (including supplying and fixing MS Conduit) along with the earth wire directly from the MCB-Distribution Board. Wiring for 20A Metal Clad Socket outlet shall be done on linear basis i.e. complete wiring directly from MCB-Distribution Board to the socket outlet.

21.5.7. CONDUCTOR SIZE.

Wiring shall be carried out with following sizes of PVC insulated FRLS multiple stranded single core copper conductor wire/cable.

i. Light Point. - 1.5 sq.mm

ii. Ceiling /Cabin/Exhaust Fan Point - 1.5 sq.mm

iii. Call Bell Point - 1.5 sq.mm

iv. 6A Plug Point/ UPS Computer outlets (up to 3 outlets on one ckt.) - 2.5 sq.mm

v. Circuit Wiring - 2.5 sq.mm

vi. General Power Point – 4 sq.mm

vii 20A Industrial Socket Outlet – 6 Sqmm

viii Special Power Point – 6 Sqmm

ix A/C Industrial box / Modular Socket with 32A MCB- 6 Sqmm

21.6. LIGHTING FIXTURE AND FANS

21.6.1. GENERAL

a. The Contractor shall supply and install all LED Lighting fixtures as per relevant IS Codes for all buildings.
b. All fixtures shall be delivered to the building complete with suspension accessories, canopies, hanging devices, sockets, holders, reflectors, ballasts, diffusing material, louvers, plaster frames, recessing boxes, etc. all wired and assembled as indicated.
c. Full size shop detail drawings of special fixture or lighting equipment, where called for in the fixtures, shall be submitted to the Engineer In Charge for approval.
d. Fixtures, housing, frame or canopy, shall provide a suitable cover for fixture outlet box or fixture opening.
e. Fixtures shall comply with all applicable requirements as herein outlined unless otherwise specified or shown on the Drawings.
f. Manufacturer's name and catalogue number of light fixtures, fans, switchgears etc. shall be strictly adhered.
g. Fixtures shall bear manufacturer's name and the factory inspection label.
h. Fixtures shall be completely wired and constructed to comply with the IEE wiring regulations requirements for lighting fixtures, unless otherwise specified.
i. Revamping the fixture shall be possible without having to remove the fixture from its place.

j. Lamps of the proper type, wattage and voltage rating shall be furnished and installed in each fixture.
k. For Labs, ICU, CCU and other Critical Areas, Clean Room LED Light Fixtures shall be provided to maintain requisite Lux level as per NBC 2016, ECBC and as directed by Engineer-In-Charge.

21.6.2. INSTALLATION

Fixtures shall be installed at mounting heights as detailed on the Drawings or as instructed on site by the Engineer-In -charge.

Pendent fixtures within the same room or area shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation.

Flush mounted recessed fixtures, shall be installed so as to completely eliminate leakage of light within the fixture and between the fixture and adjacent finish.

Fixtures mounted outlet boxes shall be rigidly secured to a fixture stud in the outlet box. Hickeys or extension pieces shall be installed where required to facilitate proper installation.

Fixtures located on the exterior of the building shall be installed with non-ferrous metal screws finished to match the fixtures.

21.6.3. LED Light Fixtures -GENERAL

Indoor & Outdoor type LED Lighting Fixtures shall conform to following specifications:

LED Light Fixtures - Indoor

Sl	Criteria	Specification
1	The Luminaire Construction	Single Piece Pressure die cast Aluminium alloy housing for better thermal conductivity. Seperate driver and optical compartment for Thermal isolation.
2	Beam Angle	Injection Moulded PC diffuser for optimum light transmission
3	Operating Voltage Range	140-280 VAC
4	Frequency	50 Hz
5	Power Factor@240 VAC	≥0.95
6	Driver	Driver Efficiency ≥ 85% Driver inbuilt Surge Protection - 3 KV Silicon Potted IP-66 Over voltage Protection Short circuit Protection Thermal Protection
7	THD @ 240 VAC	< 5%
8	Ingress Protection	IP-20
9	Colour Temperature	5300 K to 6000 K
10	CRI	>80
11	System Efficacy	>110 Lumens Per Watt
12	Junction Temperature of LED	≤ 65 degree Celcius
13	LED Make	NICHIA/Philips Lumileds/ CREE/ OSRAM/ Samsung/ BridgeLux

14	Operating Temperature Range	0°C to 35°C
15	Humidity	10 to 80%

LED Light Fixtures - Outdoor

Sl	Criteria	Specification
1	The Luminaire Construction	Single Piece Pressure die cast Aluminium alloy housing for better thermal conductivity. Seperate driver and optical compartment for Thermal isolation. Each LED should be covered with IP-66 or more protected lens. Luminaire with glass/PC/Acrylic cover/diffuser will not be accepted due to accumulation of insects/dust and decrease in light output.
2	Operating Voltage Range	140-280 VAC
3	Frequency	50 Hz
4	Power Factor@240 VAC	≥0.95
5	Driver	Driver Efficiency ≥85% Driver inbuilt Surge Protection: 5 KV Silicon Potted IP66 Over voltage Protection Short circuit Protection Thermal Protection
6	THD@240 VAC	< 5%
7	Ingress Protection	IP-66
8	Impact Resistance	IK-08
9	Colour Temperature	5300 K to 6000 K
10	CRI	>70
11	System Efficacy	>110 Lumens per Watt
12	Junction Temperature of LED	≤ 85 degree Celcius.
13	LED Make	NICHIA/Philips Lumileds/ CREE/ OSRAM/ Samsung/ BridgeLux
14	Operating Temperature Range	0°C to 50°C
15	Humidity	10 to 80 %

All relevant Test Reports for Light Fixtures from NABL accredited laboratory shall be submitted at site alongwith Ligh Fitting consignments.

21.6.4. Ballasts/ Driver

Ballasts/ Driver shall be electronic type and having high power factor type.

Ballasts shall have manufacturer's lowest sound level and case temperature rise rating.

21.6.5. TESTING

After all lighting fixtures are installed and are connected their respective switches, test all fixtures to ensure operation on their correct switch in the presence of the engineer.

All non-operating fixtures or ones connected to the wrong or inconveniently located switch shall be correctly connected as directed by the Engineer In- charge. Stickers are to be placed on each light fixture w.r.t. controlling switch of respective light.

21.6.6. CEILING FANS

All ceiling fans shall be provided with suspension arrangement in the concrete/slab/roof members. Contractor to ensure that provision are kept at appropriate stage at locations shown on the drawing. Fan box with MS hook shall be as per CPWD specification. Ceiling fan shall be Heavy Duty, double ball bearing type, copper wound motor complete with canopy, down rod, blades etc. and shall conform to relevant IS Standards. Ceiling Fans shall be white in colour. Ceiling fan shall be provided with electronic regulator with stepped control. Electronic Regulator shall be suitable for 240 volts A.C supply 50 Hz and shall be of continuous duty type and with BEE Star rating. Ceiling Fans shall be 5-Star BEE rated & comply to ECBC norms.

21.6.7. EXHAUST FANS

Exhaust fans shall be heavy-duty type with double ball bearing and conforming to IS 2312 (latest revision). Exhaust fan shall be complete with copper wound motor, capacitor, Louver/shutter, frame and mounting bracket. Exhaust fan shall be suitable for operation on 240 volts single phase A.C supply with BEE 5-star rating & comply to ECBC norms.

21.7. TELEPHONE SYSTEM

21.7.1. Telephone point wiring

(a) The point wiring shall be carried out with four pair Cat6a LAN cable, in the PVC conduit Minimum Dia. of Conduit for Internal/External Telephone Wiring - 20mm.

If more than one telephone point has to be provided at one point, multi CAT6a Cable shall be used in suitable size of conduit.

(b) The point shall commence from the main telephone Rack and would terminate at outlet box of point.

(c) Fixing of conduit, conduit accessories draw out boxes and outlet box etc. in concealed/surface conduit works as that of wiring for light fixtures shall be applicable for telephone wiring conduit system also.

(d) Joint in telephone wiring (between Rack and outlet box of point) shall not be allowed and the contractor should bear the wastages of wire if resulted due to this special requirement of telephone system.

(e) External/Internal telephone and intercom wiring can be drawn in the same conduit, provided after drawing wires, 50% of conduit cross sectional area is free. However, independent armoured CAT 6A wire shall be used for external intercom.

(f) To identify telephone wire/cable, PVC indication numbers shall be put on both ends of wire/cable just before termination.

21.7.2. Telephone Rack

The Telephone CAT6A cables can also be terminated in the existing LAN Rack of suitable space.

21.7.3. Telephone Instruments:

Telephone Instruments shall be provided at various locations in the all the buildings and as directed by Engineer-In-Charge.

22. MASTER ANTENNA TELEVISION SYSTEM

The system shall comprise the reception and distribution of VHF Broadcast signals through one Master Head Antenna through suitable cable network, to each individual outlet. The equipment shall be: Master Antenna, Master Head Antenna Pre-Amplifier (if required), Broad Band (VHF-UHF) Amplifier/Mixer, Splitters and Directional Coupler, Wall Connectors/Terminations of Antenna Cables and Interconnecting low-loss MATV co-axial cables.

MATV systems allow multiple receivers (TV & FM) to receive signals from a single (Master) antenna, as opposed to individual antennas for each receiver. MATV systems are separated into two portions, the 'Head End' and the 'Distribution System'.

22.1. Master Antenna in MATV System

The Master Antenna shall be selected, as per as site location and requirement. The antenna shall be fixed on to the highest point of the building and shall be orientated for reception of maximum signal level. Construction of Master antenna shall be Outdoor type & weather protected. Frequency should be either VHF or UHF as required, and impedance to be 75 ohms.

22.2. Antenna Pre-Amplifier

The Master Pre-Amplifier shall be mounted on the Antenna Master. The Master Pre-Amplifier shall be of low noise, offering a gain of 15-25 dB or as required to boost the incoming signal to feed free signals to the main amplifier. Its construction shall be outdoor, totally enclosed type, frequency to be 40 MHz to 230 MHz/ 470-890 MHz, Input Impedance shall be 75 ohms, output Impedance shall be 75 ohms, gain should be between 15-25 dB, noise figures of 3 dB or similar, operating temp between -10 Degree C to 45 Degree C and electrical power supply should be 230 V, 50 HZ, AC.

22.3. Broad Band Amplifier / Mixer for MATV System

The Board Band Amplifier / Mixer shall be suitable for amplification of VHF / UHF signal strength sufficiently, to enable further distribution. The gain shall be adjustable over 40 dB, so that distribution voltage can be adjusted for week signals as well as for strong signals. The amplifier shall have high noise rejection characteristics. The amplifier / mixer shall have common output with two separate inputs for VHF and UHF signals. Construction of broad band amplifier / mixer shall be indoor type, aluminium housing, input frequency should be separately given for both VHF and UHF, output to be single common, frequency bandwidth for VHF 40-230 MHz and UHF 470-860 MHz. Signal gain shall be 35 dB (VHF) and 40 dB (UHF), input Impedance to be 75 ohms, output impedance to 75 ohms, noise level shall be 3 dB for VHF and 4 dB UHF; operating temp to be -10 Degree C to 45 Degree C.

22.4. Splitters for MATV System

The splitters in Master Antenna System shall be for 2 way and 4 way output as required. The incoming signal shall be split into 2 or 4 equal signal outputs. The attenuation and mismatch shall be minimum. Construction of Splitters for MATV System to be indoor, totally enclosed type. It shall have 2/4 ways, 4/8 dB VHF insertion loss, 75 ohms impedance and F type cable termination.

22.5. Directional Couplers for MATV System

Directional couplers to be constructed suitable for indoor type, totally enclosed. No. of outputs to be 1/2, less than 3 dB insertion loss, 75 ohms input impedance, 75 ohms, output impedance, branch loss to be 12 dB for VHF and 14 dB for UHF and F type cable termination.

22.6. Wall Connectors of MATV System

The wall connectors shall be suitable for termination of TV Antenna co-axial plug-connectors, in positions shown in drawings. The outlets shall be recessed in walls, with the connectors fixed onto acrylic sheets.

22.7. MATV CABLE

The MATV cable shall be Co-axial, solid copper conductor PE insulated, shielded with fine tinned copper braid and protected with PVC Sheath. It shall be laid in the PVC conduit.

22.8. Specification of the devices shall be as following:-

RG 59 Dual Shield MATV Cable-

MATV CABLE	Conductor size (mm)	(AWG)	Cond. Type	Shield Type	Nominal O.D. (mm)	Inslulation & Core O.D. (mm)	Velocity of Propagation (%)
RG 59 Dual Shield MATV Cable	0.813	20	Solid BCCS	60% Aluminium Braids	6.02	3.66	83
RG6 Dual & Tri Shield MATV Cable	1.02	18	Solid BCCS	60% Aluminium Braids	6.86	4.57	85
RG6 Quad Shield MATV Cable	1.02	18	Solid BCCS	60% & 40% Aluminium Braids	7.57	4.57	85
RG11 Quad Shield MATV Cable	1.63	14	Solid BCCS	60% & 40% Aluminium Braids	11.34	7.1	83

24dB Wide-band VHF/UHF Amplifier

	Frequency Range	Maximum Gain(dB)	Inputs	Noise Figure	Gain Figure	Current (mA)	FM Trap Option	Pager Option	Output Figure (dB)
VHF	44-470	18	1 or	<3	Tilt 14-10	80	NO	NO	105
UHF	470-860	24 fixed	comb	<3	NO	80	N/A	N/A	105

34dB Wide-band VHF/UHF Amplifier

	Frequency Range	Maximum Gain(dB)	Inputs	Noise Figure	Gain Figure	Current (mA)	FM Trap Option	Pager Option	Output Figure (dB)
VHF	44-230	20-27	1,2 or	<3	Tilt 12-10	90	-24	-24	108
UHF	520-860	34	comb	<2.5	10	90	N/A	N/A	108

38dB Wide-band VHF/UHF Amplifier

	Frequency Range	Maximum Gain (dB)	Inputs	Noise Figure	Gain Control	Current (mA)	FM Trap Option	Pager Option	Output Figure (dB)
VHF	44-230	20-28	1,2 or comb	<3	10	100	33	25 (Freq.Adj)	110
UHF	470-860	24 fixed		<2.5	10	100	N/A	N/A	110

23. UPS SYSTEM

23.1. Quality power Supply

The UPS shall be ON-LINE double conversion with filter & isolation transformer, stabilized and reliable voltage that is free from all mains interference (Over voltage, frequency variations, voltage drops).

The battery bank should have provision for future expansions. The UPS shall have Optional filters, Isolation transformer module, LCD-based remote control panel etc.

23.2. The Operating mode of UPS

It should operate in following on-line operating mode:

- **Economy Mode**: The UPS should use Line Interactive technology, i.e. the load is powered from the mains; the energy consumption is reduced with a subsequent improvement in efficiency .
- **Smart active mode:** The UPS should automatically selects On Line or Line Interactive operating mode according to the quality of the mains supply, by monitoring the number, frequency and type of disturbances at the mains power input.
- **Stand-by-off mode:** With the mains available the UPS should normally not powered and consequently the power consumption is almost nil. Only when the mains fails or falls outside a preset range, does the inverter take over using power from the batteries. This mode shall be suitable for Emergency escape lighting as pr standard **EN 50171.**
- **The UPS shall have Expandable feature.** The UPS shall have expandable feature to increase power availability or redundancy. For the expandability there shall be "Hot System Expansion" feature, the additional unit can be connected in parallel while the other units are on-line and supplying regular power to the load.

23.3. Maximum safety for personnel

There should be a feedback protection device in the UPS to prevent any voltage back feed in the upstream distribution board, thus ensuring the maintenance personal.

For Advanced communication there shall be software system which displays the most important information such as the input and output Voltage, the load applied, the remaining back-up time, etc. It should also be able to provide information even in the event of a failure, to support the fault diagnostics.

It should also contain the following hardware interfaces:

- RS 232 serial port/Communication port

- Dry contacts
- EPO (Emergency Power Off)

The UPS should have Mimic Panel for status and alarm, control and commands, input, output, battery status and settings.

23.4. Low Input Harmonic Distortion

The UPS shall have the Power Factor Correction (PFC), standard on all modules, so that the input power factor level to 0.95 for any load percentages so that it is ideal in conjunction with motor generator or in installation with other sensitive loads. There shall be built in Active Filter designed to reduce the level of THDi to less than 4% and to increase the input power factor up to 0.99.

This Active filter shall be based on the IGBT's Technologies controlled by the Digital Signal Processor (DSP). This DSP instantly monitors and controls the inputs current absorbed by the UPS in order to eliminate the unlike harmonics and maintain the THDi less than 4%. With the effect of Active Filter the UPS can also be connected to the low loads. These active filters shall be fitted inside the UPS so that no additional footprint is required.

23.5. UPS & its features:-

a. The input requirements of the UPS are as follows:

Voltage	:	415 V, Three-phase + Neutral
Voltage tolerance	:	± 20%
Frequency	:	45-65 Hz
Current distortion	:	<4% with active filter
Power factor	:	0.99 with active filter

b. The Bypass of the UPS are as follows:

Rated voltage	:	415 V, Three-phase + N
Phases number	:	3 + N
Voltage tolerance	:	± 15%
Rated frequency	:	50 Hz
Frequency tolerance	:	± 2%
By-pass	:	Static and manual for maintenance
Transfer time	:	Nil

c. The Battery for the UPS are as follows:

Type of battery	:	maintenance-free sealed lead-acid
Battery blocks	:	12 V
Recharge time minimum	:	6 Hr

d. The Output of UPS are as follows:

Rated power	:	As per General arrangement/DBR
Active power	:	As per General arrangement/DBR
Phases number	:	3 + N
Waveform	:	Sinewave
Rated voltage	:	415V

Frequency	:	50 Hz
Dynamic stability	:	± 5%
Static stability	:	± 1%
Crest factor	:	3 : 1
Overload	:	110% for 10 min, 125% for 5 min

e. The System of UPS is as follows:

AC/AC efficiency	:	92% in On-line mode
Noise	:	50-56 db at 1 M distance
Operating temperature	:	-2° to 45°C
Relative humidity	:	95% non-condensing
Remote controls	:	EPO & Bypass
Remote signals	:	Volt free contacts
Protection degree	:	IP20
Communication	:	Double RS232 + Slot for SNMP Adapter

23.6. The Codes & Standard for UPS are as follows:

1. Safety EN 62040-1
2. EMC IEC 62040-2
3. EN 50091-2 lev. A
4. Directives 73/23, 93/68, 89/336 EEC
5. EN 62040-3.

All LV equipments installed in Data/IT Server Room, Audio-visual media room, IPABX Room, CCTV System, BMS system, Nurse Call System, SCADA System, Fire Alarm System, PA System, Fire Officer Control Room & Security room etc. shall be fed from UPS supply only.

24. EXTERNAL STREET LIGHTING SYSTEM:

24.1. Scope of Work:

The scope of works under External Street Lighting System requires illumination of all external areas like streets, roads, entrance gates, boundary walls, parks, gardens, landscaping, porches, building facades, walkways, pathways etc., which shall be illuminated conforming to NBC 2016, ECBC 2017 and CPWD specifications maintaining required Lux levels. Suitable LED fixtures shall only be used with inbuilt harmonic suppression mechanism for external area illumination. Conventional street light poles, bollards, gate lights, post-top lantern etc. shall be used for this purpose keeping in view aesthetical and architectural requirements. The external lighting shall be fed from outdoor type feeder panels and automatically controlled through 24-hour Digital/ Astronomical Timers.

All conventional street light poles of single arm /double arm/triple arm, as required shall be GI Octagonal with heights as per relevant IS Codes, NBC Code & ECBC.

24.2. GENERAL SPECIFICATION FOR HIGH MAST:

i. SCOPE:

This specification covers the technical requirements of design, manufacture, testing at manufacturer's works, packing, forwarding of High Mast. High Mast lighting shall be

provided as per specification Type-I, unless stated otherwise, as per direction of Engineer-In-Charge.

ii. APPLICATION STANDARDS:

The equipment covered by this specification shall unless otherwise stated, be designed, manufactured and tested in accordance with the latest editions of the following Indian, International standards and shall confirm to the regulations of the local authorities.

- IS 875 (Part III) 1987 (Code and practices for design loads for structures)
- IS 2062 : 2006 (Hot rolled low, medium and high Tensile structural steel)
- BSEN 10025/DIN 17100 (Grades of MS Plates)
- BSEN 60529 (Degree of provided by Enclosures- IP code)
- BS 5135 / AWS (Welding)
- BS EN ISO 1461 : 1999 (Galvanizing)
- BS EN 5649-4: 1982 (Lighting columns, Recommendations for surface protection of metal lighting columns)
- TR No. 7 1996 of ILE, UK (Specifications of Masts and foundations)

iii. GENERAL CONSTRUCTIONS:

The High Mast shall be designed to withstand the maximum wind speed as per IS: 875. The top loading, i.e. the weight and the area of luminaries are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS: 5649 Part VI – 1982. The Mast shall be designed using limit state principle. The limit states to be considered are: (i) Ultimate and (ii) Serviceability; based on a design wind speed with a return period of 25 years. The total Height of the High Mast, with luminaries mounting carriage cum head frame and luminaries installed shall be measured as the vertical distance between the base flange plate and the plane in which the lamps lie in their operating position.

a. STRUCTURE:

The High Mast shall be of continuously tapered, polygonal cross section; ranging from 8 to 20 sided, and shall be based on proven In-Tension design conforming to the standards referred above, to give an assured performance and reliable service. The structure shall be suitable for wind loading as per IS 875 part3 1987.

b. CONSTRUCTION:

The High Mast shall be manufactured using steel plates, conforming to BS-EN 10-025. The high mast shall be manufactured in two sections for 12.5 meters, 16metres and 20metres. In case of 25 meters and 30 meters high mast shall be manufactured in three sections. Each mast section shall be fabricated out of single plate duly folded and welded. The Mast shaft shall have polygonal cross section and shall be continuously tapered with single/Double longitudinal welding. There shall not be any circumferential welding and pole shafts with more than two longitudinal weld shall not be acceptable. The welding of pole shaft shall be done by Submerged Arc Welding (SAW) process. No site welding and bolted joints shall be done on the mast. The minimum overlap distance shall be 1.5 times the diameter at penetration. The minimum top diameter and bottom diameter shall be as specified in data sheets and plate thickness shall be as per the structural design requirements. The calculation for civil design and foundation details shall be submitted by the EPC Contractor for approval of Engineer-In-Charge. The mast shall be provided with

fully penetrated flange, which shall be free from any lamination or incursion. The welded connection of the base flange shall be fully developed to the strength of the entire section. The base flange shall be provided with supplementary gussets between the bolt-holes to ensure elimination of helical stress concentration.

c. GALVANIZING:

For environmental protection of the mast the entire fabricated mast shall be hot dip galvanized internally and externally as per BS EN ISO 1461 standards with an average coating thickness of minimum 85 micron. The galvanizing shall be done in single dipping only. Double dip-galvanized shafts with overlapping are not acceptable. Further, no post galvanizing painting, touch-up or rectification shall be allowed.

d. DOOR OPENING:

All adequate door opening shall be provided as per the GTP such that the minimum distance from the mast flange plate to the bottom of the door opening shall twice the width of the door opening. The door shall be flushed with the exterior surface. The door opening shall be such that it permits clear access to equipment like winches, cables, plug and socket, etc. and also facilitate easy removal of the winch. The door opening shall be complete with a close fitting, vandal resistant, weatherproof door, provided with heavy duty double internal lock with special paddle key. The minimum radius at the corners of openings shall be 20mm. The door opening shall be carefully designed and reinforced with welded steel section, so that the mast section at the base shall be unaffected and undue buckling of the cut portion is prevented.

e. DYNAMIC LOADING FOR THE MAST:

The mast structure shall be suitable to sustain an assumed maximum reaction arising from a wind speed as per IS: 875 (Part-III) 1987 (three second gust) and shall be measured at a height of 10 meters above ground level. The design life of the mast shall be minimum of 25 years.

f. LANTERN CARRIAGE:

i. FABRICATION:

A fabricated raising and lowering type Lantern Carriage cum head frame shall be provided at the top of high mast shaft properly secured for fixing and holding the flood light fittings and control gear boxes. The Lantern Carriage shall be of special design and shall be of steel channel construction. The Lantern Carriage shall be so designed and fabricated to hold the required number of flood light fittings and the control gear boxes, and also have a perfect self balance. The Lantern Carriage shall be fabricated in two/three halves and joined by bolted flanges with stainless steel bolts and nylon type stainless steel nuts to enable easy installation or removal from the erected mast. The inner lining of the carriage shall be provided with protective PVC arrangement, so that no damage is caused to the surface of the mast during the raising and lowering operation of the carriage.

The entire Lantern Carriage shall be hot dip galvanized after fabrication. The lantern carriage shall be fabricated out of M.S. channel with suitable reinforcements. Also an certificate to this effect quoting safe working load shall be supplied with each carriage. The carriage shall carry a permanently attached label stating the safe working load. Both the Mast Shaft and Luminaries Mounting Carriage shall be sourced from one manufacturer only so as to ensure compatibility and overall finish of the material.

ii. JUNCTION BOX:

Weather proof junction box, made of Cast Aluminum shall be provided on the Carriage Assembly as required, from which the inter-connections to the designed number of the flood light luminaries and associated control gears fixed on the carriage shall be made.

iii. RAISING AND LOWERING MECHANISM:

For the installation and maintenance of the luminaries and lamps, it will be necessary to lower and raise the Lantern Carriage Assembly. To enable this, a suitable Winch Arrangement shall be provided, with the winch fixed at the base of the mast and the specially designed head frame assembly at the top.

iv. WINCH:

The winch shall be of completely self sustaining type, without the need for brake shoe, springs or clutches. Each driving spindle of the winch shall be positively locked when not in use by gravity activated PAWLS. The capacity, operating speed, safe working load, recommended lubrication and serial number of the winch shall be clearly marked on each winch. The gear ratio of the winch shall be calculated considering minimum working load not less than 750 kg. The winch shall be self-lubricating type by means of an oil bath and the oil shall be readily available grades of reputed producers. The winch drums shall be grooved to ensure perfect seat for stable and tidy rope lay, with no chances of rope slippage. It shall be possible to operate the winch manually by a suitable handle and electrically by an external power tool also. It shall be possible to remove the double drum after dismantling, through the door opening provided at the base of the mast. A test certificate shall be furnished by the Contractor from the original equipment manufacturer, for each winch in support of the maximum load operated by the winch.

g. STAINLESS STEEL WIRE ROPES:

The suspension system shall essentially be without any intermediate joint and shall consist of only non-corrodible stainless steel of AISI 316 grade. The stainless steel wire ropes shall be of marine grade 7/19 construction, the central core being of the same material. The overall diameter of the rope shall not be less than 5mm for 12mtr. High mast and 6mm for 16mtr. And 20mtr. High mast. The breaking load of each rope shall not be less than 2350 kg giving a factor of safety of over 5 for the system at full load as per the TR-7 referred to in the beginning of this specification. The end constructions of ropes by compression splices. Continuous lengths of stainless steel wire ropes shall be used in the system and no intermediate joints are acceptable in view of the required safety. No intermediate joints/ terminations, either bolted or else, shall be provided on the wire ropes between winch and lantern carriage. The design of the whole suspension system shall be such that the wire ropes can be removed and replaced from ground level without the necessity of lowering the mast or use of special equipment.

h. ELECTRICAL SYSTEM,CABLE AND CABLE CONNECTIONS:

The control panel at the bottom of the mast shall have facility for terminating up to 1.1kV, 4C x 25 sq. mm, Aluminium conductor, armoured, XLPE incoming cable. The outgoing from this panel shall be the trailing cable, which is terminated at the weather proof junction box provided at the top. This cable shall be minimum 6 cores, 2.5 sq. mm,1100V, electrolytic grade, EPR insulated, copper conductor and PCP sheathed cable to get flexibility and endurance. The connections from the top junction box to the individual luminaries shall be made by using 3 core 4 sq.mm flexible PVC cables of reputed make. The cable shall run via metal ducts or tubes provided in luminary's carriage up to individual luminaries and control gear units. All steel conduits shall be of heavy gauge welded type with hot dipped galvanized finish.

i. LIGHTNING SPIKE:

One number heavy duty hot dip galvanized lightning spike shall be provided for each mast. The lightning spike shall be minimum 1.2 M in length (except for 12.5m where it will be 0.6m) and shall be provided at the centre of the head frame. It shall be bolted solidly to the head frame to get a direct conducting path to the earth through the mast. The lightning spike shall not be provided on the lantern carriage under any circumstances in view of safety of the system.

j. AVIATION OBSTRUCTION LIGHTS:

Provision for mounting LED type aviation obstruction lights of reliable design shall be provided on top of each mast for20m high masts only.

12.5 METER HEIGHT

S.No.	Description [Lighting Mast]	Specification
1	High mast Height [mtrs] Incl. Luminaires Carriage	12.5
1.1	Material Construction [BSEN100025 Equi.]	BSEN 10025 or Equi.
1.2	Welding	As per IS
1.3	No. of Sides	8
2	WIND LOAD DATA AS PER IS875;PART-3 I987	as per IS 875
3	Mast Section Details	
3.1	Top Diameter [In mm]	150
3.2	Base Diameter[In mm]	340
3.3	Number of Sections[Nos]	2
3.4	Top Sections length[mm] x thickness[mm]	6500X3
3.6	Bottom Section Length[mm] x thickness[mm]	6500X3
3.7	over lapping[between Sections]	500
3.8	Base Flange Diameter[mm]	540
3.9	Base Flange Thickness[mm]	32
3.10	P.C.D [mm] x Hole Dimensions[mm]	440
3.11	No. of Bolts [Qty]	6
3.12	Foundation bolts Details	750x25mm
3.13	Metal Treatment protection for Mast	Galvanised
3.14	Thickness of Galvanisation(min.)	min 65 mic for sheet thk-2mm upto 5 mm
3.15	Size of opening and door at base	900mmx220mm
3.16	Type of locking arrangement	Anti-Vandalism
3.17	Size of anchor plate & thickness	540mmx3mm
3.18	Details of template	540mmx4mm
4	HEAD FRAME	3-POINT
4.1	Construction	M.S. Fabricated
4.2	Metal Treatment protection for HEAD FRAME	Galvanised

4.3	Pulley Arrangement (For Steel Wires)	3SETS OF PULLEYS
4.4	Pulley Arrangement (For Electrical cables)	1 SET of pulleys
5	LANTERN CARRIAGE	
5.1	Material of Construction	IS2062
5.2	Diameter of Carriage Ring(mm)-1NO	900 plus arm length of 850 mm on both sides
5.3	Construction	M.S fabricated
5.4	Number of joints	3
5.5	Buffer arrangements between Carriage& MAST	Will be provided
6	Compensating Disc Between L-Ring & DD Winch	PROVIDED
7	Safety Locking on both sides of Base of Mast	PROVIDED
8	Winch	D/Drum, 500 Kg
9	Stainless Steel wires diameter	6mm
9.1	Number of Ropes	
9.2	C/disc to D/d. winch	two[6mm size]
9.3	C/disc to Lantern Ring	Three[6mm size]
9.4	Thimbles & Terminals	Provided.
9.5	Factor Of Safety	>5
10	POWER TOOL	Integral
10.1	Model	Bharat Bijlee/ Remi
10.2	Input Supply	415v,50c/s;3-ph
10.3	WATTAGE	0.75 kW
10.4	Num. Of Speeds	Single
10.5	Reversible/Non-reversible	Reversible
10.6	Operating Speed	1400 Rpm
11	Lightning Arrestor [0.6 m Length]	will be provided
12	Aviation Obstruction light	Provision for mounting will be provided

16 METER HEIGHT

S.No	Description [Lighting Mast]	Specification	Specification	Specification	Specification
	Type	**1**	**2**	**3**	**4**
1	High mast Height[mtrs] incl.Luminaires Carriage	16	16	16	16
1.1	Material Construction	BSEN100025 or Eqiv	BSEN100025 or Eqiv	BSEN100025 or Eqiv	BSEN100025 or Eqiv
1.2	Welding	As per IS	As per IS	As per IS	As per IS

1.3	No. Of Sides	20	20	20	20
2	WIND LOAD DATA taken for this project	as per IS 875	as per IS 875	as per IS 875	as per IS 875
3	Mast Section Details				
3.1	Top Diameter [In mm]	166	166	220	220
3.2	Base Diameter[In mm]	415	415	485	485
3.3	Number of Sections[Nos]	2	2	2	2
3.4	Top Sections length[mm] x thickness[mm]	8375X3	8375X4	8375X4	8375X4
3.5	Middle Section Length[mm] x thickness[mm]	NA	NA	NA	NA
3.6	Bottom Section Length[mm] x thickness[mm]	8375X4	8375X4	8375X4	8375X5
3.7	over lapping[between Sections]	375	375	375	375
3.8	Base Flange Diameter[mm]	630	630	730	730
3.9	Base Flange Thickness[mm]	32	32	32	32
3.10	P.C.D [mm] x Hole Dimensions[mm]	530	530	630	630
3.11	No of Bolts[Qty]	8	8	12	16
3.12	Foundation bolts Details	1200x24 mm	1200x24 mm	1200x24 mm	1200x24 mm
3.13	Metal Treatment protection for Mast	Galvanised	Galvanised	Galvanised	Galvanised
3.14	Thickness of Galvanisation(min.)	min 65 micron for sheet thickness of 2mm up to 4 mm and 86 Microns for 5 mm and above.			
3.15	Size of opening and door at base	1000mmx300mm	1000mmx300mm	1000mmx300mm	1000mmx300mm
3.16	Type of locking arrangement	Anti-Vandalism	Anti-Vandalism	Anti-Vandalism	Anti-Vandalism
3.17	Size of anchor plate & thickness	730mmx6mm	730mmx6mm	730mmx6mm	730mmx6mm
3.18	Details of template	730mmx6mm	730mmx6mm	730mmx6mm	730mmx6mm
4	HEAD FRAME	3-POINT	3-POINT	3-POINT	3-POINT
4.1	Construction	MS. Fabricated	MS. Fabricated	MS. Fabricated	MS. Fabricated
4.2	Metal Treatment protection for HEAD FRAME	Galvanised	Galvanised	Galvanised	Galvanised
4.3	Pulley Arrangements (For Steel Wire Rope)	3SETS OF PULLEYS	3SETS OF PULLEYS	3SETS OF PULLEYS	3SETS OF PULLEYS
4.4	Pulley Arrangements (For Electric Cable)	1 set OF PULLEY	1 set OF PULLEY	1 set OF PULLEY	1 set OF PULLEY
5	LANTERN CARRIAGE				
5.1	Matreial of Construction	IS2062	IS2062	IS2062	IS2062
5.2	Diameter of Carriage Ring(mm)-	1200	1200	1200	1200

	1NO				
5.3	Construction	M.S fabricated	M.S fabricated	M.S fabricated	M.S fabricated
5.4	Number of joints	3	3	3	3
5.5	Buffer arrangements between Carriage& MAST	Will be provided	Will be provided	Will be provided	Will be provided
6	Compensating Disc between L-Ring and DD Ring	PROVIDED	PROVIDED	PROVIDED	PROVIDED
7	Safety Locking on both sides at Base of Mast	PROVIDED	PROVIDED	PROVIDED	PROVIDED
8	Winch	D/Drum, 750 Kg cap	D/Drum, 750 Kg cap	D/Drum, 750 Kg cap	D/Drum, 750 Kg cap
9	Stainless Steel wires diameter	6 mm	6 mm	6 mm	6 mm
9.1	Number of Ropes	3	3	3	3
9.2	C/disc to D/d.Winch	two[6mm size]	two[6mm size]	two[6mm size]	two[6mm size]
9.3	C/disc to Lantern Ring	Three[6mm size]	Three[6mm size]	Three[6mm size]	Three[6mm size]
9.4	Thimbles & Terminals	Provided.	Provided.	Provided.	Provided.
9.5	Factor Of Safety	>5	>5	>5	>5
10	POWER TOOL	Gear Ration 53:1	Gear Ration 53:1	Gear Ration 53:1	Gear Ration 53:1
10.1	Model	Integral	Integral	Integral	Integral
10.2	Input Supply	415v,50c/s;3-ph	415v,50c/s;3-ph	415v,50c/s;3-ph	415v,50c/s;3-ph
10.3	WATTAGE	1.5KW	1.5KW	1.5KW	1.5KW
10.4	Num. Of Speeds	Single	Single	Single	Single
10.5	Reversible/Non-reversible	Reversible	Reversible	Reversible	Reversible
10.6	Operating Speed	1400 Rpm	1400 Rpm	1400 Rpm	1400 Rpm
11	Lightning Arrestor [1.2m Length]	will be provided	will be provided	will be provided	will be provided

Note:

a. Dimensions are subjected to tolerance allowed as per IS.

b. Diameter of wire rope may increase to 8 mm wherever qty. of light fittings are more on lantern carriage.

c. Motor can be supplied in single and three phase as per requirement.

20 METER HEIGHT						
S.No	**Description[Lighting Mast]**	**Specification**				
	Type	1	2	3	4	5
1	High mast Height[mtrs] incl.Luminaires Carriage	20	20	20	20	20
1.1	Material Construction	BSEN100025 or Eqiv	BSEN100025 or Eqiv	BSEN100025 or Eqiv	BSEN100025 or Eqiv	BSEN100025 or Eqiv

1.2	Welding	As per IS	As per IS	As per IS	As per IS	As per IS
1.3	No.Of Sides	20	20	20	20	20
2	WIND LOAD DATA taken for this project	as per IS 875	as per IS 875	as per IS 875	as per IS 875	as per IS 875
3	Mast Section Details					
3.1	Top Diameter [In mm]	166	166	206	208	210
3.2	Base Diameter[In mm]	419	419	489	489	518
3.3	Number of Sections[Nos]	2	2	2	2	2
3.4	Top Sections length[mm]xthickness[mm]	10375X3	10375X4	10375X4	10375X4	10375X5
3.5	Middle SectionLength[mm]xthickness[mm]	NA	NA	NA	NA	NA
3.6	Bottom Section Length[mm]xthickness[mm]	10375X4	10375X4	10375X4	10375X5	10375X6
3.7	Over lapping [between Sections]	375	375	375	375	375
3.8	Base Flange Diameter[mm]	630	630	730	730	730
3.9	Base FlangeThickness[mm]	32	32	32	32	32
3.10	P.C.D [mm] x Hole Dimensions [mm]	530	530	630	630	630
3.11	No.Of Bolts[Qty]	12	12	16	16	20
3.12	Foundation bolts Details	1200x24 mm	1200x24 mm	1200x24 mm	1200x24 mm	1200x24 mm
3.13	Metal Treatment Protection for Mast	Galvanised	Galvanised	Galvanised	Galvanised	Galvanised
3.14	Thickness of Galvanisation (min.)	min 65 micron for sheet thickness of 2mm up to 4 mm and 86 Microns for 5 mm and above.				
3.15	Size of opening and door at base	1000mmx300 mm	1000mmx300 mm	1000mmx300 mm	1000mmx300 mm	1000mmx300 mm
3.16	Type of locking arrangement	Anti-Vandalism	Anti-Vandalism	Anti-Vandalism	Anti-Vandalism	Anti-Vandalism
3.17	Size of Anchor Plate & Thickness	630mmx6mm	630mmx6mm	730mmx6mm	730mmx6mm	730mmx6mm
3.18	Details of Template	630mmx6mm	630mmx6mm	730mmx6mm	730mmx6mm	730mmx6mm
4	HEAD FRAME	3-POINT	3-POINT	3-POINT	3-POINT	3-POINT
4.1	Construction	MS.Fabricated				
4.2	Metal Treatment protection for HEAD FRAME	Galvanised				
4.3	Pulley Arrangements (For Steel Wire Rope)	3SETS OF PULLEYS	3SETS OF PULLEYS	3SETS OF PULLEYS	3SETS OF PULLEYS	3SETS OF PULLEYS

4.4	Pulley Arrangements (For Electric Cable)	1 set OF PULLEY	1 set OF PULLEY	1 set OF PULLEY	1 set OF PULLEY	1 set OF PULLEY
5	LANTERN CARRIAGE					
5.1	Matreial of Construction	IS2062	IS2062	IS2062	IS2062	IS2062
5.2	Diameter of Carriage Ring(mm)-1NO	1200	1200	1200	1200	1200
5.3	Construction	M.S fabricated	M.S fabricated	M.S fabricated	M.S fabricated	M.S fabricated
5.4	Number of Joints	3	3	3	3	3
5.5	Buffer arrangements between Carriage & MAST	Will be provided	Will be provided	Will be provided	Will be provided	Will be provided
6	Compensating Disc between L-Ring and DD Ring	PROVIDED	PROVIDED	PROVIDED	PROVIDED	PROVIDED
7	Safety Locking on both sides at Base of Mast	PROVIDED	PROVIDED	PROVIDED	PROVIDED	PROVIDED
8	Winch	D/Drum, 750 Kg cap	D/Drum, 750 Kg cap	D/Drum, 750 Kg cap	D/Drum, 750 Kg cap	D/Drum, 750 Kg cap
9	Stainless Steel wires diameter	6 mm	6 mm	6 mm	8 mm	6 mm
9.1	Number of Ropes	3	3	3	3	3
9.2	C/disc to D/d.Winch	two[6mm size]	two[6mm size]	two[6mm size]	two[6mm size]	two[6mm size]
9.3	C/disc to Lantern Ring	Three[6mm size]	Three[6mm size]	Three[6mm size]	Three[6mm size]	Three[6mm size]
9.4	Thimbles & Terminals	Provided.	Provided.	Provided.	Provided.	Provided.
9.5	Factor Of Safety	>5	>5	>5	>5	>5
10	POWER TOOL	Gear Ration 53:1	Gear Ration 53:1	Gear Ration 53:1	Gear Ration 53:1	Gear Ration 53:1
10.1	Model	Integral	Integral	Integral	Integral	Integral
10.2	Input Supply	415v,50c/s;3-ph	415v,50c/s;3-ph	415v,50c/s;3-ph	415v,50c/s;3-ph	415v,50c/s;3-ph
10.3	WATTAGE	1.5KW	1.5KW	1.5KW	1.5KW	1.5KW
10.4	Num. Of Speeds	Single	Single	Single	Single	Single
10.5	Reversible/Non-reversible	Reversible	Reversible	Reversible	Reversible	Reversible
10.6	Operating Speed	1400 Rpm	1400 Rpm	1400 Rpm	1400 Rpm	1400 Rpm
11	Lightning Arrestor [1.2m Length]	will be provided	will be provided	will be provided	will be provided	will be provided
12	Aviation Obstruction light	Provision for mounting will be provided				

Note:

a. Dimensions are subjected to tolerance allowed as per IS.

b. Diameter of wire rope may increase to 8mm wherever qty. of light fittings are more on lantern carriage.

c. Motor can be supplied in single and three phase as per requirement.

25 METER HEIGHT				
S.No	Description[Lighting Mast]	Specification		
	Type	1	2	3
1	High mast Height[mtrs] incl.Luminaires Carriage	25	20	20
1.1	Material Construction	BSEN100025 or Eqiv	BSEN100025 or Eqiv	BSEN100025 or Eqiv
1.2	Welding	As per IS	As per IS	As per IS
1.3	No.Of Sides	20	20	20
2	WIND LOAD DATA taken for this project	as per IS 875	as per IS 875	as per IS 875
3	Mast Section Details			
3.1	Top Diameter [In mm]	206	212	215
3.2	Base Diameter[In mm]	500	600	666
3.3	Number of Sections[Nos]	3	3	3
3.4	Top Sections length[mm]xthickness[mm]	9000X4	9000X4	9000X4
3.5	Middle SectionLength[mm]xthickness[mm]	9000X4	9000X4	9000X5
3.6	Bottom Section Length[mm]xthickness[mm]	9000X5	9000X5	9000X6
3.7	over lapping[between Sections]	1000/900	1000/900	1000/900
3.8	Base Flange Diameter[mm]	730	830	890
3.9	Base FlangeThickness[mm]	32	32	32
3.10	P.C.D [mm]xHole Dimensions[mm]	630	730	790
3.11	No.Of Bolts[Qty]	20	20	20
3.12	Foundation bolts Details	1200x24 mm	1200x24 mm	1200x32 mm
3.13	Metal Treatment protection for Mast	Galvanised	Galvanised	Galvanised
3.14	Thickness of Galvanisation(min.)	min 65 micron for sheet thickness of 2mm up to 4 mm and 86 Microns for 5 mm and above.		
3.15	Size of opening and door at base	1000mmx300mm	1000mmx300mm	1000mmx300mm
3.16	Type of locking arrangement	Anti-Vandalism	Anti-Vandalism	Anti-Vandalism
3.17	Size of anchor plate & thickness	730mmx6mm	730mmx6mm	730mmx6mm
3.18	Details of template	730mmx6mm	730mmx6mm	730mmx6mm
4	HEAD FRAME	3-POINT	3-POINT	3-POINT
4.1	Construction	MS.Fabricated	MS.Fabricated	MS.Fabricated

4.2	Metal Treatment protection for HEAD FRAME	Galvanised	Galvanised	Galvanised
4.3	Pulley Arrangements (For Steel Wire Rope)	3SETS OF PULLEYS	3SETS OF PULLEYS	3SETS OF PULLEYS
4.4	Pulley Arrangements (For Electric Cable)	1 set OF PULLEY	1 set OF PULLEY	1 set OF PULLEY
5	LANTERN CARRIAGE			
5.1	Matreial of Construction	IS2062	IS2062	IS2062
5.2	Diameter of Carriage Ring (mm)-1NO	1200	1200	1200
5.3	Construction	M.S fabricated	M.S fabricated	M.S fabricated
5.4	Number of Joints	3	3	3
5.5	Buffer arrangements between Carriage & MAST	Will be provided	Will be provided	Will be provided
6	Compensating Disc between L-Ring and DD Ring	PROVIDED	PROVIDED	PROVIDED
7	Safety Locking on both sides at Base of Mast	PROVIDED	PROVIDED	PROVIDED
8	Winch	D/Drum, 750 Kg cap	D/Drum, 750 Kg cap	D/Drum, 750 Kg cap
9	Stainless Steel wires diameter	6 mm	6 mm	6 mm
9.1	Number of Ropes	3	3	3
9.2	C/disc to D/d Winch	two[6mm size]	two[6mm size]	two[6mm size]
9.3	C/disc to Lantern Ring	Three[6mm size]	Three[6mm size]	Three[6mm size]
9.4	Thimbles & Terminals	Provided.	Provided.	Provided.
9.5	Factor Of Safety	>5	>5	>5
10	POWER TOOL	Gear Ration 53:1	Gear Ration 53:1	Gear Ration 53:1
10.1	Model	Integral	Integral	Integral
10.2	Input Supply	415v,50c/s;3-ph	415v,50c/s;3-ph	415v,50c/s;3-ph
10.3	Wattage	1.5KW	1.5KW	1.5KW
10.4	Num. Of Speeds	Single	Single	Single
10.5	Reversible/Non-reversible	Reversible	Reversible	Reversible
10.6	Operating Speed	1400 Rpm	1400 Rpm	1400 Rpm
11	Lightning Arrestor [1.2m Length]	will be provided	will be provided	will be provided
12	Aviation Obstruction light	Provision for mountingwill be provided	Provision for mountingwill be provided	Provision for mountingwill be provided

Note:

a. Dimensions are subjected to tolerance allowed as per IS.
b. Diameter of wire rope may increase to 8mm wherever qty. of light fittings are more on lantern carriage.
c. Motor can be supplied in single and three phase as per requirement.

30 METER HEIGHT

S.No	Description[Lighting Mast]	Specification				
	Type	1	2	3	4	5
1	HIGH MAST HEIGHT[MTRS] INCL.LUMINAIRES CARRIAGE	30	30	30	30	30
1.1	MATERIAL CONSTRUCTION	BSEN100025 OR EQIV	BSEN100025 OR EQIV	BSEN100025 OR EQIV	BSEN100025 OR EQIV	BSEN100025 OR EQIV
1.2	WELDING	AS PER IS	AS PER IS	AS PER IS	AS PER IS	AS PER IS
1.3	NO.OF SIDES	20	20	20	20	20
2	WIND LOAD DATA TAKEN FOR THIS PROJECT	AS PER IS 875	AS PER IS 875	AS PER IS 875	AS PER IS 875	AS PER IS 875
3	MAST SECTION DETAILS					
3.1	TOP DIAMETER [IN MM]	166	206	208	300	300
3.2	BASE DIAMETER[IN MM]	578	600	666	661	756
3.3	NUMBER OF SECTIONS[NOS]	3	3	3	3	3
3.4	TOP SECTIONS LENGTH[MM] XTHICKNESS[MM]	10600X4	10600X4	10600X4	10600X4	10600X4
3.5	MIDDLE SECTIONLENGTH [MM] XTHICKNESS[MM]	10650X4	10650X4	10650X5	10650X5	10650X5
3.6	BOTTOM SECTION LENGTH [MM]XTHICKNESS[MM]	10650X4	10650X5	10650X6	10650X6	10650X6
3.7	OVER LAPPING[BETWEEN SECTIONS]	1000/900	1000/900	1000/900	1000/900	1000/900
3.8	BASE FLANGE DIAMETER[MM]	770	830	890	890	990
3.9	BASE FLANGETHICKNESS[MM]	32	32	32	32	32
3.10	P.C.D [MM]XHOLE DIMENSIONS[MM]	690	730	790	790	890
3.11	NO.OF BOLTS[QTY]	16	20	20	20	20
3.12	FOUNDATION BOLTS DETAILS	1200X24 MM	1200X24 MM	1200X32 MM	1200X32 MM	1200X32 MM
3.13	METAL TREATMENT PROTECTION FOR MAST	GALVANISED	GALVANISED	GALVANISED	GALVANISED	GALVANISED
3.14	THICKNESS OF GALVANISATION(MIN.)	MIN	65 MICRON FOR SHEET THICKNESS	OF 2MM UP TO 4 MM AND	86 MICRONS FOR 5 MM AND ABOVE.	
3.15	SIZE OF OPENING AND DOOR AT BASE	1000MMX300MM	1000MMX300MM	1000MMX300MM	1000MMX300MM	1000MMX300MM
3.16	TYPE OF LOCKING ARRANGEMENT	ANTI-VANDALISM	ANTI-VANDALISM	ANTI-VANDALISM	ANTI-VANDALISM	ANTI-VANDALISM
3.17	SIZE OF ANCHOR PLATE & THICKNESS	730MMX6MM	730MMX6MM	730MMX6MM	730MMX6MM	730MMX6MM
3.18	DETAILS OF TEMPLATE	730MMX6MM	730MMX6MM	730MMX6MM	730MMX6MM	730MMX6MM
4	HEAD FRAME	3-POINT	3-POINT	3-POINT	3-POINT	3-POINT
4.1	CONSTRUCTION	MS.FABRICATED	MS.FABRICATED	MS.FABRICATED	MS.FABRICATED	MS.FABRICATED
4.2	METAL TREATMENT PROTECTION FOR HEAD FRAME	GALVANISED	GALVANISED	GALVANISED	GALVANISED	GALVANISED
4.3	PULLEY ARRANGEMENTS (FOR STEEL WIRE ROPE)	3SETS OF PULLEYS	3SETS OF PULLEYS	3SETS OF PULLEYS	3SETS OF PULLEYS	3SETS OF PULLEYS
4.4	PULLEY ARRANGEMENTS (FOR ELECTRIC CABLE)	1 SET OF PULLEY	1 SET OF PULLEY	1 SET OF PULLEY	1 SET OF PULLEY	1 SET OF PULLEY
5	LANTERN CARRIAGE					
5.1	MATREIAL OF CONSTRUCTION	IS2062	IS2062	IS2062	IS2062	IS2062
5.2	DIAMETER OF CARRIAGE RING(MM)-1NO	1200	1200	1200	1200	1200
5.3	CONSTRUCTION	M.S FABRICATED	M.S FABRICATED	M.S FABRICATED	M.S FABRICATED	M.S FABRICATED

5.4	NUMBER OF JOINTS	3	3	3	3	3
5.5	BUFFER ARRANGEMENTS BETWEEN CARRIAGE& MAST	WILL BE PROVIDED	WILL BE PROVIDED	WILL BE PROVIDED	WILL BE PROVIDED	WILL BE PROVIDED
6	COMPENSATING DISC BETWEEN L-RING AND DD RING	PROVIDED	PROVIDED	PROVIDED	PROVIDED	PROVIDED
7	SAFETY LOCKING ON BOTH SIDES AT BASE OF MAST	PROVIDED	PROVIDED	PROVIDED	PROVIDED	PROVIDED
8	WINCH	D/DRUM, 750 KG CAP	D/DRUM, 750 KG CAP	D/DRUM, 750 KG CAP	D/DRUM, 750 KG CAP	D/DRUM, 750 KG CAP
9	STAINLESS STEEL WIRES DIAMETER	6 MM	6 MM	8 MM	8 MM	8 MM
9.1	NUMBER OF ROPES	3	3	3	3	3
9.2	C/DISC TO D/D.WINCH	TWO[6MM SIZE]	TWO[6MM SIZE]	TWO[6MM SIZE]	TWO[6MM SIZE]	TWO[6MM SIZE]
9.3	C/DISC TO LANTERN RING	THREE[6MM SIZE]	THREE[6MM SIZE]	THREE[6MM SIZE]	THREE[6MM SIZE]	THREE[6MM SIZE]
9.4	THIMBLES & TERMINALS	PROVIDED.	PROVIDED.	PROVIDED.	PROVIDED.	PROVIDED.
9.5	FACTOR OF SAFETY	>5	>5	>5	>5	>5
10	POWER TOOL	GEAR RATION 53:1	GEAR RATION 53:1	GEAR RATION 53:1	GEAR RATION 53:1	GEAR RATION 53:1
10.1	MODEL	INTEGRAL	INTEGRAL	INTEGRAL	INTEGRAL	INTEGRAL
10.2	INPUT SUPPLY	415V,50C/S;3-PH	415V,50C/S;3-PH	415V,50C/S;3-PH	415V,50C/S;3-PH	415V,50C/S;3-PH
10.3	WATTAGE	1.5KW	1.5KW	2.2KW	2.2 KW	2.2 KW
10.4	NUM. OF SPEEDS	SINGLE	SINGLE	SINGLE	SINGLE	SINGLE
10.5	REVERSIBLE/NON-REVERSIBLE	REVERSIBLE	REVERSIBLE	REVERSIBLE	REVERSIBLE	REVERSIBLE
10.6	OPERATING SPEED	1400 RPM	1400 RPM	1400 RPM	1400 RPM	1400 RPM
11	LIGHTNING ARRESTOR [1.2M LENGTH]	WILL BE PROVIDED	WILL BE PROVIDED	WILL BE PROVIDED	WILL BE PROVIDED	WILL BE PROVIDED
12	AVIATION OBSTRUCTION LIGHT	PROVISION FOR MOUNTING WILL BE PROVIDED				

Note:

a. Dimensions are subjected to tolerance allowed as per IS.
b. Diameter of wire rope may increase to 8mm wherever qty. of light fittings are more on lantern carriage.
c. Motor can be supplied in single and three phase as per requirement.

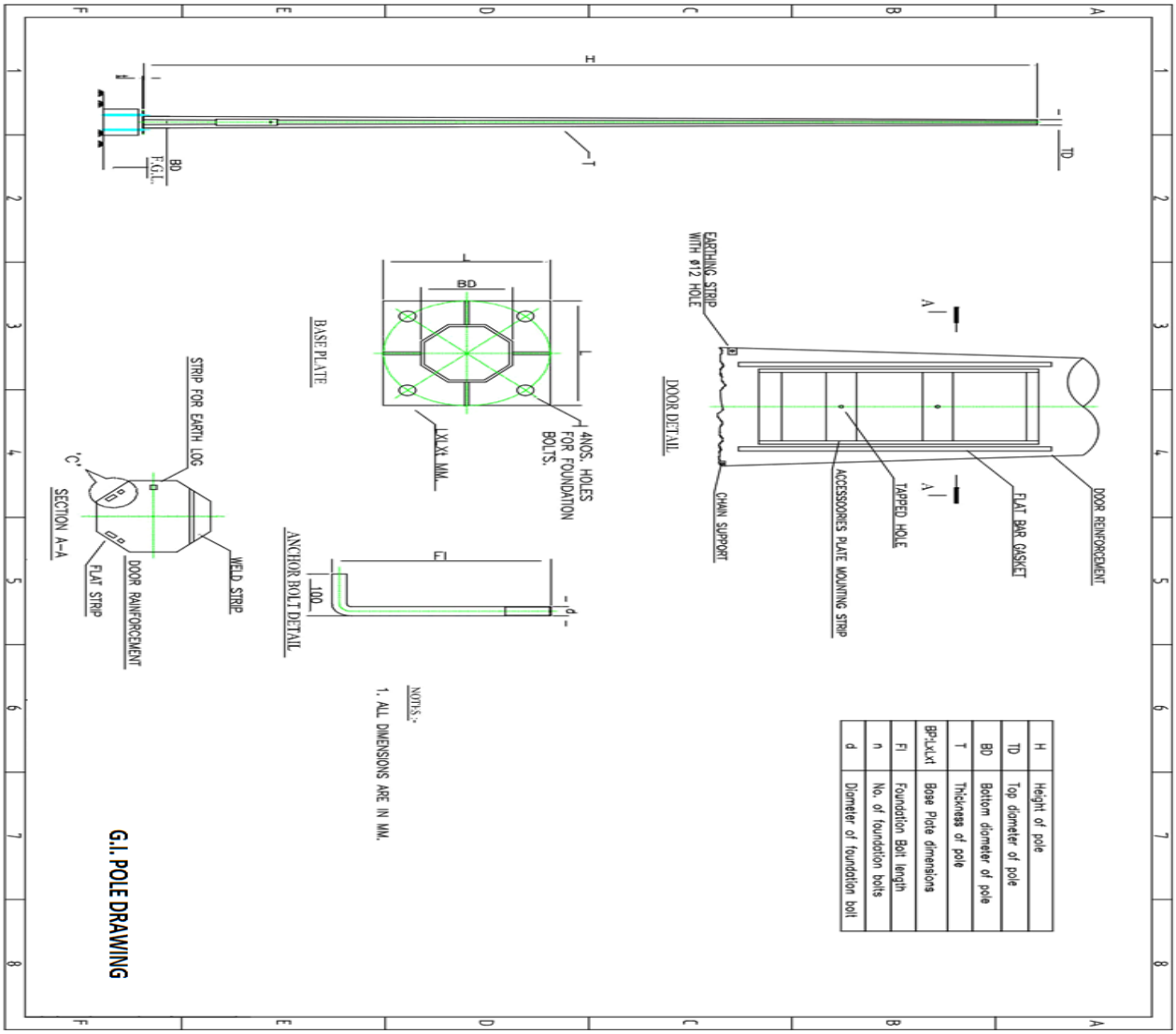
24.3. Standard Galvanised Octagonal Poles

Octagonal poles shall be designed as per ILE TR7 & BS5649 for structural design & as per IS875 (Part III), 1987 for dynamic loading.

The pole shaft shall be made single piece MS structure continuously tapered having polygonal (8/12 sides) cross section and a single longitudinal welding. The welding will be done as per BS 5135 / IS 9595. No circumferential welding shall be allowed in the pole shaft. The MS shall conform to BSEN 100025/100027. The structure shall be single hot dip galvanized as per BS 729 / IS 2629. A suitably designed door shall be provided at approximate 700mm height from the pole base. The door opening will be suitably reinforced for structural strength. The door shall be flushed with pole external surface and shall provide easy access for electrical connections at a maintainable height. A Suitable base flange will be welded and plate reinforcements will be provided between base flange & pole. Foundation accessories will be as per IS 1367.

POLE DESCRIPTION	HEIGHT	POLE DETAILS TOP	BOTTOM	THICKNESS	BASE PLATE	FOUNDATION BOLT DETAILS LENGTH	NOS	DIA.
	H	TD	BD	T	BP: LXLXT	FL	N	D
3 MTR GI OCTAGONAL POLE	3000	70	130	3	200 X 200X 12	450	4	16
4 MTR GI OCTAGONAL POLE	4000	70	130	3	220 X 220X 12	450	4	20
5 MTR GI OCTAGONAL POLE	5000	70	130	3	200 X 200 X 12	600	4	24
6 MTR GI OCTAGONAL POLE	6000	70	130	3	220X 220 X 16	600	4	24
7 MTR GI OCTAGONAL POLE	7000	70	130	3	220 X 220 X 16	700	4	24
8 MTR GI OCTAGONAL POLE	8000	70	135	3	225 X 225 X 16	750	4	24
9 MTR GI OCTAGONAL POLE	9000	70	155	3	260 X 260 X 16	750	4	24
10 MTR GI OCTAGONAL POLE	10000	70	175	3	275 X 275 X 16	750	4	24
11 MTR GI OCTAGONAL POLE	11000	90	210	3	300 X 300 X 20	750	4	24
12 MTR GI OCTAGONAL POLE	12000	90	240	3	320 X 320 X 20	750	4	24

NOTE: ALL DIMENSIONS ARE IN MM.



25. Solar Street Lighting System

25.1. Scope of Work:

Solar Street Lighting System shall comprise of Solar Panel Module, LED Luminaires, Solar Charge Controller /LED driver in a single PCB, SMF Battery with 36 hours back up, Hybrid Charger etc. Mounting System shall include, panel frame, panel holder, Battery Box, Battery Box Stand, Luminaire arm, GI Octagonal Pole etc.

Maximum Power Point Tracking (MPPT) System shall be provided with charge controllers for extracting maximum available power from PV module under certain conditions. MPPT (18 W – 45W) Solar Charge Controller with maximum efficiency shall be provided as per Lux level requirements to maximise the generation of solar power.

25.2. Features of Solar Street Light Poles:

System Wattage	15Watts	18Watts	21Watts	24Watts	27Watts	30Watts

Total Lumen Output	1600	1900	2200	2600	2900	3150
Charge Controller Type	MPPT (DIM)	MPPT (DIM)	MPPT (DIM)	MPPT (DIM)	MPPT (DIM)	MPPT (DIM)
Charge controller efficiency	>96%	>96%	>96%	>96%	>96%	>96%
LED Driver efficiency	>96%	>96%	>96%	>96%	>96%	>96%
No of Leds	8	8	8	12	12	12
No Load current from battery	<10mA	<10mA	<10mA	<10mA	<10mA	<10mA
Housing	LM6 PDC Housing	LM6 PDC Housing	LM6 PDC Housing	LM6 PDC Housing	LM6 PDC Housing	LM6 PDC Housing
Front Cover	Toughened Glass	Toughened Glass	Toughened Glass	Toughened Glass	Toughened Glass	Toughened Glass
Ingress Protection	IP66, Class I	IP66, Class I	IP66, Class I	IP66, Class I	IP66, Class I	IP66, Class I
Life	50,000Hrs@ L70	50,000Hrs@ L70	50,000Hrs@ L70	50,000Hrs@ L70	50,000Hrs@ L70	50,000Hrs@ L70
CCT	5700K (+/- 5SDCM)	5700K (+/- 5SDCM)	5700K (+/- 5SDCM)	5700K (+/- 5SDCM)	5700K (+/- 5SDCM)	5700K (+/- 5SDCM)
CRI	>70	>70	>70	>70	>70	>70
Solar Panel	75 WP	75WP	100WP	120WP	120WP	120WP
Battery	75AH	75 AH	100AH	100AH	100AH	120 AH
Battery Box	Sheet Metal	Sheet Metal	Sheet Metal	Sheet Metal	Sheet Metal	Sheet Metal
Autonomy (battery backup)	3 days	3 days	3 days	3 days	3 days	3 days
Pole Height (Above ground)	5 MTS OCTAGONAL 4 MM THICK	5 MTS OCTAGONAL 4 MM THICK	5 MTS OCTAGONAL 4 MM THICK	5/6 MTS OCTAGONAL 4 MM THICK	5/6 MTS OCTAGONAL 4 MM THICK	5/6 MTS OCTAGONAL 4 MM THICK
Other accessories	Battery stand , Panel holder , Arm 0.5 mts 5 degree tilt	Battery stand , Panel holder , Arm 0.5 mts 5 degree tilt	Battery stand , Panel holder , Arm 0.5 mts 5 degree tilt	Battery stand , Panel holder , Arm 0.5 mts 5 degree tilt	Battery stand , Panel holder , Arm 0.5 mts 5 degree tilt	Battery stand , Panel holder , Arm 0.5 mts 5 degree tilt

25.3. Façade & Flood Lighting:

Façade illumination shall be achieved by providing LED based flood lights, outdoor type light fittings (IP-66) with impactful and bright lighting effects in wide area. These flood lights shall be housed in High Pressure die-cast aluminum housing with sealed glass /polycarbonate cover. The light shall be mounted with various angular adjustments with beam angles generally ranging from 15 degree to 120 degree. Luminous efficacy must be more than 110 Lumen/watt and Color Rendering Index (CRI) more than 70.

These light should have integrated constant current Electronic driver with nominal voltage range from 120 Volt to 280 Volt, Operating Temperature - 20 degree C to 50 degreeS C, Total Harmonic

distortion less than 5%, Power Factor > 0.95, Electrical safety class, Built in surge protection of upto 10 kV.

25.4. Power cabling for External illumination:

The power shall be fed to Street Light Poles, High Mast Poles, Hybrid Solar street Light Poles, Bollards, Post Top lanterns, Gate Lights, Façade Lights, Walk way lights etc through suitable size aluminium armoured XLPE insulated power cables, laid underground as per CPWD Specifications. Suitable Feeder Pillars shall be provided to feed various circuits of street lights.

25.5. Street Light Pole Height & distance between poles:

Street Light Poles, High Mast Poles, Hybrid Solar street Light Poles, Bollards, Post Top Lanterns of suitable height shall be provided to achieve illumination with required Lux levels in the external areas as per CPWD, NBC 2016 & ECBC norms. Distance between street light poles shall be as per CPWD, NBC 2016 & ECBC norms as applicable.

Inspection: Street Light Poles, High Mast Poles, Hybrid Solar Street Light Poles etc shall be offered for inspection by HLL Engineers at manufacturer's works before final dispatch to site as per terms of the contract.

Drawings: Site Layout drawings and Single Line diagrams shall be prepared and submitted for approval of Engineer-In–charge by the contractor for the Street Light Poles, High Mast Poles, Hybrid Solar street Light Poles, Bollards, Post Top lanterns, Gate Lights, Façade Lights, Walk Way lights etc. The drawings shall be got approved from Engineer-In–charge before commencement of works at site.

25.6. Applicable IEC Standards:

i. IEC 61215 latest: Solar Panel
ii. IEC 61347-2-13 : LED driver safety
iii. IEC 62384 : LED driver performance
iv. CISPR 15 : Radio disturbance characteristics
v. IEC 61547 : EMC immunity requirements
vi. IEC 60598 : General requirements and tests

CHAPTER –G

TECHNICAL SPECIFICATIONS – DIESEL GENERATOR SETS & ASSOCIATED WORK

1. SCOPE OF WORK:

This specification covers the design, manufacture, assembly, packing, dispatch, transportation, supply, erection, testing, commissioning, performance and guarantee testing of Diesel Gen-Sets with Acoustic Enclosure, complete in all respects with all equipment, fitting and accessories for efficient and trouble free operation as specified here under. All DG Sets shall be provided with Hospital Type Silencers capable of noise reduction as per CPCB norms.

DG Sets shall be supplied with Prime Power duty, 3-phase, 50 Hz, 1500 rpm, 415 V, Silent Type Diesel Generator Set with suitable batteries, electrical panels, Radiator Cooling System, Exhaust System (including suitable height of independent steel structure for all DG sets), Day Tank Fuel system, fuel piping etc. as per requirement.

The Scope of work shall also include labour, tools, tackles and plants, hardware and consumables, steel fabrication and items as prescribed below:

- Diesel Engine and Alternator set complete with base frame and accessories.
- DG Set shall be with latest Model of PCCM / Synchronizing relay suitable for auto /manual synchronizing, Load sharing & By pass arrangements.
- Engine mounted engine control integral panel duly wired upto terminal box for engine safeties with sensors and protection for inter facing with PLC/Microprocessor based relay.
- Fuel Oil system including day service oil tank, piping, valves, filters etc. from engine to service day oil tank.
- Lube oil system with piping etc. (Pre-lube oil pump with controller if required).
- For DG Sets upto & including 1010 KVA Rating: Radiator Cooled System without Cooling Towers.
- For DG Sets above 1010 KVA Rating: Cooling system with Heat Exchanger, suitable rating Cooling Towers complete with makeup water tanks. Water pumps, GI B class Water Pipes of suitable size with valves, fittings & bends etc shall be provided between DG Sets & Cooling Towers.
- Exhaust emission shall meet latest CPCB norms without catalytic converter or online scrubber and hospital silencers capable of noise reduction as per CPCB norms, exhaust piping with mineral wool insulation and aluminum cladding as called for.
- Steel fabricated structure/support/hanger including fixing, grouting and bolting etc.
- Painting of steel work.
- LT Termination Box shall be suitable for suitable size Sandwich busducts through flexible tinned copper busbars of suitable ratings.
- Copper Control cabling between DG sets and respective LT Panels
- Exhaust Gas Pipes MS C Class, minimum 6 mm thick with all accessories and hardwares. Height of Exhaust pipes shall be provided as per relevant CPCB and CPWD norms.
- MS Stack structure for supporting DG Exhaust Pipes duly painted with 2 coats of red-oxide primer & synthetic enamel paint of approved shade.

- All DG Sets shall be provided adequate shading with polycarbonate sheets supported on MS structure duly painted.
- Body & Neutral earthing of DG Sets complete with earth pits and earth strips/wire etc as per relavant latest CPWD specification.
- All DG Sets shall be certified by an independent test laboratory ICAT (Manesar)/ ARAI, Pune to ascertain that DG Set will generate the net nominal full load at the stipulated ambient temperature conditions. Test Certificates for DG Sets shall be produced.

2. CODES & STANDARDS

The design, construction, manufacture, inspection, testing and performance shall comply with all the currently applicable statutes, safety codes, relevant Bureau of Indian Standard (BIS), British Standards (BS), International Electro Technical Commission (IEC) publication, standards amended up to date.

Some of the applicable standards are listed below:

(A)	**Generating Set**	
ISO 8528	Part - I	Application, rating and performances.
	Part - II	Engines
	Part - III	A.C. Generator for generating set
	Part -IV	Control Gear & Switch Gear
	Part - V	Generating Sets
	Part -VI	Test Methods
(B)	**Engines**	
IS 10000 (Naturally Aspirated)	Part - I 1980	Methods of tests for I.C. Engines Part - I- Glossary of terms relating of test methods
	Part - IV- 1980	Declaration of power, Efficiency, fuel consumption, lubricating oil consumption.
	Part - VII- Performance Tests	
	Part - X	Test for smoke level, limit and correction for smoke level for variable speed.
ISO - 3046	Part - V 2001	Performance, Torsional vibrations.
(C)	**Alternator**	
IS 4889/BS - 269		For declaring efficiency of electrical machines.
IS 4722 -1992		Capability of machine to withstand over current / overload.
IS- 13364	Part I 1992	Alternator - Voltage Regulations upto 20 KVA
IS- 13364	Part II 1992	Alternator - Voltage Regulations above 20 KVA to 80 KVA
IEC 34-1 - 1983		Rotating Electrical machines - Rating & Performance
IP -21	IS - 4691/85	Alternator (Degree of Protection)
(D)	**Acoustics Enclosure**	
IS - 8183		Insulation material for sound absorption.
ISO 3744	1998 (E)	Acoustics - Determination of sound power levels of noise sources.
ISO 9614 -	1983 Part -I	Requirement of grade - II, Accuracy for insulation.

ISO 9614 -	1983 Part -II	Requirement of grade - II, Accuracy for insulation.
(E)	**Control Panel / AMF Panel**	
IS - 2147 1962		Degree of protection.
IS - 4722		H.V. testing for Panel

3. DESIGN

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The equipment offered by the contractor shall be complete in all respects. Any material or accessories, which may not have been specifically mentioned, but which are usual and necessary for the satisfactory and trouble free operation and maintenance of the equipment shall be provided without any extra cost to the purchaser.

The DG Sets shall be mounted on suitable anti-vibration mountings of reputed make to prevent transfer of vibration to the foundation and structures. The DG Set equipment shall be tropicalised and shall be suitable for operating in humid atmosphere at an ambient temperature of 45 deg. C.

The engine alternator set shall be capable of working at ambient temperature between -5°C to 45°C and relative humidity upto 95%.

The operating capacity of each set shall be arrived at after considering a load with power factor of 0.8 lagging, and after taking into consideration suitable de-rating on account of above parameters of the station.

The engine/alternator set shall be capable of taking 10% over-load for a period of one hour during any 12 hours period, while operating continuously at full rated load.

Nominal output voltage of engine/alternator set shall be 415 volts 50 Hz AC Supply with manual adjustment at all conditions of load with coarse and fine controls with a range of ± 5%.

The frequency shall be maintained at 50 Hz ± 2/% for the set. The output wave-form shall be sinusoidal at all load conditions.

The engine/alternator set shall be selected for a high degree of performance with over all low fuel consumption for the normal life of the alternator set.

The engine/alternator set shall meet the requirements of all linear & non-linear loads, but over-sizing of the alternator in order to meet the non-liner characteristics of loads in not envisaged.

The Engine shall be capable to minimum 50% bulk load of the rating during transfer of the load from NO Load position without tripping.

4. SYSTEM OPERATION

The set may be idle for a long time except for periodical test whenever there is a electrical supply failure, the set may required to run continuously for period even exceeding 24 hours.

5. SYSTEM FEATURE

The entire work shall confirm to Bureau of Indian Standards safety standards; British Standards, and CPWD specifications.

6. PERFORMANCE REQUIREMENT

The equipment shall be capable of delivering power continuously at the generator Terminal, a net output not less than the specified value at 0.8-0.95 p.f. excluding auxiliary power (shall be included over and above), when operating under the site ambient conditions described in this specification. Gen Set should be capable of taking 100 % step load & it should be able to take full load in less than 25 sec. from start. The set shall be suitable for prime duty.

The design parameters of the generator and excitation system shall be chosen that the set is stable while running at any load between no – load and full load and also during starting of motors. It

should also have synchronous speed control with load sensing governing system suitable for parallel running of D.G. sets.

Engine should be heavy duty four strokes, turbo charged after cooler 'V' construction/in line electric start. Engine should have minimum lube oil change period 500 Hrs. Bidders are required to offer the Duplex filter system for lube oil and fuel oil in case of non compliance.

The set shall have vibration limit less than 130 microns (as per BS:4999 Part – 142) & noise level shall be meet CPCB norms under all conditions of load. The set shall be dynamically balanced. The set shall be mounted directly on the inertia foundation or with foundation bolts etc. The efficient silencer as per CPCB norms shall be provided with or without catalytic converter on-line scrubber & the set shall meet EURO-II norms for D.G Sets, for the exhaust. Air inlet shall also be provided.

The engine shall be stationary, compression ignition, totally enclosed, water cooled, 4 stroke direct injection, cold battery starting, turbo charged and low temperature with after cooled Radiator Cooled 1500 RPM in accordance to BS 5514 and IS:10002 complete with all accessories. The DG engine shall be suitable for quick start & should be able to pick up 100% load within optimum time.

The DG Engine & the batteries shall be designed to take up at least six starting attempts beyond which the system shall be protected by means of an over crank relay. The successful bidder will submit GFC drawings of the equipments/accessories selected for this work for the approval.

7. SERVICE INTERVAL AND OPERATION

The set shall be capable of running at full load for not less than 500 hrs continuously. The change period both for the lube oil, lube oil filters shall be minimum 500 Hours of operations.

8. DIESEL ENGINE - CONSTRUCTION

Material of construction of major parts shall be as under or as per manufacturer design.

- M.S. base frame with anti-vibration mountings.
- Crankcase – Aluminium alloys.
- Crank shaft, connecting rods –Forged Alloy Steel.
- Piston – AL alloy casting.
- Piston rings – Alloy Steel.
- Engine Block – Cast Iron
- Cylinder Liner – Cast Iron

All other material of construction shall be as per relevant standard/code.

One common base frame shall be provided for mounting the engine and alternator complete with electric suspension between D.G set and foundation bolts, leveling lines etc. as required.

All externally mounted hardware shall be high tensile steel only.

The normal speed of the engine shall be 1500 RPM and the direction of rotation shall be clearly marked on the set.

The engine shall be fitted with an exhaust gas driven turbo charger of air / water cooled type complete with its own self contained lubricating system. The turbo-charger shall be positioned at the free end of the engine preferably

The engine shall be fitted with a charge air inter cooler of the air/water type. Air from the turbo-charger compressor passes through the inter cooled and then to the engine manifold. The inter cooler shall be of tubular construction or as per manufacturer design with aluminum bronze tubes, mild sheet steel and cast iron water headers.

Fuel injection and valves shall not require frequent adjustment while in service.

All filters like fuel, lubrication oil, by pass etc shall be provided in the engine and shall be dry, paper element type.

Starting system shall be 12V/24V DC comprising of suitable batteries, Voltage Regulator and arrangement for initial charging of batteries.

Bed Plate:-

The bed plate shall be fabricated from M.S. channel. The welding shall be radio graphed, and the entire fabrication shall be stress relieved after welding. The bed plate shall have integral well ribbed diaphragms for supporting the main bearing housings.

Crank Case:-

The crank case shall be steel construction with heavy steel plates to form water compartments around the cylinder. To facilitate access for purpose of inspection, inspection ports shall be provided.

Lube - Oil Priming Pump:-

An A.C. motor driven intermittent operation lube-oil priming pump shall be provided. This shall also include necessary piping, fitting instruments etc. for lubrication system along with clock timers if required.

Crank Shaft:-

The crank shaft shall be made of high tensile strength steel forging, and shall have a suitable flange to which the flywheel shall be bolted.

The bearing journals and fillets shall be induction hardened; and fully balanced.

Main And Big End Bearings:

The main and big end bearings shall be detachable shells of high grade bearing material, and shall be pre-finished.

Connecting Rods:-

The connecting rods shall be of high grade drop forged steel I - beam section, centre to centre length. The rods shall be rifle drilled for pressure lubrication of piston pin. The rod shall be tapered at piston pin end provided to reduce unit pressures. The piston pin of suitable diameter shall be full floating and made of tubular steel, and retained by a snap ring.

Cylinder Liners:-

The cylinder liners shall be replaceable wet liners, cast iron alloy, and provided with specially machined grooves in their bores to give an oil retaining surface. These liners shall be easily replaceable without re-boring the block.

Piston:-

The piston shall be made of forged aluminum alloy, cam ground and machined on outer surface. The piston shall be fitted with an oil scraper ring, and compression rings of hardened cast iron alloy. The piston shall be oil cooled.

Camshaft:-

The camshaft shall be of induction hardened steel alloy with gear drive, and one of this shall be provided for each block of cylinders.

Exhaust Manifold:-

The exhaust manifold shall be multi-branch, of insulated design utilizing Ni-resist casting.

Flywheel:-

The flywheel, which shall conform to requirements of NEMA/ASA/BS codes, shall be made of mild steel statically balanced after machining and shall have graduated markings around the periphery / markings for checking of the valves can also be located on the vibration damper. Barring slots shall be provided around the flywheel rim for hand-barring/ alternatively a suitable barring arrangement should be provided.

Governing System:-

The governor shall be Isochronous, electronic digital type with a steady state frequency variation of ± 0.5%. The transient performance shall comply with ISO 8528-5, Class G3 requirements.

It should be possible to adjust the over speed settings on the governor by means of digital signals Manual adjustments for over speed trip settings are not preferred.

9. HEAT EXCHANGER

The DG Set should be equipped with a Heat Exchanger/ Radiator for suitable continuos duty operation.

10. ALARMS/TRIP (AUDIO AND VISUAL)

The following Alarm/Trip indications shall be provided as minimum with first stage as pre alarm & second stage as trip:

- ❖ High water temperature.
- ❖ Low lube oil pressure.
- ❖ Low fuel level.
- ❖ Low coolant level.
- ❖ Over crank
- ❖ Over speed

11. OTHER AUXILIARY EQUIPMENT/SERVICES

These shall be complete include the following:-

i. Silencer

Exhaust Silencer shall be residential type to reduce the noise level. Values for Pressure drop across the silencers to be indicated by the Contractor.

ii. Cooling

The engine shall be water cooled heat exchanger type or radiator cooled depending on its capacity. DG Set shall be adequately designed for continuous operation on ambient conditions at 45 deg C.

12. INSTALLATION OF GENERATING SET

The engine and alternator shall be mounted on specially designed common MS base plate and frame of extremely rigid welded construction, so as to provide no deflection.

The engine/ alternator set shall be installed over the Dunlop-make, S-type anti-vibration cushy base in order to isolate the transmission of vibrations to the floor or building structures.

The exhaust system shall be designed and installed in such a manner that it avoids excessive stresses on the exhaust manifold of turbocharger, washing spray or any other source.

The exhaust pipe shall pass through an oversized collar, filled with glass wool when crossing floor/wall.

All exposed metal parts shall be suitably painted to prohibit corrosion under the climatic conditions at site.

The installation of fuel piping, power distribution and control panels shall be carried out in accordance with the specification of respective items.

13. DAY SERVICE FUEL TANK (Inbuilt/ External)

Day service fuel tank shall be made of 3 mm thick MS sheet of 990 litres capacity or as OEM standard capacity for each set with all accessories such as oil level indicator, inlet pipe connection, outlet pipe connection, trough to collect spilt oil, air vent pipe with air filter, manhole with cover, low level and full level float valve arrangements with all fittings, interconnections between tanks and engine. The tank shall be provided with suitable calibration scale. The Fuel to be used for trials and acceptance tests shall be high speed diesel. Required first fill of 990 litres HSD per DG set, coolant and lube oil is included in the scope of this contract.

14. FOUNDATION

Foundation shall be casted as per the recommendations of the manufacturer in consultation with the Supplier and as per the requirements of the site.

PAINTING

The Contractor shall paint all exposed metal parts and equipment supplied by him. All sheet metal work shall undergo a process of phosphating, passivating and then sprayed with high corrosion resistant primer. The finishing treatment shall be of two coats of synthetic enamel paint of approved color. All piping shall be color coded.

15. ALTERNATOR

The alternator shall be brushless synchronous and suitable for 3 phase 415 Volts, 4 wire, 50 Hz, 0.8 PF, 1500 RPM.

The alternator shall be suitable for coupling directly to the diesel engine It shall be Drip proof, screen protected as per IP-23. The alternator shall be single bearing type & self ventilating. The alternators shall be continuously rated and shall have class 'H' insulation with a temperature rise restricted to that of Class F designed and built to withstand tropical conditions. It shall generally conform to BS: 5000 (Part - 99) / standards listed above. The alternator shall be suitable for sustaining a 10% overload for 1 hour in any 12 hour period without injury. The terminal arrangement for alternator shall be suitable for Cable connections of adequate size to deliver the full load of the alternator.

The alternator shall also have a solid state type digital voltage regulator (D.V.R.) suitable for single running with control limits of 1% from no load to full load under normal load changes. It shall be of static type and complete with cross current compensation. The regulator shall be provided with voltage adjusting potentiometer, and shall be complete with all alarm contacts, internal wiring, etc.

The Engine and Alternator shall be direct coupled and mounted on a common rigid fabricated steel base frame with suitable vibration isolation system.

16. EXCITOR

Self excited, self regulated and providing alternator output regulation at plus or minus 0.5%. The alternator shall be provided with a pilot-excited, permanent magnet-excited generator (PMG)/ Auxiliary Winding Regulation Excitation Principle (AREP) for superior short circuit capabilities. Bidders to specify sustained short circuit current capabilities for up to 10 seconds.

The alternator shall be provided with sealed Barings to give minimum service life of 40,000 Hours. The Bidders to specify the maximum rating of the motor that can be started direct on line without any base load, with 50% base load, restricting the voltage depth to 20%.

17. INSTRUMENTATION

Instrumentation shall be provided and mounted on the Generator Set to monitor the following:

- Engine Speed
- Oil Pressure
- Oil Temperature
- Water Temperature.

The generator shall be provided with a microprocessor-based controller with a facility for remote start, remote annunciation , auto / manual synchronizing and remote communication capability. It should be possible to monitor the parameters of the engine and the alternator and display the status of the faults on the DG set if any and generate a complete report on the PC individually. The following minimum monitoring & protection is required for the alternators.

Alternator Monitoring

- Current. (I1, I2, I3)
- Frequency
- Voltage (L-L & L-N)
- KVA
- KVAR
- Power Factor

The Generator shall be protected against the following electrical faults:

- Overload and short circuit
- Ground fault
- Over current
- Over frequency
- Under frequency
- Under Voltage
- Over Voltage
- Locked Rotor
- Reverse power protection.

It should be possible to read the data i.e. Parameters and Shutdown status locally on the D.G Set. All the above Parameters should be displayed on The Local Control Panel through appropriate meters and status on faults should be indicated through a facia annunciator. It should be possible to display all the functions as above on a personal computer.

18. EXHAUST PIPING

Exhaust Piping: The exhaust silencer piping system shall be of heavy duty MS, Class-C pipes, 6 mm thick minimum. The runs forming part of factory assembly on the engine fl exible connections up to exhaust silencer shall be exclusive of exhaust piping item. The work include necessary cladding of

exhaust pipe work using 50 mm thick loosely bound resin (LBR) mattress/ mineral wool/ Rockwool, density not less than 120 kg/m^3 and aluminium cladding (0.6 mm thick) for the complete portion. The exhaust pipe work includes necessary supports, foundation etc. to avoid any load & stress on turbo charger / exhaust piping. The exhaust pipe shall be run along the existing wall of the building duly clamped/supported on independent structure for which, the design and Drawing for such structure shall be got approved from the Engineer-in-charge.

- Exhaust system should create minimum back pressure.
- Number of bends should be kept minimum and smooth bends should be used to minimize back pressure.
- Pipe sleeve of larger dia. should be used while passing the pipe through concrete wall & gap should be filled with felt lining.
- Exhaust piping inside the Acoustic Enclosure/ Genset room should be lagged with asbestos rope along with aluminium sheet cladding / insulated to avoid heat input to the room.
- Exhaust flexible shall have it's free length when it is installed. For bigger engines, 2 flexible bellows can be used.
- For engines up to 500 KVA, only one bellow is required. However, if exhaust pipe length is more than 7 m then additional bellow/ provision for expansion should be provided.
- 'C' Class MS pipes and long bend/elbows should be used.
- The exhaust outlet should be in the direction of prevailing winds and should not allow exhaust gases to enter air inlet/ windows etc.
- When tail end is horizontal, 45 Degree downward cut should be given at the end of the pipe to avoid rain water entry into exhaust piping.
- When tail end is vertical, there should be rain trap to avoid rain water entry. If rain cap is used, the distance between exhaust pipe and rain cap should be higher than diameter of pipe. Horizontal run of exhaust piping should slope downwards away from engine to the condensate trap. Silencer should be installed with drain plug at bottom.

19. TESTS AT MANUFACTURER'S WORK

The following tests shall be performed at manufacture's works prior to packing and dispatch to site.

On DG Set

- Maximum power load capacity.
- Maximum motor starting capacity
- Endurance test.
- Fuel consumption at full load, 50% load, 75% load and 25% load.
- Engine - Alternator cooling air flow
- Load acceptance Test

On the Alternator

- High voltage tests on stator and rotor windings.
- Insulation resistance of stator and rotor windings.
- Temperature rise test.

- Measurement of resistance of stator and rotor windings.
- Measurement of losses.
- Mechanical balance.
- Load rejection and over speed tests.
- Stator voltage and current tests.
- Stator phase sequence check.

On the Excitor

- High voltage tests on stator and rotor winding.
- Insulation resistance of stator and rotor windings.
- Temperature rise test.
- Measurement of resistance of stator & rotor winding
- Measurement of losses.
- Response ratio test.
- Over speed test.
- Mechanical Balance test.
- On the Automatic Voltage Regulator
- Sensitivity test.
- Response time test

All routine test as per IS/BS codes shall be conducted on alternator, exciter and AVR. DG Panel shall be part of Main L.T. Panel, supplied by the Owner. However DG supplier shall do the coordination and provide all the inputs required for successful operation.

20. Battery/ Electrical System

Batteries supplied with Genset are generally dry and uncharged. Initial charging should be done for 72-80 hours. Batteries shall be placed on MS stands and relatively at cool place.

Battery capacity and copper cable sizes for various engine capacity are recommended as indicated in the table below. Cable sizes shown are for maximum length of 2 m. If length is more, cable size should be selected in such a way that voltage drop does not exceed 2 V. However capacity as recommended by manufacturer may be taken.

DG Set Capacity	Battery Capacity (AH)	Cable Size (Material Copper) Sq. mm	Electrical System (Volts)
Above 500 KVA	2 X 180 AH	70	2 x 12 V
Above 125 KVA upto 500 KVA	1 x 180 AH	70	12 V
Above 82.5.KVA upto 125 KVA	1 x 180 AH	50	12 V
Above 62.5 KVA upto 82.5 KVA	1 x 150 AH	50	12 V
Above 25 KVA upto 62.5 KVA	1 x120 AH	50	12 V
Upto 25 KVA	1 x 100 AH	35	12 V

Note: 1 Set of spare batteries shall be provided in parallel along with each DG Set in addition to the batteries mentioned in the Table above.

i. Cabling & Bus Trunking-

Power cabling between DG Set to Main LT Panel shall be carried out as per recommended cable sizes.

While terminating cables, any tension on the bolts/ busbars shall be avoided (if cable is specified). While terminating R, Y & B phase notations should be maintained in the alternator and LT Panel for easy maintenance. Crimped cables should be connected to alternator and control panel through cable glands.

Multi-core copper flexible stranded cable of 2.5 Sqmm size should be used for inter connecting the engine controls with the switchgear and other equipments. External wirings, when provided for remote voltage / excitation monitoring/ droop CT etc. shall be screened sheathed type.

ii. Alternator Termination Links-

For proper terminations between links and Cables/switchgear terminals, the contact area must be adequate. The following situations should also be avoided as they lead to creation of heat sources at the point of termination:

(i) Point contact arising out of improper position of links with switchgear terminals

(ii) Gaps between busbars / links and terminals being remedied by connecting bolt/stud In such cases the bolt will carry the load current. Normally these bolts / studs are made of MS and hence are not designed to carry currents.

Adequate clearance between busbars / links at terminals should be maintained (IS 4232 may be referred to for guidelines). Improper termination will lead to local heat generation which may lead to failure.

21. INSPECTION AND TESTING AT SITE

All pre-commissioning and commissioning test and checks shall be carried out at site. The Contractor shall be required to produce manufacturer's test certificate for the particular batch of materials supplied to him by the manufacturers. The test carried out shall be as per the relevant standards. For examination and testing of materials and the works at site, the Contractor shall provide necessary testing and gauging equipment as required. All such testing and gauging equipment shall be tested for calibration at any approved laboratory as required by the Engineer In Charge. The Contractor shall give notice well in advance to the Engineer In Charge before commencement of any site testing. All materials like consumable stores, fuel oil grease, lubricating oil etc. required for the trails shall be arranged by the contractor. The Contractor shall make all necessary hook-ups to carry out tests at site and shall furnish necessary fuel. The complete installation should be initially started and checked out for operational compliance by manufacturer's representative.

21.1. TRIALS (AT SITE):-

i. **Preliminary Trials:-** After completion of erection of generating sets and before carrying out main trials, preliminary site trials shall be conducted in the presence of the Engineer In Charge. Such trials shall include the checking and adjustments of all instrument relays, timers, interlocks and meters. Insulation resistance of stator, rotor and exciter windings shall be checked and reading recorded. A check shall be made for the satisfactory working of all auxiliary motors and their starting accessories supplied with the set. Diesel & lubricating oils for establishing performance at site shall be arranged by the contractor without any extra cost.

ii. Main Trials

The main trials shall include over 8 hours continuous run at available load. D.G. Panel shall be tested for automatic operation by injecting proper current and voltage by a separate source. The satisfactory working of automatic operation shall be tested and necessary adjustments shall be done for relays in the presence of the Engineer In Charge and the results shall be recorded in the test sheet at 30 minutes intervals. Alternator efficiencies as determined in works test shall be used as the basis of calculation for fuel consumption rate. A tolerance of 3% shall be allowed on the fuel oil consumption to cover possible errors in measurement.

Tests providing the satisfactory performance of all safety and operating controls shall be carried out. Governor trials shall be carried out as laid down in ISO: 3046. Alternator insulation resistance and commutation check shall be as per ISO: 3046. Starting time of sets shall be tested at least five times after sufficient time intervals to allow for cold start. On completion of tests, inspection doors shall be removed and running gears inspected and alignment checked.

Any further reasonable trial as suggested by the Engineer In Charge shall be carried out with no extra charges. All instruments, materials and labour required for carrying out the trials shall be provided by the Contractor. Test sheets of trials shall be forwarded in quadruplicate to Engineer In Charge.

21.2. TEST WITNESS

Tests shall be performed in the presence of Engineer In Charge. The contractor shall give at least thirty (30) days advance notice of the date when the tests are proposed to be carried out.

22. COOLING TOWERS AND WATER CIRCULATING EQUIPMENT

22.1. GENERAL

The various items of the water circulating system shall be complete in all respect and comply with the specification given below. The total sound intensity with all fans in operation shall not practically exceed noise levels as prescribed in CTI, CPWD and other relevant norms, from all around the cooling towers.

22.2. COOLING TOWERS (FRP CONSTRUCTION)

The cooling towers shall be of FRP, Vertical induced draft type complete with FRP basin FRP body, fan and motor assembly, fill media, distribution pipes etc.

22.3. GENERAL CONSTRUCTION

The body shall be made of FRP (Fibre glass reinforced plastic) section of equal segments, all bolted together. The surface on both inside and outside shall be smooth, for minimum air resistance. The fan deck shall form an integeral part of the body. The structural strength of the body shall be sufficient to withstand wind velocities upto 60 m/sec. Vibrations and earth quake.

The water basin shall also be of FRP. Having an auxiliary suction tank, at the bottom. The basin shall be complete with conections for drain, overflow, makeup water, quickfill and float valve, plus hot dipped galvanized stainer.

The support structure for the tower shall be of mild steel duly hot dipped galvanized. The water diffusion deck shall of rigid PVC fill in Honeycomb design, arranged in a suitable pattern for ease of replacement. PVC fills shall be of high efficiency. The colour of the cooling tower body shall be of the owner / architect choice.

22.4. COOLING TOWER CAPACITIES:

The cooling towers of adequate capacity along with suitable size make up water tank shall be installed at the terrace of the substation buildings from where the common header of the cooling towers shall be brought down to the DG Sets. Soft water is required to be filled up in Makeup

water tank for closed circuit cooling of DG Set engine. The contractor shall obtain the required data from the manufacturers (OEM) of DG Sets for calculating the cooling tower capacity for smooth operation of the DG sets.

The inlet temperature to the cooling tower shall be of 43.3 degree C or as per design requirements. The inlet temperature from cooling tower shall be of 32.3 degree C or as per design requirements.

Individual Cooling Towers of suitable capacity shall be provided for continuous operational duty of each DG Set. Likewise, individual Water Pumps along with standby spare pump of suitable capacity for Cooling Towers' operation shall be provided for each DG Set. The size of common headers and water pipes for cooling towers shall be designed as per operational requirements. The common headers and water pipes for cooling towers shall have temperature gauges, pressure gauges, Butter fly valves, Non return valves, fittings and all other instruments as required.

22.5. WATER DISTRIBUTION SYSTEM

The hot water shall be distributed through a sprinkle system consisting of PVC sprinkler pipes, which shall be mounted on the top of the main supply stand pipe. Each cooling tower shall have twin header system coupled with gravity flow distribution system.

22.6. FAN ASSEMBLY

The fan shall be of axial flow type with cast aluminium multiple blades of aerofil design and adjustable pitch. The fan assembly shall be statically balanced. The fan outlet velocity shall not be less than 10 m/ s and the tip speed shall be below 4500 m / minutes.

The fan shall be directly mounted on the motor or through speed reduction gears. In the latter case, the housing shall be of heavy cast iron, construction with large oil reservoir.

The fan motors shall be totally enclosed fan cooled squirrel cage type confirming to IP 55

Protection for outdoor operation.

The fan guard shall be hot dipped galvanized with wire mesh screen to prevent bird nesting during idling period.

22.7. LADDER

All towers, whose height exceeds 2.5 mtrs, shall be provided with a ladder, made out of hot dip galvanized MS Tubes.

22.8. PUMP SETS

The pump sets shall be mono block type with end suction and top discharge flanged connections directly mounted on the dripproof squirrel cage induction motors and suitable starter as specified.

The impeller shall be of Bronze, single enter shrouded design, and properly balanced. Water seal shall be of mechanical type to minimized water leakage and should be easily serviceable in the field.

Motor and starter shall confirm to relevant specifications and of rating as per DBR / Drawings.

22.9. MISCELLANEOUS

The following items to be provided:

- Water pressure gauge at inlet and outlet of each pump complete with gauge cocks and connected tubing.(To be priced separately)
- Vibration isolation pads for each pumps.
- Drain line from each pumps up to drain pit, (priced separately).

22.10. INSTALLATION AND TESTS

The cooling towers shall be mounted on the beam/ steel structure member, provided by Contractor and shall be unconnected with the roof slab. All nuts / bolts etc. for mounting shall be provided by the Contractor.

On installation of the capacity of the cooling towers shall be checked by measuring water flow rate, water IN and OUT temperature and the ambient W.B. Temperature and then computing the capacity and efficiency.

The pumps sets shall be mounted on cement concrete foundation which shall be provided by HVAC contractor including grouting nuts, bolts, channels etc. shall be provided by the contractor.

On installation the capacity of the pumps shall be checked by measuring water flow. Motor current and pressure difference at inlet and outlet. The reading shall be recorded to compare actual performance with the specified data. Magnetic level switches shall be provided for low level alarm, in each cooling tower.

22.10.1. PIPE WORK

i. General :

All piping work shall confirm to quality standards and shall be carried out as per specifications and details given hereunder:

ii. Pipes:

All pipes in sizes 200 shall M.S. E.R.W. tube (black steel) heavy class as per I.S. 1239-79, Part -1 with amendment-I. All pipes above 150 mm dia. shall be minimum 6.4 mm thick.

iii. Fittings:

The dimensions of the fittings shall conform to I.S. 1239/69 Part-II unless otherwise indicated, in the specifications.

All bends in sizes up to and including 150 mm dia., shall be ready, made of heavy duty, wrought steel of appropriate class.

All bends in sizes 200 mm and larger dia., shall be fabricated from pipes of the same dia and thickness, with a minimum of 4 sections, and having a minimum centre line radius of 1.5 diameter of pipes.

All fittings such as branches reducers etc. in all sizes shall be fabricated from pipes of the same dia. And thickness and its length should be at least twice the dia. of the pipe.

The branches may be welded straight to the main line without making a separate fitting, where specified on drawings or required by engineer-in-charge.

Blank ends are to be formed with flanged joints and 6 mm thick blank between flange pair for 150 mm and over, in case where, a future extension is to be made otherwise bland and discs of 6 mm thickness are to be welded on, with additional cross stiffeners from 50mm x 50mm M.S. Heavy angles, for sizes up to 350mm. All ends larger than 400 mm dia. shall have dished ends.

iv. Flanges.

All flanges shall be of mild steel as per I.S. 6392/71 and shall be steel slip-on-type, welded to the pipes, flanges thickness shall be to suit class-II pressures.

Flanges may be tack welded into position, but all final welding shall be done with joints dismounted. 3 mm thick gaskets shall be used with all flanges joints. The gaskets

shall be filer reinforced rubber as approved by the Engineer-in-charge. Special adhesive compound shall be used between flanges of steam, air and gas lines.

Flanges shall be used as follows :-

- Counter flanges for equipment having flanges connections.
- Flanged pairs shall be used on all such equipment, which may require to be isolated or removed for service e.g. Pumps, refrigeration machines air handling units etc.
- All thread valves shall be provided with nipples and flanged pairs on both sides to permit flange connections, for removal of valves from main line for repair/replacement.

v. Valve :

a) Butterfly Valves

The butterfly valve shall consist of cast iron body preferably in two piece construction.

The discs shall consist of disc pivot and driving stem shall be in one piece centrally located.

The valve seat shall be synthetic material suitable for water duty. It shall line the whole body.

The discs should move in slides bearing o both ends with 'o' ring to prevent leakage.

The handle should have arrangement for locking in any set position.

All gate valves and check valves up to & including 65 mm dia. shall be of gunmetal screwed type, conforming to class 2 of I.S. 778. and shall be with I.S.I marking and certification.

All gate valves and check valves up to 80 mm dia . and above shall be of cast iron flanged type, conforming to class 2 of I.S. 780/69 (for sizes up to 350 mm) and of I.S. 2906/69 (for sizes 350 mm and above) marking and certification.

All gauge cocks shall be of gunmetal plug type, complete with siphon (brass chrome plated).

All drain valves shall be of gunmetal with a hose union connection of one hand.

All valves o the supply of fan coil units shall be of gunmetal ball type with integral water strainers, having (BSP) fpt inlet and flare type MPT outlet connection.

All valves on the return line of fan coil units shall be as in 5.6 but without integral water strainer.

b) Balancing Valves :

The balancing valves up to 80 mm dia. shall be of gunmetal screwed type confirming to B.S. 5154 or equivalent specifications.

The valves shall be cast gunmetal ASTM B-62 and complete with non rising spindle. PTFE disc seal cast metal hand wheel.

The port opening shall permit precise regulation of flow rate, by accurately measuring the pressure drop across the port.

The valves shall be complete with two ports for connection to a mercury manometer, to measure the pressure drop, as well as a drain port.

The spindle shall have shielded screw to set the flow at the desired level.

The valves shall be used wherever specified.

c) Strainers :

The strainers shall either be pot type or 'Y' type with cast iron or fabricated steel body, tested up to pressure applicable for the valves as shown on the drawings.

The strainers shall have a perforated bronze sheet screen with 3 mm perforation and with a permanent magnet, to catch iron fillings.

Pot strainers shall be provided with flanged connection and 'Y' strainers shall be provided with flanged ends.

The strainers shall be designed to facilitate east removal of filter screen for cleaning without disconnection of pipe line.

d) Jointing

All pipes line shall be welded type.

Square cut plain ends will be welded for pipes up to and including 100 mm dia.

All pipes 125 mm dia or larger will be beveled by 35 deg before welding.

e) Miscellaneous :

Provide all pipe work as required to make the apparatus connection complete and ready for regular and safe operation. Unless otherwise noted, connect all apparatus and equipment in accordance with manufacture's standard details, as approved by Engineer-in-charge.

Unless otherwise specified, pitch the lines of piping as follows:-

- All condensation drainage, including air handling unit and fan coil unit shall be pitched in the direction of flow to ensure adequate drainage, with an adequate trap seal to prevent leakage of air due to static pressure developed by air conditioning units. Pitch, 20 mm per meter wherever possible, but not less than 10 mm per meter.
- Drains from other equipments shall be pitched similarly without trap seal.
- Provide valves and capped connections for all low points in piping system, where necessary or required for draining system. Provide isolating valves & drain valves in all risers to permit repairs without interfering with the rest of the system.
- Support piping independently of all equipment so that the equipment is not stressed by the piping weight or expansion.
- To facilitate the maintenance, repair and replacement.
- Provide shut-off valves where indicated and for individual equipment, units at inlet
- And outlet, to permit unit removal for repairs, without interfering with the remainder of
- The system. Additional shout-off valves shall be provided as required to enable all systems

- to be fully sectionalized. By-pass and stop valves shall be provided for all automatic
- control valves as specified.
- Arrange piping for maximum accessibility for maintenance and repair, locate valves
- for easy access and operation. No valves shall be installed with handles pointing down, unless unavoidable.
- Cut the pipes accurately according to measurements, established site & work into phase without springing or forging.
- Pipe supports shall be adjustable for height and prime coated with rust preventive paint & finish coated with grey paint, both as approved by engineer-in-charge. The spacing of
- Pipe supports shall not be more than that specified below:-

Nominal pipe size (mm)	**Spacing (meters)**
15	1.25
20&25	2.00
32,30,50,&65	2.50
80,100,&125	2.50
150 & Above	3.00

Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stresses on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic approved dash fasteners.

Insulated piping shall be in such a manner as not to put undue pressure on the insulation, such as providing teak wood block between pipe and support.

Where pipes are to be buried under ground, they should be coated with one coat of bituminous paints. The top of the pipes shall not be less that 75 cms. From the ground level. Where this is not practical permission of engineer-in-charge shall be obtained for burning pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushion of not less than 15 cms. After the pipes have been laid and top sand cushion proved, the trench shall be refilled with the excavated soil, excess soil shall be removed from the site of work by the contractor.

f) Hangers & Supports :

Hangers & supports shall be provided and installed for the piping and tubing wherever indicated, required or otherwise specified. Wherever necessary, additional hangers and support shall be provided to prevent vibration or excessive deflection of piping and tubing.

All Hangers & supports shall be made of steel or other durable and non-combustible material, given two coat of primer red oxide and then painted with aluminium colour paint. Wood wire or perforated strap iron shall not be used as permanent hangers or supports.

Hangers shall be supported from structural steel, concrete inserts & pipe racks, as specifically approved.

No hangers shall be secured to underside of light weight roof decking and light weight floor glass.

Mechanical equipment shall be suspended midway between steel joists and panel points.

Drilling or punching of holes in steel joist members will not be permitted.

g) Sleeves :

Where pipes pass through floors, walls, etc provide Galvanized steel pipe sleeves 50 mm larger than outside diameter of pipe. Where pipes are insulated, sleeves shall be large enough to ample clearance for insulation.

Where pipes pass through outside walls or foundation, the space between pipe and sleeve shall be caulked with lead wool and oakum.

The centre of pipes shall be in the centre of sleeves, and sleeves shall be flush with the finished surface.

h) Expansion or Contraction :

The contractor shall provide for expansion and contraction of all piping installed by the use of swing connection and expansion loops.

i) Arrangement and alignment of Piping :

All piping shall be arranged and aligned in accordance with the drawings as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the engineer-in-charge. The piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceiling, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angle and shall not run diagonally across rooms or other piping. Wherever possible all piping shall be arranged to provide maximum head room.

All piping shall be installed as directly as possible between connecting points in so far as the work of other trades permits. Where interference occurs with another trade whose work is more difficult to route, this contractor shall reroute his pipes as required to avoid interference, at the discretion of the engineer-in-charge

All piping shall be carefully installed to provide for proper alignment, slope and expansion

The stresses in pipe lines shall be guided and pipes shall be supported in such a manner that pipe lines shall not creep, sag or buckle

Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.

Small tubing gauges, controls or other equipment installed on any apparatus, shall not be coiled nor Excessive in length, but shall be neatly, carefully bent at all change in direction, secured in place and properly fastened to equipment at intervals to prevent sagging.

The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

j) Testing:

In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall the piping, appliance be subjects to pressures exceeding their test ratings.

The tests shall be completed and approved before any insulation is applied. Testing of segments of pipe work will be permitted, provided all open ends are first closed, by blank offs or flanges.

After tests have been completed the system shall be drained and flushed 3 to 4 times and cleaned of all dust and foreign matter. All strainers, valves and fitting shall be cleaned of all dirt, filling and debris.

All piping shall be tested to hydraulic test pressure of at least one and half times the maximum operating pressure but not less than 10 kg/sq. cm for a period of not less than 12 hours. All leaks and defects in the joints revealed during the testing shall be rectified to the satisfaction of the engineer-in-charge, without any extra cost.

All the piping system shall be tested in the presence of the engineer-in-charge or their authorized representative. Advance notice of test dates shall be given all equipments, labour, materials required for inspection, and repairs during the test shall be provided by the contractor. A test shall be repeated till the entire systems are found to be satisfactory to the above authority. The tests shall be carried out for a part of work if required by engineer-in-charge in order to avoid hindrance in the work of the insulation contractor.

All steam and condensate pipes shall be tested and proven tight under hydrostatic pressure of 20 kg/sq.cm, unless otherwise stated, for a minimum period of 4 hours without drop in pressure.

Miscellaneous piping, tests with air at 10.5 kg/sq.cm for a minimum of 24 hours without drop in pressure.

k) Painting:

All pipes supports, hangers, etc, shall be given two coats of red oxide primer.

All pipes, which are not to be insulated, shall then be given one or more coat of red oxide primer along with two or more coat of finish paint, of a type and colour, as per releavant IS code.

23. EXHAUST PIPING

The Exhaust piping system for the DG Sets shall be as per CPWD Specifiactaions meeting the requirements of CPCB Norms. The exhaust silencer piping system shall be of Heavy Duty Class C, MS pipes confirming to IS-3589. Suitable length of flexible piping shall be used for connecting the exhaust piping to the engine as per the recommendation of the manufacturer. MS screws flanges and bends shall be used as per site requirements. Exhaust pipe inside the building shall be logged with heat resistive glass wool of 48 kg / meter cube and then cladded with Al. foil all along the pipe.

Exhaust Stack Height- In order to dispose exhaust above building height, minimum exhaust stack height should be as follows:-

(a) For DG Sets up to 1000 KVA - $H = h+0.2\sqrt{KVA}$

where H = Height of Exhaust stack, h = Height of building

(b) For DG set above 1000 KVA - 30 M or 3M above the building height, whichever is higher

The Exhaust Piping stack shall be supported by suitable MS steel structure with twin aviation light at the top of the exhaust piping.

24. SYNCHRONIZATION SYSTEM

The synchronization panel shall be complete in all respects for auto operation of D.G. Sets. The minimum requirement for D.G. set operation shall be as detailed below, however, the Contractor shall indicate in details the additional features and facilities being offered by them.

The parallel operation of D.G. set in Synchronization mode shall be completely through Power Control Center Module (PCCM). The PCCM shall be mounted on DG Sets outside the Building (the supplying and fixing of the PCCM is in the scope of Supplying and fixing of DG Set). The PLC for the further operation shall be mounted on the Synchronizing panel with SLC 5/03 processor, kw transducer & suitable input /out put card, 8 channel analog card Power Monitors – IV . The wiring between the DG Sets, PCCM and Synchronizing Panel is included in the scope.

During the parallel operation, the system take care of the load sharing i.e. active and reactive both for all the D.G. sets. and issue soft commands for voltage / frequency raise / lower, depending upon the load requirements, the system shall start / stop the D.G. sets.

Monitoring & logging of the electrical data and events through existing P C. This will be achieved by using microprocessor based PC controller or equivalent networking kits & required hardware like GCM, modlon convertor ,communication cable.

Alarms and necessary remedial commands for D.G. and electrical system fault.

- **D.G synchronizing panels .**

  For Local Control and Manual Synchronization, the minimum instrument/equipment shall be as follows:

  a. DG selector switch
  b. PLC / manual selector switch
  c. Double scale voltmeter
  d. Double scale frequency meter
  e. Synchronoscope
  f. Check synchronization relay
  g. Synchronization lamps
  h. Solo parallel selector switch
  i. Manual synchronization circuit “ON”/”OFF” selector switch
  j. Push buttons & indicating lamps
  k. Control PT
  l. Mimic

  The following components shall be provided for each DG Set :

  a. Breaker control Switch except for DG Incomer.
  b. Automatic battery charger having inbuilt Trickle /boost facility selector switch for battery charger
  c. DC digital Ammeter and Voltmeter selector switch
  d. Auto/Manual selector switch for priming pump
  e. Breaker control switch (only for one number bus-coupler required)

f. Indicating lamps (LED type) for following:
   (i) Each phase indication (for all 3 phases)
   (ii) D.G breaker ON,OFF,TRIP, Spring charged
   (iii) Neutral contactor "ON" /"OFF"
   (iv) Engine running
   (v) Battery charger "ON"
   (vi) Control supply healthy
   (vii) Priming pump "ON" /"OFF"

g. Speed raise /low joystick

h. Voltage raise / low joystick

i. 12 window annunciator with alarm Accept/Test/Reset push buttons, Hooter.

j. Temperature Scanners for RTD and BTD

k. Beacon light

l. Hour meter

m. Under voltage relay for mains feeder

n. Over Voltage relay for mains feeder

o. Earth fault relay

p. Reverse power relay (reactive)

q. Trip circuit supervision relay

r. Master trip relay

s. 5 H.P, DOL starter for oil priming pumps for D G Set

t. Power factor meter (Analog)

u. Frequency meter (Digital)

v. Ammeter (Digital)

w. Voltmeter (Digital)

x. Multi function meter (Digital)

y. D.C. Ammeter (digital)

z. D.C. Voltmeter (digital)

aa. Breaker Control Switch for bus coupler

bb. Battery Charger on / off switch with boost and trickle charger facility

cc. Trickle / booster charger selector, switch

dd. Push buttons (lot)

ee. P. T

ff. Aux. Contactor (lot)

gg. transducers

24.1. <u>Automatic Generator Sequencing</u>

a) Automatically start & stop gen sets based on plant load or bus on process demand.

b) Configurable plant bus demand start / stop levels and timers.

c) On line engine priority sequence configurability from any synch. Unit or PC to equalize run time of all DG Sets.

24.2. Synchronising Panel

The technical specification and details of the microprocessor based PLC controller for the DG set synchronizing and load sharing shall be as follows:

- The microprocessor based PLC panel shall be suitable for use with AVR and electronic speed governor to protect and monitor DG sets.
- Double Frequency Meter and Double Voltmeter shall be provided in synchronizing panel.
- Synchronus check relay shall be provided.
- The PLC shall be provided with following features and audible alarm:
    - Engine pre glow control
    - Fuel solenoid control
    - Engine starter control
    - KVA controlled cool-down timer
    - Speed monitoring
    - Over speed protection
    - Oil pressure monitoring, alarm and shutdown of the engine.
    - Water temperature monitoring, alarm and shutdown of the engine
    - Battery voltage monitoring
    - Over speed monitoring and alarm.
    - 3 attempt start failure alarm
    - Under/Over Frequency
    - Reserve Power (Inverse time delay)
    - Loss of excitation
    - Over current (inverse time delay)
    - Loss of utility power detection
    - Load surge
    - Current unbalance
    - Voltage unbalance
    - Mains Protection (vector shift, df/dt)
    - True RMS power calculations accurate control
    - Configurable loading/unloading ramp rates
    - Isochronous load sharing of up to 4 units using percentage based load sharing
    - Base load control for optimum fuel efficiency
    - Import export control using a watt transducer
    - Soft utility transfer function

- Digital signal processing to eliminate harmonic issues
- Adjustable phase window, Voltage and dwell time
- Safe dead bus closing logic internal to the control
- Synchronization across generator and mains breakers
- Multiple short re-closing with adjustable time delay
- Manual voltage and speed adjusts for manual synchronizing
- VAR sharing on isolated busses using percentage based reactive load sharing
- Power factor or VAR control when base loaded
- Externally adjustable VAR or PF set point levels.
- The DG set shall start and stop automatically based on plant bus demand.

- The PLC system shall be provided with built in relays for protection of the following:
  - Reverse Power
  - Reverse KVAR
  - Over current
  - Under and over voltage
  - Under and over frequency
  - Synchronization check and earth fault relay.
- The PLC system shall be suitable for load sharing by sensing active and reactive power.
- The PLC system shall comprises of the following:
  - Main processor unit
  - Power module for power supply to the processor and the system
  - Power monitor to monitor voltage, KVA, KVAR, KW, KWH, KVAH, KVARH.
  - 16/32 channel Digital input module
  - 16/32 channel Digital output module
  - EEPROM for main processor unit
  - Computer to PLC communication card with necessary cables.
  - Window based operator interface Software Package
  - Mounting chassis for the equipment
- The microprocessor based main processor of the system shall be suitable for 128 digital I/P and 128 O/P and comprises of the following:

  The main processor unit shall be suitable for operation on 24 Volts DC with integrated memory. The integrated Ram memory shall be 20 K Words for program, data and constants plus data memory and flash EPROM of 16 K works for backup application program, communication card and real time clock. 4 Nos. discrete combination module (Input/output Module) shall be provided and the same shall be suitable for operation on 24 volts DC system. Combination module shall be with 16/32 inputs and 16/32 output channels as per the actual requirement.
  - 1 No. 2 slot extension rack
  - 1 No. Ram back up battery unit

- 8/4 Nos. digital input module
- 8/4 Nos. digital output module

The CPU display unit shall be suitable for 4 lines of 40 characters. The display shall be with back lit LCD. Clarity shall be not less than 5 x 7 pixels. The height of the characters shall be not less than 5 mm. The data entry shall be with the help of 24 function keys. In addition to this there shall be 10 service keys and 12 alphanumeric keys. The system shall be provided with RS 232 communication port.

24.3. OPERATION AND COMMUNICATION

The PLC shall monitor the bus bar load continuously. In event of mains failure the PLC shall give signal to select and start the generator, which is closer to the load sensed during the last 60 seconds. In case the load at the time of main failure is more than the highest rating DG set, the PLC shall give command to start 2 Nos. DG sets to suit the load, synchronize the sets and give command to close the breaker on the main LV panel.

If load starts reducing the PLC shall give command to turn off the DG sets through cool down timer. On restoration of main power supply, the PLC shall check the voltage and frequency and if they are stabilized and within the permissible tolerances, the PLC shall give command to shut down the DG sets through cool down timer.

The control and monitoring of the cooling tower and fan and feed pump shall be done through PLC control system with necessary control wiring between cooling tower, pumps and PLC panel.

24.4. SYNCHRONIZING MODULE

- The synchronizing module shall be a microprocessor based intelligent unit, which shall monitor the electrical parameters and shall able to communication with the PLC control unit in the process of synchronizing and load management. The system shall be suitable for dynamic synchronization. The synchronizing module shall be suitable for programming and set the preferred difference between DG set and bus bar.
- The synchronization module shall monitor and fulfill the following conditions before the system synchronizes the DG set to mains.
- Feed back signal from the DG breaker on main LV Panel that the breaker is in open condition.
  - Bus bar voltage is present
  - Generator voltage is present
- The frequency regulator in the system shall start when the generator voltage and the bus bas voltage is over 50% of normal voltage. The voltage regulator in the system shall start when the frequency is within 90% of the normal system frequency.
- The system shall close the breaker on the power panel without carrying out synchronization when all the below mentioned conditions are fulfilled.
- Feedback signal from the DG breaker on main LV panel that the breaker is in closed condition.
  - Bus bar voltage is present
  - Generator voltage is present

CHAPTER –H

TECHNICAL SPECIFICATIONS – FIRE ALARM & PUBLIC ADDRESS SYSTEM

1. GENERAL

a. The specifications includes furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm network equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Network Fire Alarm Control Panels (FACP), Network Reporting Terminals (NRT), Network Liquid Crystal Display (NLCD), auxiliary control devices, annunciators, and wiring as specified herein.

b. The fire alarm system shall comply with requirements of IS:2189:1999 & 1996 NFPA Standard 72 for Protected Premises Signalling Systems except as modified and supplemented by this specification, or the stringent one of the two specification in case of any discrepancy. The system shall be electrically supervised and monitor the integrity of all conductors.

c. Fire Alarm System shall be integrated with P.A. system. A digitized pre-recorded voice message shall notify occupants that a fire condition has been reported. The message shall instruct the occupants with emergency instructions. Emergency manual voice override shall be provided.

d. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and shall be in compliance with the UL listing for equivalent European standard EN54.

e. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Alarm Control Room and designated personnel.

f. The FACPs shall be active/interrogative-type systems where each transponder is repetitively scanned, causing a signal to be transmitted to the fire alarm control panel node indicating that the transponder and its associated initiating device and notification appliance circuit wiring is functional. Loss of this signal at the FACP shall result in a trouble indication on both the FACP display and at the network display, as specified hereinafter for the particular input.

g. The system shall be arranged such that not less than 20 percent additional transponders may be inserted into any network communication loop.

h. The installing company shall employ technicians on site to guide the labours and to ensure the systems integrity.

1.1. SCOPE:

a. A new network intelligent reporting, microprocessor controlled fire detection and shall be compatible with PA system emergency voice alarm communication network shall be installed in accordance with the specifications and drawings.

b. **Basic Performance:**

i. Alarm and trouble signals from the FACP, NRT, and NLCD network nodes shall be digitally encoded by listed electronic devices onto a NFPA Style 9 looped multiplex communication system.

ii. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto NFPA Style 6 (Class A) Signaling Line Circuits (SLC).

iii. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D). Connected by the SLC.

iv. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z). Connected by the SLC.

v. Power for initiating devices and notification appliances must be from the main fire alarm control panel, the transponder to which they are connected or to a Field Charging Power Supply (FCPS).

vi. A single ground or open on any system signaling line circuit, initiating device circuit, or notification appliance circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

vii. Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.

viii. Digitized electronic signals shall employ check digits or multiple polling.

ix. Transponder devices are to consist of low current, solid-state integrated circuits, and shall be powered locally from a primary power and standby power source.

x. F.A. System shall be integrated with P.A system & Car Calling system so that it can be used for Emergency evacuation under fire condition.

1.2. SUBMITTALS

A. General:

All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the following standards. For equipment other than that specified, the contractor shall supply proof that such substitute equipment does in fact equal or exceed the features, functions, performance, and quality of the specified equipment. Two copies of all submittals shall be submitted to the Engineer-in-charge/Engineer for review.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
3. Show equipment layout and main control panel, module layout, configurations and terminations.

C. Manuals:

Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s) including technical data sheets.

Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment.

Provide a clear and concise description of operation, which gives the information required to properly operate the equipment and system.

Approvals will be based on complete submissions of manuals together with shop drawings.

D. Software Modifications

Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 2 hours.

Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm network on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for

devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

E. Certifications:

Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer and trained on network applications. Include names and addresses in the certification.

1.3. APPLICABLE PUBLICATIONS:

The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

A. The fire alarm system shall comply with requirements of NFPA for protected premises signaling systems except as modified and supplemented by this specification. The system field wiring shall be supervised either electrically or by software-directed polling of field devices.

B. Underwriters Laboratories Inc. (UL) - USA: / EN - 54

C. NBC - 2016 (Part-4)

D. All requirements of the Authority Having Jurisdiction (AHJ).

1.4. APPROVALS:

A. The system must have proper listing and/or approval from any of the following recognized agencies:

UL	-	Underwriters Laboratories Inc
FM	-	Factory Manual
ULC	-	Underwriters Laboratories Canada
CPWD	-	Central Public Work Department
BIS	-	Bureau of Indian Standards

EN 54 or Equivalent European Standards

B. The fire alarm control panel, network interface and all transponders shall meet the modular labeling requirements of Underwriters Laboratories, Inc. Each subassembly, including all printed circuits, shall include the appropriate UL modular label. Systems which do not include modular labels, which may require return to the manufacturer for system upgrades, and are not acceptable.

1.5. EQUIPMENT AND MATERIAL:

1.5.1. GENERAL

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

B. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for

all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.

C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

1.5.2. WIRE & Cable

Fire Survival Cable: For the detector and sounders proposed to fixed on false ceiling/surface, the wiring shall be done with Fire Survival Cable capable of withstanding temperature up to 950 degree C for 20 minutes and 650 degree C for the 180 minutes. The fire survival cable shall be laid on surface with proper saddle etc. ar per requirement & in cable tray above false ceiling. The cables may be armoured/unarmoured as per the location of use.

1.6. FIRE ALARM CONTROL PANELS AND FIRE CONTROL ROOM:

The Fire Alarm Control Panel shall be as per IS: 2189 (latest amended). Each network FACP shall contain a microprocessor-based central processing unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable detectors, addressable modules, Panel modules including initiating circuit, control circuits, transponders, local and remote operator terminals, printers, annunciators, emergency voice communication systems, and other system controlled devices.

Each FACP on the network shall perform the following functions:

1. It shall Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.

2. It shall supervise all initiating signaling and notification circuits throughout the facility by way of connection to monitor and control modules.

3. It shall detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

4. It shall visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.

5. When a any of the following condition is detected and reported by one of the system initiating devices or appliances:

   i. Fire Alarm Conduits

   ii. Trouble Confirmation

   iii. Supervisory Card

   iv. Security Alarm

   v. Pre Alarm

Then the following functions shall immediately occur:

a. The FACP alarm LED on the FACP shall flash.

b. A local piezo-electric indication for the event signal for the event in the FACP shall sound a distinctive Signal.

c. The 640-character / minimum 4 " (inch) LCD display on the local FACP node and on the network displays shall indicate all information associated with the fire alarm condition, including the type of alarm point, and its location within the protected premises. This information shall also be displayed on the network reporting terminal.

d. Printing and history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.

e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated on either local outputs or points located on other network nodes.

General FACP Configuration & Operation

f. Each FACP node shall include a full featured operator interface control and annunciation panel which shall include a backlit 640-character / minimum 4 " (inch) Liquid Crystal Display (LCD), individual, color coded system status LEDs, and an alpha-numeric keypad for field programming and control of the node.

g. All programming or editing of the existing programming in the system shall be achieved without special equipment or interrupting the alarm monitoring functions of the fire alarm control panel.

h. FACP nodes shall be designed so that it permits continued local operation of remote transponders under both normal and abnormal network communication loop conditions. This shall be obtained by having transponders operate as local control panels upon loss of network communication.

i. FACP nodes shall be modular in construction to allow ease of servicing. Each CPU and transponder shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems which require use of external programmers or change of EPROMs are not acceptable.

j. The CPU and associated equipment are to be protected so that they will not be affected by voltage surges or line transients including RFI and EMI.

k. Each transponder and peripheral device connected to the FACP node CPU shall be continuously scanned for proper operation. Data transmissions between network nodes, FACP CPUs, transponders, and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques. Failure of any transponder or peripheral device to respond to an interrogation shall be annunciated as a trouble condition.

The FACP shall be able to provide the following software and hardware features:

1. Pre- Signal and Positive Alarm Sequence: The system shall provide means to cause pre-alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-Second time period for acknowledge an alarm signal from a

fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local remote outputs shall automatically immediately.

2. Smoke Detector Pre-Alarm indication at control panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values abovethe programmed setting. Two levels of Pre-Alarm indication shall be available at the control.

i) Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.

ii) Action: if programmed for action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition, Sounder bases installed with either heart or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on alarm level.

3. The system shall be integrated with P.A. System Car Calling system for Emergency evacuation under fire.

4. Each FACP node shall be capable of providing the following features:

a) Block Acknowledge for Trouble Conditions.

b) Rate Charger Control

c) Control-By-Time (Delay, Pulse, time of day, etc.)

d) Automatic Day/Night Sensitivity Adjust (high/low)

e) Device Blink Control (turn of detector LED strobe)

f) Environmental Drift Compensation (selectable ON or OFF)

g) Smoke Detector Pre-alarm Indication at Control Panel

h) NFPA 72 Smoke Detector Sensitivity Test

i) System Status Reports

j) Alarm Verification, by device, with tally

k) Multiple Printer Interface

l) Multiple CRT Display Interface

m) Non-Fire Alarm Module Reporting

n) Automatic NFPA 72 Detector Test

o) Programmable Trouble Reminder

p) Upload/Download System Database to BMS

q) One-Man Walk Test

r) Smoke Detector Maintenance Alert

s) Security Monitor Points

t) Alpha-numeric Pager Interface

u) On-line or Off-line programming

The configuration features & peripherals of FACP shall be given below:

Doc1	**Standard Data Sheet**
Item	Floor Fire Alarm Panel
Purpose	Automatic fire detection and alarm
Interconnection	Peer to peer networked floor Panels
Type	Solid state micro-processor based analogue addressable
Loop capacity	Loop cards as per floor requirement
Compatibility	Photo electric smoke sensors Loop isolators Loop sounders Loop manual call points Loop input monitoring cards RS 485 cards for networking & RS 232 cards for printer & CRT Convention devises
No of devices	Each loop shall be able to cater to minimum as per IS or manufacturer standard
Operation Voltage	15 V to 28 V DC, 3 amps
Input Voltage	230 V AC, 1 Ph 50HZ, 0.75 amps.
Standby battery charging	28 V DC, 1.5 A
Wiring/ Cabling	2 core 1.5 mm2, copper, PVC insulated, twisted, screened wires in concealed conduits wherever available & in other places by fire survival cables for notification loop, sounder loop, RS 232 & RS485 communication
Loop wire monitoring	Open circuit
	Short circuit
	Earth Leakage
	Device removed
	Wrong Device

Communication	To remote repeater panel through proprietary protocol over RS 485 link
Outputs	2 X programmable sounders on panel 1 X Fire Contact 1 X Fault Contact
Printer	24 character built in printer
Communication port	RS 485 RS 232
Selectable Features	Common sounders coincidence alarm RMC Fire
	RMC Fault Zone walk test Control Output
	Output delay Alarm counter Alarm Counter
	Alarm verification Sounder silence
Dialing Time	4 second per loop for 127 devices, 3 second per loop for MCPs
Software	Firmware Field configuration programmable
Memory	EPROM non volatile for 600 event memory storage
Configuration	Power supply module
	CPU
	memory extension module
	memory buffer module
	printer interface module
	LCD ineterface module
	relay driver module
	1 no. 80 column external printer

	1 no. menu driven membrance switch keyboard
	1 set control switches
	1 set operator push buttons
	Loop cards
	Remote terminal unit connection port
	LCD display & driver module
Connectivity	To proprietary protocol compatible to analogue addressable detectors of type
LCD display	640-character / minimum 4 " (inch) alpha numeric LCD auto back lit with occurrence of event or manual override
Display Format	Alarm/pre-alarm/fault/isolation
	Alarm & event acknowledge
	Commands/report/programming
	Time/day/date
Power supply	SMPS
Back up power supply	As per clause 7.5 of IS 2189
Power pack	SMF lead acid / Nicd 24 V DC 30 AH
Test features	Panel self test
	LCD Test
	Fault Test
	Detector Test
	Battery Fault
	Internal Hooter Test
	External hooter Test
Control facility	Scroll/next
	Alarm silence
	Fault silence
	Lamp evacuate
	System reset
	LCD back Lighting

	Trouble Silence
Indications	System normal
	Priority 1 Alarm
	Priority 2 Alarm
	Fault
	Alarm Silence
	Power ON
	Battery ON
Event report	Type
	Address
	Location
	Time/day/date
	Date
	Time
Zone recording	In order of occurrence regradless of alarm priority
	Print Interrupt of occurrence of fresh event & on its record resume print
Testing facility	Possible with digital and analogue input and output digital simulation from panel through software
	Under maintenance mode testing possible with balance system in normal operation
Fire pattern	No alarm issue for short duration
	Quick response for fast smoke build up
	Early detection and suitable modification for of alarm level for dirt accumulation
	Programmed output actuation
	Access protection through 4 levels of pass words
	Hardware security lock
	Detector sensitivity adjustment and display of set value
	Disable/isolate detectors/ interface units
	Single button operation front panels keys

Software facility	Individual detector
	Sensitivity setting
	Trending
	Adjustable dual alarm thresholds
	Pre alert warning
	Cross zoning
	Alarm verifications
	Input/ output assignment
	Event history indexing
Local Sounder	Yes
Panel Sounder output	1 no. rated for 1 Amp.
Surge withstand	As per IEEE 472 for mains, input/ output/loops, 7 kv discharge on panel electronics except LCD display
Ambient	From (-) 5 deg. C to (+) 45 deg C Max.
Humidity	15% to 95% non condensing
Mounting	Wall / Floor
Enclosure	1.6 mm sheet steel, dust and vermin proof to IP-55
Enclosure treatment & painting	Degreased, de-rusted, pickled, rinsed, phosphattized, putty finished. Double primer and final epoxy painted FIRE RED shade
Front doors	Hinged and lockable with transparent visor for viewing LEDs etc.
Cable Entry	From both top & bottom, through 2 mm thick removable gland plate

Network Repeater Panel (NRP)

- A network control annunciator shall be provided to display all system intelligent points. The NRP shall be capable of displaying all information for all possible points on the network.
- Network display devices which are only capable of displaying a subset of network points shall not be suitable substitutes.
- The NRP shall include a minimum of 640-character / minimum 4 " (inch), backlit by a long life, solid state LCD display. It shall also include a keypad. Additionally, the network display shall include ten soft-keys for screen navigation and the ability to scroll events by type. i.e. Fire Alarm, Supervisory Alarm, Trouble, etc.

- The network control annunciator shall have the ability to display up to eight events in order of priority and time of occurrence. Counters shall be provided to indicate the total number of events by type.

- The NRP shall mount in any of the network node fire alarm control panels. Optionally, the network display may mount in a back box designed for this use.

- The NRP shall include long life LEDs to display Power, Fire Alarm, Pre-Alarm, Security Alarm, System Trouble, Supervisory, Signals Silenced, Disabled Points, Other (non-fire) Events, and CPU Failure.

- The network control annunciator shall include a Master password and up to nine User passwords. Each password shall be up to eight alpha-numeric characters in length. The Master password shall be authorized to access the programming and alter status menus. Each User password may have different levels of authorization assigned by the Master password.

- The NRP shall allow editing of labels for all points within the network; control on/off of outputs; enable/disable of all network points; alter detector sensitivity; clear detector verification counters for any analog addressable detector within the network; clear any history log within the network; change the Time/Date settings; initiate a Walk Test.

The configuration, features & peripherals of the Repeater panel shall be given below:

Doc 2	**STANDARD DATA SHEET**
Item	Network Repeater Panel
Purpose	Repeat indication
Compatibility	With networked analogue addressable floor fire alarm panel through proprietary communication protocol
Type	Solid state micro-processor based
Communication	By 2 core RS 485 twisted pair screened with networked floor fire alarm analogue addressable panels
Distance maximum	Up to 2 Km from nearest networked floor addressable fire alarm panel. Connection to system by tee off / spur / daisy chained
Power Supply	From power supply unit or from nearest floor addressable fire alarm panel.
Operating Voltage	15 V to 28 V DC
Monitoring	Panel power disconnection
	Floor / Loop / Zone indication LEDs (50 nos)
	Select keys for point addresses in display zone
	Fire
	Fault
	Disabled
	Accept / Reset / Silence / Sound alarm
	Control key for current Fire / Fault / Disabled status
Power consumption	100 mA mains fail state
	250 mA nominal
	350 mA max. draw
LCD display	Back lit, Alphanumeric, 4 line 160 character display
Data interface	RS 485 serial bus driver board
Mounting	Suitable for both surface & recess mounting
Enclosure	1.8 mm sheet steel, dust and vermin proof
	Hinged lockable double door
Ambient	From (-) 5 deg C to (+) 450 deg C Max

Humidity	15 % to 95 % non condensing
Paint	Degreased, de - rusted, pickled, rinsed, phosphatized expoxy painted in FIRE RED paint
Local sounder	Yes

1.7. Water flow Indicators:

Water flow Switches shall be an integral, mechanical, non-coded, non-accumulative retard type.

Water flow Switches shall have an alarm transmission delay time, which is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30-45 seconds.

All water flow switches shall come from a single manufacturer and series.

Water flow switches shall be provided and connected under this section but installed by the mechanical contractor.

Where possible, locate water flow switches a minimum of one (1) foot from a fitting, which changes the direction of the flow and a minimum of three (3) feet from a valve.

1.8. Sprinkler and Standpipe Valve Supervisory Switches:

Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.

PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.

The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.

The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 25 mm conduit entrance and incorporate the necessary facilities for attachment to the valves.

The switch housing shall be finished in red baked enamel.

The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.

Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.

1.9. Non-Alarm Input Operation

Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

Combo Zone: - A special type code shall be available to allow water flow and supervisory devices to share a common addressable module. Water flow devices shall be wired in parallel, supervisory devices in series.

1.10. SYSTEM COMPONENTS - ADDRESSABLE DEVICES

1.10.1. DETECTORS & ADDRESSABLE DEVICES

The addressable detector and devices shall comply to the below mentioned specifications. The addressing of detectors and devices shall be of rotary type electronic addressing shall not be acceptable.

I. Intelligent Laser Photo Smoke Detector

a) The intelligent laser photo smoke detector shall be a spot type detector that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.

b) The laser detector shall have conductive plastic so that dust accumulation is reduced significantly.

c) The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.03 percent per foot.

d) The laser detector shall not require expensive conduit, special fittings or PVC pipe.

e) The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases.

f) The laser photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.

g) The laser photo detector shall include two bi-color LEDs that flash green in normal operation and turn on steady red in alarm.

II. Intelligent Multi Criteria Acclimating Detector

a) The intelligent multi criteria Acclimate detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.

b) The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).

c) The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

III. Intelligent Thermal Detectors

Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

IV. Intelligent Photoelectric Smoke Detector

The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

V. Intelligent Multi Sensor Intelliquad Detector (CO, IR, Smoke & Heat)

a) The intelligent multi sensor Intelliquad detector shall be an addressable device that is designed to monitor a minimum of photoelectric, thermal technologies, carbon monoxide & infrared in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine it's environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.

b) The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, parking etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).

c) The intelligent multi sensor detection device shall include the ability to combine the all of four signals in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

VI. Intelligent Duct Smoke Detector

a) The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.

b) When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

a) Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.

b) If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

c) The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

d) The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

e) The isolator module shall not consume any detector or device address from the loop capacity.

VII. Addressable Control Relay Module

Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

VIII. Addressable Control Module

a) Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered polarized audio/visual notification appliances.

b) The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation.

c) Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised UL listed remote power supply.

d) The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

IX. Manual Pull Stations

The fire alarm station shall be of polycarbonate construction and incorporate an internal toggle switch. A locked test feature shall be provided. The station shall be finished in red with silver "PULL IN CASE OF FIRE" lettering.

X. Programmable Electronic Exit Point Directional Sounders With Strobe Light

a) Shall follow NFPA 72 2007 edition recommendation.

b) Electronic sounders shall operate on 24 VDC nominal.

c) Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device.

d) Shall be capable to broadcast pre programmed Voice Message also

e) Shall be flush or surface mounted as shown on plans.

f) Shall produce broad band directional sound with 20 Hz to 20 Khz frequency band to guide occupants to safe exists even in complete darkness.

g) Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:

h) The maximum pulse duration shall be 2/10 of one second.

i) Strobe intensity shall meet the requirements of UL 1971.

j) The flash rate shall meet the requirements of UL 1971.

k) Field Wiring Terminal Blocks

l) For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for #18 to #12 AWG wire. Terminal blocks that are permanently fixed are not acceptable.

1.11. TEST

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system.

a. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
b. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
c. Verify activation of all flow switches.
d. Open initiating device circuits and verify that the trouble signal actuates.
e. Open signaling line circuits and verify that the trouble signal actuates.
f. Open and short notification appliance circuits and verify that trouble signal actuates.
g. Open and short (wire only) network communications and verify that trouble signals are received at network annunciators or reporting terminals.
h. Ground initiating device circuits and verify response of trouble signals.
i. Ground signaling line circuits and verify response of trouble signals.
j. Ground notification appliance circuits and verifies response of trouble signals.
k. Check alert tone and prerecorded voice message to all alarm notification devices.
l. Check installation, supervision & operation of all intelligent smoke detectors using walk test.
m. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
n. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

1.12. FINAL INSPECTION:

At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

1.13. INSTRUCTION&SEQUENCE OF OPERATION:

Instruction shall be required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided. The contractor and/or the systems manufacturer's representatives shall provide a typed written "Sequence of Operation."

2. PUBLIC ADDRESS SYSTEM CUM VOICE EVACUATION SYSTEM

2.1. Introduction

The Networked Digital Public address system is configured for broadcasting information and emergency announcements to the public. A public address system which will be provided should be IP networked system. The public address system shall also be integrated to Voice evacuation module of Fire Alarm & detection system and suitable for use during all emergency conditions.

2.2. General Description

Public Address system provided should be completely networkable over IP. The system will distribute background music and pre-recorded messages through the graphical user interface and live announcements from the call stations. The recessed ceiling-type loudspeakers are to be used mostly providing PA coverage in where the false ceiling is present. For areas without false ceiling, wall mount loudspeakers will be installed to provide PA coverage. The PA system should be installed at the Fire Control Room in OPD Building. The system is supplied with user-friendly software for system configuration. This allows all system functions to be configured. The software is based on web technology, which gives authorized users full freedom of configuration in terms of time and location. The system architecture should be daisy chain in nature complying with the following standards.

BS 5839-8 – Code practice for the design, installation and servicing of voice alarm system.

IEC 60849 – Sound systems for emergency purposes

BS EN 54 -16 -Voice control indicating equipment and alarms

Emergency according to EN60849/EN54-16/ISO 7240-16

EN-54 - For entire Public Address system

The system should allow an undistorted speech reproduction of 85dB SPL at listening level. The system should also provide uniform coverage within +/-5dB for the entire area.

2.3. Call Station Function

Call Station: The operator/user can make an announcement to any zone or any combination of zones of that station via the call station. The type of announcements from the call station are as follows:

- Live announcements
- Pre-recorded announcements
- Background Music

2.4. Pre-recorded emergency announcements / Emergency Announcements:

The pre-recorded announcements can be initiated by the fire alarm signal that is sent from the fire alarm system. The operator can make an announcement to any combination of zones in the system.

a) Pre-recorded Announcements: The pre-recorded announcement can be activated from the pre-defined keys at the call station, and scheduled to be played at specific times.

b) Fault Indication: The failure of the PA equipment will be notified to the call station in the system; and the fault will also be presented at the configuration / diagnostic and logging PC located in the communications equipment room in the building.

The PA System should be capable of integration with BMS system seamlessly. It provides digital audio signal processing and transmission of audio signals via a simple IP network system. The audio transmission in the system is in digital form except for the 100V line from the power amplifiers to the loudspeakers.

The PA system is comprised of the following basic elements:

- Network Controller
- Power Amplifiers
- PA Call Stations

- Network cables
- Loudspeakers
- Background Music Source

The PA System elements are connected by the daisy chain principle. The interconnection between the system units is achieved by using optical fibre cable. The system cabling can be implemented in ring network whereby a single failure on the network cable will not affect the functioning of the system.

The equipment for the PA System, i.e. network controller, power amplifiers, and PA call stations, have built-in audio processing facilities, the audio processing is done in the digital domain.

The distribution of PA cables is configured to ensure that the failure of an amplifier, a cable or a speaker does not render the PA system inoperative or result in the total loss of PA facility in any part of any zone.

2.5. Equipment Specification

I. Network controller

The control unit is the heart of the public address system. The unit shall be capable of routing minimum 28 audio channels, delivering power to the system, fault reporting and controlling of the system. This unit can work either as stand-alone mode or with a PC connected to it. It should have at least the following functionalities:

There shall be 8 control inputs, which should be freely programmable.

The network controller shall have analog audio line outputs for fire alarm signals, music sources etc.

The network controller shall have the capability to handle at least 100 levels of priorities and at least 200 zones, 30 call stations or MMI (Man Machine Interface)

The network controller shall monitor the status of all zones in the system and the last 200 status change and fault events should be logged.

Attention and alarm tone definitions shall be stored in the network controller or recalled from an external storage device through control ports. These tones can be accessed by any call stations or control inputs for announcement broadcast or alarm broadcast.

At least 4 pre-recorded messages should be played simultaneously.

The network control unit shall have extensive audio processing possibilities for audio inputs and audio outputs. Parametric equalization, limiter, and gain can be adjusted with the configuration software.

The network controller shall monitor the status of all equipment including the status of the microphone capsule of a call station and report any fault.

The network controller should have hot standby auto switchover facility to redundant controller.

The system shall be able to make emergency calls (all calls) even if the network controller has failed.

The controller should 16X2 front panel LCD display and rotary control, through which debugging of faults will be possible.

The network controller is EN-54 certified and complies with the safety and emergency standards according to EN54-16 and EN60849 standards

Power Source	115/230 VAC ±10%, 50/60 Hz
Battery Power Supply	48V DC
Power consumption	14W with no load, 150W with maximum load
Audio inputs	28 channels
Control Inputs	8
Control Outputs	8
Line Outputs	4
Operating Temperature	- 50 degree C to +55 degree C
Frequency response	20 Hz to 20 kHz (-3 dB)
Event Logs	200

II. Power amplifiers

The main function of the power amplifier is the amplification of audio signals for the loudspeakers. It shall be possible to select the output voltage between 100V and 70V by changing jumpers.

It should have at least the following functionalities:

The amplifier should have DSP built in for Equalization, delay settings etc. The noise dependant Automatic Volume Control (AVC) circuitry should be built in. Each amplifier should have min two channels for AVC function.

The amplifier monitoring and changeover facility shall be incorporated with the power amplifier. The changeover relays shall be integrated with the standby unit. In case of failure of any working amplifier, the standby amplifier shall automatically come in the circuit.

The amplifier should have rotary or push control for selection of system enquiry mode and Headphone volume along with LCD display.

The amplifier should have the built-in line and loud speaker supervision, automatic volume control, automatic ventilation temperature control, auto change over to DC power supply.

The power amplifier should be capable of monitoring the speaker lines (zones) connected to it through pilot tone supervision

Separate amplifiers or separate channels of amplifiers for every zone.

The network controller is EN-54 certified and complies with the safety and emergency standards according to EN54-16 and EN60849 standards

Mains supply	115/ 230VAC +/- 10% at 50 Hz
Type of Amplifiers	Class D
Indication & Controls	854-character LCD display for status display Rotary/push control for selection of system enquiry mode .
Output power	1 x 500W, 2 x 250W, 4 x 125W, 8 x 60W or as required.
Outputs	Selectable 100V, 70V.
Audio Inputs	Mono, balanced
Control Inputs	8
Control Outputs	1 or 2 or 4 or 8 depending on the amplifier type.

Frequency response	60 Hz to 20 kHz (-3 dB).
Frequency Response (audio inputs)	Line: -3dB at 20Hz and 20KHz Mic: -3dB at 100Hz to 16KHz
Total harmonic distortion	<0.3% (1 kHz) at 50% of rated power
Cross talk	-70 dB (1 kHz) nominal (only multichannel).
Signal to noise ratio	>85 dB with pilot tone off
Battery Power Supply	48V
Safety and Emergency	According to EN 60849 and EN 54-16

III. **Loudspeaker**

Rated Power	6W	12W
Sound pressure level at rated power	90 dB	100 dB
Frequency Range (-10dB)	80Hz to 20 KHz	55Hz to 20 kHz
Opening Angle at 1 kHz/4 kHz (-6 dB)	180° / 50°	180° / 64°
Rated Voltage	100 V / 70	100 V / 70
Colour	off-white (RAL 9010)	off-white (RAL 9010)
Safety compliance	EN60065	EN60065

IV. Metal Grille Ceiling/Wall Speakers

Compact 6W/12W or as required ceiling/wall speakers with fire dome for indoor areas. Speakers should have wide opening angle, with perforated metal grill of approved color and with the following specifications.The speakers are EN-54 certified and complies with the safety and emergency standards according to EN54 and EN60849 standards

V. Metal Column Speakers

Compact 20W or as required Column speakers with fire dome for indoor areas. Speakers should have wide opening angle, with perforated metal grill of approved color and with the following specifications.The speakers are EN-54 certified and complies with the safety and emergency standards according to EN54 and EN60849 standards.

Rated Power	20 W
Sound pressure level at rated power	105 dB
Frequency Range(-10dB)	240Hz to 16 KHz
Horizontal Opening Angle at 1 kHz/4 kHz (-6 dB)	210° / 82°
Vertical Opening Angle at 1 kHz/4 kHz (-6 dB)	82° / 24°
Rated Voltage	100 V
Colour	off-white (RAL 9010)
Safety compliance	EN60065

VI. Call Station

a. Remote Call Station

Remote call station basic is used to make manual or pre-recorded announcements to any pre-assigned zones or to executing predefined actions. The call station basic has a microphone on a flexible stem to transmit speech over the network, one push-to talk button and a headset socket. When a headset is connected the microphone and speaker are muted.

The remote call station is powered by the call station interface via the CAT-6a cable (STP), but a local power supply connection is also provided for long distance use with many keypads. The remote call station is fully supervised and complies to IEC60849. Even in case the network controller would fail, the remote call station is still able to do emergency calls (fail safe).

The network controller is EN-54 certified and complies with the safety and emergency standards according to EN54-16 and EN60849 standards

b. Call station keypad

Safety covers to prevent accidental activation of the keys should be available as an option.

The keypad gets its power from the call station where it is connected to. The call station keypad shall have following features:

Controls and indicators

• Eight function keys

• Eight two-color LEDs Interconnections

• Two serial data and power connections

External power supply	20 to 58 V (dc)
Performance Frequency response	340 Hz – 14 kHz (-3 dB)
Nominal input level	75 to 90 dBSPL
Total harmonic distortion	< 0.5 % (1kHz)
Signal–to-noise ratio	> 60 dB at 85 dBSPL
Headset Mic input sensitivity	sensitivity -44 to -59 dBV (configurable)
Headpones impedance	32 Ohm
Safety compliance	EN60065

c. PC Call station

The PC call stations will be used for the Controller's call stations in the main Control Room.

The PC Call station is used for making live speech or pre-record announcements to any zone or a group of zones or to execute any pre-defined actions. The PC Call Station is comprised of a high quality microphone on a gooseneck, user-friendly operation PC software and a PC with a 19" Touch screen LCD monitor. The PC Call station software provides the user with a powerful and easy-to-use tool that brings all aspects of announcements to a single point control.

The on-screen configuration sections allow the user to enter the properties of zones of individual zone such as entering the name of a zone/group, pre-defined input/output relay actions and selected attention/alarm tones or pre-recorded messages. After configuration, the user can operate the system via the Operation key layout section.

Configuration, Diagnostic and Logging Software

Configuration Software:- The configuration software is required for every system. Once the configuration has been completed with data entry and downloaded to the network controller, the system can operate without the configuration PC. The configuration software is required only during installation and when changes are made to the existing system configuration. The configuration software is designed to allow even first-time users to navigate easily through the configuration.

Diagnostic and Logging Software:- The main function of the diagnostic & logging software is to monitor and record the status of all elements of the PA system. This software handles logging of all events like calls and status change of system elements, and gives a current view of the status of the system. This software section can be used for realtime logging by connecting a PC to the network controller, via TCP/IP.

File Transfer Software:- The main purpose of the file transfer software is to transfer both data and audio files from the PC to the network controller.

d. IP Audio Interface

The VOIP interface is a universal, IP-based audio device supporting VoIP and Audio over IP applications. It is an ideal solution for bridging audio and contact closures over long distance LAN and WAN networks, The unit has analog audio inputs and outputs for easy interfacing with optional pilot-tone supervision for emergency sound purposes. One audio input can be switched to microphone sensitivity with built-in microphone supervision. Also, the control inputs offer cable and connection supervision. Control inputs and outputs can be used to set up an audio connection to start a remote call, but also to pass remote fault events to the system controller.

e. Audio

Multiple audio formats are supported: single channel, full duplex 16-bit PCM or G.711 for very low latency, and two channel send or receive MP3 for high quality audio with various sample rates and compression settings

f. Audio formats

- MPEG 1-layer 3 (MP3) 32, 44.1 and 48 kHz sample rate
- Encoding up to 192 kbps VBR
- Decoding up to 320 kbps (stereo)
- MPEG 1-layer 2 16, 22.05 and 24 kHz sample rate
- G.711 uLaw, aLaw at 8, 24 or 32 kHz sample rate
- PCM 16-bit at 8, 24 or 32 kHz sample rate

g. Network Interfaces

The unit interfaces to 10 and 100 Mbit Ethernet networks and announces its IP address that was given by a DHCP server. It can also search the network for a free IP address or can be given a static IP -address. A second Ethernet connection is available to support network redundancy. An RS 232 interface is build in to communicate additional serial data over the IP network.

Connector Dual RJ45, DTE-pinout

Standard 802.3i / 802.3u

Speed 10 / 100 Mbps, auto-negotiation

Flow Full / half-duplex, auto-negotiation

Protocol TCP/IP, UDP, RTP, IGMP, DHCP,SNMP

CHAPTER –I

TECHNICAL SPECIFICATIONS – LOW VOLTAGE SYSTEM

1. LAN NETWORKING & WIFI SYSTEM

1.1. General:

RJ 45 data outlets are proposed to be provided for Computers networking, telephones, WiFi, Low voltage system equipment etc. as per requirement in rooms and other areas at various floors in all the blocks / buildings .The Data Outlet points shall be connected to Rack Panel/Computer hub with 4 pair CAT6a wiring in recessed conduit / Raceways.

The maximum Length of the CAT6A cable from end user point to the Hub or Edge switches shall not be more than 90Mtr. Beyond this length Fiber Optic Cable shall be used. UPS Power supply to these computers will also run through conduits/ floor trunking.

The Rack Panel/computer hub at various floors will be connected to Main rack of the building/ block with fiber optic cable through conduit or raceways on surface/in recess.

The Server is proposed to be located in server rooms in Academic Block. The main server shall be connected to Distribution switch through Optical fiber cable of 40 Gbps and Distribution switch shall be connected to Edge switches of each building/ block withfiber cable of 10 Gbps link in underground HDPE pipe of suitable size in outside connectivity or in cable raceway/conduit inside the buildings. Brick masonry manholes with covers shall be provided at suitable lengths to facilitate easy wire pulling & Maintenance.

Wireless access points for Wi-Fi connectivity alongwith wired LAN data outlets are proposed in Hospital Block, Academic Block, Hostels, Sports complex cum Auditorium, Guest House, M.S. office in M.S. Residence block etc.

20% LAN switches, Wifi routers shall be provided as spare as required & as per directions of EIC.

The LAN SYSTEM comprises of Passive components and Active Components. The Technical specifications of both the components are given below:

1.2. PASSIVE (STRUCTURED CABLING)

1.2.1. Specification for CAT 6A LSZH U/UTP Cable

Standard Compliance
Channel Performance
The Category 6A/ Class EA UTP SCS shall comply with the following standards
a) ISO/IEC 11801:2010
b) EN 50173 Part 1 through Part 5:2010 and 2011
c) ANSI/TIA-568-C
d) IEC 60603-7-4
e) IEEE 802.3 applications
The Category 6A/ Class EA UTP system should support the following IEEE Ethernet applications
a) 802.3e - 1BASE 5
b) 802.3i - 10BASE-T
c) 802.3u - 100BASE-TX, 100BASE-T4
d) 802.3y - 100BASE-T2
e) 802.3z - 1000BASE-X
f) 8023ab - 1000BASE-T

g) 802.af - Power Over Ethernet (15.4W)
h) 802.3at - Power Over Ethernet Enhancements (25.5W)
i) 802.3az - Energy Efficient Ethernet
Additionally the Category 6A/ Class EA UTP SCS shall be capable of supporting the following Fibre Channel Applications Standards, per Technical Committee 11 of INCITS:
a) 1GFC-BASE-T
b) 2GFC-BASE-T
c) 4GFC-BASE-T
It is critical that guaranteed worst-case values are provided to ensure the SCS can support 1G transmission without risk. "Average value" or "Typical Value" is not acceptable as they do not account for lower performance channels. The proposed Category 6A UTP SCS, when configured as a worst-case 100 metre channel shall provide performance headroom over limits specified by Cat6A
NeXT (Near end Cross Talk)- Minimum 3 db or as per relevant standards
Should support a minimum of 4 connector Channel with a minimum 3 db guaranteed NeXT
Insertion Loss - 3%
Return Loss - 1.0 db
The SCS must consist of individual components provided by the same manufacturer. "Mix and Match" products are not allowed as there is no guarantee that the overall channel will meet Category 6A Channel requirements if constructed with components from different vendors.
The Category 6A cable and Category 6A channel components shall be manufactured by a single manufacturer.
The SCS must be tested by an ISP 17025 accredited 3rd Party test facility to EIA/TIA 568C, ISO/IEC 11801 Amendment 1 and for the channel testing must be provided as part of the bid response.
The Category 6A system should support channels that are shorter than 15 meters for 2, 3, 4 connector channels without any minimum length requirements or as per relevant standards
Horizontal Cable
The Cable should meet ANSI/TIA 568C.2 Category 6A Specifications
Cable/Cable reel : TRACKING Number to check the genuineness/ details of the test reports
The cable should consist of Eight 23 AWG copper conductors. Copper Clad Aluminium or any other combinations are not allowed
The Cable should be round in shape
The weight of the cable box of 1000 Feet should not be less than 34.7 lb
The nominal Jacket thickness should be 0.05 inches
The nominal Outside diameter should be as per relevant standard.
The cable should support the installation temperature: 0 to 50 degree C
It should support Operating temperature of -10 to 60 degree C
The cable shall be available in Low-Smoke, Zero Halogen (LSZH) compatibility and The LSZH version must comply with the following Fire Safety standards:
1) Flame Spread:- as per relevant ISO/IEC 60332 standard
2) Acidity:- as per relevant ISO/IEC 60754-2 standard
3) Smoke Density:- as per relevant ISO/IEC 61034 standard

The cable and cordage shall be "True UTP" components that do not include internal or external shields, screened components or drain wires. No Special Grounding requirements.

1.2.2. Specification for Category 6A U/UTP Information Outlets

Standard Compliance
The 8-pin modular (RJ-45) jacks shall comply with IEC 60603-7-4
The Category 6A outlets shall be backward compatible with Category 6a and 5E cords and cables.
The Category 6A outlets shall be of a universal design supporting T568 A & B wiring.
The information outlet shall have a Current Rating of 1.5 A at 20°C
The information outlet must support 90 degree cable termination. As some mounting hardware does not allow for cable entry directly from the rear, this capability is necessary
3rd Party Verification test certificates shall be provided to show compliance to ISO/IEC 11801 Amendment 2 testing for CAT 6A components.
The 8-pin modular (RJ-45) jacks shall comply with IEC 60603.
The information outlet will have insertion life of 750 cycles minimum.

1.2.3. Specification for CAT 6A LSZH U/UTP RJ45 Patch Cords

Standard Compliance
SCS must support patch cord lengths of 1 meter minimum and equipment cords of 2 meter minimum and The Patch cords shall be available in Stranded and solid core construction
Cords shall be equipped with 8-pin modular plugs on each end.
All cords shall be round, and consist of copper conductors, tightly twisted into individual pairs.
Nominal cordage diameter shall not exceed 7.24 mm.
Plugs shall be designed with an anti-snag latch to facilitate easy removal during move, add and change processes.
The LSZH version must comply with the following Fire Safety standards:
Flame Spread:- as per relevant ISO/IEC 60332 standard
Acidity:- as per relevant ISO/IEC 60754-2 standard
Smoke Density:- as per relevant ISO/IEC 61034 standard
3rd Party verification of the Fire Safety/ Environmental tests listed above must be provided as part of the bid response.
The cordage shall be UTP components that do not include internal or external shields, screened components or drain wires.
The patch cords will have insertion life of 750 cycles minimum.

1.2.4. Specification for CAT 6A Jack Panel

Standard Compliance
24 or 48 Port Patch Panel
The ganged adapter style patch panel will utilise increments of six RJ-45 style jacks in a common moulded component.
The ganged adapters shall have RJ45 jack in the front and Insulation Displacement Connector (IDC) at the rear of the module.
The panel must be capable of supporting an upgrade to an intelligent system without any interruption to service due to patch cord removal or terminal block re-termination.
Termination managers must be provided with the panel. These termination managers provide proper pair positioning, control, and strain relief features to the rear termination area of the

panel.
3rd Party Verification test certificates shall be provided to show compliance to ISO/IEC 11801 Amendment 2 testing for Cat 6A components.
When configured in worst-case 100 meter channels with full cross-connects and consolidation points with the other products proposed in this tender, the panel shall be capable of delivering the minimum guaranteed channel performance
The patch panel type shall be a 1U (24 port) or 2U (48 port) panel capable of supporting 24 or 48 unshielded modular 8-pin connectors compliant with IEC 60603 while meeting the Channel Performance as specified in Amendment 1 to ISO/IEC 11801:2002
The panel shall be available in 24-port and 48-port configurations with universal A/B labelling and 110 connector terminations on rear of panel allowing for quick and easy installation of 22 to 24 AWG cable
The panel shall be equipped with a removable rear mounted cable management bar and front and rear labels
The panel shall be UL and cUL Listed
Operating Temperature Range = 0°C to 40°C
Storage Temperature Range = -20°C to 70°C
Humidity = 95% (non condensing)
Nominal Solid Conductor Diameter = 0.025 to 0.020 in (0.64 to 0.51 mm) (22 to 24 AWG)
Nominal Stranded Conductor Diameter:=0.025 to 0.020 in (0.64 to 0.51 mm (22 to 24 AWG)
Insulation Types = All plastic insulates (including PVC, irradiated PVC, Polyethylene, Polypropylene, PTF Polyurethane, Nylon, and FEP)
Insertion Life = 750 minimum insertions of an FCC 8-Position Telecommunications Plug

1.2.5. 2 & 4 Port Shuttered Face Plate

Standard Compliance
Shall be available in 2 port and 4 port square versions.
General Specifications a) Color: White b) Width: 86.36 mm (3.4 in) c) Height: 86.36 mm (3.4 in) d) Depth: 13.72 mm (0.54 in)
Material shall be high impact, flame retardant, UL-rated 94 V-0, thermoplastic.
Flammability Rating: UL 94 V-0 Safety Standard: UL Listed
Shall be compatible with CAT 5e/CAT 6/CAT 6A information outlets.
Shall have inbuilt shutters to prevent dust to accumulate on the information outlets which are not in use.

1.2.6. 6/12 CORES INDOOR MM OM3 FIBER CABLE

Standard Compliance
Shall be Multimode (OM3), Low Smoke Zero Halogen Riser Distribution Cable, 6/12fiber single-unit.
Qualification Standards: ANSI/ICEA S-83-596 and Telcordia GR-409
Standards Compliance: TIA-492AAAC (OM3), Bend-Insensitive Multimode Fiber
Flame Test Method: IEC 60332-3, IEC 60754-2, IEC 61034-2, IEEE 383, UL 1666 and UL 1685

Regulatory Compliance: RoHS 2011/65/EU compliant
No. of Fibers: 6/12
Construction Materials
a) Jacket Material: LSZH
b) Jacket Color: Aqua
c) Subunit Type: Gel-free
d) Non Armored: Yes
e) Core/Cladding/buffer diameter: 50 / 125 / 900 µm
Dimensions
a) Cable Diameter: 6.07 mm (0.24 in)
b) Cable Weight: 34 kg/km
Physical Specifications
a) Minimum Bend Radius, As per IEC 60794
b) Minimum Bend Radius, As per IEC 60794
c) Tensile Load, long term, Max: 200 N
d) Tensile Load, short term, Max: 667 N
e) Vertical Rise, Max: 500 m
Environmental Specifications
a) Environmental Space: Low Smoke Zero Halogen (LSZH) and Riser
b) Installation Temperature: -5 degree Celsius to +50 degree Celsius
c) Operating Temperature: -30 degree Celsius to +70 degree Celsius
d) Storage Temperature: -30 degree Celsius to +70 degree Celsius
Mechanical Test Specifications
a) Compression: 10 N/mm (as per IEC 60794-1 E3)
b) Flex: 100 Cycles (as per IEC 60794-1 E6)
c) Impact: 5.88 N-m (as per IEC 60794-1 E4)
Optical Specifications
Attenuation, Maximum
a) 1.00 dB/km @ 1300 nm
b) 3.00 dB/km @ 850 nm
Index of Refraction
a) 1.479 @ 1300 nm
b) 1.483 @ 850 nm
1 Gbps Ethernet Distance
a) 600 m @ 1300 nm
b) 1020 m @ 850 nm
10 Gbps Ethernet Distance
a) 300 m @ 850 nm
Bandwidth, Laser, Min.
a) 500 MHz-km @ 1300 nm
b) 2000 MHz-km @ 850 nm
Bandwidth, OFL, min.
a) 500 MHz-km @ 1300 nm
b) 1500 MHz-km @ 850 nm

1.2.7. Fiber Optic LC style OM3 Cassettes

Standard Compliance
Shall have provision to terminate 12 Fibers
Shall have Aqua color adapters with LC interface.
Shall be intelligent ready cassettes
The adaptor plate shall be RoHS compliant

1.2.8. Fibre Optic LC style OM3 pigtail for Cassettes

Standard Compliance
Minimum Specifications
Each pigtail shall have attenuation value as per as per IEC 60794/EIA/TIA 568
Each Pigtail shall be made as per IEC 60794/EIA/TIA 568
Each pigtail shall have a return loss as per IEC 60794/EIA/TIA 568
Each pigtail shall be RoHS compliant

1.2.9. Fiber Optic Patch Cable (LC-LC, SC-LC), 3/5/10 Mtrs. Long, ISO/IEC-11801-OM3 50µ Duplex, LSZH

Standard Compliance
Minimum Specifications
Length shall be 3/5/10 meters
All patch cords shall conform to EIA/TIA-568C.3 and ISO/IEC-11801
Shall be Duplex Multi Mode Fiber Optic Patch Cords OM3 50µ
Shall support network line speeds up to 10 Gbps.
Each patch cord shall have a LC connector on both sides or SC LC as per requirement
All patch cords shall be factory terminated and packed.
Shall be RoHS Compliant
Shall be Low-Smoke & Zero-Halogen
Shall have minimum 20-Year Extended Product Warranty

1.2.10. 12 CORES - OUTSIDE PLANT FIBER CABLE

Standard Compliance
Shall be Singlemode (OS2), Single Jacket, Single Armor, Zero Water Peak Fiber as per TIA-492CAAB(OS2) and IEC 60794
Qualification Standards: as per relevant standard and Telcordia GR-20
Standards Compliance: ITU-T G.652.D, ITU-T G.657.A1 (bend insensitive) and TIA-492CAAB (OS2)
Regulatory Compliance: RoHS 2011/65/EU compliant
No. of Fibers: 12
No. of Tubes: 1
Construction Materials
a) Jacket Material: MDPE
b) Armor Type: Corrugated Steel
c) Number of fibers per tube: 12
d) Filler Quantity: 4
e) Jacket Color: Black

f) Jacket UV Resistance: UV Stabilized
g) Subunit Type: As per TIA-492CAAB(OS2) and IEC 60794
h) No. of Rip cords: 2
i) Water insertion protection: Yes
Dimensions
a) Cable Diameter: 11.50 mm (0.45 in)
b) Cable Weight: 108 kg/km
Physical Specifications
a) Minimum Bend Radius: As per IEC 60794
b) Minimum Bend Radius, As per IEC 60794
c) Tensile Load, long term, Max: 800 N
d) Tensile Load, short term, Max: 2700 N
Environmental Specifications
a) Environmental Space: Aerial, lashed or Buried
b) Installation Temperature: -5 degree Celsius to +50 degree Celsius
c) Operating Temperature: -30 degree Celsius to +70 degree Celsius
d) Storage Temperature: -30 degree Celsius to +70 degree Celsius
Mechanical Test Specifications
a) Compression: 44 N/mm (as per IEC 60794)
b) Flex: 35 Cycles (as per IEC 60794-1 E6)
c) Impact: 2.94 N-m (as per IEC 60794-1 E4)
d) Water Penetration Test Method: 24 h (as per IEC 60794-1 F5)
Optical Specifications
Attenuation, Maximum
a) 0.22 dB/km @ 1550 nm
b) 0.27 dB/km @ 1490 nm
c) 0.31 dB/km @ 1385 nm
d) 0.34 dB/km @ 1310 nm
Index of Refraction
a) 1.467 @ 1310 nm
b) 1.468 @ 1385 nm
c) 1.468 @ 1550 nm
Cabled Cutoff Wavelength, maximum: 1260 nm

1.2.11. 48/24/12 Sliding Fiber Shelf – For Single Mode & MultimodeFiber

Standard Compliance
Shall accommodate 4 coupler plates or 4 pigtail cassettes for a total of 48 fiber terminations.
The width shall be 19 inches and height of 1U (1.75 inches), with a maximum of 18 inch depth.
The shelf/LIU shall be sliding.
The Fiber shelf must be intelligent ready and must support field upgrade to intelligent fiber panels without removal of existing patch cords and without disruption of network services.
Shall have splice trays to splice minimum 32 fibers.

1.2.12. 12 Fiber Single mode Fiber Pigtail Cassettes

Standard Compliance

Shall be Single mode OS2, zero water peak fiber.
Standards Compliance: G.652.D, G.657.A1 and OS2
Regulatory Compliance: RoHS 2011/65/EU
Safety Standard: UL
Number of Fiber: 12
Interface, Front: LC
Adapter Color: Blue
Optical Performance
a) Insertion Loss Change, mating: 0.30 dB
b) Insertion Loss Change, temperature: 0.30 dB
c) Insertion Loss, Typical: 0.30 dB
d) Return Loss, Min: 55.0 dB
Pigtail Environmental Specifications
Environmental Space: Plenum
Operating Temperature: -10 degree Celsius to +60 degree Celsius
Cable Retention Strength, Max: 1.00 lb @ 0 degree, 1.00 lb @ 90 degree
Ferrule Geometry: Pre-radiused
Ferrule Material: Zirconia
Optical Components Standard: ANSI/TIA-568-C.3

1.2.13. LC – LC Single mode LSZH Patch Cords

Standard Compliance
Shall be Single mode (OS2), zero water peak, LC to LC, Fiber patch cords.
Standards Compliance: G.652.D, G.657.A1 and OS2
Regulatory Compliance: RoHS 2011/65/EU
Jacket: Low Smoke Zero Halogen (LSZH) compliant to IEC 60332-3, IEC 60754-2, IEC 61034-2, IEEE 383, UL 1666, UL 1685
Flame Test Listing: NEC OFNR-LS (ETL) and c(ETL)
Cable Qualification Standards: as per relevant standard and Telcordia GR-409
Optical Components Standard: ANSI/TIA-568-C.3
General Specifications
Connector Color: Blue
Connector Interface: LC
Operating Temperature: -10 degree Celsius to +60 degree Celsius
Connector Optical Performance
Insertion Loss, Typical: 0.20 dB
Return Loss, minimum: 55.0 dB
Insertion Loss Change, mating: 0.30 dB
Insertion Loss Change, temperature: 0.30 dB

1.2.14. 24/48 Fiber Joint Enclosure (IP 68 Rated)

Standard Compliance
Shall be a butt type enclosure with a dome and base
The Cable entries should be through the cable ports located in the base.
The dome and base should be sealed using a clamp with O-ring system. The cable entry ports

should be sealed mechanically and using gel sealing technology instead of heath shrink.
General Specifications
a) IP68 Rated
b) No. of Splice trays: 6 nos.
c) Splice Tray Capacity: 24 Fibers
d) No. of cable entry ports: 4 round ports and 1 oval port.
The mechanical sealing unit should have a rotary mechanism which can used for sealing, no special tools should be used for sealing
The block should be opened and closed repeatedly without removing or replacing the Gel
The closure should have the capability to accommodate loop cables (un cut loose tube cables)
The cables should be secured to the closure using hose clamps and a cable attachment device.
The closure should have a basket for storing loose tubes.
The dome should have pressure valve.

1.2.15. Single Side 1U Cable Manager

Standard Compliance
Shall be a single sided 1U, 19 Inch Cable Manager
Safety Standard: UL
Regulatory Compliance: RoHS 2011/65/EU
Material Type: Aluminium and Steel
General Specifications
a) Color: Black
b) Rack Units: 1
c) Finish: Powder coated, smooth
Shall have fingers to maintain the patch cord bend radius
The front shall have a hinged door for easy access

1.2.16. Specification for CAT 6 LSZH U/UTP Cable

Standard Compliance
The Category 6/Class E UTP system shall comply with the following standards
ISO/IEC 11801
EN 50173 Part 1 through Part5: 2010 and 2011
ANSI/ TIA 568C.2
IEC 60603-7-4
IEEE 802.3 applications
The Category 6/ Class E UTP system should support the following IEEE Ethernet applications
802.3e - 1BASE5
802.3i - 10BASE-T
802.3u - 100BASE-TX, 100BASE-T4
802.3y - 100BASE-T2
802.3z - 1000BASE-X
8023ab - 1000BASE-T
802.af - Power Over Ethernet (15.4W)
802.3at - Power Over Ethernet Enhancements (25.5W)
802.3az - Energy Efficient Ethernet

Channel Performance
It is critical that guaranteed worst-case values are provided to ensure the SCS can support 1G transmission without risk. "Average value" or "Typical Value" is not acceptable as they do not account for lower performance channels. The proposed Category 6 UTP SCS, when configured as a worst-case 100 metre channel shall provide performance headroom over limits specified by Cat6
The SCS must consist of individual components provided by the same manufacturer. "Mix and Match" products are not allowed as there is no guarantee that the overall channel will meet Category 6 Channel requirements if constructed with components from different vendors.
The Category 6 cable and Category 6 channel components shall be manufactured by a single manufacturer. The manufacturer shall warrant the Category 6 channel cable, components, and applications for a period of 20 years.
The 20 year warranty shall be a transferable warranty and has component replacement policy in case of manufacturing defect
Should support a minimum of 4 connector Channel with a minimum 6 dB guaranteed NEXT over and above the standard TIA 568 C.2
Should support 6 connector Channel with a minimum 4 db guaranteed NEXT or as per relevant standard
The Delay Skew on the 100 meter channel shall not exceed 30 ns
The SCS must be tested by an ISP 17025 accredited 3rd Party test facility to EIA/TIA 568C, ISO/IEC 11801 and for the channel
SCS must support patch cord lengths of 1 meter minimum and equipment cords of 1 meter minimum
The Category 6 system should support channels that are shorter than 15 meters for 2,3,4 connector channels without any minimum length requirements.
Should support 117 meters with a 4 connector channel design for IEEE 802.3ab 1000BASE-T
Horizontal Cable
The Cable should meet ANSI/TIA 568C.2 Category 6 Specifications
Cables should have TRACKING Number to check the genuity / details of the test reports
The cable should consist of Eight 23 AWG copper conductors. Copper Clad Aluminium or any other combinations are not allowed
The weight of the cable box of 1000 Feet should not be less than 25.6 lbs
The nominal Jacket thickness should be 0.022 inches
The nominal Outside diameter should be 0.232 inches
The cable should support the installation temperature: 0 to 40 ^{0} C
It should support Operating temperature of -10 to 50 ^{0} C
It should have ETL verified CMR, CMG
The LSZH Cable should support the following standard to qualify
ISO/IEC 60332-3-22 Vertical Flame spread test
ISO/IEC 60754-2Acidity
ISO/IEC 61034-2 Smoke Density
3rd Party verification of Fire safety/environmental tests listed above must be provided as part of the bid response.
The cable and cordage shall be UTP components that do not include internal or external shields, screened components or drain wires.
The horizontal cable shall have a unique print string on the cable jacket. This unique identifier shall also be used for on-line reference to a full set of factory tests that were performed on a

sample from the same mater reel. The test parameters shall include NEXT, PSNEXT, Return Loss, Attenuation, ELFEXT and PSELFEXT. The on-line reference must be available on the SCS public website, such that it can be accessed at any time.

1.2.17. Specification for CAT 6A LSZH U/UTP RJ45 Patch Cords

Standard Compliance
Patch Cords shall be equipped with 8-pin modular plugs on each end.
All cords shall be round, and consist of copper conductors, tightly twisted into individual pairs.
Nominal cordage diameter shall not exceed 5.92 mm.
Plugs shall be designed with an anti-snag latch to facilitate easy removal during move, add and change processes.
The cordage shall be available in Plenum, Non-Plenum and Low-Smoke, Zero Halogen (LSZH) compatibility.
The LSZH version must comply with the following Fire Safety standards:
ISO/IEC 60332-3-22: Vertical Flame Spread
ISO/IEC 60754-2: Acidity
ISO/IEC 61034-2: Smoke Density
3rd Party verification of the Fire Safety/ Environmental tests listed above must be provided as part of the bid response.
The cordage shall be UTP components that do not include internal or external shields, screened components or drain wires.
The patch cords will have insertion life of 750 cycles minimum.
The Patch cords shall be available in Stranded and solid core construction

1.2.18. Specification for CAT 6 Jack Panel

Standard Compliance
The ganged adapter style patch panel will utilize increments of six RJ-45 style jacks in a common moulded component.
The patch panel type shall be compliant with IEC 60603-7-4.
The ganged adapters shall have RJ45 jack in the front and Insulation Displacement Connector (IDC) at the rear of the module.
The panel must be capable of supporting an upgrade to an intelligent system without any interruption to service due to patch cord removal or terminal block re-termination.
The upgrade to an intelligent system shall be performed through the addition of an overlay panel that does not require tools for installation.
Termination managers must be provided with the panel. These termination managers provide proper pair positioning, control, and strain relief features to the rear termination area of the panel.
3rd Party Verification test certificates shall be provided to show compliance to ISO/IEC 11801 testing for category 6 components.
When configured in worst-case 100 meter channels with full cross-connects and consolidation points with the other products proposed in this tender, the panel shall be capable of delivering the minimum guaranteed channel performance.

1.2.19. 42/15/12 U Closed Rack (2 Type of 42 U 800X800 & 800X1000 & 600X600 15/12 U)

Standard Compliance
2 Post 19" 42U Closed rack , with copper & fiber cable management accessories& 19" Closed Wall Mount Rack (15U/12U)

2 Nos. of 1U power distribution box, with 10 x IEC - C13 sockets & with 32Amp MCB-terminating on a IP56 power sockets
1 No. Horizontal PDU with 5/15Amp Universal Sockets with 32Amp MCB
Front mounting PVC Cable managers/ guide
Integral Cable management ducts/ arms (on either side) with covers
Cantilever Tray x 1 (19" / 1U/ 255mm - D)
Cable retention bobbins X 5 (both sides) + Window Molding x 6
Cable Hangers (set of 3) x 2 (Right & left side one set each)
Bar, Earthing 42U
Mounting Hardware (Pack of 10) x 5
IP65 Rated Outdoor if used in outdoor environment (Weather resistant)

1.2.20. Testing & Commissioning of Passive Components:

All the passive components shall have their Testing reports from the OEM with Batch No. and all standard parameters for RIPANS Aizawl complex. There shall be the proper ferruling and Numbering on the CAT 6A/fiber cables. There Shall be proper dressing of the cables and equipment management inside the racks.

The Cat 6A cable installation shall be done through penta scanning with standard parameters and shall have the OEM certification for the installation of all the components.

The optical fiber cable installation shall be checked by the OTDR machine and the reports shall meet all the parameters of the technical data sheet of the Cable and shall have the OEM certification for the installation.

After installation & OEM certification Commissioning of the passive components shall be completed.

1.3. ACTIVE COMPONENTS

1.3.1. Firewall with Unified Threat Management (UTM)

S.N.	Description
1	The UTM solution should be Hardware based, Reliable, purpose-built security appliance with hardened operating system that eliminates the security risks associated with general-purpose operating systems.
2	It Should support 1:1 high availability.
3	It Should have minimum 6 x 10G supporting SFP+ interfaces & 4 x 100/1000/10 BaseT RJ45 ports to cater to connectivity from multiple service providers and load balance them.
4	The Firewall should have ultra-low latency (~ < 5 micro seconds).
5	The Firewall should support IPSEC & SSL VPN, inbound and outbound both. The IPSEC VPN should deliver at least 20 Gbps throughput to ensure connectivity with Multiple colleges / University catering to Data / Voice traffic over IPSEC tunnel.
6	The Firewall should be able to handle very high concurrent sessions like 20 Million or above and at least 400,000 of new sessions per second.
7	The solution should support Virtualization with 10 Virtual contexts scalable to 250 to help University use the logical Firewalls for internal / student projects run isolated with each other.
8	The proposed solution should have integrated IPS module with at least 10Gbps of throughput for deep pack inspection of traffic and also should be able to inspect encrypted SSL traffic.
9	The solution should have at least 5 Gbps of Threat Protection throughput and the so that the entire

	traffic is scanned before reaching the end user. The antivirus engine should be able to inspect the encrypted traffic like HTTPS, SMTPS, POP3s , IMAPs, FTPs etc.
10	The proposed system should have integrated Web Content Filtering solution which can be used to block any unwanted sites / category of sites to adhere to University IT guidelines.
11	The Firewall & IPSEC VPN module shall belong to product family which minimally attain Internet Computer Security Association (ICSA) Certification or equivalent
12	The proposed system should have modules/Licenses for integrated Web Content Filtering along with IPS, Application Control, Antivirus / Malware Protection & Anti spam.
13	Proposed solution should be an Appliance/Virtual Machine based solution. In case of Virtual Machine based, required server must be quoted by bidder.
14	It Should have direct OEM TAC support.

1.3.2. Core Switch

S. N.	TECHNICAL SPECIFICATION
1	The proposed Switch should be a chassis based and have minimum~~4~~ 8 interface slots and 2 supervisor slots.
2	Switch should have 24 X 1/10G SFP+ Ports, 24 x 1G/10G Base-T RJ45 and 16 x 40 Gig QSFP+ (for switch to switch inter connectivity) ports spread across two cards. 24 Nos. of single mode LR transceivers should be populated from day 1.
4	Switch should have minimum 1.2 TB per interface slot throughput & 950 Mpps forwarding rate on Day 1. Switch should be scalable to support additional 192 x 10G Ports or 128 x 40G Ports or 48 x100G Ports at line rate performance.
5	The proposed line-cards must have non-blocking and wire-speed performance for all packet sizes for IPv4 & IPv6 traffic and should have distributed forwarding architecture.
6	It Should have redundant and replaceable Supervisor / CPU, Management Modules, Replaceable Fabric Modules/ Power Supply and Fans to provide full redundancy and high availability. The performance of the switch should not degrade in case of any failure.
7	Chassis should support 100G interface line-cards for future connectivity requirement without any replacement in hardware configuration.
8	Switch should have IPv4 & IPv6 static routes, OSPF, OSPFv3, PBR, PIM-SM / DM, BGP, VRF and SDN.
9	Should support Layer 2 protocols 802.1d, 802.1s, 802.1w and 802.3ad.
10	Switch should support minimum 8 hardware queues per port for applying various traffic prioritizations through QoS.
11	Switch should support minimum 2K ACL's, minimum 2K/4K Multicast and 200K Unicast Routes for IPv4 and IPv6.
12	Should support Port Security and RADIUS / TACACS+ integration.
13	Should be upgradable to support Open Flow or equivalent functionality, to support SDN (Software Defined Networking). The SDN functionality shall be native to switch
14	Should have NetFlow/sflow functionality for traffic monitoring.
15	The proposed switch should be IPv6 logo certified.
16	Should have compatibility to work in atmospheric tempemperature range -5 degree C to 50 degree C.

1.3.3. Distribution Switch

S. No.	TECHNICAL SPECIFICATION
1	Switch should support 40 Gbps of stacking bandwidth

2	Should have compatibility to work in atmospheric tempemperature range -5 degree C to 50 degree C.
3	Switch ports should be populated with 24 x 1G loaded with 12 x Multi Mode (SX) transceiver for access layer uplinks & with 4x10G Single Mode Transceivers (LR) for core layer and distribution ring uplinks from day 1.
4	The proposed interfaces must have non-blocking and wire-speed performance for all packet sizes for IPv4 & IPv6 traffic and should have distributed forwarding architecture.
5	Should be supplied with hot swappable redundant internal Power Supply.
6	Switch should have dedicated 1 x 10/100/1000 Base T port for Out of band Management port.
7	Switch should have IPv4 & IPv6 static routes and support for OSPF
8	Should support Layer 2 protocols 802.1d, 802.1s, 802.1w and 802.3ad & RFC 3619/G.8032 for sub 50ms failover
9	Switch should support minimum 8 hardware queues per port for applying various traffic prioritization through QoS.
10	Switch should support SP Queuing, minimum 1K ACL's, 2K/4K Multicast and WRED/WTD. Network OS, 400 Unicast Routes, IPv4 and IPv6 compliant.
11	Should support Port Security and RADIUS / TACACS integration.
12	Should be upgradable to support Open Flow or equivalent functionality, to support SDN (Software Defined Networking).
13	Switch should support port security, DHCP snooping, Dynamic ARP inspection, IP Source guard, BPDU Guard, Spanning tree root guard. IPv6 RA guard Should have MAC security – Lockdown & Limit and MAC address tracking with syslog & SNMP notification, Multicast traceroute.
14	Should support NetFlow/sflow functionality for traffic monitoring.
15	The proposed switch should be IPv6 logo certified. Desirable: EAL2 / NDPP / NDcPP certification.
16	Should have direct OEM 24x7x365 TAC support and Advanced hardware replacement warranty.

1.3.4. 48 Port PoE+ Layer 2 Switch

S. No.	TECHNICAL SPECIFICATION
1	Should have minimum 48 X 10/100/1000 BaseT PoE/PoE+ RJ45 Ports (minimum 740W) plus 2x 1/10G BaseX SFP+ Ports populated with 2 nos 1G (SX) SFP. Switch would use 1G uplinks on day 1 and be upgradable to 10G operations in future.
2	Should have 40 Gbps of stacking bandwidth proposed with stacking cable. Stacking should support upto 8 Stacking members
3	Should have compatibility to work in atmospheric tempemperature range -5 degree C to 50 degree C.
4	Switch should support External/Internal Redundant Power Supply
5	Switch should have dedicated 1 x 10/100/1000 Base T port for Out of band Management port.
6	The proposed interfaces must have non-blocking and wire-speed performance for all packet sizes for IPv4 & IPv6 traffic and should have distributed forwarding architecture.
7	Should support Layer 2 protocols IEEE 802.1s, 802.1w, 802.3ad, 802.1x, 802.1p, 802.1Q, 802.3, 802.3u, 802.3ab, 802.3z & RFC 3619/G.8032 for sub 50ms failover

8	Switch should have IPv4 & IPv6 static routes from day 1
9	Switch should have minimum 1K ACL's and 500 IPv4 and IPv6 multicast groups.
10	Switch should support minimum 8 hardware queues per port for applying various traffic prioritization through QoS. Switch should support SP Queuing and WRED/WTD
11	Should support 802.1 X authentication, Port Security and RADIUS / TACACS integration, Should have MAC security – Lockdown & Limit and MAC address tracking with syslog & SNMP notification, Multicast traceroute.
12	Should be upgradable to support Open Flow or equivalent functionality, to support SDN (Software Defined Networking).
13	Should have NetFlow / sFlow/equivalent functionality for traffic monitoring.
14	Switch should support port security, DHCP snooping, Dynamic ARP inspection, IP Source guard, BPDU Guard, Spanning tree root guard and IPv6 First Hop Security.
15	The proposed switch should be IPv6 logo certified. Should have EAL2/ NDPP/NDcPP certification from Day 1.
16	Should have direct OEM 24x7x365 TAC support with software update and NBD Advanced hardware replacement warranty.

1.3.5. 48 Port Layer 2 Switch

S. N.	TECHNICAL SPECIFICATION
1	Should have minimum 48 X 10/100/1000 BaseT RJ45 Ports plus 2x 1/10G BaseX SFP+ Ports populated with 2 nos 1G (SX) SFP. Switch would use 1G uplinks on day 1 and be upgradable to 10G operations in future.
2	Should have dedicated 40 Gbps of stacking bandwidth proposed with stacking cable. Stacking should support upto 8 Stacking members. Switch should have dedicated 1 x 10/100/1000 BaseT port for Out of band Management port.
3	Should have compatibility to work in atmospheric temperature range -5 degree C to 50 degree C.
4	Switch should support External/Internal Redundant Power Supply
5	The proposed interfaces must have non-blocking and wire-speed performance for all packet sizes for IPv4 & IPv6 traffic and should have distributed forwarding architecture.
6	Should support Layer 2 protocols IEEE 802.1s, 802.1w, 802.3ad, 802.1x, 802.1p, 802.1Q, 802.3, 802.3u, 802.3ab, 802.3z & RFC 3619/G.8032 for sub 50ms failover.
7	Switch should have IPv4 & IPv6 static routes from day 1
8	Switch should have minimum 1K ACL's and 500 IPv4 and IPv6 multicast groups.
9	Switch should support minimum 8 hardware queues per port for applying various traffic prioritizations through QoS. Switch should support SP Queuing and WRED/WTD
10	Should support 802.1x authentication, Port Security and RADIUS / TACACS integration. Should have MAC security – Lockdown & Limit and MAC address tracking with syslog & snmp notification, Multicast traceroute.
11	Should be upgradable to support Open Flow or equivalent functionality, to support SDN (Software Defined Networking).
12	Should have NetFlow / sFlow/Equivalent functionality for traffic monitoring.
13	Switch should support port security, DHCP snooping, Dynamic ARP inspection, IP Source guard, BPDU Guard, Spanning tree root guard and IPv6 First Hop Security.
14	The proposed switch should be IPv6 logo certified. Should have EAL2/ NDPP/NDcPP certification from Day 1.

15	Should have direct OEM 24x7x365 TAC support with software update and NBD Advanced hardware replacement warranty.

1.3.6. 24 Port PoE+ Layer 2 Access Switch

S. N.	TECHNICAL SPECIFICATION
1	Should have minimum 24 x 10/100/1000 BaseTPoE/PoE+ RJ45 Ports (minimum 370W) plus 2x 1/10G BaseX SFP+ Ports populated with 2 nos 1G (SX) SFP. Switch would use 1G uplinks on day 1 and be upgradable to 10G operations in future.
2	Should have dedicated 40 Gbps of stacking bandwidth proposed with stacking cable. Stacking should support upto 8 Stacking members. Switch should have dedicated 1 x 10/100/1000 BaseT port for Out of band Management port.
3	Should have compatibility to work in atmospheric temperature range -5 degree C to 50 degree C.
4	Switch should support External/Internal Redundant Power Supply
5	The proposed interfaces must have non-blocking and wire-speed performance for all packet sizes for IPv4 & IPv6 traffic and should have distributed forwarding architecture.
6	Should support Layer 2 protocols IEEE 802.1s, 802.1w, 802.3ad, 802.1x, 802.1p, 802.1Q, 802.3, 802.3u, 802.3ab, 802.3z & RFC 3619/G.8032 for sub 50ms failover
7	Switch should have IPv4 & IPv6 static routes from day 1
8	Switch should have minimum 1K ACL's and 500 IPv4 and IPv6 multicast groups.
9	Switch should support minimum 8 hardware queues per port for applying various traffic prioritization through QoS. Switch should support SP Queuing and WRED/WTD.
10	Should support 802.1x authentication, Port Security and RADIUS / TACACS integration. Should have MAC security – Lockdown & Limit and MAC address tracking with syslog & snmp notification, Multicast traceroute.
11	Should be upgradable to support OpenFlow or equivalent functionality, to support SDN (Software Defined Networking).
12	Should have NetFlow / sFlow/ Equivalent functionality for traffic monitoring.
13	Switch should support port security, DHCP snooping, Dynamic ARP inspection, IP Source guard, BPDU Guard, Spanning tree root guard and IPv6 First Hop Security.
14	The proposed switch should be IPv6 logo certified. Should have EAL2/ NDPP/NDcPP certification from Day 1.
15	Should have direct OEM 24x7x365 TAC support with software update and NBD Advanced hardware replacement warranty.

1.3.7. Authentication, Authorization and Accounting (AAA)

S. N.	TECHNICAL SPECIFICATION
1	Proposed AAA solution should be an Appliance based solution.
2	Proposed solution must support integration and security for both wired and wireless infrastructure. It should be ready to handle 7000 concurrent Devices from day1 and scalable for up to 12000 end systems. Devices are mixture of guest users, institute staff, machine endpoints.
3	AAA should support BYOD with Self-service authorization and device provisioning via open network.
4	It must allow for Machine Authentication (or an appropriate alternative) by AD-joined Windows laptops/tablets allowing wireless connection before user login.
5	The Solution should have detailed reporting capabilities for historical & real time data.

	Should be equipped with custom report designer to meet the need of specific data attributes and periodic email of the same to relevant administrative team.
6	The proposed solution should have Built-in user database with per device/user credential management and should also provide Seamless backend integration with RADIUS, AD, LDAP.
7	Solution should support agentless and agent-based assessment to reduce security vulnerabilities with End system Posture assessment.
8	Proposed solution should address (but not limited to) the below requirements:
	Intuitive user/device management and Unified device visibility and reporting
	Self-service 802.1X and guest access. Should also have option for MAC authentication for selective devices and Social Login.
	Integrated AAA server with key policy definitions. Should also support integration with external AAA server.
9	AAA should be able to integrate with existing user databases like Microsoft AD/LDAP/local.
10	It should be scalable to enforce device-specific settings for antivirus, firewall and OS patches, passcodes, NAC, proxies.
11	It should be able to enforce custom user and device privileges.
12	It should have direct OEM 24x7 TAC support with software upgrade and NBD Advanced hardware replacement warranty.

1.3.8. Network Management System (NMS)

S. N.	TECHNICAL SPECIFICATION
1	NMS shall be able to monitor and configure 500 devices (should be proposed against the proposed devices) and should have scalability to manage up to 2000 devices in future. NMS shall be able to manage both wired (routing/switching) and wireless networks in single pane of glass management.
2	NMS should be scalable to provide Deep application visibility using AVC, NetFlow/Sflow, NBAR or packet inspection to recognize a wide variety of applications and SNMP.NMS should be able to provide Network topology .
3	NMS solution should deliver pinpoint visibility into who, what, when, where, and how of wireless access through its own data collection and key integrations. It should support spatial / floor mapping; integrated location-based tracking of client
4	Should provide a customizable at-a-glance summary of all discovered devices and existing network switches to proactively identify problem areas and help prevent network downtime. The network has to be manageable at Network Operations Center (NOC) and through secured browser.
5	Should be able to discover, configure, monitor, manage, and deploy configurations to dynamically update groups of devices.
6	Should allow flexible definitions of administrator roles and responsibilities with RBAC (Role based Access Control) for different teams.
7	Should enable performance management by providing customizable dashboards and historical data visibility
8	Should be able to generate reports designed to summarize utilization of and traffic patterns on network interfaces.
9	Should allow administrators to track device configuration changes, enabling viewing, retrieval, and restoration of configuration files, and monitoring of configuration drift for troubleshooting

	purposes.
	The system design should provide access to only authorized users, RBAC and by using Secure Digital Certificates to completely trace back an individual user, in case of Cyber Crime or any other cyber investigation, as per the Computer Assets and Information Technology (CAIT) Policy of RIPANS .
10	Should have direct OEM 24x7x365 TAC support with software upgrade and NBD Advanced hardware replacement warranty.

1.3.9. Wireless LAN Controller

S. N.	TECHNICAL SPECIFICATION
1	Must be compliant with IEEE CAPWAP for controller-based WLANs or equivalent feature and it should be appliance based.
2	WLC should support IPv4 and IPv6 including IEEE 802.11a, 802.11b, 802.11g, 802.11d, WMM/802.11e, 802.11n, 802.11ac standards.
3	WLAN Controller should have minimum 6x of 10/100/1000 Ethernet Ports, 2x USB port and one Console port.
4	WLC should support up to 500 Access points day 1 and up to 16,000 Devices in a single chassis. Standalone controller should support seamless roaming access over L2/L3 network. Should be a dedicated hardware based appliance with minimum 4 GB RAM and 32 GB storage space. Spinning Hard Drive must be avoided.
5	There should be 100% redundancy for Primary controller i.e. N: N including Hardware and desired licenses to support AP's
6	WLC should provide air-time fairness between these different speed clients – slower clients should not be starved by the faster clients and faster clients should not adversely affected by slower clients.
7	WLC Must support an ability to dynamically adjust channel, power settings and airtime, based on the RF environment.
8	WLC should support L2/L3 discovery for AP's.
9	Should support adhere to the strictest level of security standards, including 802.11i Wi-Fi Protected Access 2 (WPA2), WPA, 802.1X with multiple Extensible Authentication Protocol (EAP) and 802.1x Authentication.
10	Controller should support WIDS/WIPS includes rogue AP detection, classification and automatic containment feature and prevention for DOS attacks.
11	WLC should support L2/L3/L4 Access Control and L2 Client Isolation so User cannot access each other's devices. Isolation should have option to apply on AP or SSID's
12	Controller/System should support Access Control based on Identity/Role/ Device/Time or Application.
13	Must support client roaming in L2/L3 networks and also across controllers.
14	Controller should support integrated or External AAA servers including Microsoft AD and Linux based open source AAA.
15	The Controller/System should support L7 Application/OS/Device finger printing and device type based policies i.e allow or deny, Bandwidth rate limit, VLAN mapping
16	Wireless Network should support deep packet inspection for all user traffic across Layer 4-7 network to analyses information about applications usage
17	The controller/System should be able to raise critical alarms by sending an email and/ or SMS.
18	Per SSID or dynamic Per user bandwidth Rate Limiting

19	Support advanced multicast features and WMM support to provide best performance on Video applications and should have
20	Controller/System should have BYOD features and should support integrated/ and external captive portal integration.
21	System should provide a web-based application that allows non-technical staff to create Guest accounts with validity for fixed duration like hours or days and restricted to number of devices. Password to guest should be shared over Email and SMS (SMS gateway services shall be provided by Campus).
22	Proposed solution should be an Appliance based solution.
23	Should have direct OEM 24x7 TAC support with Software upgrade and NBD Advanced hardware replacement warranty.

1.3.10. Wireless Indoor Access Points

S. N.	TECHNICAL SPECIFICATION
1	Wall/Ceiling mounted Wi-Fi access-point suitable for indoor use with at least 2 10/100/1000Mbps Ethernet ports supporting standard 802.3af/at POE+.
2	802.11ac AP should operate in 2.4 GHz (450 Mbps or more) and 5 GHz simultaneously and capable of minimum 1.7Gbps on 5 Ghz for 802.11ac clients supporting minimum4x4 MIMO with 4 spatial streams. It must support minimum 3 concurrent MU-MIMO users.
3	Should support minimum 16x BSSID per AP. Should have compatibility to work in atmospheric temperature range -5 degree C to 50 degree C.
4	Must have an dynamic or smart RF Management features which allows WLAN to automatically and intelligently adapt to changes in the RF environment. The access point should support captive portal and local data base for authentication.
5	Maximum conducted transmit power shall be 24.7 dBm on both 2.4 and 5 GHz with two antennas and EIRP complying to regulatory requirements. The External antenna gain proposed should be minimum 8 dBi or above on both the bands. Should support 20,40 and 80 MHz Channels.
6	AP should support band steering and load balance across bands and AP's. The access point or the controller should be capable of running a local DHCP Server.
7	Security mechanisms should be in place to protect the communication between the Access Point controller and the Access Points. Access points must support a "controllerless" mode where one AP will provide full RF and network management.
8	The access point should support WPA2 enterprise authentication and AES/CCMP encryption. WLAN solution must support personal and enterprise WPA2 authentication for a staff WLAN concurrent with open access public WLAN.
9	AP should support 802.11k for Radios Resource management and 802.11r for fast roaming.
10	Implement Wi-Fi alliance standards WMM, 802.11d, 802.11h and 802.11e and should support VoWLAN
11	AP must support L7 Application Identification and spectrum analysis functions
12	AP should support Minimum -90dB Receiving sensitivity. AP should support Receiver sensitivity Threshold to reduce noise reception in the AP to increase SNR and performance
13	802.11 a/b/g/n/ac wave 2 functionality certified, Wi-Fi alliance Should be approved & certified UL / cUL 60950-1, IEC / EN60950-1, UL2043, RoHS. FCC (USA), EU, TELEC, Medical EMC standard: EN/IEC 60601-1-2.
14	Should have direct OEM 24x7x365 TAC support with software update and NBD

	advanced hardware replacement warranty.

1.3.11. Wireless Outdoor Access Points

S. N.	TECHNICAL SPECIFICATION
1	Wall/Ceiling/Poll mounted Wi-fi access-point suitable for outdoor use with at least 1 10/100/1000 Mbps Ethernet ports supporting standard 802.3af/at POE+.
2	802.11ac AP should operate in 2.4 GHz (450 Mbps or more) and 5 GHz simultaneously and capable of minimum 1.3 Gbps on 5 Ghz for 802.11ac clients supporting minimum 3x3 MIMO with 3 spatial streams. It must support minimum 3 concurrent MU-MIMO users.
3	Should support minimum 16 X BSSID per AP. Should have compatibility to work in atmospheric temperature range -5 degree C to 50 degree C.
4	The access point should be capable of performing security scanning and serving clients on the same radio. It should be also capable of performing RF analysis and security scanning using same radio.
5	Maximum conducted transmit power shall be 24.7 dBm on both 2.4 and 5 GHz with two antennas and EIRP complying to regulatory requirements. The External antenna gain proposed should be minimum 8 dBi or above on both the bands. Should support 20, 40 and 80 MHz Channels.
6	AP should support band steering and load balance across bands and AP's. The access point or the controller should be capable of running a local DHCP Server.
7	Security mechanisms should be in place to protect the communication between the Access Point controller and the Access Points.
8	The access point should support WPA2 enterprise authentication and AES/CCMP encryption.
9	AP should support 802.11k for Radios Resource management and 802.11r for fast roaming.
10	Implement Wi-Fi alliance standards WMM, 802.11d, 802.11h and 802.11e and should support VoWLAN.
11	AP must support L7 Application Identification and spectrum analysis functions.
12	AP should support Minimum -90dB Receiving sensitivity. AP should support Receiver sensitivity Threshold to reduce noise reception in the AP to increase SNR and performance.
13	802.11 a/b/g/n/ac wave 2 functionality certified by the Wi-Fi alliance, Should be IP67 rated and RF transmission power should be approved by WPC.
14	AP should support up to 100-mph sustained winds and up to 165-mph wind gusts
15	Should have direct OEM 24x7x365 TAC support with software update and NBD advanced hardware replacement warranty.

1.3.12. Router

S. N.	TECHNICAL SPECIFICATION
1	Router should be a modular aggregation platform. It should support broadband aggregation for voice, video, data, and mobility services with QoS scaling to a large number of queues per device.
2	Router should have 8 nos. of 10/100/1000 Base-T ports and 4 nos. SFP based ports.
3	Router should have at least 1 open slots for additional LAN/ WAN modules other then asked ports.
4	Router should have 4x10 Gigabit SFP+ ports from day 1

5	Router should have minimum 4 GB RAM from day 1.
6	Router should have DES, 3DES and AES Standards through dedicated encryption module/processor. Should support IPSec with IKEv2 and Suite-B Encryption
7	Router shall have hot swappable 1:1 redundant internal power supply
8	Router should have a minimum performance of 15 Mpps and 10 Gbps of bandwidth, Scalable to 20 Gbs in future.
9	Router should support static Routes, OSPFv2, OSPFv3, BGP4, MBGP, BFD, Policy based routing, IPv4 and IPv6 tunneling, MPLS LDP, MPLS L3VPN, MPLS L2VPN , MPLS TE, FRR Link & Node Protection, LDP, MPLS Static label, MPLS VRF-aware static labels, LDP - Session Protection, LDP - Graceful Restart, MPLS L2VPN Pseudo wire Redundancy with TE/FRR protection, Support for QinQ to Ethernet/VLAN Ethernet/IP interworking, MPLS VPN - Carrier Supporting Carrier (CsC), CsC with IPv4 BGP label distribution (RFC 3107)
10	Router should support IGMP v1/v2/v3 and PIM multicast routing
11	Should support other IP Services like GRE tunnel, IPv4 tunnel, IPv6 tunnel, Virtual Router Redundancy Protocol (VRRP), Network Address Translation (NAT), Access Control Lists (ACLs)
12	Shall have 802.1p class of service, IP differentiated service code point (DSCP) and IP precedence,
13	Routers should support marking, classification, policing and shaping, Hierarchical QoS for Traffic Management inspections, QoS classification with TCP Application traffic. The router shall provide up to 16k queues for deployment of per-user per-application per-port QoS.
14	Router should support SSHv2, SNMPv2c, SNMPv3, NTPv3 or/and NTPv4 (if available with OEM)
15	Routers should support AAA using RADIUS and TACACS+
16	Support for accounting of traffic flows for network planning and security purposes. Router shall provide application recognition through analysis of flows.
17	Support for accounting of traffic flows for network planning and security purposes. Router shall provide application recognition through analysis of flows.
18	Router should support monitoring of network traffic with application level insight with deep packet visibility into web traffic, RTP-Based VoIP traffic and cRTP
19	Router shall have traffic load balancing capability on dual WAN Links based on based on advanced criteria, such as reachability, delay, loss, jitter and bandwidth utilization.
20	Router / Router's Operating System should be tested and certified for EAL 4 or above under Common Criteria Certification
21	Router should be IPv6 Certified/IPv6 logo ready
22	Router should have direct OEM TAC support and hardware replacement warranty.

1.4. Testing & Commissioning:

All Active components shall have the OEM test reports and shall have direct OEM warranty/ Guarantee support for hardware replacement and for software operational related issues. All equipment's installation shall be considered completed after verifying all the features of the system as mentioned in the specifications and as per the standards.

All equipment shall be replaced if there is any fault in the hardware or in software within two to three hours. The Agency shall supply the spares of the main equipments in the stock so that the work of the complex shall remain smooth & undisturbed. All equipment's installation shall be

considered completed after verifying all the features of the system as mentioned in the specifications in the Tender and as per the standards.

2. IPABX SYSTEM

IP Based Central IPABX of initially capacity of 500 Telephones & expandable up to 2000 telephones shall be located at a central location in the Hospital OPD block at RIPANS Aizawl. All the Telephone in the Complex will be IP Based and will use the existing LAN Network for the communication within the complex as well as for outside the complex. All Rack Panels of Individual buildings shall be connected to Central EPABX system through Optical Fiber Cable to be laid underground in HDPE Pipe of suitable size. Manholes with covers shall be provided in the underground HDPE pipe at suitable lengths for easy pulling & maintenance of cables. 20% LAN switches shall be provided as spare as required & as per directions of E-I-C.

Type of IP Phones shall be provided as detail given below as per directions of Engineer In Charge:-

1. Type -4 IP Phone – President, Director, Medical Superintendent, Dean, Principal, Auditorium Conference Room, Office In Directors Residence. etc.
2. Type -3 IP Phone – HODs, Chairman, Conference Room etc.
3. Type -2 IP Phone – Guest House,Security room, Server Room, Fire Control Room, etc.
4. Type-1 IP Phone – All Residential Blocks, Hostels, WTP,ETP,STP etc.

2.1. The following are the specifications for the proposed IPABX System for the RIPANS Aizawl:

2.1.1. IPABX Hardware:

Item	Feature description	Remarks
Processors	Each server shall have a minimum of two (2) Intel E5-2600 series CPUs and supports the Intel E5-2697 v2 2.70 GHz 130 W CPU	Offers the latest technology
Storage	The server should have up to 24 front-accessible, hot-swappable, SAS ,SATA or SSD drives	Offers more options for local storage, providing redundancy options and ease of serviceability
	The Server RAID controller should support the following configurations RAID 0, 1, 5, 6, 10, 50, and 60	Provides redundancy options and ease of serviceability
	Should support a write cache of 1 GB for the storage controller	To meet the demands of disk intensive applications
	Support for a battery back write cache for the storage controller	Increase data reliability and integrity
	Must have an internal slot for SD card / Flash which supports booting hypervisors	Offers more internal storage options for HLL to choose from
Memory	Should have at least 24 DIMM slots for up to 768 GB of DDR3 memory using 32 GB DIMMs	To meet most typical server requirements
	Support for advanced memory redundant technologies like Advanced error-correcting code (ECC) and memory mirroring	Flexibility, increased performance, and compatibility with industry standards
Network	Should have 2 * 1 GbE LAN on Motherboard (LOM) for network connectivity	Offers network connectivity without using any of the PCIe expansion slots
	The server should support the technology of 10-Gbps unified network fabric which aggregates both the	Fewer interface cards, cables, and upstream network ports to purchase,

	Ethernet and FC connectivity on a single controller using Low-latency, lossless, 10-Gbps Ethernet and industry-standard Fiber Channel over Ethernet (FCoE) fabric	power, configure, and maintain
PCIe Slots	Each server should offer 5 PCI Express (PCIe) 3.0 slots ● 2 x 16x both full height ,one half length & the other 3/4 length ● 2 x 8x both full-height and one is half-length ● 1 x 8x half height half length	Flexibility, increased performance, and compatibility with industry standards
Management	The integrated management controller should support web user interface for server management; remote keyboard, video, and mouse (KVM); virtual media; and administration with Virtual media support for remote KVM and CD and DVD drives as if local	Simplified and easier management
	The server should support Intelligent Platform Management Interface (IPMI) 2.0 support for out-of-band management through third-party enterprise management systems	Follows industry standard
	The server should support Command-line interface (CLI) for server management	Follows industry standard and offers a choice for the administrators
Ports	Should have the following ports for server connectivity ● 1 serial port ● 2 USB ports ● 1 VGA video port	Options for further scalability
Others	Supports hot swappable redundant fans	Builds capability for enterprise-class reliability and uptime
	Supports hot swappable redundant power supplies	Builds capability for enterprise-class reliability and uptime
Environmental	Operating Temperature support from 23°F to 104°F (-5°C to 40°C) and Non operating Temperature from -40°F to 149°F (-40°C to 65°C)	Wide range of operating environments
	Operating Humidity from 10 to 90% non condensing	Wide range of operating environments
	Operating Altitude from 0 to 10,000 ft (0 to 3000m) and Non operating Altitude up to 40,000 ft (12,000m)	Wide range of operating environments

2.1.2. Exchange Software:

The network will have SIP based call control architecture with call control functionality centralized or distributed across multiple nodes across WAN for enhanced redundancy.
General Specifications for Solution
A comprehensive IP based solutions based on a Server Gateway Architecture.
Support for integrated telephony solution for Video conferencing devices, Analog & IP Phones, PSTN gateways over IP architecture.
The solution should offer executive users the ability to use their video device outside of the enterprise (Internet) to make audio and video calls with or without VPN.
The solution should allow for business to business (B2B) video calls using SIP, H.323 with other organizations without bypassing existing firewalls. At least 5 concurrent video calls @720p30 should be allowed from day one.
The solution should allow provisioning of gateways with redundant power supplies.
Call Control, MCU and IP Phones should be from the same OEM for better interoperability and user experience.

The OEM and bidder should be profit making entity.
The acceptable makes of the offered equipment for IP PBX, IP Phones and UC clients shall be as per Leader's quadrant of Gartner's magic quadrant for unified communications from the latest publication of Gartner.
System Architecture
The call control system should be fully redundant solution with NO single point of failures & should provide 1:1 redundancy. Both the server should do call processing all the time and act as backup in case of the failure of one server and must be deployed in High Availability mode.
The call control should support clustering over WAN
The proposed system should be Integratable with ACD, IVR.
The call control system should support IPv4 and IPv6 from day one.
The system should natively support tenant partitioning so as to comply with TRAI regulations for not allowing VoIP (CUG calls) and PSTN calls to be bridged. Any third party applications to manage tenant partioning should not be quoted in the architecture.
The proposed call control server should provide support for standards based SIP IP Phones (Wired & Wireless), Analog Phones, Video Phones, Video Conferencing endpoints and soft clients to provide centralized management and unified dial plan.
Conference Bridge—provides software conference bridge resources that can be used by IP EPABX.
The system should support an inbuilt reporting tool for calls. Reports that are provided include Calls on a user basis, Calls through gateways, Simplified Call Quality.
Should support signaling standards/Protocols – SIP, MGCP, H.323, Q.Sig.
CODEC support - G.711, G.729, G.729ab, g.722, iLBC
The system should provide the ability to perform tasks in bulk i.e. Add, Remove, Update users, phones, gateways, dial plan etc.
The system should support creation of users and their authentication locally and via an integration with LDAP.
The system should support an inbuilt reporting tool for calls. Reports that are provided include Calls on a user basis, Calls through gateways, Simplified Call Quality.
The system should support call admission control to configure number of calls that can be active between locations – intercluster and intracluster.
Call preservation – redundancy and automated failure – on call-processing failure. In progress PSTN calls at each of the locations should not be interrupted in the event of any WAN failure or call control server failure.
Open API should be provided when required which will help to develop customized IP applications which will integrate with call processing.
It is required to provide Survivable Call Control functionality so that the survivable system at the remote location i.e. Media Gateway shall provide fall back call control service in case the remote site looses all connectivity to the main Call Control system placed. It is expected that the survivability call control system will provide a minimal set of essential telephony features to the end-users that could be a subset of the feature that are available from the main call control system.
The call control system must support all types of phones required by RIPANS Aizawl
Security
All the appliances in the call control system should have dual redundant and hot swappable power supply and fans for high availability.
All appliances in the call control system should have hot swappable storage media to ensure high availability.
Support for configuration database (contains system and device configuration information, including dial plan)
Having inbuilt administration web based administration. No additional thick client for administration on the Admin PC. Should also support HTTPS for management.
Access to the system should be secure for the purpose of access over IP network. The protection of signaling connection over IP by means of authentication, Integrity and encryption should be carried out using TLS.
There should be provision of defining password aging, one time passwords. Provision shall be available to bar unauthorized user to connect to the system. The system should monitor and report the following types of security \ violation login Violations, authorization code violation Station security code violations etc.

IP Phones should not support direct, external initiated, connections via HTTP, telnet, FTP, TFTP or any other protocol as means to prevent distributed Denial of Service attack exploitation, except those required for routine firmware upgrades.
Role Based Account Management to define different levels of administrator access depending on specific function responsibility
The system should support complete encryption capabilities with the ability to encrypt all traffic (media and call control signaling) between IP phones, soft phones, call controllers, gateways and all other associated endpoints using a strong encryption algorithm (AES, IPSec and SRTP, for example).
All management traffic between the remote console/session and control server should be encrypted (SSH for Direct Command Line Sessions, Interface, HTTPS (SSL) for Web Sessions, SFTP for File Transfer Etc.).
Should support SSL for LDAP directory integration.
All Hardware & Software with license required for providing above Security measures must be incorporated.
System Capabilities Summary
The System should have IP capability for interfacing & Communicating with Voice, Video and Data infrastructure
The architecture should support a minimum of 1500 IP phones and VC systems per Server from day one.
The architecture should support single Server Clustering to provide scalability to offer support for 40,000 users and also to provide redundancy. All the 40,000 users to be managed in a single database which is managed centrally, no multiple databases.
The System should support Alternate Call Routing
The System should have GUI support web based management console
System backups: The management system should have the provisioning for taking manual as well as scheduling of automatic periodic backup of complete system & data.
The System should support Audio message-waiting indicator (AMWI)
The System should have Automated bandwidth selection
Should support SNMP v2, v3
It should be possible to monitor the call control system i.e. system performance, device status, device discovery, CTI applications, voice messaging ports etc.
IM & Presence
Solution should provide a "presence" application for users, so that they can see the availability status of their contacts in their contact list.
The common supported status for this application should be available, busy, idle, away etc.
Should support the users to see other user's IP phone's on/off hook states
The instant messaging application should support manual setting of user status to: Available, Away, Do Not Disturb (DND) etc.
Shall provide support for open protocols like XMPP.
Presence based desktop application shall allow escalation of Instant Message to Audio call and further to Video call
Should support management of contact list and personal settings from Presence based desktop application
Should support click to call, click to Video and click to conference features.
The Soft Client should have soft phone capability and should support desktop and iPad based point to point video calls.
Video Telephony Support
The call control system should provide integrated video telephony features to the users so that user with IP Phone / Soft phone and video telephony end point should be able to place video calls with the same user model as audio calls.
The solution must support escalation of point to point video calls to Multiparty video calls using the central MCU without disconnecting the call.
The users should be able to transfer video calls as audio calls
Call-Server should provide a common control agent for signaling, configuration, and serviceability for voice or video end points.

Call control system should handle CODEC and video capabilities of the endpoints, bandwidth negotiation to determine if video/audio call can take place.
End user Features required:
Extension mobility
Call forward all
Message-waiting indicator (MWI)
Privacy
Device mobility
Do not disturb
Hunt groups
Dial-plan partitioning
Distributed call processing
Deployment of devices and applications across an IP network
"Clusters" of Call-Servers for scalability, redundancy, and load balancing
Inter cluster scalability to 100+ sites or clusters through H.323 gatekeeper
Fax over IP—G.711 pass-through and Fax Relay
Forced authorization codes and client matter codes (account codes)
H.323 interface to selected devices
Hotline and private line automated ring down (PLAR)
Interface to H.323 gatekeeper for scalability, CAC, and redundancy
Language support for client user interfaces (languages specified separately)
Multi-Level Precedence and Preemption (MLPP)
Multi location—dial-plan partition
Multiple ISDN protocol support
Multiple remote Call Server platform administration and debug utilities
Prepackaged alerts, monitor views, and historical reports with Real Time Monitor Tool (RTMT).
Real-time and historical application performance monitoring through operating system tools and Simple Network Management Protocol (SNMP)
Remote terminal service for off-net system monitoring and alerting
Real-time event monitoring and presentation to common syslog
Trace setting and collection utility
Cluster wide trace setting tool.
Trace Collection tool.
Multisite (cross-WAN) capability with intersite CAC
Q.SIG (International Organization for Standardization [ISO])
Video calls to be placed with the same user model as audio calls.
Call-Server should support new video end points.
SIP Video endpoints which should inherit the functionality of audio calls which gives the user the same call model for both video and audio calls.
Call-Server should have the infrastructure to handle codec and video capabilities of the endpoints, bandwidth negotiation to determine if video/audio call can take place, single point of administration, management of media devices such as gateways and MCUs.
Call-Server should provide a common control agent for signaling, configuration, and serviceability for voice or video end points.

2.1.3. Type -1 IP Phone:

Type -1 IP Phone
The phone should support at least 1 line.
It should support the following codec G.711a/μ, G.729a

It should have graphical display with a minimum resolution of 128 x 32 pixels
The phone should support QoS mechanism through 802.1p/q.
Should have built-in high-quality full-duplex speakerphone
Should include audio controls for the full-duplex speakerphone and handset.
IP address Assignment by DHCP or statically configured
The Phone should support the ability to provide different ringtones for internal and external calls.
Should have volume control button for easy decibel-level adjustments for the speakerphone, handset and ringer.
The phone should support mounting against a wall
The phone should support IPv4 and IPv6 from day one.
The phone should support Power over Ethernet IEEE 802.3af class 1/2/3 and should also have AC power adapter option
The phone should be a SIP based Phone i.e. session Initiation protocol (SIP) supported
The phone should provide basic 3-way conferencing
The phone should support at least 50 entries for call history i.e. missed, received, placed etc.
Should have keys for specific functionalities such as – Redial, settings, transfer, speakerphone, mute on/off, hold/resume
Should have 4 MB flash memory and 30 MB or more SDRAM.

2.1.4. Type -2 IP Phone:

Type -2 IP phone
The phone should support Power over Ethernet IEEE 802.3af class 1/2/3 and should also have AC power adapter option
Should feature a LCD display of at least 3.5" for information such as calling party name, calling party number, and digits dialed to be displayed.
The phone should have two Ethernet ports of at least 10/100/1000 BASE-T Ethernet ports, one for the LAN connection and the other for connecting to PC/laptop.
Corporate directory and Lightweight Directory Access Protocol (LDAP) integration.
Ready access to missed, received or placed calls (plus intercom history and directories).
The phone should support QoS mechanism through 802.1p/q.
IP address Assignment by DHCP or statically configured
Hands-free operation with full-duplex speaker-phone
The phone should be a SIP based Phone i.e. session Initiation protocol (SIP) supported
The phone should support XML based services and applications.
The phone should have a distinct LED indicator for message waiting.
Should have keys for specific functionalities such as – voicemail, directories, settings, transfer, speakerphone, mute on/off, headset etc
Media Encryption (SRTP) using AES
Signaling Encryption (TLS) using AES
Should support 802.1x
Encryption of Configuration Files
The phone should have the ability to register to call control server over an internet link with or without VPN.
The phone should support IPv4 and IPv6 from day one.

The phone should support at least 100 entries for call history i.e. missed, received, placed etc.
It should support the following codecs: G.711a/μ-law, G.722, G.729a, iLBC
The phone should have RJ9 headset port to connect any standards based headset. The phone should also have a separate headset key
The phone also includes the following settings - Display contrast, Ring type, Network configuration, Call status
The Phone should support the ability to provide different ringtones for internal and external calls.
Should have volume control button for easy volume adjustments for the speakerphone, handset and ringer.
The phone should support mounting against a wall
The phone should support 4 programmable lines keys.
The phone should the following features:
i Call forward
ii. Call pickup
iii. Call waiting
iv. Extension Mobility
v. Auto answer
vi. Message waiting indicator
vii. Music on hold
viii. Forced Authorization Code (Account Code/FAC)
ix. Conference
x. Music on Hold (MoH)
xi. Corporate directory
xii. Auto-detection of headset
xiii. Busy Lamp Field (BLF)
xiv. Callback
xv. Immediate Divert

2.1.5. Type -3 IP Phone -Video:

Type - 3 IP Phone –Video
The phone should support Power over Ethernet IEEE 802.3af class 1/2/3 and should also have AC power adapter option
The phone should have 2 x 1GE ports, one for the LAN connection and the other for connecting to PC/laptop.
Corporate directory and Lightweight Directory Access Protocol (LDAP) integration.
Ready access to missed, received or placed calls (plus intercom history and directories).
The phone should support QoS mechanism through 802.1p/q.
IP address Assignment by DHCP or statically configured
Hands-free operation with full-duplex speaker-phone
The phone should be a SIP based Phone i.e session Initiation protocol (SIP) supported
The phone should support XML based services and applications.
The phone should have a distinct LED indicator for message waiting.
Should have keys for specific functionalities such as – voicemail, directories, settings, transfer, speakerphone, mute on/off, headset etc

Media Encryption (SRTP) using AES
Signaling Encryption (TLS) using AES
802.1x support
Encryption of Configuration Files
The phone should have the ability to register to call control server over an internet link with or without VPN.
The phone should support IPv4 and IPv6 from day one.
Should have min 5" screen with colour display with at least 4 programmable line keys
The phone should support backlit indicators for the audio path keys (handset, headset, and speakerphone), select key, line keys, and message waiting.
Should support following audio codec - G.711a, G.711u, G.729a, G.722, iSAC, Internet Low Bitrate Codec (iLBC)
The phone should have RJ9 headset port to connect any standards based headset. The phone should also have a separate headset key
Should have a built-in camera with 720p resolution (encode & decode). The camera should have a shutter to open/close camera. Should support standards based video protocol H.264
Should support self-view video, picture in picture (pip) with adjustable positions of pip.
Should support Bluetooth (v4.1 LE) for hands free earphones
Should support Call history synchronization to view placed and missed calls of mobile device from the IP Phone
Should support Contact synchronization to synchronize the contacts from the mobile device to IP Phone
The phone should support mounting against a wall
The phone should support at least 100 entries for call history i.e. missed, received, placed etc.
Should support busy lamp indicator (BLF) to indicate the presence
Should support boss-secretary feature, so that secretary can answer calls on behalf of Manager
The handset should be hearing aid-compatible
The phone should be available in white color
The phone should support the following features at a minimum:
a. Call forward
b. Call pickup
c. Call waiting
d. Call back
e. Call park
f. Conference
g. Extension Mobility
h. Auto answer
i. Auto-detection of headset
j. Immediate Divert
k. Music on hold (MoH)
l. SIP URI dialing
m. URL Dialing
n. Message waiting indicator (MWI)
o. Personal directory
p. Forced Authorization Code (Account/FAC)
q. Call history lists

2.1.6. Type -4 Executive IP Video Phone:

Type - 4 Executive IP Video Phone	
Specifications for the Personal Video conferencing system for executives.	
Should be an integrated system with at least 22 to 24 inch LCD/TFT screen,**1080P resolution** (16:9), HD camera and with speakers for wide band audio output. The Codec should be a part of the unit. No separate Codec's are preferred.	
The LCD/TFT screen should be a touch screen to provide a touch interface to the user.	
Features	**Specifications**
General	
	Must support IPv4 and IPv6 from day one.
	Must have the following physical buttons for ease of use 1. Mute/ Unmute 2. Volume Increase/ decrease
Video	
Video Standards	Minimum H.264 and above
	The system should support SIP protocol.
	Must support desktop sharing SIP calls
Video Frame Rate	Must support 1080p 30 fps
Video Features	Ability to send and receive two live simultaneous video sources in a single call.
	The unit must support layout control for video and presentation on a single LCD screen.
Video Input	Should have HDMI or DVI (Digital Video Interface) input to connect PC/ Laptop directly to the Video conferencing system and display a resolution of XGA/SXGA.
	The user must be able to toggle between the Laptop/PC mode and the Video conferencing mode at a push of button/icon.
Video Resolution	CIF (352 x 288 pixels) VGA, 240p, 360p, 480p 720p (1280 x 720 pixels) 1080p (1920x1080 pixels)
Dual Stream	Must support H.239 and BFCP for resolutions upto 1080p
Firewall Traversal	Should support firewall traversal solution using the H.460.18 and H.460.19 protocol.
Audio	
	Audio System : The system should have two stereo front speakers with inbuilt microphones, wideband speakers.
	G.722, G.711, MPEG 4 AAC or better - which supports 20 KHz audio must be supported
Other Features	Noise Reduction/Echo Cancellation, Automatic Gain control, Automatic Audio mixer
	Must support escalation of point to point calls to Multiparty calls using the central MCU without disconnecting the call.
Network Interfaces	
LAN	1 x LAN /Ethernet--10/100/1000
	1 x LAN /Ethernet--10/100/1000 to connect a PC (i.e. built in switch)
Wi-Fi	Must support 802.11a/b/g/n
Bluetooth	Must support bluetooth 3.0 for connecting bluetooth headsets
SIP/H.323/ IP Features	
	Must support Standard based Packet loss recovery alogorithm to handle packet loss.

	QOS
	Should support URI Dialing
	Must support SIP and H.323
Data Collaboration	
	Presentation through presence of DVI/HDMI Input port
	The system must have the ability to pair mobile devices such as Tablets and Smart phones based on iOS or Android platforms so that these devices can be used for: 1) View the Presentation that is being shown in the VC call. 2) Add and disconnect call, move the call from mobile device to/ from video unit. The system must have the ability to pair with laptop for sending content without any wires to the video unit. In case the above feature is not available natively, then additional components can be provided to achieve this functionality.
Security	
	Password protected system menu
	Meetings both point and point and multipoint , should be password protected and the same should be possible for SIP networks
	Encryption of video call: ITU-T standards based Encryption of the video call using Advanced Encryption Standard (AES)
	Call should be encrypted end-to-end on IP calls
	The unit must support the option of disabling the secondary network port if not in use.
Camera	
	Should be HD at least 6 megapixel camera, with privacy shutter
	Must support 1080p resolution.
	60 degress horizontal Field of View
	35 degress vertical field of view
	Must have a privacy shutter
	The VC unit must allow the camera to be used as a document camera to capture hard copies and transmit it to the far end site.
Directory Services	
	Should support Local and Global directories
	Should support LDAP and H.350 protocols for directory transfer.

2.1.7. Meeting Server:

Specifications for High Definition Multipoint Control Unit (MCU)		
MCU must be standards based and meet the following specifications:		
S No.	**Feature**	**Specifications**
1	**General**	The MCU should be running on standard intel servers on standard Virtualized platforms. The hardware, software and virtualization software should be supplied and supported by a single bidder.
		All necessary hardware to support the required capacity needs to be supplied from day one. Each of the server supplied for the MCU must have a redundant power supply from day1.
		The MCU must have 25 Full HD ports @1080p 30 fps with H.264 AVC and

		Continuous presence from day one.
		All the 25 ports must be able to connect different sites at different bandwidths and protocols. H.264 AVC standard must be supported at the minimum to connect all the 25 devices.
		The MCU must be able to host at least 4 simultaneous conferences each having different capacities restricted by the maximum port capacity of the MCU
		The MCU must also support HD mode and it must provide a capacity of connecting at least 50 sites @720p30 fps
		MCU should be capable of supporting participants using various means i.e. via video enabled phones, room based video endpoints, soft clients on mobile/tablet or via the browser using WebRTC compatible browsers in a single conference. The meeting quality has to be consistent and of high quality. The end points can be present on the WAN network or on the internet. In case additional components are required for this functionality, all additional components required to have this functionality has to be included in the solution
		The MCU should have the capability to host meetings with internal and external participants in a secure way such that it should co-exist with the enterprise security policies
		The MCU should support H323 and SIP protocols.
		The MCU should support geographical redundancy, so that MCU could be placed in DC/DR setup in case future expansion is needed.
		The MCU must support the concept of virtual meeting rooms to users who Hosts meeting frequently. Such meeting rooms should support dialing in from standard based video end points, internal and external users and browser based clients. The system should allow one Virtual meeting room per employee, however it should not consume resources when not in use.
		The MCU should be able to maintain the dynamic resource allocation capacity for 1080p, 720p and SD participants simultaneously without having to reboot or change any configuration.
		The MCU should support 90 ports or more at HD 720p (transmit and receive) up to 4Mbps on IP in continuous presence mode with 30fps, 1500 audio ports, 50 WebRTC connections and H.264 resolution and AES encryption on the same MCU.
		The MCU should display a security icon on the endpoint if the conference is secure.
		The administrator should be able to specify maximum resolution for main video and content.
		Video conferencing endpoints deployed at other organization must be able to take part in video conferencing. The endpoints can be of various makes using open standards.
		Interoperability with all organization must be possible using standards based dialling methodology using the Internet.
		The MCU should support on-screen text messaging on video endpoints, so that if there's a delay in starting a meeting, participants can be informed.
		The MCU should be able to integrated with existing IP PBX to provide audio conferencing ports to phones.
		The MCU should be able to integrate with Call Control system using SIP.

2	**Video Standards**	Should support H.263, H.263+, H.263++, H.264, H.264 SVC/H.264 High Profile video algorithms
3	**Video Resolution**	Should support video resolution from SD to Full HD to join into a conference
		The proposed MCU should be able to combine HD and SD in the same conference without degrading the HD resolution from and to the HD endpoints. The MCU shall interoperate with multiple vendors' endpoints. The supported mediums should be IPv4 and IPv6.
4	**Audio Standards**	Along with the support for basic algorithms like G.711 and G.722.1 the MCU should also support wideband Audio protocols like MPEG 4 AAC - LC and MPEG 4 AAC - LD
5	**Trans coding & Rate Matching**	The MCU should support transcoding of different Audio/video Protocols.
		MCU should be able to combine HD and SD in the same conference without degrading the HD resolution from and to the HD endpoints.
6	**Dual Video**	The MCU should have H.239/BFCP protocol for sending and receiving dual video streams (Presenter + Presentation).
7	**Video Layouts**	At least 16 sites to be seen simultaneously on the screen in traditional Continuous Presence mode.
		The MCU must also support advanced continuous presence such that the site that is "on-air" to be seen on a larger window and the other sites are seen in smaller quadrants.
8	**Security**	The MCU must be a secure Non-PC Hardware with a strong operating system. The Hardware and software must be from the same OEM.
		The MCU should support 128 Bit strong AES encryption for calls and H.235 for authentication
		The MCU must support encryption for calls on SIP.
9	**Network /USB Interface**	At least 1 LAN /Ethernet--10/100/1000 Mbps full duplex and dedicated serial/USB connection for maintenance/upgrade.
10	**Conference Layout**	MCU Solution should support minimum of 10 layouts
11	**Firewall Traversal**	Should support firewall traversal solution for Business to Business (B2B) Video Calling.

2.1.8. PSTN Gateway:

Hardware Features
Should provide 2 X 10/100/1000 interfaces
Router should have minimum forwarding rate of 1.5 Mpps
Shall support variety of Voice interfaces like FXO, FXS, BRI, Channelized PRI (E1), E&M and WAN interfaces like V.35 Sync Serial (2 Mbps), Async Serial, E1 G.703, Fast Ethernet, Gigabit Ethernet, ISDN BRI, Channelized and Clear channel E1.
Should be provided with 4 X E1 Ports Day 1 to terminate 4 PRI lines.
It should support embedded hardware encryption acceleration, voice/ video-capable digital signal processor (DSP) slots or equivalent.
The gateway should be able to support at least 40 IP Phones in surviability mode.
It should support embedded Voice/ video-capable digital signal processor (DSP) slots or equivalent feature.
Protocol Support

Shall support Routing protocols like RIP ver1 &2 OSPF ver2.
Multicast routing protocols support: IGMPv1, v2, PIM-SM and PIM-DM, DVMRP.
Shall support IPv6 features: DHCPv6, IPv6 QoS, IPv6 Multicast support, RIP and OSPFv3 for IPv6.
Shall support IP Accounting features
Should support cRTP to compress voice (RTP) streams
QoS Features
Shall support the following
Classification and Marking: Policy based routing, IP Precedence, DSCP, MPLS exp bits
Congestion Management: RED, Priority queuing, Class based weighted fair queuing
Traffic Conditioning: Committed Access Rate/Rate limiting
Per VLAN QoS.
Resource Reservation Protocol (RSVP)
Security Features:
Shall support the following
AAA support using Radius and/or TACACS
GRE
IPSec
PAP and CHAP authentication for P-to-P links
Multiple privilege level authentication for console and telnet access
Time based & Dynamic ACLs.
Management
Shall have support for management thru Telnet, SSH, Secure Web based management thru HTTPS and SNMPv3 and Out of band management through Console and external modem for remote management
Should provide a provision to analyze IP service levels for IP applications and services by using active traffic monitoring (the generation of traffic in a continuous, reliable, and predictable manner) for measuring network performance
Should support flow-based traffic analysis of applications, hosts, performance-based measurements on application and network latency, quality of experience metrics for network-based services such as voice over IP (VoIP) / video.
Should have the ability to monitor events and take informational, corrective, action when the monitored events occur or when a threshold is reached.

3. CLOSED CIRCUIT TELEVISION SYSTEM

The Entire surveillance system is proposed and designed to control and monitors the different buildings of RIPANS Aizawl Campus. All the buildings shall have IP Based Dome/Bullet Camera indoor type and PTZ Cameras for outdoor surveillance. The different types of cameras shall be provided at locations as mentioned in Design Basis Report.

The indoor Dome Cameras and Bullet Cameras are proposed to be installed at all Entry & Exit Points in Ground floor. And in other Floors these cameras will be fixed in corridors, Lift Lobby & staircase entrances.

All the outdoor cameras shall be in IP 66 Housing and Junction box, power supply unit, media converter etc are proposed in dust proof housing The existing LAN network switches would be used for CCTV connectivity and will be connected to central CCTV server & cameras shall have POE connectivity ports. The power supply to LAN switches will be on UPS. The video recording shall be non embedded based recording server of reputed make with video management software.

Control Room shall be located in the Admin block in the Security /Control Room. The wiring inside the building shall be with CAT 6A cable in PVC conduit and armoured fiber Optic Cable and Outdoor connectivity shall be under ground in HDPE pipes with suitable Manholes for proper Maintenance of the system. PTZ cameras will be placed on roof top and Street light Poles in external areas. The video management server should have minimum 30 days storing capacity.

3.1. CAMERA SPECIFICATIONS-

3.1.1. ONVIF Conformant, UL Listed Day/Night True IP Full HD Infrared Bullet/Dome Camera

S.NO.	Camera Characteristics	Description
1	Requirement Overview	The camera shall capable of resolutions up to 2560x1920 @ 30 fPS while optimizing network usage with either H.264, H.265 or MJPEG compression.
2	Sensor Type	1/1.8" progressive CMOS or Better
3	Max Resolution	2560x1920 @ 30 fPS & 1080x1920@60fps with H.264/H.265 2560x1920 @ 12 fps and 1080x1920@30fps with MJPEG
4	Dynamic Range	100 dB or Better
5	Lens/Iris	4-9mm/P-IriS Remote focus and zoom
6	Minimum illumination	Color mode: 0.04 lux @ F 1.3
		Black-and-white mode: .001@ f 1.3
7	Field of View	45° to 84° (horizontal) 34° to 62° (vertical)
		64° to 113° (diagonal)
8	Privacy regions	The camera supports up to five user-defined privacy regions. Any video within a privacy region is masked in the video stream.
9	Digital I/O	Digital in x 1 & Digital out x1
10	Audio I/O	Audio in x 1 & Audio out x1
11	Number of streams	Should support at least 3 or more streams simultaneously
		Should support H.265, H.264, or MJPEG video streams simultaneously
		Each Video streams can be configured with Individual resolution, quality and frame rate setting
12	Day/Night	The cameras provide true day/night functionality, and include an infrared (IR) filter that automatically switches to night mode in low-light scenes. This should be setup Automatic, manual, scheduled.
13	Local Storage	Micro SD
14	Video Compression	H.264 & Motion JPEG and H.265 (Smart Stream)
15	Open API	ONVIF & profile G& S for standard based interoperability
16	Shutter speed	1/5 sec. to 1/32,000 sec
17	Protocols	IPv4, IPv6, TCP/IP, HTTP, HTTPS, UPnP, RTSP/RTP/RTCP, IGMP, SMTP, FTP, DHCP, NTP
18	Camera Tamper	The camera should support tamper feature when any of the following events occur and persist for a designated period:
		• The IP camera view is changed
		• The IP camera view is blocked
		• The IP camera view is substantially out of focus
19	Quality of service (QoS)	Differentiated services code point (DSCP) marking and class of service (CoS) marking

20	Enclosure for Outdoor Bullet Camera	IP67 & IK10 rated Enclosure and Mounting bracket for outdoor mounting

3.1.2. ONVIF Conformat, UL Listed Day/Night IP 66 HD PTZ Outdoor Camera

S.N	Camera Characteristics	Description
	Image Sensor	1/3" Progressive CMOS or Better
	Maximum Resolution	1920 X1080 (2MP)
	Lens type	30 X Optical Zoom, Auto Focus (30X)
	Focal length	f= 4.7 ~ 94 mm
	Auto-iris	DC- Iris
	Day/Night	Removable IR-cut filter for day & night function
	WDR Technology	WDR Pro, True WDR or Better
	Field of View	3° ~ 55° (Horizontal) , 2° ~ 33° (Vertical)
	Pan Speed	0.05° ~ 450°/sec.
	Pan Range	360°
	Tilt Speed	0.05° ~ 450°/sec.
	Tilt Range	220° (-110° ~ +110°)
	Video Compression	H.264, H.265 & MJPEG
	Maximum frame rate	30 fps @ 1920x1080 in all compression mode
	Local Storage	Micro SD
	Maximum Stream	Four simultaneously Streams
	Audi Capability and Compression	Full duplex Audio and G.711, G.726 Compression codecs
	ONVIF	Should support for ONVIF 2.0 allows for standards based interoperability
	Motion Detection	Five-window video motion detection
	Auto Tracking	Auto-tracking on moving object
	Casing	IP66, IK10, NEMA 4X
	Operating Temperature	-40 to 50°C
	Certifications Safety and Certifications EMC-Requirements	CE, FCC Class A, NEMA4X, UL
	PTZ Auto Tracking	The PTZ IP camera should automatically track an object that is larger than a configured threshold. When tracking, the IP camera uses its pan and tilt features to keep the object in its field of view.
		If there are several objects that are travelling in different direction within the field of view, the IP camera identifies each object that is larger than the configured threshold and tracks the object that is closest to the top left of the field of view.
	Connectors	RJ-45 cable connector for Network/PoE connection Audio input & Audio output
	Image Settings	Time stamp, text overlay, flip & mirror; Configurable brightness, contrast, saturation, sharpness,

		white balance, exposure control, gain, backlight compensation, privacy masks ; Scheduled profile settings, EIS, 3DNR, defog
	Alarm triggers	Manual trigger, system boot, recording notification, motion detection

3.1.3. ONVIF Video Management Software

S.NO.	Characteristics and Description
	General Video Management System requirement
1	The Video Surveillance System is intended to effectively monitor all the critical operational areas i. e Perimeter wall, corridors and entrance gate etc. The Surveillance System shall provide an on-line display of video images on monitors at security control room.
2	It should facilitate viewing of live and recorded images and controlling of all cameras by authorized users.
	VMS shall include, as a minimum, the following features/ functions/ specifications;
3	The surveillance system shall provide a scalable and reliable platform to enable customized, network-based surveillance applications.
4	The system shall support digital pan-tilt-zoom on live video. PTZ cameras should allow operators to use PTZ controls to zoom to a specific region in the viewing pane. Operators should select part of the full image and perform the PTZ controls within that region.
5	The surveillance system viewing system should be thin client through http browser for local/remote viewing. VMS shall provide the capability of viewing single or multiple live and archive cameras, and control of PTZ camera.
6	VMS should support mobile application for Android & Apple devices such as the iPad and iPhone. App features should include recorded video playback, thumbnail video preview, and user profiles that allow multiple users to share a single device.
7	VMS system should highly scalable and shall be expandable up to 10,000 cameras.
8	The video management system shall support both appliance & virtual machine based deployment
9	Video Surveillance Storage System – The video surveillance storage system should support multiple options to store video. Servers, Direct Attached, shall augment server internal storage. The video surveillance storage system shall store video in loops, one-time archives, or event clips triggered by alarm systems.
10	The system shall provide for integration with other software applications through an open and published Application Programming Interface (API). Such applications shall include, but not be limited to, access control, video analytics, and other alarm and sensor inputs.
11	The system should ensure that once recorded, the video cannot be altered; ensuring the audit trail is intact for evidential purposes.
12	All camera recordings shall have camera ID and location or area of recording and shall be programmable by the system administrator with user ID and password.
13	System shall support camera template to define the resolution, frame rate, recording duration, and then apply to a group of cameras. The modification of the template will be reflected to all the

S.NO.	Characteristics and Description
	cameras under the template.
14	The system shall supports Bulk Action to allow to search and perform administration activities on multiple camera.
15	System shall support Bulk import of cameras from file such as excel/.csv, or other standard file format. The files shall include camera name, IP address, server, template, location, camera username and password
16	The System should support LDAP (Lightweight Directory Access Protocol) server
17	Shall have Advanced map system with ability to position cameras and floor plans by GIS coordinates The VMS should support redundancy in 1:1, N:1 and 1:N forms. The Redundancy feature should allow to failover critical cameras from various servers into the failover server. The redundancy feature should be automatic failover and automatic failback without any manual intervention. The failover should happen for VMS, Analytics and I/O devices .
	VMS Server Management Console
	VMS server management console shall provide the initial server Setup Wizard, monitor system logs and resources, and troubleshoot hardware and system software issues, and gather information about the installed hardware and software components.
	The VMS Server Management Console user interface shall available for each instance of system software installed on either a physical server or as a virtual machine.
	VMS Server Management systems should support network time protocol (NTP) on server, which automatically sets the server time and date.
	VMS Operations & Management Console
	The VMS Operations Management Console should have browser-based configuration and administration tool used to manage the devices, video streams, archives, and policies for Video Management System deployment.
	VSM operation and management system should support the following feature ;
	Manage physical devices - Add, configure and monitor the cameras and servers that provide live and recorded video.
	Manage server services - Configure, enable or disable server services, such as the recording servers that manage video playback and recording.
	Monitor video - View live and recorded video, save video clips, search thumbnail summaries of recorded video, use the camera, Pan, Tilt and Zoom (PTZ) controls, or configure pre-defined video Views and Video Walls.
	Define recording and event policies - Create recording schedules, define event-triggered actions, configure motion detection, and other features.

S.NO.	Characteristics and Description
	Monitor system and device health - View a summary of system health for all devices, or device status, alerts and events.
	VMS Monitoring Console
	VMS monitoring Console application should allow VMS System users to monitor live and recorded video.
	VMS monitoring Console should support below viewing tools & features;
	I. Desktop Monitoring application
	Shall support for viewing the monitoring at minimum 5 different places in the complex.
	shall support simultaneous viewing of up to suitable No. of cameras as per workspace/work station configuration.
	Create Video Matrix windows for display in separate monitors.
	Create unattended workstations.
	View and manage alerts.
	View cameras, video, and alerts based on a graphical map
	II. Web-based configuration and monitoring tool
	Allows simultaneous viewing of multiple video panes, View up to suitable No. of cameras with the 64-bit version of Internet Explorer.
	Configure the camera, streams and recording schedules
	III. Web Based Server Console
	Should provide basic viewing features for a single stream (Stream A) from a single camera
	Analytic features: Shall support following Analytics Feature
	Clip Management—Use Clip Management to view, download and delete MP4 clips. that are stored on the server.
	Motion detection and Analysis—Use Motion Analysis to view a summary of motion events for recorded video.
	Thumbnail Search—Use the Forensic Search feature to create thumbnail images from a video archive. Use the thumbnails to locate specific scenes or events in the archive, then play the video in the Operator window or save it to a drive.

S.NO.	Characteristics and Description
	Edge Video Analytic: Surveillance solution should support the Edge video analytic capability that should enable camera to trigger events when it detects activities or behaviors that match predefined rules. Should support following Analytic features on cameras.
	Activity- Detects moving objects within an area that is configured in the camera view
	Line Crossing—Detects moving objects that cross a line that is configured in the camera view
	Object Taken—Detects a marked object in the camera view being removed from its location
	Zone Intrusion—Detects objects that enter an area that is configured in the camera view
	Wrong Way—Detects objects that are moving in the direction of an arrow that is configured in the camera view
	VMS software & recording & Management server should be from same OEM VMS software, Analytics software & recording & Management server should be from same OEM. Also ANPR and facial detection from the same OEM The VMS should be able to integrate with the edge analytics of the cameras.

3.1.4. Specifications of Central Core Server for Surveillance Operation & Management Application at DC.

S.No.	Characteristic	Description
1	Form factor	Management server should be an enterprise-class server in a 1RU form factor
2	CPU	Should have Intel Xeon processor (Preferably E5-2600 family) with atleast 2.3GHz speed & with 6-core CPU
3	SAS drive	Should support atleast 4 Number of Hot-swappable SAS drive and Server should be populated as per solution need
4	Integrated Ethernet Port	Dual Gigabit Ethernet Port
5	USB Port	2 ports (USB 3.0)
6	Video Ports	1 VGA video port
7	RAID Controller	Should have RAID controller card
8	Fans & Power supply	Dual-redundant fans and hot-swappable, redundant power supplies
9	Memory	Should have atleast 16GB DDR4 RAM
10	Operation & Management Licenses	Server should be supplied with VSM licenses for Management & Operation license, which should be able manage atleast 15 recording servers & 300 camera's

3.1.5. Recording or Media Server Specification for Data Center-

S.No.	Characteristic	Description
1	Form factor	Recording server should be an enterprise-class server in a 2RU form factor
2	CPU	Should have dual Intel Xeon processor (Preferably E5-2600 family) with atleast 2.3GHz speed & with 6-core each CPU
3	SAS drive	Should support atleast 12 Number of Hot- swappable SAS drive and Server should be populated with 8*10TB HDD to record the video.
4	Integrated Ethernet Port	Dual Gigabit Ethernet Port
5	USB Port	2 ports (USB 3.0)
6	Video Ports	1 VGA video port
7	RAID Controller	Should have RAID controller card
8	Fans & Power supply	Dual-redundant fans and hot-swappable, redundant power supplies
9	Memory	Should have atleast 16GB DDR4 RAM
10	Recording/ VMS licenses	Server should be supplied with VSM licenses

3.1.6. Storage Server

Sr. No.	Item	Description
• Storage Server shall be capable to record data up to 30 days.		
1	Capacity	The capacity should be 240 TB RAW or 200 TB Usable with RAID-6 (10+2) Configuration for Storage using 10 TB of each disk Capacity for video content.
		The offered disk storage should be of 56 Disk Enclosure and capable to add min. three more Disk expansion module to increase the Capacity offered by adding disk and controller units or min. 226 disk in the system.
2	Fault Tolerant	The Disk controller offered should have minimum support for RAID 0,1,3,5,6,10, and 50.
		The cache of each controller should not be less than 6GB per controller and shall have backup mechanism to protect the data on cache in case of power failure.
		The Disk controller or expansion units should have redundant power supplies and to be connected to alternative power sources such as UPS.
3	Supported Disk Types.	The offered disk controller shall support for SSD, SAS and NL-SAS disk types of maximum capacity available.
4	Host Interface	The offered storage shall support for minimum 4 no. of 8 Gbps or more Fiber channel host interfaces or iSCSI ports for connectivity.
		The host interface module shall be inter-changeable to switch to 10GigE or

		iSCSI interface if required.
5	Performance	The offered storage should be configurable to provide minimum 90% Write and 10% read workload. It should support Read Performance up to 3.2 GBps & Write Performance up to 2.4 GBps
6	Regulatory Compliance	The offered Disk Platform should be Network Equipment Building System-compliant Or MIL-STD-810F/G
7	Protocol & Standards support	SNMP, SSL, SSH, SMTP, SMI-S Provider, HTTP(s) IP (RFC, 984, 1092) SCSI-2 and SCSI-3 OpenStack Cinder compatible IP (RFC, 894, 1092), SCSI-2 and SCSI-3
8	Shock & Vibrations	Shock, Operational - 3Gs for 10ms, half sine Shock, Non-Operational - 10Gs for 11ms, half sine Vibration, Operation - 5Hz to 500Hz, 0.21 Grms flat spectrum Vibration, Non-Operational - 3-365-3Hz, 1.22 Grms, Z-axis, 0.85 Grms, X- & Y-axis shaped spectrum
9	Others	Virtual Disks per System - 32 Volumes per System - 1024 Super Capacitor Cache Backup - Yes Mirrored Cache – Yes

3.1.7. Network Video Recorder:

Sr. No.	Item	Description
1	Maximum IP Cameras	128/64/32/16 channel
2	Pre-Loaded VMS Software	Professional (standard), Enterprise (optional)
3	Typical Video Storage Rate (Mbps)	350 Mbps (Windows) 550 Mbps (Linux
4	Local Client Display Rate (FPS)	Windows – 700 FPS (HD) Linux – 900 FPS (HD)
5	Maximum Storage	80 TB (RAID 5 Optional)
6	Monitor Output	1 DVI-I + HDMI + 1 Display Port, max 2 simultaneous monitors
7	Operating System	Windows 10, Windows 2012 R2 (Optional), Ubuntu Linux 16.04
8	CPU	Gen 4 Intel Core i3, Intel Core i5 or i7 (optional)
9	RAM	4 GB, 8 GB, 12 GB (optional)
10	USB	6 x USB 2.0, 2 x USB 3.0
11	Operating Temperature	40° - 95° F 4.5° - 35° C
12	Regulatory	CE, FCC, cULus, UL Listed

3.1.8. 40"/55" Full HD LED Display Monitor

Sr.No	Parameter	Specification
1	Display:	
2	Screen Size:	40"/55" (Diagonal)
3	Panel:	DIRECT LED
4	Resolution (HxV):	1920 x 1080 pixels
5	Brightness:	350 cd/m2
6	Viewing Angle:	178 degrees
7	CONNECTION TERMINAL:	
8	VIDEO IN:	BNC x 1
9	AUDIO IN (L/R):	RCA x 1 set
10	COMPONENT/RGB IN:	1 set (BNC x3)
11	HDMI IN:	HDMI x 1
12	DVI-D IN/Out:	24pin x 1/24pin x 1
13	PC IN:	MINI D-SUB 15PIN x1 (Female)
14	AUDIO IN:	M3 jack x 1
15	Speaker Out:	External Speaker Jack (Side), 20W (10W x 10W)
16	Line Out:	RCA Pin (L/R) x1 (Side)
17	CONTROL TERMINAL:	
18	LAN:	RJ45 x 1 (Web Browser Control)
19	SERIAL Port:	D-SUB 9 pinx 1 (SERIAL IN/Out) RS-232C Compatible
20	IR IN/OUT:	M3 Jack x 1/x 1
21	ELECTRICAL:	
22	Power Requirements:	110-127 V AC, 50Hz/60Hz, 120 V AC 50/60HZ
23		220-240 V AC, 50/60Hz
24	Power Consumption:	Less than 250 W
25	MECHANICAL:	
26	Temperature:	32°F to 104°F(0 to 40 degrees C)
27	Humidity(Non condensation):	20% to 80% (Non condensation)

4. ACCESS CONTROL SYSTEM & BOOM BARRIER

4.1. ACCESS CONTROL SOFTWARE:

Sl. No.	Features of the Software
1	The Access Management Software shall use industry standard hardware with Windows Server (latest version) operating systems.
2	The Access Management Software shall provide full support for Virtualization technologies like VMware ESX and Windows HyperV.
3	The Access Management Software shall provide full support for leading open standards: BACnet, LonMark, OPC and Modbus. Enterprise Web Services shall also be available to extend Access Management Software with powerful value added applications.
4	The Access Management Software shall be designed and developed to International Standards ISO 9001 for quality.
5	The Access Management Software must be UL Listed to Standards: UL864 (Accessory and Panels Fire, Smoke Control, UL1017 and UL1076 (Security Systems), UL1610 (Central Station) and UL294 (Access Control)
6	The Access Management Software shall support superior fault tolerance, Access Management Software shall be configured for high-availability architecture to operate in a redundant hot standby configuration. To achieve this level of reliability, there shall be two servers: one is dedicated as the primary server and the other acts as the standby server. If the primary server encounters a problem, the standby server automatically assumes control and reconnects controllers and clients within 10 seconds without loss of data minimized to a this period.
7	The Access Management Software redundancy solution shall not replicate all operating system software between the two servers, ensuring that malware or driver and Operating System problems are NOT replicated to the backup system.
8	The Access Management Software shall support servers to be connected together in a Distributed System Architecture, allowing very large or geographically distributed sites to be operated as a single system.
9	The Access Management Software shall support upto 80 concurrent operator workstation connections on a single server. Client software can be loaded on unlimited number of PC's allowing a limitless number of users to access these connections on a first-come, first-served basis.
10	The Access Management Software shall support station based resident clients, web browser clients and clients on mobile and tablet devices.
11	The Access Management Software shall have Web-based user interface providing operators or facility engineers easy access and puts the user in control of every situation.
12	The Access Management Software shall have Web-style menus, tool bars, and icons allowing intuitive navigation and fast access to important information
13	The Access Management Software shall also have an unlimited number of custom (facility specific) displays created to meet the needs of the specific facility. The Access Management Software shall also have a set of standard displays for configuration, and navigation around the Access Management Software system.
14	The operator interface shall be interactive and totally graphics and/or icon based. The operator interface shall allow a user to perform the following tasks:

Sl. No.	Features of the Software
a	Monitor and Control field equipment
b	Acknowledge alarms on a priority basis
c	Display point status and history information
d	Display information about cardholders
e	Define and alter time schedules
f	Initiate printing of reports
g	View, archive and retrieve event logs
h	Monitor data communications channels
i	Configure system parameters
j	Display information from Internet and Intranet sites
15	The Access Management Software shall have a utility to create Custom HTML displays. A typical custom display shall include a static background, and dynamic objects that indicate the status and alarm condition of relevant devices. Pop up face plates showing more information about a device can also be used. Also, controls, such as buttons, can be added so that users can execute tasks, call up other displays and generate reports. The HTML format of custom displays shall provide interoperability with other Web technologies and Web authoring tools.
16	The Access Management Software shall support integration of Video into custom displays and control of PTZ cameras using display controls.
17	The Access Management Software shall support integration of existing Intranet or Internet pages into custom displays, enabling Access Management Software data to be matched with external information such as weather or key company policies and procedures.
18	The Access Management Software shall support integration of data into intranet, providing building occupants with live data regarding their comfort or other facility information.
19	The Access Management Software shall have browser independent, optimized user interface for Smart Phones. The mobile interface shall provide anywhere and any time supervisory monitoring and control.
20	The Access Management Software shall supports six different levels of operator security. It shall be possible to restrict and control what activity operators can perform by giving them different security levels.
21	The Access Management Software shall have "control levels" to limit manual control of specified critical points. Only operators with appropriate control levels can issue commands to these points.
22	The Access Management Software shall support HTTPS connections (secure web connections) and also requires use of certificates to authenticate users and applications to operate and control the system remotely over public networks.
23	The Access Management Software shall have an event-based rules engine to simplify the automation of routine integration tasks and reduce the need to write complex, time-consuming scripts.
24	The Automation Rules shall support integration of Video, Access, Fire and BMS points with each other and calling of plant display on a specific station.

Sl. No.	Features of the Software
25	The Access Management Software shall be able to group points based on alarm inputs, outputs, controller, area, doors or elevators etc. An operator can then control a group or monitor it as one entity. There shall be a summary display showing information about the groups, including the number of points in a group and the number of points in each state.
26	The Access Management Software shall support logical partitioning of facility into separate locations. Each location shall have a logical set of points, cardholders, reports and displays. Each operator shall be allowed to view, monitor, and control only those points or cardholders within their designated Location.
27	The Access Management Software shall have Alarm Summary feature and the operator shall be able to view a display showing all currently active alarms on a single click.
28	The alarm messages shall be color - coded to show priorities. From the Alarm Summary display, the operator shall be able to acknowledge alarms and access an associated display defined for each point.
29	The operator shall be able to sort alarms or filter only for certain characteristics.
30	The operator shall be able to add comments to alarms or print an appropriate alarm list.
31	The Access Management Software shall be able to annunciate the alarms as audible tone based on a customizable *.wav file on each station.
32	Alarms shall annunciate at Stations even if no user is currently signed on. Even if Station is minimized, the audible tone sounds and the Station icon flashes to indicate that there is an alarm.
33	The Access Management Software shall have a dedicated alarm line appearing on all displays and showing the most recent, highest priority, unacknowledged alarm in the system.
34	The Access Management Software shall have sophisticated alarm prioritization by assigning different priority levels- Journal, Low, High and Urgent. Each alarm priority level shall support up to 15 sub-priorities within it.
35	It shall be possible to automatically elevate an alarm to the next highest priority level or generate an additional alarm if an operator does not acknowledge an alarm within a certain time, ensuring alarms are always handled promptly.
36	The Access Management Software shall automatically keep count of how many times this same alarm has recurred, which allows the Alarm Summary Display to remain less cluttered as common or nuisance alarms are aggregated into a single alarm message.
37	The Access Management Software shall automatically calculates alarm metrics to quickly tell the number of urgent, high and low priority alarms in each location. These alarm metrics can be historized and trended, and reported on at shift boundaries or other times.
38	The Access Management Software shall have Advanced Alarm Management feature to assist operators. When an operator acknowledges an alarm, they proceed to an alarm instruction page which details appropriate alarm handling procedures. After following these procedures, the operator can enter a response that indicates the actions taken to correct the situation, or can choose from a pre-configured list of responses. Operator responses are logged to an event file for subsequent analysis.
39	The Access Management Software shall allow alarms to be routed to mobile phones and emails through GPS/GPRS modem. It shall also support remotely acknowledge the alarm via an SMS. It shall be possible to nominate a range of points and the alarm priority for recipients of SMS and emails.

Sl. No.	Features of the Software
40	The Access Management Software shall store event data in an online buffer. It shall be possible to store as many events as necessary—subject only to disk space on the server. When the on-line buffer becomes full, event data shall be transferred to an archived buffer and notifies the operator to save the file to external media.
41	The Access Management Software shall provide comprehensive reporting facilities including a range of standard reports, the ability to create custom reports, the ability to export and import information and the ability to use other standard reporting systems.
42	The Access Management Software shall be able to generate all standard reports on demand from the reporting subsystem or from a custom display.
43	It shall be possible to generate the report periodically, such as once per day, or may be initiated by an event.
44	The Access Management Software shall provide ODBC (open database connectivity) access to its database from any ODBC - compliant tool.
45	The Access Management Software shall utilize SQL Server Reporting Services (SSRS) to deliver powerful custom reports which can be configured and tailored via Visual Studio 2008, or the simple custom report tools delivered within SSRS.
46	Deadman Timer: If there is no operator activity for a defined period, The Access Management Software system shall automatically sign off the operator. A warning message shall notify the operator before this happens. If that operator does not sign onto the system again, Access Management Software shall automatically controls an output to alert help.
47	The Access Management Software shall be able to track a guard through defined tours of a building or facility using a Guard Tour. Guard Tours can be programmed using any logical combination of card readers and input points as tour checkpoints. At each point along the tour, it shall be possible to switch cameras, disable alarms, or toggle lights.
48	The Access Management Software shall support use of Enterprise Web Services (EWS) to allow open interface with custom apps, queries, web pages or business systems.
49	The Access Management Software shall have seamless integration with Video Surveillance System that allows live viewing and digital recording of video from network connected cameras through Access Management Software user interface.
50	The Access Management Software shall directly interface with Access Controllers installed in or across the buildings connected over LAN. It shall also provide the comprehensive control and monitoring of all access controlled doors and cardholders inside the premises.
51	The Access Management Software shall have easy-to-use card holder management system supporting minimum 100K cardholders.
52	The Access Management Software shall have 94 pre-configured user fields for each card holder. All of these user fields shall be editable to match the requirement. In addition, it shall be possible to add or remove user fields to customize card holder database structure.
53	The layout of card holder information on displays in Access Management Software shall be editable to reflect a set of user fields and meet the design preferences.
54	The Access Management Software shall be able to assign multiple cards to each card holder to allow a flexible approach to dealing with situations such as lost cards, forgotten cards or the need to issue two cards to a card holder.
55	It shall be easily possible to add cards and cardholders to the system.

Sl. No.	Features of the Software
56	It shall be possible for cards assigned to cardholders or remain as "unissued" cards.
57	It shall be possible to simultaneously edit Multiple cardholders at by using the "multi-select" capability.
58	The Access Management Software shall be able to create a customized Card holder Templates for each group of cardholders.
59	The Access Management Software shall allow a search for cardholders and cards by entering the first couple of letters of the card holder's name or any searchable field.
60	The Access Management Software shall be able to generate photo identification badges displaying a card holder's image and/or signature.
61	The Access Management Software shall support TWAIN standard for interfacing to image capture device and WinTab standard for interfacing with Signature Pads.
62	The application to design the Photo Identification Card shall be the part of Access Management Software software package.
63	The Access Management Software shall support standard windows supported card printers to generate Photo ID cards.
64	The Access Management Software shall have the ability to add pictures, logos, magnetic strip encoding and bar codes to photo identification cards. It shall be possible to use chroma key or image ghosting for extra security.
65	The Access Management Software shall support biometric devices such as fingerprint, palm-vein , retina and face readers that have an industry standard Wiegand output to connect to an access control panel.
66	The Access Management Software shall support updation of card holder data from external systems such as the People Soft Human Resources database or SAP Enterprise Management System.
67	It shall be possible to send Time and Attendance data and card holder details from Access Management Software back to HR systems. This information shall be used to calculate how long particular cardholders have been on site for occupational health and safety purposes or for payroll purposes.
68	The Access Management Software shall support a minimum of 256 time periods. Time periods shall be used to specify the times when cardholders have access to certain zones.
69	The Access Management Software shall support up to 1024 zones to control access to the facility. Each zone shall consist of the following: * Description * Organization * Up to 128 doors
70	The Access Management Software shall support up to 1024 access permissions. Each access permission shall consist of the following: * Description * Organization or Company / Department * Up to 256 zone and time period pairs
71	It shall be possible to assign up to 64 access rights/level to each card holder.
72	The Access Management Software shall have Path Control feature to force a card holder to follow a fixed path to reach a destination.

Sl. No.	Features of the Software
73	The Access Management Software shall have Escort feature to allow a transit if a card holder is escorted by another user with "escort" rights.
74	The Access Management Software shall have Zone Control feature to limit maximum number of people authorized to be present simultaneously in the zone and/or Time duration for each person to stay in the zone.
75	The Access Management Software shall have Trace feature to send an alarm to the host every time a certain card holder uses a door.
76	The Access Management Software shall have Global Anti pass back feature and shall be supported across the system without having Access Management Software system running, this shall be possible using peer to peer communications between the Access Controllers.
77	The Access Management Software shall have Use before Expiry feature to define the number of times that a card holder may use their cards. This number shall be decremented every time the card holder uses their card at a reader until the number is 0, when the card holder shall no longer have access.
78	The Access Management Software shall have an integrated Time & Attendance Module. The T&A module must have following features. 1. Calculating Attendance data based on the first in and last out transaction 2. Provides Shift Management 3. Identify attendance exceptions such as Single Swipe and absenteeism. 4. Track departmental Attendance. 5. Shall be able to generate Man Hour Report, Absent Report, Over Time Report, Exception Report and Analysis Report. 6. Comprehensive Management Information, reporting and historical data enquiry management 7. Attendance Regularization in case of- Out Duty, Leave and Mismatch

4.2. ACCESS DOOR CONTROLLER:-

Sl. No.	Technical Specifications
	Access Controller
1	The controller shall be a 32 bit microprocessor with Linux OS.
2	The controller shall have 128 MB DDR SRAM and 64 MB Flash memory.
3	Support minimum 16 doors with a readers for entry and exit.
4	Support minimum 16 standard Weigand Interface on LONbus.
5	Support minimum 64 I/Os with expandable 4 DI/DO modules on LONbus.
6	Controller level redundancy with Hot Redundant Controller failover without manual intervention.
7	The access controller shall support minimum Card Holder Memory: 1,00,000 card holders, expandable upto 2,50,000 card holders
8	The controller shall support minimum 100000 transaction buffer and 10000 event buffer.
9	The controller shall have autonomous clock/calender with geographic time zone support and daylight saving.

Sl. No.	Technical Specifications
10	The controller shall have on-board 10/100MB Ethernet connection for TCP/IP connectivity.
11	Controller shall have built-in web server and support web access.
12	Shall perform in a peer to peer network with other controllers
13	Controller shall have IPSEC with 3DES encryption on LAN communication.
14	Controller shall have Tamper protection feature.
15	Controller shall have battery backup with full functionality for 90 minutes in case of power failure and signalling of battery recharge on the controller itself.
16	Wall mountable with IP55 protection
17	Input Power: 230 Volts, AC power supply (single phase).
18	Certification: CE, UL, FCC
19	Operating Temp.: -10°C to +40°C
20	Operating Humidity.: up to 90% non condensing Humidity

4.3. BIOMETRIC READER:-

S.No.	Parameters	Technical Specifications
	Finger print Readers	
1	Fingerprint Sensor	500 dpi Optical Sensor
2	Fingerprint Capacity	10K templates (5K users with 2 templates per user)
3	Log Capacity	50K events
4	Identification Speed	2000 matches per second
5	Card Reader	13.56MHz Mifare
6	Operation Mode	Fingerprint, Fingerprint+ Pin/Card
7	Network Interface	TCP/IP, RS485
8	Reader output	Wiegand
9	Display	128x64 graphic monochrome LCD, Multi - color LED
10	Keypad	3x4 keypad, 3 navigation keys
11	Audio	Multi tone Buzzer
12	Power Supply	12 VDC
13	Protection Class	IP66
14	Operating Temp	-20°C to +50°C
15	Certifications	CE

4.4. CARD READER:

S.No.	Technical Specifications

	Smart Card Reader
1	Read Range- upto 5cm
2	Mounting- Mullion
3	Operation Frequency- 13.56MHz
4	Reader Output- Wiegand
5	Card Compatibility- 2KByte, 4KByte I - Class smart cards, Mifare and DESFire.
6	Environmental Rating- IP55
7	Operating Temp: -35° to 65° C
8	Operating Humidity: 5% to 95% relative humidity non-condensing
9	Power Rating: 5-16VDC, 55mA AVG Current
10	Certification: CE, UL, FCC

4.5. SPECIFICATION FOR CABLES

i) 8 Conductor, 18-24 AWG, Overall Shielded, PVC for Card Readers

Description	:	Shielded multi conductor control cable
Conductors conductors	:	18/22 AWG 7/32 Strand Tinned Copper, 6
Insulation	:	Colour coded PVC 0.010"
Colour Code	:	Black, white, red, green, blue, brown
Shielding	:	100% aluminium mylar foil shield overall with a 24 AWG 7/32 strand tinned copper drain wire.
Jacket	:	Gray flame retardant PVC 0.032"
Nominal OD	:	0.205"
Capacitance	:	33 pF/Ft between conductors
Ratings	:	Manufactured in accordance with UL subject 13, type CM Passed UL VW-1 Flame Test UL CM approved

ii) 2 Pair, 18 AWG, Individually Shielded, Poly propyene Insulated Signal Cable for Intelligent Controller Communication.

Description	:	2 pair individually shielded cable
Conductors	:	18 AWG 7/30 Strand tinned copper, twisted into 2 pairs
Insulation	:	Colour coded polypropylene, 0.008"
Colour Code	:	Black with red, Green with white
Shielding	:	Each pair individually shielded with 100% aluminium mylar foiled shield plus 22 AWG 7/30 strand tinned copper drain wire.
Jacket	:	Gray flame retardant PVC
Nominal OD	:	0.170"

Capacitance	:	35 pF/Ft
Voltage	:	UL rated 300 Volts
Ratings	:	Manufactured in accordance with UL subject 13, type CM Passed UL VW-1 Flame Test UL CM approved

iii) 2 Pair, 20 AWG, Shielded, Multi-pair, Signal Cable for Electrical Bolt Release.

Description	:	3 pair over-al l shielded cable
Conductors	:	20 AWG 7/28 Strand tinned copper, twisted into 3 pairs
Insulation	:	Colour coded polypropylene, 0.010"
Colour Code	:	Black with red, Black with white, Black with Green
Shielding	:	100% aluminium mylar foiled shield overall with 22 AWG 7/30 strand tinned copper drain wire.
Jacket	:	Gray flame retardant PVC 0.020"
Nominal OD	:	0.251"
Capacitance	:	45 pF/Ft between conductors
Voltage	:	UL rated 300 Volts
Ratings	:	Manufactured in accordance with UL subject 13, type CM Passed UL VW-1 Flame Test, UL CM approved

5. NURSE CALL SYSTEM

It is proposed that Hospital Building shall be provided with a "IP based Nurse Call System". The System shall be approved in accordance with VDE guidelines/ international guidelines. It is proposed that Nurse Call System shall be provided for all Beds with Speech facility & without Speech facility. Nurse Call System for Single Bed/ Double Bed/Deluxe Suite/ Super Deluxe Suite Rooms, Critical Areas etc. shall be equipped with Speech Facility as directed by Engineer-In-Charge. Likewise, Nurse Call System for the Beds in General Wards/Rooms, Toilets etc. shall be without Speech Facility as directed by Engineer-In-Charge.

The "System" shall be designed in such a way that the most effective communication between Patient, Nursing Staff, Doctor & management staff can be provided in the least possible time.

Nurse Call System shall be provided in the wards/ rooms where patient will stay. Some areas mentioned below but not limited to, are as follows:

a) IPD Wards
b) IPD Rooms (Single Bed/ Double Bed/Deluxe Suite/ Super Deluxe Suite)
c) Recovery Rooms
d) MICU/ ICU/ HDU
e) Emergency Rooms
f) Pre/ Post Operation & Cath,
g) Ward (Chemo, Multipurpose, observation, Triage, Day Care) etc.
h) Any other area as required.

The Nurse Call System with voice facility shall be provided for Single Bed/ Double Bed/Deluxe Suite/ Super Deluxe Suite rooms. The other wards shall be provided with Nurse Call System without voice facility.

5.1.1. Main Controllers:

Controller shall be IP based & all the nurse station/ patient handset & other equipment shall be connected to main controller through CAT6a cable. Main controllers shall be networkable with other controllers through IP/ CAT6a. Fault in one controller shall not have the effect on working of another controller. Each controller shall be able to work independently in case there is problem in network.

5.1.2. Nurse Station:

Nurse station shall have large LC display capable of showing multiple patient call at a time with bed/ ward no., type of call, date & time. There shall be scroll down feature as well in case no. of patient call increase at a given time i.e. there shall not be any chance of missing any patient call. There shall be feature to priorities patient call depending upon patient condition, type of call & location (Bed or WC). Nurse station shall have voice facility. It shall be user friendly & have good aesthetic looks. All Nurse Stations shall be networked with other nurse station with facility of call forwarding/ diverting/ escalating calls in between nurse station. Nurse station shall be programmable so that emergency calls shall always be on top priority.

There shall be option of displaying patient call on external monitors through VGA/ HDMI/ DVI output from the nurse call system. The system shall be interfaced with IPBX to use as a telephone also.

5.1.3. Patient Handset without voice facility:

Whenever the patient needs the attention of any "Nurse", patient just press the button provided at his/ her bedside. On pressing the button, the alarm shall be annunciated at the Nurse Station by local sounder having volume & tone adjustment informing the nursing staff about the bed no. / Room no. along with type of call (Bed call or WC call or Doctor call) for their necessary action. Patient handset shall be connected to bed head unit through plug in cable. For safety reason, handset shall have antimicrobial coating to avoid infection transfer, shall be shock & spill proof & having suitable colour & symbol for nurse call button on the handset. There shall be call cancel/ reset button either on bed head unit or separate button.

5.1.4. Patient Handset with voice facility:

Patient handset shall be connected to whenever the patient needs the attention of any "Nurse", patient just press the button provided at his/ her bedside. On pressing the button, the alarm shall be annunciated at the Nurse Station informing the nursing staff about the bed no. / Room no. along with type of call (Bed call or WC call or Doctor call) for their necessary action. There shall be speech facility in both patient handset & nurse station with suitable inbuilt microphone & speaker. Nursing staff shall receive the call from nurse station itself & respond to the patient queries. It will reduce the nurse staff movement to patient room. However, if required, nurse staff shall visit the patient room as & when needed by patient. Patient handset shall be connected to bed head unit through plug in cable. For safety reason, handset shall have antimicrobial coating to avoid infection transfer, shall be shock & spill proof & having suitable colour & symbol for nurse call button on the handset. There shall be call cancel/ reset button either on bed head unit or separate button.

5.1.5. Lamp Module:

Lamp module shall be installed outside the room/ ward above the door for visual indication of different type of call. There shall be different colour of indication for different type of calls.

Once the patient annunciates the alarm, the signal shall go to the nurse station. The lamp outside the patient room/ ward shall also glow simultaneously red provide a visual alarm.

Lamp shall have different colours light to inform about the type of call like red light for bed call, blue light for code blue call etc.

5.1.6. Doctor Call & Cancel Button:

Each bed/ ward shall have code blue button (Doctor Call). Doctor call button shall be used only by nurse staff & programmed in such a way to avoid direct code blue call by patient. It shall be a separate programmable button with cancel button. It shall not be in patient handset with nurse call button & shall have separate cancel button. Once nurse press code blue button, call shall go to every nurse station of the hospital or as programmed as per site requirements with room no. & bed no. information so that code blue team available at any nurse station shall be informed & they can reach the patient room on immediate basis.

5.1.7. Call-Cancel Button for common toilet:

There shall be nurse call & cancel button with suitable colour/ symbol in common toilet near WC to generate nurse call by patient from WC in case of any emergency. It shall be installed at waist height for easy access. The buttons shall be moisture protected.

Pull cord Button for room/ ward toilet with shower/ bath facility.

There shall be nurse call button with suitable length of pull cord with colour/ symbol for nurse call from the toilet. It shall be installed above shower head preferably in such a way to access from bath area as well as WC. Pull cord shall be detachable & replaceable without changing the unit. The buttons shall be moisture protected & suitable for bath areas.

5.1.8. Central Monitoring Station

Complete nurse call system shall be centrally connected to a PC having a software recording of all the different type of call & cancel with date & time. The software shall record the date & time of call generated by patient & call cancel by nurse with type of call. Software shall be able to generate report on daily, weekly or monthly basis as per requirement. It shall also be possible to put reminder/ highlighted on calls if nursing staff do not attend/ cancel the patient call with in specific time decided by the hospital management.

6. INFORMATION DISPLAY SYSTEM:

It is proposed that Information Display System shall be provided for Hospital Building. Information display systems will achieve information sharing in order to significantly improve the hospital management and service level, and enhance the hospital's brand and core competitiveness. This system shall have centralized control over LAN with unified management of video and audio signals, pictures, Text scroll and other multimedia information to be transmitted to various display terminals.

Information display systems will be used to display:-

- images, scrolling texts & videos of advertisements,
- to share Internal information's,
- Public information
- Advertisement or Promotions.
- And influencing HLL behaviour.

System Architecture LED Screen, Application Server will be used for Uploading & Displaying movies, PPTs, Screen etc.

System advantages: Centralized control, centralized management.

Real-time: Issue Emergency information, Events, Media / Marketing Info etc.

PC based: It can play any file as per requirement of controller.

The Information Display System shall display welcome messages at reception, waiting & lobby areas of OPD & IPD. Displays can be programmed to show videos that explain medical procedures, healthy eating tips and guidelines, medical innovations, drug information etc.

ULTRA HD (4K) Media Player	
Description	**Technical Specification**
HDMI Output Resolution	Up to 3840x2160 (@60fps)
HDMI Input Resolution	Up to 1920x1080
Color Space	RGB 4:4:4, YCbCr 4:4:4, YCbCr 4:2:2(Output)
CPU	Quad-Core 1.8Ghz
Memory	2GB DDR3
Storage	64 GB eMMC 5.1
Video Codec	H.264 (4Kp30)/ H.265(4Kp60)/ Mp4
Image Format	Jpeg/ Png
Audio Format	Mp3
Beacon(BLE)	Supported
Watch dog Timer	Supported (External)
RTC	Supported
IO Interface	
Ethernet	1xRj45(GigaLAN)
WLAN	802.11 b/g/n, With 2db antenna
HDMI Out	1xHDMI 2.0 with CEC
HDMI IN	1xHDMI 1.4b with HDCP
USB	2xUSB2.0/ 1x Micro USB OTG
3.5mm Audio Jack	1x2-in-1 (Speaker /Mic-in)
Digital Stereo Out	1xS/PDIF
COM Port	1xRs-232 port(Male)
Expansion Storage	1xMicro SDHC slot
Mechanical & Enviroment	
Dimension (WxDxH)	165x118.5x27mm(6.49"x4.66"x1.06"inch)
Weight (Net)	415g
Mounting	Easy Wall mount
Enviroment	Operating Temp- 40 c to 70 c, Storage Temperature- 40 c to 80 c, humidity 5% to 90% (non-condensing)
Power Adapter	DC 12V, 1.5A
Certification	CE/FCC
ULTRA HD (4K) Display Panel	
Description	**Technical Specification**

Screen Size	43" or better
Light Source	Direct LED
Panel Type	IPS
Display Orientation	Landscape / Portrait
Usage (hrs/days)	18 hrs /7 days
Active Area (mm)	941.2 (H) x 529.2 (V)
Resolution (pixel)	UHD 3840 x 2160
Aspect Ratio	16:9
Brightness (typ.) (nits; cd/m^2)	380
Contrast Ratio (typ.)	1200:1
Response Time (ms)	8
Pixel Pitch(mm)	0.25 (H) x 0.25 (V)
Frame Rate	60Hz
Viewing Angle	178 degree (H) / 178 degree (V)
Light Life (typ) (hrs)	30,000
Panel Surface	AG, Haze 3%
System Memory	2GB
Storage	8GB
OS	Android 4.3
Voltage	100V~240V, 50-60Hz
Maximum (Watt)	98W
Typical (Watt)	53W
Standby (Watt)	<0.5W
Operation Temp (°C)	0°C ~ 40°C
Operating Humidity	10% ~ 80% RH Non-Condensing
Internal Speaker	8W x 2
Input/Output Ports	
VGA In	x1
HDMI Input	x3 (1.4 x 3)
MHL	Yes
Composite video In	x1
Composite video Out	x1
Component In (YPbPr, RCA)	x1
Component Out (YPbPr, RCA)	No
Audio Input (L/R, RCA)	x1
Line out (3.5mm)	x1
RJ45 Port	x1

USB (Type A)	x4 (2.0 x 3; 3.0 x 1)
Power (AC) Input	x1
Weight (without packing / with packing) (kg)	9.5 / 12.0
Bezel Width (T/B/L/R) (mm)	11.7 / 18.1 / 11.7 / 11.7
Wall Mounting (VESA) (mm)	200 x 300

7. AUDIO-VIDEO SYSTEM & STAGE LIGHTING:

7.1. Scope of Work: The scope of work covers design, supply, installation, testing and commissioning of following facilities for Auditorium, Conference Rooms and Lecture Theatres at RIPANS complex:

- Audio System for Auditorium, Conference Rooms & Lecture Theatres
- Lighting System embedded in Acoustic Interior Works for Auditorium
- Video Projection & Control System for Auditorium, Conference Rooms & Lecture Theatres
- Stage Lighting & Stage Furnishing for Auditorium

7.2. Followings are the specifications of the different devices:

I. HD CODEC UNIT, A1 MICROPHONE AND REMOTE CONTROL:

H.320, H.323 and SIP compliant H.261, H.263 and H.264 video coding support H.261, H.263 and H.264 video coding support G.728,G.722 and G.711 audio coding support Built-in Acoustic Echo canceller and Noise Reduction System should be capable to do automatic Gain Control, Noise Suppression and must have Instant Adaptation Echo Cancellation with Audio System should be able to connect at speeds from 128 kbps to 10 Mbps in multiples of 128kbps on IP and 768 kbps on ISDN System should support Dual Network support (LAN and WAN) The system should be upgradeable to 5+1 MCU (Multi Conferencing Unit System should support Dual monitor mode System must be equipped with two number of Omni directional High Definition Microphone Array with mute button on Mic or Remote control It should be possible to integrate the system with high definition mic mixer for larger room coverage System should support Two images, in one monitor. Should be able to support H.239 for sharing of video and graphics content during the video call.

II. HD COMMUNICATION COLOR CEILING CAMERA:-

To support 1920 x 1080 with 10X optical zoom or higher,+- 90 deg pan range,+15/-25 deg tilt range , FOV 70 deg in order to accept HD resolution video Capability to support 16:9 for supporting High defi. To Live Video resolution of 1080 at 60fps

III. HD MCU MULTI CONFERENCING LICENCE (5+1):-

Connect up to 5 remote site

IV. DATA SOLUTION LICENSE :

To share the computer data between two or more location.

V. Gooseneck Microphone(12") with on/off Base:-

- Frequency Response : 50 to 17000 Hz
- Output Impedance : up to 180Ω
- Signal to noise ratio at 94 dB SPL Cardioid
- Open circuit sensitivity at 1 kHz, ref. 1V/Pascal–35.0 dB (17.8 mV

- Maximum SPL (1 kHz at 1% THD, 1 kΩ load) 124.2 dB
- Maximum Equivalent output noise : 28.0 dB
- Dynamic Range at 1 kΩ Load 96.2 dB
- Power Requirements 11 to 52 Vdc phantom, 2.0 mA

VI. Chairman (19 inch.) Microphone with on/off Base :-

- Frequency Response : 50 to 17000 Hz
- Output Impedance : up to 180Ω
- Signal to noise ratio at 94 dB SPL Cardioid
- Open circuit sensitivity at 1 kHz, ref. 1V/Pascal–35.0 dB (17.8 mV
- Maximum SPL (1 kHz at 1% THD, 1 kΩ load) 124.2 dB
- Maximum Equivalent output noise : 28.0 dB
- Dynamic Range at 1 kΩ Load 96.2 dB
- Power Requirements 11 to 52 Vdc phantom, 2.0 mA
- Microphone will be 'OFF' after speech in 45 seconds
- The indication lamp will be ON when the microphone id turned on and Microphone is supplied power by main unit.

VII. Wireless Handheld Microphone :-

- Frequency Response 50 hz to 15khz
- RF Level Switch between 1mW and 10m
- Power and battery status LED System Distortion: <1 % (ref. ±48 kHz deviation, 1 kHz tone)
- Transmitter Type: Handheld
- RF Output Power: 1 , High: 10mW; Low: 1mW
- RF Output Power: 10 mw
- Audio Input Level: -19 dBV (XLR), -5 dBV (1/4")
- Dynamic Range: >90dB, A-weighted
- Available Frequencies: between 794 –806 MHz
- Up to 8 selectable channels
- Up to 4 compatible systems
- Antenna Switching Diversity
- Audio Output Connector: XLR balanced and ¼" unbalanced
- Mic / Line Switch
- Operating Range: 75m
- Microphone will be 'OFF' after speech in 45 seconds

- The indication lamp will be ON when the microphone id turned on and Microphone is supplied power by main unit.

VIII. Digital Automatic Mixer/DSP:-

- Channel Microphone input
- Two Aux-level input
- LED indication
- Front-panel headphones output with level control
- Frequency Response 50 Hz to 20000Hz (±1 dB)
- Hardware/Software Control Adjust Eatings directly on the front and back panels or through the browser-based control software
- Equalization inbuilt
- Phantom Power up to 48 Vdc
- Dual Mixer Mode Route two entirely different and independent automixes to mix A and B outputs.
- Control System Compatible
- Linking capability
- Mounts in a single 19" rack space via integral rack-mount
- Intellimix operational concept
- capability for system upto 96 Microphone
- Logic Operation will be available
- AD/DA Converter 24-bit, 48 kHz, 113 dB dynamic range typical
- Last Mic Lock-On (LMLO)Keeps the most recently activated microphone open until aEAther microphone is activated
- Dante™ Digital Audio Multichannel audio over Ethernet
- Remote Control Convenient browser-based software
- Digital Feedback Reduction

IX. Wall mounted / Ceiling speaker:-

- Power RMS Out put Up to 15W
- Over all Dia up to 8”
- Frequency Response 80 to 18khz
- Line Voltage 70V/100V
- Driver Sensitivity up to 87db
- Speaker Type Coaxial

X. Amplifier :-

- Rated out put RMS Wattage 240W/480W/500W

- Sensitivity 1V ,100mv @10Kohms
- Impedance @10k ohms
- Signal to noise Ratio up to 86db
- AC Power consumption up to 640W
- Input interface XLR
- Battery Voltage 24VDC
- Out put interface XLR & 6.3mm Phone Jack
- Total Harmonic Distortion < =1% at 1khz
- Speaker out put 8Ω ,70V/100V
- Main voltage 115V/230V
- Power ON indicator
- Mountable Desktop & 19" rack.

XI. Feedback Destroyer:-

- Maximum Output Level +20dB 2 Output
- Dynamic Range Eat Less than 119dB
- Balance Impedance EAt Less than 120Ohms
- Minimum Frequency Response 20Hz to 20Khz
- Filter Per Channel at least 24 Programmable
- Operating Level Switch required Per Channel wise
- Cross Talk Input to Output atleast 80dB EAise level

XII. Voice Recorder :-

- Recording to SD(HC) cards
- Interface Balanced & Unbalanced
- 19" Rack mountable
- Format Support MP3
- Date Transfer through USB to computer
- Powe on auto play
- Input sensitivity 500mvrms
- Input impedance 75Ω
- USB Connection to PC for fast secure download
- to read LCD display
- Dictation/Conference/Lecture recording Facility
- Max SD Card 32GB

XIII. Hydraulic Pop Up Box on Conference Table :-

SITC of Hydraulic Pop Up Box for connecting , computer Tabletop Interconnect box Inbuilt Port , VGA/HDMI ,Power, Audio

XIV. Motorized Screen:-

- Size:7 ft X 5ft , Width 7ft & Height 5ft, diagonal 100" ,
- High Contrast Matte White,
- Video Spectra 1.5,
- Remote range up to 40mtrs.

XV. Multimedia Projector:-

Highest brightness 1 Chip DLP Laser projector. Light Ourput: 5000 Lumens, Color Light Ourput: 5000 Lumens, Aspect Ratio- 16:10, Contrast Ratio: 5,00,000:1, Laser source life: 20000 hrs. or better, Focus - manual, Zoom: manual (approx: 1.45X), Throw Ratio - 1.27;1 to 1.89;1, Lens Shift: Manual ; Vertical: + 20% ~ +55% ; Horizontal: +/- 10%, Input A : RGB/Y Input Connector: Mini D-sub 15-pin (female); Audio input connector: Stereo Mini Jack, Input B : HDMI Input Connector: HDMI 19 pin HDCP support; Audio Input connector: HDMI audio support, Input C: HDMI Input Connector: HDMI 19 pin HDCP support; Audio Input connector: HDMI audio support, InputD: HDBaseT interface connector: RJ45, 4 play (Video, Audio, LAN, Control), Video IN: Video Input connector: BNC, LAN Connector: RJ-45,100BASE-TX (Shared with HDBaseT), USB: Type A, Type B, Remote: RS-232 connector: D-sub 9-pin (male)

XVI. 16- Professional Full HD LED Panel 70":

Screen Size: 70", Audio out put 10w+10w, USB Auto play back, HDMI 2, USB 2, Component, Composite, LAN Port ,Smart Energy Saving

XVII. LED Interactive Monitor 19" for Chairman:

19inch display with SXGA (1280x1024) resolution and wide viewing angle, Built in DVI /VGA Port, Aspect Ratio- 16:9 .Tablet Resolution 4000 line per inch, pressure sensitivity 2048 level,

XVIII. DVD Player with HDMI:

Video DAC 12bit/108MHz , USB Content Playback ;Multi Disc and Format Playback Video Format NTSC / PAL, Aspect ratio 16:9 Digital Output 96kHz/24bit

XIX. Audio Video Control System:-

- RS 232 Serial Port: 5 nos or more inbuilt or with additional card/module
- Ethernet Monitoring & Control of AV devices , IR/Serial Port: 2nos or more
- Digital I/O ports: 4nos or more
- Low-voltage relay ports: 4 or more
- Integrated or supplied with IR Learner
- SDRAM: 512 mb or more
  4GB or more
  External power pack included
  Have Option & license to connect third party touch interface like iPad for control

XX. iLux Integrated Lighting System - International Version, 230V :-

- Wall mount integrated lighting and shade control
- 6 channels of dimming or switching
- 6 groups of shade and drape control

- Linkable for up to 54 lighting channels and 54 shade groups
- Up to 16 user-EAtable scenes
- configurable "rocker" buttons with customizable label strip
- Large ON and OFF buttons

XXI. IR probes:-

The IRP2 is an IR (infra-red) emitter probe designed to adhere directly over the IR sensor window of a television, DVD player, or any other IR controllable device. The IRP2 connects to any Crestron control system with a 2-pin terminal block type Crestron IR port, providing a 1-way IR control interface to the device. The IRP2 is composed of an infrared LED housed in a miniature shell. Its integral 7 foot cable may be extended up to 1000 feet using ordinary twisted pair cable. Includes IR mask and two-sided tape for mounting.

XXII. HDMI Switcher 4 in 4 out for laptop source:-

Each port supports HDMI inputs. Supports high video resolution up to 1920 x 1200 including 720p, 1080i & even 1080p. Interface compatible with Transition Minimized Differential Signaling (TMDS).Supports Both Video and Audio Signals. Supports Signaling rates up to 1.65Gbps of UXGA Display, Video Bandwidth up to 1.65GHz

XXIII. Speaker cable :-

2 core of high quality with minimum data loss,1.13mm,AWG-16.foil-shielded, twisted-pair, Capacitance: 8.5 pF ((per foot at a frequency of 10 kHz),Conductor Stranded bare copper, Insulation PVC.

XXIV. Microphone Cable:-

High quality with minimum data loss,0.4mm, AWG-20,ruggedness, flexibility, flex life and interference immunity. Low impedance,Operating Temperature Range:-30°C To +60°C,Overall Nominal Diameter:5mm

XXV. Cat6 Cable:-

Conductor Size, 23AWG bare solid copper. Total Wires 8, Drain Wire solid 23AWG tinned copper, Propagation Delay Skew 35ns/100m max. Impedance, 100Ω. DC Resistance 73Ω/km (21Ω/1000ft) nominal, MAX Resistance Unbalanced 2%. Capacitance 1.2pF/m max

XXVI. Connector XLR Male / Female:-

Capacitance between contacts ≤ 4 pF ,Contact resistance≤ 3 mΩ (inner) ,Dielectric strength 1,5 kVdc ,Insulation resistance > 10 GΩ (initial),Current per contact 16 A ,Voltage 50V

XXVII. Equipment Rack:-

With lockable rear and front glass door, power strip, castor wheel for easy movement & top knockout plate 16-gauge steel tops, bottoms, & sides Laser-cut 1/8" thick internal steel braces for strength 1 pair fully-adjustable front rackrail Large cable entry in bottom Grounding and bonding stud installed in base Finished in a durable textured powder coat for all the above audio main systems.

XXVIII. Projector Screen:-

132" Diagonal Motorised Projector Screen. Aspect Ratio: 16:10, Resolution: WUXGA (1920x1200).

XXIX. Other Items:

S.NO.	Item Description	
1	Digital Projector 1-chip DLP Laser phosphor, 1920X1200 native resolution, Brightness 13,500 lumens, Contrast Ratio : up to 700000:1, Lamp life 20000 hours, Motorized horizontal and vertical lens offset , 3D ready, Inputs: HDMI x 2, DVI-D, Display Port , HD15, HD base T , Controls: RS232 in/out, RS422 in, Ethernet (10/100), USB, device, should be complete with lens	
	Technical Specification	
	Technology	1-DLP
	Brightness	13500 Lumens
	Contrast Ratio	7,500:1
	Native resolution	1920 x 1200 pixels
	Aspect Ratio	16:10
	Illumination system	Laser phosphor
	Typical lifetime	20,000 hours
	Inputs	HDMI x 2
		DVI-D
		HD15
		HD Base T
	Outputs	DVI-D
	Control and networking	RS232 In
		HD Base T
2	55-inch Display Panel, 4K UHD 3840 x 2160 (16:9) Resolution, Brightness 400 nits or more, Contrast ratio 1200:1 or better, Inputs HDMI, Display Port, VGA, Video In, Audio inputs, Audio output	
	Technical Specification	
	Screen size (diagonal)	55", Direct-lit LED
	Brightness	400 nits (cd/m2)
	Contrast Ratio	12,00 : 1
	Resolution	3840 x 2160 (16:9)
	Viewing angle	178° h/v
	Response time	8ms typical
	Video inputs	2 x HDMI (Ver 2.0, HDCP 2.2)

		Display Port
		VGA
		YPbPr
	Video outputs	Display Port
		HDMI
		RCA (L/R) line out
	Control inputs	RS-232
3	70-inch Display Panel, 4K UHD 3840 x 2160 (16:9) Resolution, Brightness 400 nits or more, Contrast ratio 1200:1 or better, Inputs HDMI, Display Port, VGA, Video In, Audio inputs, Audio outputs	
	Technical Specification	
	Screen size (diagonal)	70", Direct-lit LED
	Brightness	400 nits (cd/m2)
	Contrast Ratio	12,00 : 1
	Resolution	3840 x 2160 (16:9)
	Viewing angle	178° h/v
	Response time	8ms typical
	Video inputs	2 x HDMI (Ver 2.0, HDCP 2.2)
		DisplayPort
		VGA
		YPbPr
	Video outputs	Display Port
		HDMI
		RCA (L/R) line out
	Control inputs	RS-232
4	Wireless Presentation and Collaboration Solution, Enables wireless presentation of HD content using laptops, tablets, and smart phones, Compatible with Windows, OS X, Apple iOS, and Android, Displays up to four presentation sources at once in Quad View, Supports up to 32 or more simultaneous presenter connections, Supports display resolutions up to Full HD 1080p and UXGA/WUXGA, Provides HDMI, VGA	
	Technical Specification	
	Compatible	Windows, Android and iOS operating system

		Displays up to four presentation sources at once in Quad View
		Display resolutions up to Full HD 1080p and UXGA/WUXGA
		Provides HDMI, VGA/Display Port, and analog audio outputs
		Choice of connection methods accommodates all types of users and organizations
		Supports up to 32 or more simultaneous presenter connections
		High quality video streaming, supports full HD 1080p/60
5	Digital Modular Matrix Switcher, Modular Design, 8 Input & 8 Output frame, Pixel Accurate Reclocking, Frame Detector and Input Signal Analysis, Zero frame Delay, Combine non-HDCP and HDCP capable, 1 Preview input & Output Port (Video Signals) with all require accessories	
	Technical Specification	
	Frame Size	8 Inputs and 8 Outputs
		Combine non-HDCP and HDCP capable I/O boards
		Advanced error handling
		Advanced EDID Management
		Hybrid Modular and Cross Platform technology
		Zero frame Delay
		HDMI, 4K x 2K, 3D and Display port 1.1 video signals
		Bi-directional RS-232 extension
		DVI/HDMI Test input
		DVI/HDMI Preview Output
6	Input Cards: Combine / Combination of 4 HD Base T & 4 HDMI input port, HDMI 1.4; DVI and HDCP compliant, support 4K, UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0), Supports all HDMI audio formats, PoE add- on option with all required accessories	
	Technical Specification	
		Four HDMI and Four HD Base T
		HDMI extension supporting 3D and 4K
		Accepts HDMI, Ethernet, RS-232 over one CAT6A Cable up to 170m
		HDMI 1.4; DVI and HDCP compliant
		supports 4K, UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0)

		48-bit color depth
		Supports all HDMI audio formats
		Bi-directional RS-232 and Ethernet transmission
		HDCP enable/disable mode
		Pixel Accurate Relocking
		Advanced EDID Management
		compatible with deep color, Dolby True HD and DTS-HD audio
7	Output Cards: Combine / Combination of 4 HD Base T & 4 HDMI output port, HDMI 1.4; DVI and HDCP compliant, support 4K, UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0), Supports all HDMI audio formats, Audio De-Embedding output, PoE add- on option with all required accessories	
	Technical Specification	
		Four HDMI and Four HD Base T
		HDMI extension supporting 3D and 4K
		Accepts HDMI, Ethernet, RS-232 over one CAT6A Cable up to 170m
		HDMI 1.4; DVI and HDCP compliant
		supports 4K, UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0)
		48-bit color depth
		Supports all HDMI audio formats
		Bi-directional RS-232 and Ethernet transmission
		HDCP enable/disable mode
		Pixel Accurate Relocking
		Advanced EDID Management
		compatible with deep color, Dolby True HD and DTS-HD audio
8	Active Wall Plate: VGA, HDMI, Display Port and Audio Input, 4K/UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0) support and 3D capabilities, VGA, YPrPb, HDMI1.4 and DP 1.1 signal support, Auto select mode, HDCP compliant, CEC, EDID transparent, HD Base T compatibility, Extends HDMI, Display Port, VGA, Audio, Ethernet, RS-232, IR over a single CATx cable up to 170 m distance	
	Technical Specification	
	Input Port	1 HDMI, 1 VGA and 1 Display Port Input ports

		1 Balanced Audio Input ports
	Output port	1 HD Base T
		Support 4K/UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0) and 3D capabilities
		Extends HDMI, VGA, Display Port, Audio, Ethernet, RS-232, IR over a single up to 170 mtr
		Event Manager
		Bi-directional RS-232 and IR
		Breakaway audio and video switching
		HDMI 1.4, HDCP 1.4 and DVI 1.0 compliant
		HDCP enable/disable function
		HD Base T compatible
		Advanced EDID Management
		No video compression
		Bi-directional RS-232 and IR extension
9	HDMI Transmitter, 1 HD Base T output and 1 HDMI Input, HDMI extension supporting 4K/UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0) and 3D capabilities over one CATx cable up to 170 m distance, Bi-directional RS-232 and IR, HDCP 2.2 compliant, CEC, EDID transparent	
	Technical Specification	
	Input Port	1 HDMI
	Output port	1 HD Base T
		HDMI 1.4, HDCP 1.4 and DVI 1.0 compliant
		Bi-directional RS-232 extension
		supporting 4K/UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0) and 3D capabilities
		Extends DVI, HDMI, Ethernet, RS-232, IR over CAT6 cable up to 170 m distance
		HDCP 2.2 compliant, CEC, EDID transparent
		No signal latency, zero frame delay
		HDBase-T compatible
		Transparent EDID pass-through
10	HDMI Receiver, 1 HD Base T input and 1 HDMI Output, HDMI extension supporting	

	4K/UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0) and 3D capabilities over one CATx cable up to 170 m distance, Bi-directional RS-232 and IR, HDCP 2.2 compliant, CEC, EDID transparent	
	Technical Specification	
	Input Port	1 HD Base T
	Output port	1 HDMI
		HDMI 1.4, HDCP 1.4 and DVI 1.0 compliant
		Bi-directional RS-232 extension
		supporting 4K/UHD (30Hz RGB 4:4:4, 60Hz YCbCr 4:2:0) and 3D capabilities
		Extends DVI, HDMI, Ethernet, RS-232, IR over CAT6 cable up to 170 m distance
		HDCP 2.2 compliant, CEC, EDID transparent
		No signal latency, zero frame delay
		HD Base T compatible
		Transparent EDID pass-through
11	Digital Audio Processor with 8 AEC Mic Input, 2 Mic / Line Input, 6 Line Output, Multichannel USB Interface, GPIO Port, Delay, Limiter, Feedback Suppressor, Equalization audio setting parameters, LAN Control complete with Wall panel control with 4 selectable zones/source and volume control	
	Technical Specification	
	Total inputs	10 or more
	AEC Inputs	8
	Outputs	6
	Phantom power	+48 VDC
	USB Audio	2 in / 2 out
	GPIO	6
	THD+N	< 0.005% or better
	Dynamic range	> 105 dB or better
	Features	Auto mixing Open architecture software configurable functionality USB audio connection RS232 connector for 3rd party control systems
12	Array Microphone for the Podium Having minimum 4 Nos of Capsule should pick up at	

	least from 3 feet with Push-To-Talk and Push-To-Mute functions	
	Technical Specification	
	Transducer type	Electret condenser
	Polar pattern	Corridor
	Frequency response	90 - 20,000 Hz
	Nominal impedance	< 200 ohm
13	Stage Lighting System: COB LED Fixture : Equipped with 4*LED Cold White / Warm White Two In One, Each LED 100 W, Beam angle 45°,Field angle 90° , Projection can be adjusted from 0-70° as desired, DMX 512 protocol, master/slave, auto, sound active with adjustable sound sensitivity, 6/13 DMX channel modes	
	Technical Specification	
	CRI	RA95
	Dimming Mode	Linear, S-Curve, Square Law, Inverse Square Law
		Beam angle 53 degree
		Field Angle 68 degree
		4 LED Cold white/Warm two in one 100 W each
		Intelligent Temp. Controlling
		Separate Strobe
		DMX512 Support
		master/slave, auto, sound active with adjustable sound sensitivity
14	Stage Lighting System: COB LED Bar : Equipped with 8 CoB RGBW four in one, Each 40W, Total 320W, Intelligent temperature self controlling, beam angle 20°,field angle 45°, DMX 512 protocol, master/slave, auto, sound active with adjustable sound sensitivity	
	Technical Specification	
	Dimming Mode	Linear
		Beam angle 53 degree
		Field Angle 68 degree
		4 LED RGBW four in one 40 W each
		Intelligent Temp. Controlling
		Separate Strobe
		DMX512 Support

		master/slave, auto, sound active with adjustable sound sensitivity
	DMX Channel Mode	5/11/39 modes
15	Stage Lighting System: Parcon Light, CoB LED (Chip on Board), 150W RGB three in one, DMX, Master/Slave, Stand Alone & Sound Active, Beam angle 40 degrees, field angle 80 degrees	
	Technical Specification	
	LED	COB High MCD RGB Three in one 150W
	Operational Mode	DMX, Master/Slave, Stand Alone and sound active
	Angle	Beam Angle 40 degree, Field Angle 80 degree
	Mode	3/5/8 DMX Channel Modes
		Shutter: Pulse effect, Strobe
16	Stage Lighting System: Parcon Light, CoB LED (Chip on Board), 200W RGBA four in one, DMX, Master/Slave, Stand Alone & Sound Active, Beam angle 40 degrees, field angle 80 degrees	
	Technical Specification	
	LED	COB High MCD RGBA Four in one 200W
	Operational Mode	DMX, Master/Slave, Stand Alone and sound active
	Angle	Beam Angle 40 degree, Field Angle 80 degree
	Mode	4/6/9 DMX Channel Modes
		Shutter: Pulse effect, Strobe
17	Control Processor, one RS-232/422/485 COM ports, two RS-232 COM ports, Eight IR/serial, eight relay, and eight Versiport I/O ports, Programmable event scheduling	
	Technical Specification	
		Enterprise-class control system
		Onboard 512MB RAM & 4GB Flash memory
		SNMP remote management support
		One RS-232/422/485 COM port
		Two RS-232 COM ports
		Eight IR/serial, eight relay, and eight I/O ports
		Programmable event scheduling
		TLS, SSL, SSH, and SFTP network security protocols

		iPhone, iPad, and Android control app support
18	10" widescreen active-matrix color Touch Panel, 1280 x 800 WXGA display resolution, Capacitive touch screen technology, Multi-touch capable, PoE or PoE+ network powered with Table top kit and power supply	
	Technical Specification	
	Screen Size	10" widescreen active-matrix color display
	Resolution	1280 x 800 WXGA
	Touch Technology	Capacitive touch screen technology
		Multi-touch capable
		Auto-brightness control
		Single-wire Ethernet connectivity
		PoE or PoE+ network powered
		Tabletop and swivel mount
19	Recording & Streaming Server, 3 DVI-I (Analog & Digital Signals), VGA Loop out, Input format HDMI, DVI, RGBHV, YPbPr, CVBS, Full HD Resolution, H.264 High Profile, AAC audio encoding, File format MP4 / MPEG4, Picture in picture, Picture by picture, Management through App, Webpage, dedicated software, Built in approx 1TB storage, with all mounting Accessories	
	Technical Specification	
	Capture Options	Video, (HD/SD) + VGA, Video
	Input format	HDMI, DVI, RGBHV, YPbPr, CVBS
		HDMI and YPbPr: 720P@50@60, 1080i@50@60, 1080p@25@30@50@60, CVBS: 480i, 576i (NTSC and PAL), VGA
		Supports input from computer, visualize and electric whiteboard, Encoding
		Encoding: H.264 HP
		High frame rate up to 30fps
		Bitrates from 128Kbps to 20Mbps
		Audio Supports balanced, and unbalanced audio in
		File Format, MP4
		Resolution: D1, 720p, 1080p
		Picture-in-picture and Picture-by-picture

		Storage, Capacity of 1TB, Around 1000 hours recording
		Supports FTP, Local Decoding
		Supports PTZ camera control
20	PTZ Camera, HD CMOS type, 20x Optical Zoom, 16x Digital Zoom,2-way HD video output, RS232 / RS485 port control, HDMI / DVI, HD-SDI, CVBS outputs with all mounting arrangements	
	Technical Specification	
		Camera incorporates a 1/2.7-type HD CMOS image sensor with over 2 million effective pixels, support up to 1080p30 resolution
		Camera supports simultaneous video outputs in multiple video interfaces including HDMI, HD-SDI, CVBS
		Reliable, Wide-Range, Quiet and Quick Pan/Tilt Mechanism
		Camera supports multiple protocols
		Camera can store up to 245 presets, those settings can be retained even after camera is shut off, can keeps high precision positioning even after long-time usage

Main Front Stage Curtain

S.No.	Items Description	Features
1	Type	Horizontal / Vertical Sliding
2	Motor	1 HP Single phase / three Phase (Geared)
3	Minimum Overlap	900 mm
4	Curtain Size Nominal	(28 M X 11M)
5	Material	Velvet Cloth
6	Special Feature	Auto Stop, Push Button for forward, reverse, stop

Rear stage Curtain

S.No.	Items Description	Features
1	Type	Horizontal / Vertical Sliding
2	Motor	1 HP Single phase / three Phase (Geared)
3	Minimum Overlap	900 mm
4	Curtain Size Nominal	(24 M X 11M)
5	Material	Glazed Cotton / Cash milon
6	Special Feature	Auto Stop, Push Button for forward, reverse, stop

Main Side Wings		
S.No.	**Items Description**	**Features**
1	Mounting	Fixed on Overhead track
2	Frame	Made of (25 mm X 50 MM) MS pipe
3	Material	Glazed cotton / Cashmilon

Frills		
S.No.	**Items Description**	**Features**
1	Mounting	Mounted on frills bar
2	Frill Size (Nominal)	(20 M X 2M)
3	Frill Bar	Made of 32 MM dia pipe
4	Material	Glazed cotton / Cashmilon

Cyclorama Screen		
S.No.	**Items Description**	**Features**
1	Screen size (Nominal)	(9 M X 4.5 M)
2	Material	High Quality cinematographic material (Matte White)
3	Frame	Tublar frame 35 mm dia MS pipe

Video Wall		
A	**LCD**	
Group	**Specification Item**	**Detailed Specification**
System	Display wall	It shall be made up of multiple LCD modules stacked up in two different video wall as: (1) 3X(R)rows and 3X(C) columns (2) 2X(R)rows and 2X(C) columns
	Display technology	Liquid Crystal Display
	Display size and resolution	The diagonal size of each display unit/ module shall be 55" with a native resolution of at least 1920x1080 pixels
	Combined bezel gap	Should be less than 1.8 mm
	Light source	LED
	Brightness	500 Cd/m2 ± 10% or better
	Color	Shall offer in excess of 16 million colors.
	Response time	8ms

	Viewing angle	H:178° V:178°
	Contrast ratio	should be minimum 1200:1
Signal Interface	Input terminals	1x Digital DVI-D, 1 x Analog RGB , 1x DP ,1x OPS slot
		1x Digital HDMI , 1x Audio (RCA L/R), Stereo mini jack x1
		1x BNC CVBS video, 3x BNC -component
		1x RS232C Dsub-9
		1x RS422 RJ45
		1x Ethernet RJ45
		1x USB,
	Output terminals	1x Digital DVI-D / DP, 1x Audio Out, 1x Speaker out
		1xRS232
User controls	Power control:	1 AC power ON/OFF switch
	Wire control:	RS232C input
	IR remote	IR remote
	OSD style	list type OSD format
	On Screen display	Input selection, picture, image and tiling should be adjusted using OSD
	Colour adjustment	User should able to adjust the primary & secondary colours for color alignment and fine tuning
	OSD Languages	English
Electrical	AC power input range	90~240VAC, 50/60Hz, 5A max.
	Power consumption	Normal operating should be < 150 W
		Standby mode < 2 W at 110VAC
System Reliability	Operating temperature	0~40°C
	Operating relative humidity	20~80%
	MTBF	>= 50,000 hours
B	**CONTROLLER**	
	Group	Specification Item
	Display & Controller	Display & Controller should be from the same manufacturer

	Reputed Company	The OEM should be an established multinational in the field of video walls and should have installations around the world
	Display controller	Separate Controllers to control: (1) 9 displays with 9 DVI outputs, 2 Universal input along with necessary software's for 3x3 Video Wall (2) 4 displays with 4 DVI outputs, 2 Universal input along with necessary software's for 2x2 Video Wall
	Chassis	19" industrial Rack mount
		Lockable front door to protect drives
	Operating System Platform	Window 7- 64 bit/Latest Available version
	Processor options	Xeon/ i3/i5/ i7
	RAM	Std. 4 GB DDR3, higher on request
	HDD	Support upto minimum 2 HDD
		Std.: 500 GB , can be upgraded on request
	Networking	Dual-port Gigabit Ethernet Controller inbuilt
		Supports Add on copper/ optical fiber adapters
	Input / Output supported	Serial ATA
		LAN
		* 2x RJ45 LAN ports
		USB 2.0 port
	RAID	RAID 0, 1, 5, 10 support
	Power Supply	(1+1) Redundant hot swappable
	Cooling	Forced cooling
	Indicators	LED's for HDD activity and Power status
	Switches	Power On/Off and System Reset
	Monitoring options	CPU, FAN, Temperature
	Accessories	DVD +RW ,Keyboard and mouse
	Voltage	100-240V @ 50/60 Hz
	Redundancy support	Power Supply
		HDD
		Cooling FAN

		LAN ports
	Scalability	Display multiple source windows in any size, anywhere on the wall
	Control functions	Brightness / contrast / saturation/ Hue/ Filtering/ Crop / rotate
	Outputs	9 DVI for 3x3 wall & 4 DVI for 2x2 wall
	Resolution support	DVI: 1920x1200 RGB: 2048x1536
	Universal Inputs	2 Universal input (DVI/ HDMI) for each set of controller
	Accessories	DVD-R,DVD+RW,, Keyboard, mouse
	Power Supply	(1 + 1) Redundant AC-DC high-efficiency power supply
		* AC Voltage 100 - 240V, 50-60Hz
	Operating Conditions	* Operating Temperature: 10° to 40°C (50° to 95°F)
		* Non-operating Temperature: -40° to 70°C (-40° to 158°F)
		* Humidity: 10 – 90% non-condensing
	Wall management SW	
	Scaling and display	Software tp enable the user to display multiple sources in any size and anywhere on the display wall.
	Auto Source Detection	Software should support for auto source detection
	Layout Management	Should support for Video, RGB, DVI, ,Internet Explorer, Desktop Application and Remote Desktop Monitoring Layouts
	Scenarios	Software should able to Save and Load desktop layouts from Local or remote machines
	Layout Scheduler	All the Layouts can be scheduled as per user convenience
		Software should support auto launch of Layouts according to specified time or event by user
	Layout Preveiw	Software should support layout preview option
	Launch Application	Software should be able to support
	Integration with 3rd party devices	System should offer interface to enable control from 3rd party devices like Creston ,AMX etc.
	Live Preview	Software should able to provide live preview of videowall
	Work space allocation	System should provide functionality to the administrator to define and allocate work space for a particular operator or

		a group of operators when working on a Video wall
	Authentication	Software should offer 4 levels of Authentication (User accounts, Permissions for functionality & Roles etc).
	Offline Layouts	It should be possble to create offline layouts
	User friendly	Software should be user friendly
	Ticker	Ticker message can be positioned anywhere on the display wall. Inside the ticker window, font size, colour and background can be set
	Ticker Type	Software should able to prepare three kinds of tickers: text ticker, RSS ticker and time ticker
	SNTP	System should support SNTP fucntion
	Protection	System should have Hardware License key to protect the software from unauthorized access.
	General Requirements	All product must be BIS certified
		Display and controller should be from same OEM to avoid intergration issues during setup or later
		OEM should have service center facility in India

CHAPTER –J

TECHNICAL SPECIFICATIONS – SOLAR PV SYSTEM

1. GENERAL

This section specifies the Design, engineering, supply, delivery to site, installation, testing, commissioning and maintenance of solar power plant as described in the Content.

1.1. SOLAR PHOTOVOLTAIC MODULES:

The total Solar PV minimum array capacity should not be less than 5% of electrical & space conditioning Load and should comprise of poly crystalline modules of minimum 250 Wp and above wattage. The Photo voltaic module must be tested and certified by an independent testing laboratory that is accredited in accordance with ISO Guide 25.

a. The PV modules should be of Indigenous make. The PV modules must conform to the latest edition of any of the following / equivalent BIS standards for PV module design qualification and type approval:

- Crystalline Silicon Terrestrial PV Modules IEC 61215 / IS14286
- In addition, the modules must conform to IEC 61730 Part 1(requirements for Construction) & Part 2 (requirements for testing, for safety qualification).
- Further, the PV modules must also qualify the Salt Mist Corrosion Testing as per IEC61701 / IS 61701

b. SPV module Conversion efficiency should be equal to or greater than 14% at STC and AM 1.5 radiations.

c. The PV modules shall perform satisfactorily in humidity up to 100 % with temperature between -40°C to +85°C. Since the modules would be used in a high voltage circuit, the high voltage insulation test shall be carried out on each module and a test certificate to that effect be provided.

e. Other general requirement for the PV modules and subsystems shall be the following:

i. Solar cells technology employed in the module production shall have to be certified and a certificate giving details of major materials i.e. cells, Glass, back sheet, their makes and data sheets to be submitted.

ii. The rated output power of any supplied module shall not have negative tolerance.

iii. The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary more than 3 (three) percent from the respective arithmetic means for all modules and/or for all module string, as the case may be

iv. Except where specified, the front module surface shall consist of impact resistant, low-iron and high-transmission toughened glass.

v. The module frame, if any, shall be made of aluminum or corrosion-resistant material which shall be electrolytically compatible with the structural material used for mounting the modules.

vi. The module shall be provided with a junction box with either provision of external screw terminal connection or sealed type and with arrangement for provision of by-pass diode. The box shall have hinged, weather proof lid with captive screws and cable gland entry points or may be of sealed type IP65 rated.

vii. Necessary I-V curves at 250 C, 450,600 and at NOC are required to be furnished.

viii. Fill factor of module shall not be less than 0.70

1.2. ARRAY STRUCTURE:

a. The array structure shall be so designed that it will occupy minimum space without scarifying the output from SPV panels.

b. Structural material shall be corrosion resistant and electrolytically compatible with the material used in the module frame, its fasteners, nuts and bolts. Galvanizing should meet ASTM A-123 hot dipped galvanizing or equivalent which provides at least spraying thickness of 70 micron on steel as per IS 5905.

c. Structures shall be supplied complete with all members to be compatible for allowing easy installation at the roof top site and the structure atop sloping roofs shall be done by the Bidder.

d. Each structure shall have a provision to adjust its angle of inclination to the horizontal as per the site conditions.

e. The array structure shall be grounded properly using maintenance free earthing kit.

f. Each panel frame structure should be so fabricated as to be fixed on the rooftop column/wall structures. The structure should be capable of withstanding a wind load of 200 km/hr. after grouting & installation. The front end of the solar array must be one meter above the rooftop. Grouting material for SPV structures shall be as per M15 (1:2:4) concrete specifications.

g. The supplier shall specify installation details of the PV modules and the support structures with appropriate diagrams and drawings. Such details shall include, the following:

i. Determination of true south at the site;

ii. Array tilt angle to the horizontal, with permitted tolerance;

iii. Details with drawings for fixing the modules;

iv. Details with drawings of fixing the junction/terminal boxes;

v. Interconnections details inside the junction/terminal boxes;

vi. Structural installation details and drawings;

vii. Electrical earthing;

viii. Inter-panel/Inter-row distance with allowed tolerances; and

ix. Safety precautions to be taken.

k. The array structure shall support SPV modules at a given orientation and absorb and transfer the mechanical loads to the rooftop columns properly. All nuts and bolts shall be of very good quality stainless steel. Detailed design and drawing shall have to be submitted for acceptance and approval before execution of work.

1.3. POWER CONDITIONING UNIT (PCU)

The PCU required of appropriate capacities as follows, should convert DC power produced by SPV modules, in to AC power and adjust the voltage & frequency levels to suit the local grid conditions.

PCU should be appropriate capacity of proposed solar PV plants

1.4. POWER CONDITIONING UNIT (INVERTER PLUS MPPT CHARGE CONTROLLER)

Input Voltage:

- From PV Module: Minimum 08KWp, 120V nominal DC from Solar PV Array.
- From AC source 415V, 3 ph, 50 Hz

Output Voltage:

Suitable for charging 120 V, 600AH tubular plate lead acid VRLA Gel type battery bank.

Protection:

- Short Circuit
- Deep discharge
- Over charging (Automatic trickle charge mode on full charge)
- Input surge voltage
- Over current (Load)
- Battery reverse polarity
- Solar Array reverse polarity

Indication (LED/LCD Indication):

- String on
- Mains on
- Input on
- Control on
- Charge on
- 80% charged, 100% charged
- Charger overload
- Battery on trickle
- Battery disconnected/fault battery reverse polarity
- Low solar power
- System fault
- Charger over temperature
- Input over/under voltage (for AC)

Operating Temp: 0-50 Deg C

Humidity: 0-95% non condensing

Enclosure IP 32

No Load Consumption: < 1%

1.5. INVERTER:

1.5.1. Common Technical Specification:

- Control Type :Voltage source, microprocessor assisted, output regulation
- Output Voltage : 3 phase, 415 Volt AC
- Frequency : 50 Hz

- DC link voltage range : 0 to 800 V
- Total Harmonic Distortion - less than 3%
- Maximum current ripple - 4% PP
- Reactive Power - 0.95 inductive to 0.95 capacitive
- Operating Temp. Range - 5 deg C to 55 deg C
- Housing Cabinet - INVERTER to be housed in suitable switch cabinet, Within IP 65 Degree of ingress protection for outdoor and IP 20 for Indoor.
- Inverter efficiency - 95% and above at full load,
- Power Control- MPPT

1.5.2. Other important Features/Protections required in the INVERTER

- Mains (Grid) over-under voltage and frequency protection
- Array ground fault detection
- Automatic fault conditions reset for all parameter like voltage, frequency and/or black out.
- MOV type surge arrester on AC and DC terminals for over voltage protection from lightening-induced surges.
- INVERTER should be rated to operate at 0-55 deg. centigrade unless provision for air conditioning is included in INVERTER
- Overload capacity (for 10 sec) should be 150% of continuous rating.
- PCU shall be capable to synchronize independently & automatically/to be phase locked with Power Supply Authority grid power line frequency to attain synchronization & export power generated by the solar panel to Power Supply Authority grid.
- The DC to AC conversion efficiency shall at least be 95percent at full load. The idling current at no load must not exceed 2 percent of the full load current.
- Transformer less inverters shall be preferred. Restriction of DC components on AC side shall be achieved.
- The INVERTER shall be capable of operating in parallel with the grid utility service and shall be capable of interrupting line-to-line fault currents and line-to-ground fault currents.
- The INVERTER shall be able to withstand an unbalance output load to the extent of 30%.
- The INVERTER shall include appropriate self-protective and self-diagnostic features to protect itself and the PV array damage in the event of INVERTER component failure or from parameters beyond the INVERTER's safe operating range due to internal or external causes. The self-protective features shall not allow signals from the INVERTER front panel to cause the INVERTER to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the INVERTER, including commutation failure, shall be cleared by the inverter protective devices and not by the existing site utility grid service circuit breaker.
- The INVERTER shall go to shut down/standby mode, with its contacts open, under the following conditions before attempting an automatic restart after an appropriate time delay;

(i) Insufficient Solar Power Input

When the solar available from the PV array is insufficient to supply the losses of the INVERTER, the INVERTER shall go to a standby/shutdown mode. The INVERTER control shall prevent excessive cycling during rightly shut down or extended periods of insufficient solar radiation.

(ii) Utility-Grid Over or Under Voltage

The INVERTER shall restart after an over or under voltage shutdown where the utility grid voltage has returned to within limits for a minimum of two minutes.

(iii) Utility-Grid Over or Under Frequency

The INVERTER shall restart after an over or under frequency shutdown when the utility grid voltage has returned to within limits for minimum of two minutes.

- The INVERTER generated harmonics measured at the point of connection to the utility services when operating at the rated power shall not exceed a total harmonics current distortion of 3 percent, a single frequency current distortion of 4 percent and single frequency voltage distortion of 1 percent, when the first through the fiftieth integer harmonics of 50 Hz are considered.
- The INVERTER power factor at the point of utility services connection shall be 0.95 lagging or leading when operating at above 25 percent of the rated output.
- The internal copper wiring of the INVERTER shall have flame resistant insulation. Use of PVC is not acceptable. All conductors shall be made of standard copper.
- Full protection against accidental open circuit and reverse polarity at the input shall be provided.
- The INVERTER shall have an appropriate display on the front panel to display the instantaneous AC power output and the DC voltage, current and power input. Each of these measurements\ displays shall have an accuracy of 1 Percent of full scale or better.
- The Inverter shall be with Bi-directional full sine wave charge controller 120 V DC output.
- Electrical safety, Earthing and Protections shall be as per CPWD specifications for Electrical works Part I- 2013.

1.6. Factory testing

a. The INVERTER shall be tested to demonstrate operation of its control system and the ability to be automatically synchronized and connected in parallel with a utility service, prior to its shipment.

b. Factory testing shall not only be limited to measurement of phase currents, efficiencies, harmonics content and power factor, but shall also include all other necessary tests/simulations required and requested by the Purchasers Engineers. Tests may be performed at 25, 50, 75 and 100 percent of the rated nominal power.

c. A factory Test Reports (FTR) shall be supplied with the unit after all tests. The FTR shall include detailed description of all parameters tested qualified and warranted.

1.7. Operating modes:

Operational or MPP tracking mode: The control system continuously adjust the voltage of the generator to optimize the power available. The power conditioner must automatically re-enter stand-by mode when input power reduces below the standby mode threshold.

Front Panel display should prove the status of the INVERTER, including AC Voltage, Current, Power output & DC Current, Voltage and Power input, pf and fault Indication (if any)

1.8. Codes and standards:

The quality of equipment supplied shall be controlled to meet codes listed in relevant ISI and other standards, such as:

• IEEE 928 Recommended Criteria for Terrestrial PV Power systems.

• IEEE 519 guide for Harmonic Control and Reactive Compensation of Static Power Controllers.

• National Electrical NEPA 70-(USA) or equivalent national standard.

• National Electrical safety Code ANSI C2-(USA) or equivalent national standard.

• JRC Specification 503 (Version 2.2 March 1991) or JPL Block V standard for PV modules.

1.9. Plant metering/data logging

a. PV array energy production: Digital Meters to log the actual value of AC/DC Voltage, Current & Energy generated by the PV systems shall have to be provided. 1 Nos. two way LT 415V energy meters (import – export) class 0.2S ABT compliant shall be incorporated in the system one for each Solar PV Plant.

b. Data logging systems(Hardware and software) one for each Solar PV Plant, for plant control and monitoring shall be provided with the following features suitable Computers: Desktop Computer 3 GHz Pentium i7 latest (3MB Cache) with 500 GB HDD, 4 GB RD RAM, 2 Parallel & 2 Serial Port, Wi-Fi Lan Card, DVD RW Drive, 20" LED Display, USB Scroll Mouse, along with All in one 1200 dpi/12 ppm Desktop LaserJet printers along with a 1 KVA on-line ups with 1 hour battery backup.

c. Remote Supervisory Control and data acquisition through SCADA software at the purchaser location through Handheld device /GSM cellular device with latest software/hardware configuration and service connectivity for online/real time data monitoring/control complete to be supplied and operation and maintenance /control to be ensured by the supplier.

d. All major parameters should be available on the digital bus and logging facility for energy auditing through the internal microprocessor and can be read on the digital LCD/LED front panel at any time the current values, previous values for up to a month and the average values. The following parameters should be accessible via the operating interface display:

- AC Voltage
- AC Output current
- Output Power
- DC Input Voltage
- DC Input Current
- Time Active
- Time disabled
- Time Idle
- Temperatures (C)

- Inverter Status

1.10. Disconnection and islanding

Disconnection of the PV generator in the event of loss of the main grid supply is to be achieved by in built protection within the power conditioner. This may be achieved through rate of change of current, phase angle, unbalanced voltage or reactive load variants. Operation outside the limits of power quality as described in the technical data sheet should cause the power conditioner to disconnect the grid. Additional parameters requiring automatic disconnection are:

- Neutral voltage displacement
- Over current
- Earth fault
- Reverse power

In case of the above, tripping time should be less than 0.5 seconds. Response time in case of grid failure due to switch off or failure based shut down should be well within 5 seconds.

Automatic re - connection after the grid failure is restored

INVERTER shall have facility to reconnect the Inverter automatically to the grid following restoration of grid, subsequent to grid failure condition. The system should have integrated SCADA and software or plant control and remote communication with web monitoring to monitoring individual strings and complete power plant.

1.11. ARRAY JUNCTION BOX, MAIN JUNCTION BOXES WITH STRING MONITORING FEATURE TO THE INVERTER:

The junction boxes are to be provided in the PV yard for termination of connecting cables. The Junction Boxes shall be made of FRP/Powder Coated Aluminum with full dust, water & vermin proof arrangement. All wires/cables must be terminated through cable lugs. The JBs shall be such that input & output termination can be made through suitable cable glands.

- Copper bus bars/terminal blocks housed in the junction box with suitable termination
- Threads
- Conforming to IP65 (for outdoor)/ IP 21 (for indoor) standards and IEC 62208
- Hinged door with EPDM rubber gasket to prevent water entry.
- Single compression cable glands.
- Provision capacity MOVs provided within the box to protect against lightening.

1.12. ENERGY METER

A 3 Phase, 20-60 A Energy Meter shall be provided as approved by Engineer-in charge to measure the quantum of energy. Meter must be provided with the necessary data cables. Energy Meter should be 0.5 Class of accuracy.

1.13. DC DISTRIBUTION BOARD:

Each Solar PV Plant shall have its separate DC Distribution panel to receive the DC output from the array field with analog measurement meter for voltage, current and power from different MJBs so as to check any failure in the array field.

DCDBs shall be dust & vermin proof. The bus bars are to be made of copper of desired size. Suitable capacity MCBs/MCCBs to be provided for controlling the DC power output to the INVERTER along with necessary surge arrestors.

1.14. AC DISTRIBUTION PANEL BOARD

Each plant shall be supplied with its dedicated AC Distribution panel which shall be located at an appropriate location in the building itself. ACDBs are to be provided at the cable terminating points emanating from the inverters. The AC power from inverter of each individual Solar PV Plant shall be fed into its dedicated AC Distribution panel. Thereafter, the outputs shall be terminated into the main LT supply.

AC Distribution Panel Board (DPB) shall control the AC power from inverter and should have necessary surge arresters. Interconnection from ACDB to mains at LT bus bar is to be carried out and complete equipment along with metering to be installed in the ACDB.

Panel type: Wall mounting type & CRCA 2.5 mm thick with IP 32 protection Cable Gland suitable to Incoming & out going cable

1.15. SOLAR CABLES:

- Solar cables of suitable size & cross section shall be provided for the interconnection purpose in photovoltaic power generation. Solar cables shall interconnect solar panels and other electrical components of the photovoltaic system. Solar cables shall be UV resistant and weather resistant. Solar cables shall withstand a large temperature range from -40°C to +90°C ambient and shall be generally laid outside.
- Solar cables shall be Tinned Copper XLPO insulated & LSZH sheathed suitable for 1100 VAC/ 1800 VDC.
- All cable tests and methods should confirm to IEC 60189 or other relevant standards.
- Cabling in the yard shall be carried out as per IE rules. All other cabling above ground should be suitably mounted on cable trays with proper covers.
- The size of cable for connecting module to terminal box, terminal box to panel junction box, panel junction box to array junction box and array junction box to PCU to Battery Bank/ACDB shall be as per site requirement. The decision of Engineer-in-charge shall be final.
- Cables ends: All connections are to be made through suitable cable/lug/terminals; crimped properly & with use of cable glands.
- Multi Strand, Annealed high conductivity copper conductor
- PVC type 'A' pressure extruded insulation
- Overall PVC insulation for UV protection and confirm to IEC 69947.
- Armored cable for underground laying
- Selected cable should carry a current density of minimum 1.2 Amp/Sq.mm
- All electrical/wires inside the building to be fixed in Rigid Steel Conduit for wiring inside the building.
- The cable's insulation must be able to withstand thermal and mechanical loads.
- The insulation and jacket materials shall be extremely resistant to weathering, UV-radiation and abrasion. Additionally, solar cables shall be salt water resistant and resistant to acids and alkaline solutions. Solar cables shall be suitable for fixed installation as well as for

moving applications without tensile load. These solar cables shall be especially designed for outdoor use for withstansing direct sun radiation and air humidity. Cables should be halogen free flame retardant and made of cross-linked jacket material. The solar cables shall also be installed in dry and humid conditions indoors.

- For laying/termination of cables, latest BIS/IEC codes/ standards to be followed.

1.16. FIRE EXTINGUISHERS:

- The firefighting system for the fire protection of solar power plants shall be consisting of:
- CO2 type 4.5 kg fire extinguishers in the control room for fire caused by electrical short circuits.
- Sand buckets in the control room. The installation of fire Extinguishers should confirm to TAC regulations and BIS standards. The fire extinguishers shall be provided in the control room housing the batteries and PCUs.

1.17. LIGHTENING PROTECTION

There shall be required number of suitable lightening arrestors installed in the array field.

1.17.1. EARTHING PROTECTION

Each array structure of the PV yard should be grounded properly. In addition the lightening arrester/masts should also be provided inside the array field. Provision should be kept for shorting and grounding of the PV array at the time of maintenance work. All metal casing/shielding of plant should be thoroughly grounded in accordance with Indian Electricity Act./IE Rules. Earth resistance should be tested in presence of the representative of Engineer In Charge.

1.17.2. DANGER BOARDS

Danger board should be provided as and where necessary as per IE act/IE rules as amended up to date.

IMPORTANT INDIAN STANDARDS

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 732:1989	Code of practice for electrical wiring installations (third revision)	March 2010	
(2)	IS 4648:1968	Guide for electrical layout in residential buildings	August 2012	
(3)	IS 8061:1976	Code of practice for design, installation and maintenance of service lines upto and including 650 V	March 2011	
(4)	IS 8884:1978	Code of practice for the installation of electric bells and call systems	August 2012	
(5)	IS 5578:1984/ IEC 60391 (1972)	Guide for marking of insulated conductors (first revision)	March 2011	
(6)	IS 11353:1985/	Guide for uniform system of marking and identification of	July 2012	

	IEC 60445 (1973)	conductors and apparatus terminals		
(7)	IS 13234:1991/ IEC 60909: 1988	Guide for short circuit current calculations in three-phase ac systems (superseding IS 5728)	August 2012	
(8)	IS 7752 (Part 1): 1975	Guide for improvement of power factor in consumer installation: Part 1 Low and medium supply voltages	March 2011	
(9)	IS 3646 (Part 1): 1992	Code of practice for interior illumination: Part 1 General requirements and recommendations for working interiors (first revision)	March 2008	
(10)	IS 3646 (Part 2): 1966	Code of practice for interior illumination: Part 2 Schedule of illumination and glare index	March 2008	
(11)	IS 3646 (Part 3): 1968	Code of practice for interior illumination: Part 3 Calculation of coefficients of utilization by the BZ method	March 2008	
(12)	IS 4347:1967	Code of practice for hospital lighting	May 2010	
(13)	IS 6665:1972	Code of practice for industrial lighting	May 2010	
(14)	IS 2672:1966	Code of practice for library lighting	May 2010	
(15)	IS 10118 (Part 1):1982	Code of practice for selection, installation and maintenance of switchgear and controlgear : Part 1 General	March 2011	
(16)	IS 10118 (Part 2):1982	Code of practice for selection, installation and maintenance of Switchgear and controlgear : Part 2 Selection	March 2011	
(17)	IS 10118 (Part 3):1982	Code of practice for selection, installation and maintenance of switchgear and controlgear : Part 3 Installation	March 2011	
(18)	IS 10118 (Part 4):1982	Code of practice for selection, installation and maintenance of switchgear and controlgear : Part 4 Maintenance	March 2011	
(19)	IS 4146:1983	Application guide for voltage transformers (fi rst revision)	September 2011	
(20)	IS 4201:1983	Application guide for current transformers (fi rst revision)	September 2011	
(21)	IS 5547:1983	Application guide for capacitor voltage transformers (first revision)	September 2011	

(22)	IS 2309:1989	Code of practice for protection of buildings and allied structures against lightning (second revision)	March 2010	1
(23)	IS 3043:1987	Code of practice for earthing	March 2011	2
(24)	IS 5216 (Part 1):1982	Recommendations on safety procedures and practices in electrical work: Part 1 General (fi rst revision)	March 2010	
(25)	IS 5216 (Part 2):1982	Recommendations on safety procedures and practices in electrical work: Part 2 Life saving techniques (fi rst revision)	March 2010	

ELECTRIC FANS

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 555:1979	Electric table type fans and regulators (third revision)	July 2010	2
(2)	IS 1169:1967	Electric pedestal type fans and regulators (first revision)	Mar 2009	6
(3)	IS 374:1979	Electric ceiling type fans and regulators (third revision)	September 2010	6
(4)	IS 2997:1964	Air circulator type electric fans and regulators	July 2010	8
(5)	IEC: 60665 (1981) IS 2312:1967	Propeller type ac ventilating fans (first revision) Draft Standard issued in wide circulation	July 2010	8
(6)	IS 3588:1987	Electric axial flow fans (first revision)	August 2009	1
(7)	IS 3963:1987	Roof extractor units (first revision)	August 2009	3
(8)	IS 4283:1981	Hot air fans (first revision)	August 2009	3
(9)	IS 6272:1987	Industrial cooling fans (man coolers) (fi rst revision)	August 2009	2
(10)	IS 4894:1987	Centrifugal fans (first revision)	August 2009	3
(11)	IS 11037:1984	Electronic type fan regulators	August 2010	3
(12)	IS 12155:1987	General and safety requirements for fans and regulators for household and similar purposes		

LOW VOLTAGE SWITCH GEAR AND CONTROL GEAR

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 4237:1982	General requirements for switchgear and controlgear for voltages not exceeding 1000 volts ac or 1200 volts dc (first revision) [superseded by IS 13947 (Part 1):1993]		
(2)	IS 6875 (Part 1): 1973	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V ac & 1200 V dc: Part 1 General requirements [superseded by IS 13947 (Part 5/Section 1)]		
(3)	IS 6875 (Part 2): 1973	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V ac and 1200 V dc: Part 2 Push-buttons and related control switches [Superseded by IS 13947 (Part 5/Section1)]		
(4)	IS 6875 (Part 3): 1980	Control switches (switching devices for control and auxiliary circuits including contactor relays) for voltages upto and including 1000 V ac and 1200 V dc : Part 3 Rotary control switches [superseded by IS 13947 (Part 5/ Section 1)]		
(5)	IS 10027:2000	Composite units of air-break switches and rewirable type fuses for voltages not exceeding 650 volt ac - Specifi cation (first revision)	March 2010	
(6)	IS 4064 (Part 1): 1978	Air-break switches, air break disconnectors, air-break switch disconnectors and fuse-combination units for voltages not exceeding 1000 V ac or 1200 V dc: Part 1 General requirements (revised) [superseded by IS 13947 (Part 3): 1993]		
(7)	IS 2675:1983	Enclosed Distribution Fuse Boards and Cut Outs for voltages not exceeding 1000 V A.C. or 1200 V D.C.	March 2011	
(8)	IS 8828:1996	Circuit-breakers for over current protection for household and similar installations (second revision)		
(9)	IS 13032:1991	Miniature circuit breaker boards for voltage upto and including 1 000 Volt ac	March 2011	1

(10)	IS 12640 (Part 1): 2008	Residual current operated circuit-breakers for household and simililar uses : Part 1 circuit-breakers without integral over current protection (RCCBs) (First Revision)		
(11)	IS 12640 (Part 2): 2008	Residual current operated circuit-breakers for household and similar uses: Part 2 circuit breakers with integral over current protection (RCBOs) (First Revision)		
(12)	IS 2959:1985	Contactors for voltages not exceeding 1000 V ac or 1200 V dc (fi rst revision) [superseded by IS 13947 (Part 4/ Section 1)]		
(13)	IS 12021:1987	Specifi cation for control transformers for switchgear and controlgear for voltages not exceeding 1000 Volt AC	March 2010	2
Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(14)	IS 5039:1983	Distribution pillars for voltages not exceeding 1000 volts (first revision)	March 2011	2
(15)	IS 8623 (Part 1): 1993/ IEC 60439-1 (1985)	Specifi cation for low voltage switchgear and controlgear assemblies: Part 1 Requirements for type-tested and partially type tested assemblies (first revision).	March 2008	2
(16)	IS 8623 (Part 2):1993/ IEC 60439-2 (1987)	Specifi cation for low voltage switchgear and controlgear assemblies: Part 2 Particular requirements for busbar trunking systems (busways)-(first revision)	March 2008	2
(17)	IS 8544 (Part 1): 1977	Motor starters for voltages not exceeding 1000 V: Part Direction line ac starters [superseded by IS 13947 (Part 4/Section 1): 1993]		2
(18)	IS 8544 (Part 2): 1977	Motor starters for voltages not exceeding 1000 V : Part 2 Star-delta starters [superseded by IS 13947 (Part 4/ Section 1): 1993]		
(19)	IS 8544 (Part 3/ Sec 1): 1979	Motor starters for voltages not exceeding 1000 V : Part 3 Rheostatic motor starters, Section 1 General requirements [superseded by IS 13947 (Part 4/Section 1): 1993]		

(20)	IS 8544 (Part 4): 1979	Motor starters for voltages not exceeding 1000 V: Part 4 Reduced voltage ac starters: two step auto-transformer starters [superseded by IS 13947 (Part 4/Section 1): 1993]		

POWER CABLE

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 694:1990/ IEC 60227-1 to 5 (1979)	PVC Insulated cables for working voltages upto and including 1100 V	February 2010	5
(2)	IS 694: 2010	Polyvinyl chloride insulated sheathed and unsheathed cables with rigid and flexible conductor for rated voltages upto and including 450/750 V : Part 1 General requirements (fourth revision)		1
(3)	IS 1554 (Part 1): 1988/ IEC 60502 (1983)	PVC insulated (heavy duty) electric cables: Part 2 For working voltages upto and including 1100 V (Third revision)		
(4)	IS 3961 (Part 1): 1967	Recommended current ratings for cables: Part 1 Paper insulated lead sheathed cables	November 2011	
(5)	IS 4288:1988	PVC insulated (heavy duty) electric cables with solid aluminium conductors for voltages upto and including 1100 V (second revision) (withdrawn)		
(6)	IS 4289 (Part 1): 1984/ IEC 60245-5	Flexible cables for lifts and other flexible connections: Part 1 Elastomer insulated cables (first revision)		

ELECTRIC WIRING ACCESSORIES

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 9537 (Part 1): 1980/ IEC 60614-1 (1978)	Conduits for electrical installations: Part 1 General Requirements	November 2010	(1)
(2)	IS 9537 (Part 2): 1981	Conduits for electrical installations: Part 2 Rigid steel conduits (superseding IS:1653)	May 2012	(2)
(3)	IS 3480:1966	Flexible steel conduits for electrical wiring	May 2012	(1)
(4)	IS 2667:1988	Fittings for rigid steel conduits for electrical wiring (first revision) [Superseded by IS 14768 (Part 2): 2003]	February 2008	

(5)	IS 3837:1976	Accessories for rigid steel conduits for electrical wiring (first revision)	May 2012	(1)
(6)	IS 9537 (Part 4): 1983	Conduits for electrical installations: Part 4 Pliable self- recovering conduits of insulating materials	May 2012	
(7)	IS 9537 (Part 5): 2000/ IEC 60614-2-3 (1990)	Conduits for a electrical installations: Part 5 Pliable conduits of insulating material [Superseding IS 6946]	June 2010	
(8)	IS 3419:1989	Fittings for rigid non-metallic conduits (second revision)	May 2012	
(9)	IS 14772:2000/ IEC 60670-1 (1989)	Enclosures for accessories for household and similar fixed electrical installations [Superseding IS 5133 (Part 1 and 2)]	May 2010	
(10)	IS 2412:1975	Link clips for electrical wiring (first revision)	May 2012	(2)
(11)	IS 371:1999	Ceiling roses (third revision)	March 2010	(4)
(12)	IS 3854:1997/ IEC 60669-1 (1998)	Switches for domestic and similar purposes (second revision)	July 2012	(6)
(13)	IS 4615:1968	Switch-socket outlets (non-interlocking type) (Withdrawn)		
(14)	IS 4160:2005/ IEC 60884-2-6 (1997)	Interlocking switch socket outlets - Specification (first revision)	June 2010	
(15)	IS 1293:2005/ IEC 60884-1 (2002)	Plugs and socket outlets of rated voltage upto and including 250 volts and rated current upto and including 16 amperes - Specification (third revision)	June 2010	(5)

ELECTRICAL LAMPS AND THEIR AUXILIARIES

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 418:2004/ IEC 60064 (1993)	Tungsten filament lamps for domestic and similar general lighting purposes (fourth revision)	March 2009	(4)
(2)	IS 2418 (Part 1): 1977/ IEC 81 (1974)	Tubular fluorescent lamps for general lighting service: Part 1 Requirements and tests (first revision)	December 2010	(8)

(3)	IS 9900 (Part 1): 1981 / IEC 188 (1974)	High pressure mercury vapour lamps: Part 1 Requirements and test [Superseding IS 2183 and IS 7023]	October 2012	(4)
(4)	IS 9974 (Part 1): 1981/ IEC 662 (1980)	High pressure sodium vapour lamps : Part 1 General requirements and tests	October 2012	(4)
(5)	IS 1258:2005/ IEC 61184 (1997)	Bayonet lamp holders (fourth revision)	June 2010	(3)
(6)	IS 3323:1980/ IEC 60400 (1972)	Bi-pin lamp holders for tubular fluorescent lamps (first revision)	October 2012	(1)
(7)	IS 3324:1982/ IEC 400 (1972)	Holders for starters for tubular fluorescent lamps (first revision)	June 2008	
(8)	IS 2215:2006/ IEC 60155 (1993)	Starters for fluorescent lamps (third revision)	Jun 2010	
(9)	IS 1534 (Part 1): 1977 / IEC 82 (1973)	Ballasts for fluorescent lamps: Part 1 For switch start circuits (second revision)	July 2011	(5)
(10)	IS 1569:1976/ IEC 566	Capacitors for use in tubular fluorescent	July 2011	(1)
(11)	IS 6616:1982/ IEC 262 (1969)	Ballasts for high pressure mercury vapour Lamps (first revision)	July 2011	(1)

LIGHT FITTINGS AND LUMINAIRES

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 1913 (Part 1): 1978	General and safety requirements for luminaires: Part 1 Tubular fluorescent lamps (second revision)		
(2)	*IS 10322 (Part 1) :1982 / IEC 598 - 1(1979)	Luminaires: Part 1 General requirements	May 2010	
(3)	IS 10322 (Part	Luminaires: Part Constructional Requirements	May 2010	

	2): 1982 / IEC 598 - 1(1979)	2		
(4)	IS 10322 (Part 5/ Sec. 2):2012	Luminaires: Part 5 Particular requirements, Sec 2 Recessed luminaires (First Revision)	March 2012	
(5)	IS 10322 (Part 5/ Sec. 3):2012/ IEC 60598-2-3 (1979)	Luminaires: Part 5 Particular requirements, Sec 3 Luminaires for road and street lighting (First revision)	March 2012	
(6)	IS 10322 (Part 5/ Sec 4):1987/ IEC 60598-2-4 (1979)	Luminaires: Part 5 Particular requirements, Section 4 Portable general purpose	May 2010	1
(7)	IS 10322 (Part 5/ Sec 5):1987/ IEC 60598-2-5	Luminaires: Part 5 Particular requirements, Section 5 Flood lights [superseding IS 1947]	May 2010	(1)
(8)	IS 3287:1965	Industrial lighting fittings with plastic reflectors		
(9)	IS 1777:1978	Industrial luminaires with metal reflectors (first revision)		
(10)	IS 2206 (Part 1): 1984	Flameproof electric lighting fittings: Part 1 Well-glass and bulkhead types (first revision)		
(11)	IS 3528:1966	Waterproof electric lighting fittings	May 2010	
(12)	IS 3553:1966	Watertight electric lighting fittings	May 2010	
(13)	IS 8030:1976/ IEC 162 (1972)	Luminaires for hospitals	March 2008	
(14)	IS 7537:1974	Road traffic signals	March 2008	
(15)	IS 9583:1981/ IEC 598-2-22 (1980)	Emergency lighting units	March 2008	

List of BIS Standards – LED Fixtures

Sr No	IS No	Title
1.	16101 : 2012	General Lighting - LEDs and LED modules – Terms and Definitions
2.	16102(Part 1) : 2012	Ballasted LED-Lamps for General Lighting Services Part 1 - Safety Requirements
3.	16102(Part 2) : 2012	Self-Ballasted LED-Lamps for General Lighting Services Part 2 Performance Requirements
4.	16103(Part 1) 2012	LED Modules for General Lighting- Safety Requirements
5.	16103 (Part 2) 2012	LED modules for general lighting Part 2 Performance requirements
6.	15885(Part 2/Sec 13) : 2012	Control Gear Part 2 Particular Requirements Section 13 or AC Supplied Electronic Controlgear for Led Modules
7.	16104 : 2012	DC or AC Supplied Electronic Control Gear for LED Modules – Performance Requirements
8.	16105 : 2012	Method of Measurement of Lumen Maintenance of Solid -State Light (LED) Sources
9.	16106 : 2012	Method of Electrical and Photometric Measurements of Solid-State Lighting (Led) Products
10.	16107 – Part 1	Luminaires Performance Part 1 General requirements
11.	16107 – Part 2	Luminaires performance Part 2 Particular requirements Section 1 LED Luminaire
12.	16108 : 2012	Photobiological Safety of Lamps and Lamp Systems

ELECTRICAL APPLIANCES

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 302 (Part 1): 2008/ IEC 60335-1 (2006)	Safety of household and similar electrical appliances: Part 1 General requirements (sixth revision)		(1)
(2)	IS 2268:1994	Electric call bells and buzzers for indoor use (second revision)	March 2009	
(3)	IS 3412:1994	Electric water boilers (second revision)	March 2009	

ELECTRICAL INSTRUMENTS

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 6236:1971/ IEC 60258 (1968)	Direct recording electrical measuring Instruments	January 2010	
(2)	IS 1248(Part 1): 2003/ IEC 600 51-1 (1997)	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 1 General requirements (fourth revision)	Sep 2008	
(3)	IS 1248(Part 2):	Direct acting indicating analogue electrical measuring	Aug 2008	

	2003/ IEC 600 51-2 (1984)	instruments and their accessories: Part 2 Ammeters and voltmeters (third revision)		
(4)	IS 1248(Part 3): 2003/ IEC 600 51-3 (1984)	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 3 Wattmeters and varmeters (third revision)	Aug 2012	
(5)	IS 1248(Part 4): 2003/ IEC 600 51-4 (1984)	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 4 Frequency meters (third revision)	Aug 2008	
(6)	IS 1248 (Part 5): 2003/ IEC 600 51-5 (1984)	Direct acting indicating analogue electrical measuring instruments and their accessories: Part 5 Phase meters, power factor meters and synchroscope (third revision)	Aug 2008	
(7)	IS 722(Part 1): 1998	AC electricity meters : General requirement and tests		
(8)	IS 722 (Part 2): 1977	AC electricity meters: Part 2 Single-phase whole-current watt-hour meters, Class 2 (first revision)		
(9)	IS 722 (Part 3): 1988	AC electricity meters: Part 3 Three-phase whole current and transformer operated and single-phase transformer operated watt-hour meters, class 2 (second revision)		
(10)	IS 722 (Part 5): 1980	AC electricity meters: Part 5 Volt-ampere hour meters for restricted power factor range, class 3.5 (first revision)		
(11)	IS 722 (Part 7/Sec 1): 1987	AC electricity meters: Part 7 Volt-ampere hour meters for full power factor range, Section 1 General requirements (first revision)		
(12)	IS 722 (Part 8): 1972	AC electricity meters: Part 8 Single-phase 2-wire whole current watt-hour meter (class 1.0)		
(13)	IS 722 (Part 9): 1972	AC electricity meters: Part 9 Three-phase whole current and transformer operated watt-hour meters and single-phase two-wire transformer operated watt-hour meters		

		(class 1.0)		
(14)	IS 8530: 1977	Maximum demand indicators (class 1)		
(15)	IEC 60211:1966 *IS 2992:1987	Insulation resistance testers, hand operated (magneto generator type) (second revision)	Jan 2010	

INSTRUMENT TRANSFORMERS

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 2705 (Part 1): 1992/ IEC 60185 (1966)	Current transformers: Part 1 General requirements (second revision)	Aug 2012	(1)
(2)	IS 2705 (Part 2): 1992/ IEC 60185 (1966)	Current transformers: Part 2 Measuring current transformers (second revision)	Aug 2012	
(3)	IS 2705 (Part 3): 1992/ IEC 60185 (1966)	Current transformers: Part 3 Protective current transformers (second revision)	Aug 2012	
(4)	IS 2705 (Part 4): 1992/ IEC 60185 (1966)	Current transformers: Part 4 Protective current transformers for special purpose applications (second revision)	Aug 2012	
(5)	IS 6949:1973	Summation current transformers	Sep 2011	

FUSES

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 9224 (Part 1): 1979	Low voltage fuses: Part 1 General requirements [superseded by IS 13703 (Part 1):1993]		
(2)	IS 9224 (Part 2): 1979	Low voltage fuses: Part 2 Supplementary requirements for fuses for industrial applications (superseding IS 2208) [superseded by IS 13703 (part 2/Section 1):1993]		
(3)	IS 2086:1993	Carriers and bases used in rewirable type electric fuses for voltages upto 650 V (third revision) [Superseding IS 8724]	Mar 2009	(1)

(4)	IS 9926:1981	Fuse wires used in rewirable type electric fuses upto 650 volts	Mar 2011	
(5)	IS 8187:1976/ IEC 269-3 (1973)	D-type fuses		

MISCELLANEOUS

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 2551:1982	Danger notice plates (first revision)	Mar 2010	
(2)	IS 2448 (Part 1): 1963	Adhesive insulating tapes for electrical purposes: Part 1 Tapes with cotton textile substrates	Oct 2010	(5)

ELECTROTECHNICAL VOCABULARY

CODES OF PRACTICE GUIDE **Date** **Amdt**

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 1885 (Part 1): 1961	Electrotechnical vocabulary: Part 1 Fundamental Defi nitions	Jul 2012	(2)
(2)	IS 1885 (Part 9): 1992/ IEC 60050 (446):1983	Electrotechnical Vocabulary: Part 9 Electrical relays (second revision)	Jul 2012	
(3)	IS 1885 (Part 11): 1966	Electrotechnical vocabulary: Part 11 Electrical Measurements	Jul 2012	
(4)	IS 1885 (Part 16/ Sec 1):1968	Electrotechnical vocabulary: Part 16 Lighting, Section 1 General aspects	Jul 2012	
(5)	IS 1885 (Part 16/ Sec. 2):1968	Electrotechnical vocabulary: Part 16 Lighting, Section 2 General illumination, lighting fittings and lighting for traffic and signaling	Jul 2012	
(6)	IS 1885 (Part 16/ Sec. 3):1967	Electrotechnical vocabulary: Part 16 Lighting, Section 3 Lamps and auxiliary apparatus	Jul 2012	
(7)	IS 1885 (Part 17): 1979	Electrotechnical vocabulary: Part 17 Switchgear and controlgear (fi rst revision)	Jul 2012	

(8)	IS 1885 (Part 32):1993/ IEC 60050 (461): 1984	Electrotechnical Vocabulary: Part 32 Electric cables (first revision)	Mar 2009	

SAFETY

CODES OF PRACTICE GUIDE

Sl.No.	Standard	Title	Reaffirm Date	Amdt.
(1)	IS 4770:1991	Rubber Gloves for electrical purposes		
(2)	IS 5424:1969	Rubber mats for electrical purpose (Superseded by IS 15652:2006)	April 2011	(2)

CHAPTER- K

TECHNICAL SPECIFICATION - LIFTS

1. GENERAL

The scope of work shall cover design, supply delivery, installation, testing and commissioning of passenger lifts/ passenger cum bed lifts/Service lifts. All lifts shall be VVVF operated, gearless, Central/Side opening and with Machine room. The Lifts shall be with facility for duplex/triplex seclective/collective operation. Car enclosure fininsh shall be SS (as per OEM) scratch proof moonrock/honeycomb. SS handrail not less than 600 mm long at 900 mm above floor level , to be provided inside the lift car as per requirement. Suitable lights and fans as per requirement shall be provided. Lift car size, Lift well size, Lift pit overhead, entrance width, car height etc. shall be as per NBC 2016 or OEM standards. The dimensions of Lift well shown in tender drawings are only indicative and EPC contractor shall provide the same as required by OEM. The scope of work shall also include the following item of civil works.

a) Necessary scaffolding temporary barricade in the hoist way required during the erection of the elevators.

b) Minor building work comprising of cutting holes and making good the car and counterweight rail brackets, hall buttons and indicators including laying of sills in position.

c) Steel items such as machine beams, bearing plates buffer support channels, sill angles and fascia plates etc.

d) Suitable trap doors with steel chequered plate covers.

e) Providing and install a suitable vertical iron ladder for access to the pit.

f) Any other item required for successful completion and commissioning of lifts. (including the hoisting beam in the machine room)

The work shall be done in accordance with regulations of any local code and following ISI codes which govern the requirements of installations.

- IS: 1860-1980 code of practice for installation, operation and maintenance of Electric Passenger and Goods Lifts.
- IS: 3534-1976 Outline dimensions of Electric Lifts.
- IS: 4666-1980 Specifications for Electric passenger and Goods Elevators.
- Indian Electricity Act 1910.
- Indian Electricity Rules, 1956.

The lift motor shall be controlled by a variable voltage variable frequency (V.V.V.F.) micro-processor control system which shall control and monitor every aspect of lift operation at all stages of the car motion cycle on real time basis. Variable voltage variable frequency drive system (with close loop) shall be used.

2. SHOP DRAWINGS AND APPROVAL OF ELECTRICAL INSTALLATIONS :

The selected tenderer shall prepare a furnish shop drawings for approval by The Client, such shop drawings shall be based on the Architectural drawings and requirements laid down in specifications, local laws and regulations etc.

The detailed drawings shall be submitted within one month of placement of order. The successful tenderer shall obtain the approval of electrical Inspector and other local authorities as per

requirements before submitting the drawings to Client/ Engineer. The contractor shall not proceed with in installation work till the drawings are approved by the Engineer-in-Charge.

Approval of contractor's drawings shall not absolve the contractor of any of his obligations to meet the requirements of specification under this contract

Five sets of completion drawings operation manual, maintenance manual, spare parts details shall be submitted to the Client/ Engineer after completion of work.

3. GUARANTEE

The contractor shall guarantee the equipment against all defects of materials and workmanship for a period of one year from the date of Handing over of the equipment as certified by the owner. Any defects arising during the guarantee period shall be rectified and replaced by the tenderer, at his own expense, to the satisfaction of the owner.

4. PERMITS, INSPECTION & LICENSE FEE

The contractor shall arrange all necessary local, provincial or national government permit/License and shall make arrangements for inspection and tests required thereby. Expenses to be borne by EPC contractor.

5. POWER SUPPLY

The apparatus shall be designed to operate on 415 + 10% - 20% Volts, 3 Phase, 4 wires, 50 Hz A.C. Supply for illumination signal equipment shall be 240 Volts single phase 50Hz A.C.

6. ELECTRICAL WIRING

The necessary A.C. supply of 3 Phase, 415 Volts 50 HZ shall be made available in the main control switch unit to be provided by the contractor in the machine room. All the electrical works beyond the main supply switch shall be carried out by the contractor i.e. supply and installations of panels for drive motors, switches and control complete with wiring as per system requirement and approval of the Engineer.

The wiring shall be carried out strictly in accordance with Indian Electricity Rules and Indian code of Practice for Electrical Wiring Installation IS-732-1963 System Voltage not exceeding 650 V).

The cable and conduits to be used shall be of suitable size and grade conforming to relevant IS specification. Wiring for LT switchboard to the motor terminal shall be with heavy duty 1.1 KV grade XLPE insulated PVC sheathed, FRLS aluminium cable. All the trailing cables used for control and safety device shall conform to IS: 4289-1967, Specifications for lifts cables. The trailing cable circuits for controls, safety devices, lighting and signaling shall be separate and distinct.

Power wiring between controller and main board to various landings shall be drawn in suitable size heavy gauge conduit stove enameled/painted conforming to I.S specifications.

The Voltage and frequency of the supply shall be subjected to variations permissible under Indian Electricity Acts and Rules.

7. CAR FRAME:

The car frame, which supports the car platform and enclosures, shall be made of structural steel and equipped with suitable guides and a car safety device mounted underneath the car platform. The hoist ropes shall include adjustable self/ aligning hinges. The car shall be so mounted on the frame that vibration and noise transmitted to the passenger is minimized.

8. CAR SAFETY AND GOVERNER:

Suitable car safety to stop the car whenever excessive descending speed is attained shall be operated by a centrifugal speed governor connected to the governor through a continuous steel rope.

The governor shall be provided with self tensioning device to keep governor rope in proper tension even after rope stretch. Suitable means shall be supplied to cut off power from the motor and apply the brake on application of the safety.

9. COUNTER BALANCE :

A Suitable guided structural steel frame with appropriate filler weights of cast iron shall be furnished to promote smooth and economic operation.

10. TERMINAL AND FINAL LIMITS :

Terminal limit switches shall be provided to slow down and stop the car automatically at the terminal landings within permissible over travel and final limit switches shall be provided to automatically cut off the power and apply the brake, should the car travel beyond the permissible over travel. They shall act independently of the operating devices and buffers.

11. TERMINAL BUFFERS :

Heavy duty spring buffers shall be installed as a means of stopping the car and counterweight at the extreme limits of travel. Buffers in the pit shall be mounted on steel channels which shall extend between both the car and counterweight rails.

12. **CONTROLLER :**

A Controller shall be provided to control starting stopping and speed of the elevator motor and also be automatically able to apply the brake if any of the safety devices operate or if power fails from any cause. In case of power failure and again restore of power the lift shall land to next floor and shall not go to basement/lowest level. Suitable software/hardware or rescue device shall be provided.

13. REVERSE PHASE RELAY :

A reverse phase relay shall be provided on the controller which is designed to protect the lift equipment against phase reversal and phase failure.

14. GUIDES :

Machined steel tee guides shall be furnished for the car and counterweight. The guide rails should be of steel solid and shall have tongued and grooved joints. Sliding clips shall be used for fastening the guides to allow building settlement without distorting the guide rails. To keep down the noise level and to reduce wear and tear of the sections, only Nylon Ribs shall be used in the guide shoes, after smoothening of the rails. The flanges shall be machined for the fish plate mounting such that rail alignment at joints almost remain constant.

15. FOUNDATIONS :

The machine shall be placed directly above the hoist way upon the machine room slab or as per design.

16. ROPES :

The elevator shall be provided with traction steel ropes. Steel wire rope having a tensile strength of not less that 12.5 Ton/cm^2 of good flexibility shall be used for lift. The lift rope shall conform to IS: 14665 – (Part-4- Sec-8):2001.

17. MACHINE :

The machine shall be gearless type.

18. BRAKE :

The direct current brake shall be spring applied and electrically released and designed to provide smooth stop under variable loads. The brake should be capable of operation automatically by

various safety devices, current failure, and by normal stopping of car. It should be possible to release the brake manually, such releases brake manually, such releases requiring the permanent application of manual force so as to move the lift car in short sties. For this purpose one set of brake release equipment shall be supplied.

19. MOTOR :

The motor shall be suited to the service proposed and arranged for adequate lubrication. The motor shall be class F insulation and one (1) hour rated squirrel cage induction type having high starting torque. It shall also be provided with Thermisters embedded in the stator windings for the highest degree of thermal motor protection.

20. CONTROL

The control shall be variable voltage variable frequency A.C. variable voltage, closed loop control system using solid state devices and electronic speed pattern generator to command the motor from a velocity transducer and load compensation circuits for a comfortable ride.

In Normal operation, the electromagnetic brake shall only be applied when the lift has come to a complete standstill. The brake shall only be meant for holding the lift in position at every landing, providing stopping without any jerking effect.

Each controller cabinet containing memory equipment shall be properly shielded from the pollution.

21. MICROPROCESSOR

The control shall employ a microprocessor working on a program such that precision leveling and highly efficient handling of passengers for least possible waiting and reduced travel time is ensured. The microprocessor system should be designed to accept programming with minimum downtime. It should be able to monitor the state of input calls (such as car calls from COP and hall calls from hall fixtures) and output commands such as starting, decelerating and stopping the elevator. It should be able to generate floor location data, thereby, providing a reference position to establish the safety zones for door opening and closing, and also to initiate leveling slowdown.

22. DUPLEX COLLECTIVE OPERATION

The operation shall be duplex collective with/without attendant for each elevator and shall consist of the following:-

a. IN THE CAR

There shall be furnished a flush type attractively finished stainless steel panel which contains a series of luminous buttons numbered to correspond to the landings served, an emergency stop switch and an emergency call button connected to a bell which serves as an emergency signal.

b. AT HOISTWAY LANDINGS

There shall be provided an UP luminous push button and a DOWN luminous push button at each intermediate landing and a single button at the terminal landings.

The car shall not start unless the door is in the closed position and all hoistway doors are closed in the locked position.

If the car is idle and one or more car or landing buttons above the landing at which the car is standing are pressed, the car shall start in the UP direction and proceed to the highest landing for which any button is pressed and stops at intermediate landing for which a car button or up landing button is pressed sufficiently in advance of the car's arrival at such landings to permit these stops to be made. After each stop, the car shall proceed in the UP direction until it reaches the highest landing for which a call is registered. The car shall not stop on the UP trip at any landing in response to a DOWN call.

Similarly, if the car is idle and one or more car or landing buttons below the landing at which the car is standing are pressed, the car shall start in the DOWN direction, proceed to the lowest landing for which any button is pressed and stop at each intermediate landing for which a car button is pressed.

When the car is idle and a button for a landing above the car and a landing below the car are pressed, the car shall start towards the landing corresponding to the button pressed first. The call registered for the landing in the opposite direction from the car shall be answered after the car has responded to the farthest call in the direction established by the button pressed first.

A time relay shall hold the car for an adjustable interval of few seconds at the landings at which stops are made to enable passengers to enter or leave the car.

23. Lift Voice Announcement:

The lift shall be provided with floor announcement system with volume control.

24. Lift instructions:

Steel plate containing following instructions shall be provided inside each lift car:

i. Lift number ____

ii. Capacity _____Kg, _____persons.

iii. Any other instruction as per manufacturer's standard or other relevant codes.

Steel plate containing following instructions shall be provided outside each lift car, on all floors:

i. Lift number _____

ii. Capacity _____Kg, _____persons.

iii. Any other instruction as per manufacturer's standard or other relevant codes.

25. Other Details

a. Work shall be carried out as per CPWD specifications unless otherwise specified.

b. Suitable scaffolding in the hoist way, cutting work and all minor civil works, if any, required shall be done by contractor without any extra cost.

d. All steel items in machine room, hoist way and lifting arrangement in the lift machine room shall be provided by the contractor without any extra cost.

e. At the time of erection, testing & commissioning of lift works all the landing door openings shall be suitably protected by the contractor to avoid any miss happening.

f. All exposed metal parts will be painted with good quality anticorrosive low VOC paint after erection and before commissioning of the lift.

It should be possible for an attendant to operate any car.

26. CAR DOOR/LANDING DOOR

The car entrance shall be provided with stainless steel centre opening doors in moon rock finish or as per direction of Engineer In Charge. The lift car door shall have a fire resistance rating of two hours.

27. HOISTWAY DOORS :

At each landing, a center/ telescopic opening , stainless steel sliding door in plain finish giving a clear opening as per CPWD general specifications for electrical works –Part-III – Lifts & Escalators, shall be provided.

28. SIGNAL AND OPERATIVE FIXTURES :

The following signal and operative fixtures shall be provided for each lift in stainless steel face plates except in fireman's switch which shall have a glass face plate.

a. **CAR OPERATING PANEL**

There shall be one (1) No. panel in car, with hinged stainless steel face plate and shall comprise Braille illuminated floor buttons, door open and emergency stop controls emergency call buttons, door open and emergency stop controls emergency call button, two position key operated switch, a Buzzer, UP and DOWN direction light panels, a non stop button, and an integral interphone. The jewels and accentuator shall be of modular construction, face plate mounted, rewired using snap on lugs.

b. **HALL BUTTONS AND HALL POSITION INDICATOR**

There shall be provided combined signal fixture (one riser) of compact design and of attractive hairline stainless steel face plate at the elevator entrance on each floor which for terminal landings shall have a single luminous push button and for intermediate landings shall have an UP Braille illuminated push button and a DOWN Braille illuminated push button. The jewels shall be of modular construction mounted on a stainless steel face plate. Whenever a button is pressed, the jewel shall light up to indicate registration of the call and shall remain enlighted till the car arrives.

c. **CAR POSITION INDICATOR IN CAR**

This shall be of compact design and of attractive hairline finish stainless steel face plate with easy to read digital display of the floors, indicating through which floor the elevator is passing or on which floor the elevator is stopped. This shall also incorporate illuminated arrows showing the direction of travel.

d. **BATTERY OPERATED ALARM BELL AND EMERGENCY LIGHT**

A solid state siren type alarm unit operated by 2 Nos. 9 volt rechargeable Nickel Cadmium batteries shall be provided which shall give a waxing and waning siren when alarm bell in the car is pressed momentarily.

An emergency light unit using a 9 volt dry battery power pack and incandescent lamp with stainless steel face plate shall be provided inside the car which shall operate automatically in the case of power failure.

e. **OVERLOAD WARNING**

Overload warning radars with audio-visual indication (visual indication shall show OVERLOADED) with stainless steel face plate shall be installed in the elevator car, so that when there is overload in the car the sign shall light up a flash indicating OVERLOADED and a buzzer shall operate during this period and the doors shall remain open unit the overload is removed.

f. **FIREMAN'S SWITCH**

A toggle switch covered by a glass cover shall be provided on the ground floor for each elevator which shall permit a fireman to call the elevator to the ground floor by canceling all car and landing calls. The elevator shall then stop at the ground floor with the door open to permit the fireman to have exclusive use of the elevator without any interference from the landing calls.

g. **INTERPHONE**

Interphone shall have one master unit in each machine room, one master unit on the ground floor for each 1 (outside hoist way) and one slave unit in each elevator car.

29. ELECTRIC DOOR OPERATOR FOR CAR DOOR AND HOISTWAY DOOR :

An electric door operator for opening and closing the car door shall b e provided. The opening of a car and hoist way doors shall be such that the doors shall start opening meant for so that by the time the elevator stops completely, the elevator and hoist way doors shall be fully open.

The equipment shall consist of a machine on the elevator car operating the car door when the car is stopping at a landing.

The car door and hoist way door shall be mechanically connected and shall move simultaneously in opening and closing.

The car and hoist way doors shall be power opened and closed and shall be checked in opening and closing with an oil cushioning mechanism built into the gear unit.

Each hoist way door shall be provided with an interlock which will prevent movement of the car away from the landing unit.

The doors are closed in the closed position as defined in the ISI codes.

An electric contact for the car door shall be provided which shall prevent car movement from the landing unless the door is in the closed position as defined in the ISI codes. The locking arrangement shall be so designed that the electrical circuit cannot be completed unless the doors are in the closed position and mechanical latching is effected.

Necessary switches shall be provided in the elevator machine room to control the operation of the doors.

The car and hoist way, doors shall open automatically as the car is stopping at a landing. The closing of the car and hoist way door must occur before the car can be started. Doors can be stopped and reversed during their closing motion.

30. DOOR HANGER AND TRACKS :

For the car and each landing door, sheave type two point suspension hangers complete with tracks shall be provided. Means shall be provided to prevent the door from jumping off the track and for vertical and literal adjustment of doors.

Sheaves and rollers shall be of steel and shall include shielded ball bearing to retain grease lubrication. Adjustable ball bearings rollers shall be provided to take the upward thrust of the doors. Tracks shall be of suitable steel section with smooth surface. The locking of the two leaf parting type doors should be positive.

31. SAFETY SENSOR:

A safety sensor(one on each door panel) shall extend to the full height of the car door.

32. LANDING ENTRANCE MATERIAL'S :

These shall consist of headers, extruded aluminium sills and strut angles.

33. WIRING :

Complete wiring in the equipment room from controller to various landings shall be done in heavy gauge conduit / metal duct & shall confirm to IE rules 1956 . DC power & AC power shall not run in same conduit / duct and they shall be laid as per IE rules.

34. AUTOMATIC RESCUE DEVICE:

Automatic Rescue Device to be provided for all the lifts with battery backup so that it can land to the nearest level in case of power failure. Automatic Rescue Device shall have suitable battery backup so that it can operate minimum seven times in a day provided the duration between usage is at least 30 minutes.

35. TESTING OF LIFTS

The contractor after the installation of the lifts has to conduct the following test and furnish the readings to ascertain the performance of the lifts.

1.	Levelling Test	:
2.	Safety Gear Test	:
3.	Contract Speed Test	:
4.	Lift Balance	:
5.	Car and Landing Interlock Test	:
6.	Controllers Test	:
7.	Normal Terminal Stopping Switches	:
8.	Final Terminal Stopping Switches	:
9.	Insulation Resistance Test	:
10.	Ropes	:
11.	Buffer Test	:
12.	Earthing	:
13.	Performance Test	:

36. Dumb Waiter Lifts:-

Capacity, speed, lift well size, lift car dimensions as per BOQ item description.

Control Panel - single speed V3F AC Drive with Micro Processor Based PLC for logic operation of lift, with Encoder for precise leveling.

Power- 415 V, 3 Phase, 50 Hz. 4 wires system.

Car & landing entrance:- No door on car. Landing entrance shall be protected by Manually operated swing type doors OR vertical bi-parting doors made from S.S. 500 mm W x 800 mm H clear opening or as per manufacturing standards.

Operation of safety - The car will not move if any of the landing doors is open or the car will instantly stop if any of the landing doors somebody opens when the car is in operation.

Car enclosure:- S.S.Sheets 304 quality – Hairline finish with LED lights.

Indicators: - Up/Dn arrow indicator with push button control on the landings with STOP push button.
Type of Balancing - Counter weight balancing type with Reduction gear.

Special Features:-

- •Auto Rescue Device.
- • Overload Indicator.
- • Door Electrical interlock.
- • Voice announcement system.
- • Floor & direction Indicator.

37. **List of IS codes for Lift installations applicable is given below:**

1.	Code of Practice for installation, operation and Maintenance of electric passenger & goods lifts.	IS-1860
2.	Code of Practice for installation, operation and Maintenance of electric service lift.	IS-6620
3.	Specification for electric passenger & goods lifts	IS-4666
4.	Electric service lift.	IS-6383
5.	Online dimension for electric lifts	IS-3534
6.	Code of practice for installation and maintenance	IS-4591
7.	Specification for steel wire suspension ropes for lifts & hoists.	IS-2365
8.	Glossary of terms relating to wire ropes	IS-2363
9.	Specification for lifts cables	IS-4289
10.	Glossary of terms for electrical cables & conduits	IS-1591
11.	Specification for rubber insulated cables	IS-434/1
12.	Specification for varnished, cotton cloths & tape for electrical Purpose	IS-3352
13.	Specification for lift door locking devices and contracts	IS-7759
14.	Specification for hot rolled and slit steel bars	IS-1173
15.	Method of loading rating of worm gear	IS-7443
16.	Code of practice for selection for selection of standard worn and helical gear box	IS-7403
17.	Isometrics screw threads	IS-4218
18.	Degree for protection provided by enclosure for low voltage Switchgear and control gear	IS-2147
19.	Specification for HRC cartridge fuse links upto 650 volts.	IS-2208
20.	Code of practice for electrical wiring installation (System voltage not exceeding 650 volts).	IS-732
21.	Voltage & frequency for AC transmission & distribution system	IS-5850
22.	Specification for AC contractors voltage not exceeding 1000V	IS-2959
23.	Heavy duty air break switched & composite unit of air break Switches& composite unit of air break switches and fuses For voltage not exceeding 1000 volts.	IS-4047
24.	General requirements for switch gear & controller for voltage Not exceeding 1000 volts.	IS-4237
25.	Specification for motor starter of voltage up to 650 V	IS-1822
26.	Nomenclature of floors & storeys	IS-2332
27.	Code of practice for sound insulation of non-industrial building	IS-1950

28. Code of practice for installation & maintenance of inducting motor IS-906
29. Specification for three phase induction motor. IS-235
30. Guide for testing three induction motor IS-4029
31. Specification for degree of protection provided by enclosure for rotating electrical machinery IS-4691
32. Designation of method of cooling for rotating electrical machines. IS-6362
33. Classification of insulating materials for electrical machinery and Apparatus in relation to their thermal stability in service. IS-1271
34. Code of practice for earthing. IS-3043
35. Electrical installation fire safety of building IS-1646
36. Code of practice for the protection of buildings and allied Structures against lighting IS-2309
37. Specification for hoist way door locks IS-7754
38. Rules for the design, installation, testing and operation of the lifts, escalator and moving parts. IS-1735

CHAPTER L

TECHNICAL SPECIFICATIONS- HVAC WORKS

1. GENERAL

Scope of work shall include design, engineering, supply, installation, testing & commissioning of HVAC system. All material shall be of conforming to relevant IS specifications wherever exists and subject to approval of Engineer in charge. The HVAC sytem shall be carried out strictly as per NBC - 2016/ASHRAE/ISHRAE/CPWD/ECBC latest versions.

1.1. TENDER DRAWINGS

For guidance of the bidder, drawings (Schematic HVAC Layout/External Burried Pipe layout, Plant Room Layout etc.) are enclosed with these tender documents. These drawings are broadly indicative of the work to be carried out. The contractor on award of work will furnish detailed stage-wise GFC drawings as required in advance for approval of Engineer-In-charge.

1.2. GOOD FOR CONDTRUCTION DRAWINGS/ TECHNICAL DATA SHEETS

The contractor shall prepare and furnish all shop drawings including floor plans & Terrace, Schematic HVAC Layout/External HVAC pipe routing etc.

The manufacturing of equipment shall be commenced only after the shop drawings/GA Drawings/ technical data sheet along with pump curves are approved in writing by the Engineer. Such drawings shall be co-ordinated with other services work. These shop drawings will be approved by HLL which will be considered as base for execution of fire fighting work.

1.3. COMPLETION / AS BUILT DRAWINGS

On completion of the work and before issuance of certificate of virtual completion, the contractor shall submit to the Engineer –in-Charge, General layout drawings, drawn at approved scale indicating layout of pump house piping and its accessories "As installed". AS built drawings shall be prepared taking approved shop drawings as base & incorporating all changes/ modifications as per site conditions. These drawings shall include the following:-

a. General Layout of Plant Room including all details mentioned in clause 1.2

b. Panels and other equipment/accessories location and their dimensions etc.

c. HVAC floor layout including terrace Plan etc.

d. Complete schematic as installed.

e. Route of all cables and pipes run along with detail sizes and mode of installation.

1.4. DRAWINGS & DOCUMENTS

The contractor shall submit to the Engineer, the following documents on completion of the work and before issuance of virtual completion.

a. Warranty for required equipment installed like Pumps, Panels, Chillers, Cooling Tower, HWG, AHU, FCU etc.

b. As Built Drawings

c. Material Test Certificates

d. Catalogues/Brochures

e. Operation and Maintenance Manuals

f. List of recommended spares and consumables

g. All approvals including technical approvals and sanctions

h. NoC from Fire authority before commencement of execution & after completion of entire work etc.

1.5. MANUFACTURING

The responsibility for ensuring the manufacture of the equipment as per the specifications shall be solely that of the contractor. The contractor shall be responsible for selection of materials as per agreed specifications.

1.6. MAKE OF MATRIALS/MANUFACTURER'S INSTRUCTION

Only approved makes as mentioned in our approved make list of tender documents of material shall be used. The Contrcator shall furnish Technical data sheets / GA drawings of all items before placing P.O. The contractor shall get the samples of required items approved from the HLL as conveyed by E-I-C before commencing the supply. In case of any discrepancy/anomolies wrt specifications, prior intimation from Contractor to E-I-C to be given. Final decision lies with HLL for according approvals.

Any specific instruction furnished by manufacturer covering the points not mentioned in technical specifications of the tender shall be brought to the notice of E-I-C in writing for further instructions in this regard at appropriate time.

1.7. MATERIAL TESTING

The E-I-C shall have full power to get any material of work to be tested by an independent agency at contractor's expense in order to prove the soundness and adequacy.

1.8. INSPECTION AND TESTING

a. All equipment shall be inspected and tested as per an agreed Quality Assurance Plan before the same is packed and dispatched from the contractor's works. The contractor shall carry out tests as specified/ directed by engineer.

b. The E-I-C may, at his sole discretion, carry out inspection at different stages during manufacturing and final testing after manufacturing.

c. Approvals or passing of any inspection by the engineer or his authorized representative shall not, however, prejudice the right of the engineer to reject the plan if it does not comply with the specification when erected or give complete satisfaction in service.

1.9. TRAINING OF DEPARTMENT PERSONNEL

a. The contractor shall train the CLIENT/ HLL's personnel to become proficient in operating the equipment installed. Training shall be done before the expiry of the defects liability period (one year after completion & handing over).

b. The period of training shall be adequate and mutually agreed upon by the Engineer and contractor.

c. The CLIENT/ HLL's personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing, minor repairs and replacement.

d. Nothing extra shall be paid to the contractor for training CLIENT/ HLL's personnel.

1.10. PERFORMANCE GUARANTEE

At the close of the work and before issue of final certificate of virtual completion by the engineer, the contractor shall furnish written guarantee indemnifying the CLIENT/ HLL against defective materials and workmanship for a period of one year after completion

and handing over. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the CLIENT/ HLL.

a. Any defective material or equipment supplied by the contractor.

b. Any material or equipment supplied by the CLIENT/ HLL which is proved to be damaged or destroyed as a result of defective workmanship by the contractor.

2.0 AIR COOLED SCREW/ SCROLL CHILLING UNITS

1. GENERAL

The contractor shall furnish and install where indicated on plans air cooled Rotary Screw/ Scroll chilling units. Each unit shall be guaranteed by chilling unit manufacturer to produce a capacity of not less than specified tons of refrigeration at specified leaving water temperature with the temperature of ambient air entering the condenser not exceeding 113 degree F (45 degree C). The construction and rating of the chillers shall be in accordance with latest ARI standard 590 and shall comply with ANS. B 9.1 safety code, National Electrical code and ASME code. Necessary 3 ph, 50 Hz, 220/415 volts, A.C. Power supply shall be made available for all units.

2. **CODES & STANDARDS**

ASHRAE 15 Safety code for Mechanical refrigeration

ASHRAE 23 Methods of testing and rating positive displacement refrigerant compressors and condensing units

ASHRAE 30 Methods of testing liquid chilling packages

ASME SEC VIII DIV I Boiler and pressure vessel code

ANSI B 31.5 Code for refrigeration piping

AHRI 550/590 (2003) Standard for Air Cooled Screw chilling packages

AHRI 575 Standard for method of measuring machinery sound within an equipments space

ISO 1940 Mechanical vibration – Balance quality requirements of rigid rotors

ISO 10816-1 Mechanical vibration – Evaluation of machine vibration of measurements on non-rotating parts. General guidelines

TEMA – C/R Heat Exchanger with acceptable deviation

ASTM: C591 Specification for Polyurethane/ Ploy isocyanurate Foam

3. **BASIC UNIT**

Each unit shall consist in general of multiple semi hermetic screw/scroll compressors, air cooled condenser coils, DX/flooded type chiller, condenser fans, outer weather proof casing, automatic control panel and accessories.

3.1 **Compressor (Screw)**

3.1.1 Each unit shall have multiple rotary, double bolted hermetic screw compressor

The rotary screw shall be manufactured from forged steel with precision cast male and female profiles which are asymmetrical. The profile of screws shall permit safe operation up to a speed of 3000 RPM for 50 Hz operation. The compressor shall unload from fully loaded to the minimum capacity by means of hydraulically actuated slide valve positioned over both the male and female rotors.

The compressor housing shall be of high grade cast iron, machined with precision, to provide a very close tolerance between the rotors and the housing.

The rotors shall be mounted on antifriction bearings designed to reduce friction and power input. There shall be multiple cylindrical bearings to handle the radial and axial loads.

There shall be built in oil reservoir to ensure full supply of lubricants to all bearings and a check valve to prevent back spin during shut down.

There shall be oil pump or other means of differential pressure inside the compressor for forced lubrication of all parts during startup, running and coasting for shut down. An oil sump header shall be provided in the casing.

The units shall be complete with automatic capacity control mechanism, by use of slide value to permit modulation between 20% to 100% of capacity range.

3.2 **Compressor (Scroll)**

1. Each unit shall have multiple hermetic Scroll compressors (Where scroll compressors are used).

2. The fixed and orbiting Scroll/Screw be made of high strength cast iron, allowing minimum thermal distortion and having maximum efficiency. The orbiting Scrolls shall touch in all the dimensions to provide a highly enclosed compressor chambers for maximum efficiency.

3. The compressor housing shall be of high grade cast iron, machined with precision, to provide a very close tolerance between the scrolls and the housing.

4. The rotors shall be mounted on plain bearings designed to reduce friction and power input.

5. There shall be built in oil reservoir to ensure full supply of lubricants to all bearings and a check valve to prevent back spin during shut down.

6. There shall be oil pump or other means of forced lubrication of all parts during startup, running and coasting for shut down. An oil header shall be provided in the casing.

7. The compressor profile shall have provision to trap impurities and separate them.

4. **COMPRESSOR MOTOR**

4.1 The driving motor shall be Hermetic squirrel cage type protected against damage by means of built in protection devices.

5. **VARIABLE SPEED DRIVE**

A variable speed drive shall be factory installed on the chiller and exactly same as per global catalogue. It shall vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller.

Drive shall be PWM type utilizing IGBT's with a power factor of 0.95 or better at all loads and speeds. It must also employ harmonic filters to minimize current and voltage distortions.

The variable speed drive shall be unit mounted in a NEMA-1 enclosure with all power and control wiring between the drive and chiller factory installed, including power to the chiller oil pump. Field power wiring shall be a single point connection and electrical lugs for incoming power wiring shall be provided. The entire chiller package shall be UL listed.

The following features shall be provided : a door interlocked circuit breaker, capable of being padlocked; UL listed ground fault protection; over voltage and under voltage protection; 3 phase sensing motor over current protection; single phase protection;

insensitive to phase rotation; over temperature protection; digital readout at the chiller unit control panel of:

- Output frequency
- Output voltage
- phase output current
- Input kilowatts (KW) and Kilowatt-hours (KWH)
- Self diagnostic service parameters

6. **DRIVE :**

The compressor shall be driven directly or through speed increasing gears as required. The gears and pinions shall be pressure lubricated. The gears shall be provided with oil filter and submerged oil pump. The gears should be of helical type with crown teeth designed such that more than one tooth is in contact at all times to provide even distribution of compressor load and quiet operation. Gears should be integrally assembled in the compressor rotor support and be film lubricated. Each gear should be individually mounted in its own journal and thrust bearings to isolate it from impeller and motor shafts.

7. **CONDENSER**

7.1 Condenser coil

The condenser coils shall be made of seamless copper tubes, integrally grooved type arranged in staggered rows and are mechanically expanded into super slit aluminum fins (the coil shall be circuited for sub cooling. The coil shall be minimum three rows deep with atleast 12 fins per inch) Or micro channel type, parallel flow aluminium alloy tubes metallurgically brazed as one piece to enhance aluminum fins. Condenser coil shall be post coated with an electro-deposited and baked flexible epoxy coating (E coat) i.e. finished with polyurethane UV resistant top coat suitable for highly corrosive applications.

7.2 Condenser fans

The units shall be furnished with necessary number of direct driven propeller type fans arranged for horizontal or vertical discharge. Condenser fan motor shall have class 'B' motor insulation, inherent protection device and shall be permanently lubricated type with resilient mounting. Each fan shall have a safety guard and shall have a low noise level.

8. **COOLER**

8.1 The cooler shall be direct expansion shell and tube type, with steel shell and seamless copper tubes. The refrigerant head shall be removable type. The tubes shall be supported in the shell by adequate stiff supports to eliminate vibrations and noise. The tube ends shall be fixed firmly into the tube sheets to prevent leakage of refrigerant gas.

8.2 The cooler shall be tested and stamped against leaks in accordance with ASME code for the refrigerant being used and otherwise tested and constructed in accordance with ASME or equivalent approved code requirements.

8.3 The cooler shall have a minimum of 2 independent direct expansion refrigerant circuits.

8.4 The cooler shall be factory insulated with 19 mm thick closed cell polyvinyl chloride and further protected by means of heater cables.

9. **CONTROLS**

9.1 All the controls shall be factory wired and located in a weather proof enclosure. These shall include fuses, selector switch, oil safety switch, high and low pressure cutouts,

interlocks for crankcase heaters and inherent motor protection devices, fan control thermostat, recycling pump-down circuit, high discharge temperature cutout indicator lamps shall be provided for the compressor units.

9.2 Necessary starters for compressor motors and condenser fan motors shall be included and provided within the unit. The compressor & the condenser fans shall be electrically interlocked such that the compressor can run only when at least one of the condenser fans are running.

9.3 Air Chilling Machine Control System

The Air chilling unit shall be complete with microprocessor based type control system, which shall have the following features:-

Electric expansion valve for economic operation of the system

9.3.1 Self diagnostic capability to locate faults and give early warning.

9.3.2 Leaving chilled water temperature control and reset capability, with provision to accept over ride commands from a central BMS system.

9.3.3 Automatic sequencing of various functions for starting, running and stopping of the various components of the unit based on demand.

9.3.4 A programmable microprocessor complete with key pad and LED display window to perform the above functions.

9.4 The control package shall also consist of, but not limited to, the following components:

9.4.1 Low control voltage to unit.

9.4.2 Field power and control circuit terminal blocks.

9.4.3 ON/OFF switch.

9.4.4 Replaceable relay board.

9.4.5 Leaving chilled water set point board.

9.4.6 Diagnostic digital display module.

9.4.7 Microprocessor board.

Temperature reset board.

9.5 The control system shall have an extended module for control and monitoring from a central BMS including the reset of chilled water temperature, ON/OFF / Fault etc.

10. **REFRIGERANT CIRCUIT**

The refrigerant piping between compressors, chiller and condenser shall be of heavy gauge copper with brazed joints. The circuit shall include sight glass, moisture indicator, solenoid valves, electronic expansion valves, filter driers and necessary shut off valves with charging connections.

11. **UNIT CASING**

All the above components shall be housed in an outer casing fabricated from galvanized steel, zinc phosphate with multiple coats of baked enamel paint to make the whole casing weather proof for outdoor installation. Removable panels shall be provided for access to all working parts.

12. AHRI/ EUROVENT CERTIFICATION, IF APPLICABLE or as mentioned in DBR.

The chilling unit shall be AHRI certified as per AHRI 550 / 590 – 2003 STANDARD. All suppliers shall furnish computer printouts along with their technical bids, giving details of capacity output at design conditions as given in tender.

13. MISCELLANEOUS

Each system shall be provided with the following:-

13.1 Necessary charge of refrigerant gas and lubricating oil.

13.2 Spring vibration isolators below the unit rated by the isolator manufacturers to absorb 90% of unit vibration and as approved by the engineer.

13.3 Dial type thermometers and pressure gauges for the inlet and outlet of the chilled water lines. (Priced Separately).

13.4 Flexible connectors between chilled water lines and cooler inlet and outlet.

13.5 Water flow switch at the outlet of chilling unit (Priced separately).

13.6 Butterfly valve at the outlet and balancing valve at the inlet of the chillers (Priced separately).

14. **Fouling Factor:**

The fouling factor for the cooler shall be not more than 0.0005 (FPS units).

TITLE AIR COOLED CHILLER PACKAGE – DATA SHEET A		
S.No.	Description	Requirement
1.	Number Required	As per DBR
2.	Location	As per DBR
3.	Duty:- Continuous	(18 hrs. /day) (Approximate)
4.	Capacity required at specified design conditions per chilling package	As per DBR
5.	Refrigerant	R134a / R410a
6.	Maximum noise level at a distance of 1.5 meters	80 dBA
7.	Compressor – type & No. of compressor per chiller	Semi-hermetic/hermetic
8.	Lubrication	Forced feed with an oil pump / differential pressure
9.	Capacity control	Automatic in stages
10.	Static and dynamic balancing of screws	As per ISO 1940
11.	EVAPORATOR	

	12.1	Type	Shell and tube, flooded/DX
	12.2	Liquid to be cooled	Water
	12.3	Chilled water quality	Potable water
	12.4	Chilled water inlet temperature	54 Deg.F
	12.5	Chilled water outlet temperature	44 Deg.F
	12.6	Minimum chilled water flow per chilling package	As per DBR
	12.7	Fouling factor-water side (FPS unit)	0.0005
	12.8	Chiller and suction line insulation	Closed cell polyvinyl chloride foam
	12.9	Maximum water side pressure drop	As per DBR
12.	CONDENSER		
	13.1	Type	Air cooled
13.	Motor		415 V +/- 10 %, 3 phase, 50 Hz
14.	Control Panel		Microprocessor based control panel
15.	Control panel to be interfaced with building automation system		Provision to be available
16.	Type of starter		Star Delta- Closed transition type
17.	Type of Fan		Dual Speed / With VSD

CHILLER PACKAGE -DETAILS TO BE FURNISHED BY TENDERER ALONG WITH OFFER			– DATA SHEET B
S.No		Description	Tenderer To Furnish
1.0		Air Cooled Chilling Unit	
		General Data	
	1.1	Number of chillers	
	1.2	Location	

	1.3	Make and country of origin	
	1.4	Model number and year of introduction model	
	1.5	Detailed list of installations of that model in India	
2.0		Operating Parameters	
	2.1	Minimum refrigeration capacity (TR)	
	2.2	Minimum chilled water flow rate (USGPM)	
	2.3	Maximum chiller pressure drop (Feet of water)	
	2.4	Entering chilled water temperature (deg F)	
	2.5	Leaving chilled water temperature (deg F)	
	2.6	Evaporating temperature (deg F)	
	2.7	Fouling factor for chiller	
	2.8	KW/TR at full load conditions	
	2.9	Entering Air temperature (deg F)	
	2.10	Leaving Air temperature (deg F)	
3.0		Compressor	
	3.1	Manufacturer	
	3.2	Model	
	3.3	Type of compressor	
	3.4	Speed (operating)	
	3.5	Speed (maximum)	
	3.6	Refrigerant used	
4.0		Evaporator	
	4.1	Manufacturer	
	4.2	Model (No)	
	4.3	Shell dia. (mm)	

	4.4	Tube length (m)	
	4.5	No of tubes (No.)	
	4.6	Material of tubes (Name)	
	4.7	Dia. of tubes (mm)	
	4.8	No of integral fins / cm (No.)	
	4.9	No of refrigerant circuits (No.)	
	4.10	No of water passes (No.)	
5.0		Compressor Motor	
	5.1	Manufacturer	
	5.2	Type	
	5.3	Motor Voltage	
	5.4	Rated output	
	5.5	Power characteristics	
	5.6	No of Motors	
6.0		Starter for Compressor Motor	
	6.1	Manufacturer	
	6.2	Type of starter	
7.0		Miscellaneous Details	
	7.1	Type of capacity control	
	7.2	Noise level of chiller (in dBA) at 1.5 m distance	
	7.3	Equipments size (LXBXH)	
	7.4	Equipments operating weight (kg) / pounds	
	7.5	Full refrigerant charge quantity	
8.0		Documents to be furnished with bid.	
	8.1	Computerized printout (certified) from chiller	

		manufacturer indicating power consumption in IKW/TR at full load and various part load conditions as per AHRI format	
	8.2	Catalogues furnishing detailed technical data for compressor, evaporator, condenser, microprocessor or micro-computer control panel etc.	

2. WATER COOLED CENTRIFUGAL CHILLERS

2.1. GENERAL

Each unit will be completely factory-packaged including evaporator, unit mounted /free standing VFD starter complete with power/ control cabling etc by chiller supplier and condenser, sub-cooler, compressor, motor, lubrication system, view control center and all interconnecting unit piping and wiring. Condenser & evaporator water circuits should be even pass design. The chiller will be painted prior to shipment.

Performance will be certified in accordance with ARI Standard 550/590 and ECBC 2017. Only chillers that are listed in the AHRI/ Eurovent Certification Program for Centrifugal are acceptable.

The initial charge of refrigerant and oil will be supplied, shipped in containers and cylinders for field installation or factory charged in the chiller.

Chiller must unload up to 30% at constant lift conditions without surging and hot gas bypass (i.e. at design chilled out water temperature of 42 Deg. F and design condenser entering water temperature of 88 Deg. F). Computerized sheet mentioning power consumption at part loads at AHRI turndown and constant ECWT of tender conditions must be submitted along with tender for verification from AHRI. Only verified performance sheets will be qualified or approved.

Variable speed must be used.

BMS Compatible & Bacnet/ Modbus output must be provided for integration with 3rd party BMS.

2.2. COMPRESSOR

The compressor will be single / multi-stage centrifugal type in open type / hermetic / semi-hermetic construction driven by electric motors. Compressor shall be designed for 235 psig working pressure and hydrostatically pressure tested at 355 psig for R-134a units or as specified in DBR. The rotor assembly will consist of a heat treated alloy steel drive shaft and impeller shaft with cast aluminum, shrouded impeller. The impeller will be designed for balanced thrust, dynamically balanced and overspeed tested for smooth, vibration-free operation. Insert-type journal and thrust bearings will be fabricated of aluminum alloy, precision bored and axially grooved.

Internal single helical gears with crowned teeth will be designed so that more than one tooth is in contact at all times to provide even load distribution and quiet operation. Each gear will be individually mounted in its own journal and thrust bearings to isolate it from impeller and motor forces. Shaft seal shall be provided in double bellows, double-seal, and cartridge type. Aauxiliary forced fed oil reservoir will be built into the the compressor to provide lubrication during coast down in the event of a power failure.

Capacity control will be achieved by use of pre-rotation vanes to provide fully modulating control from maximum to minimum load. The unit will be capable of operating with lower temperature cooling tower water during part-load operation in accordance with ARI Standard 550/590. Pre-rotation vane position will be automatically controlled by an external electric actuator to maintain constant leaving chilled water temperature.

2.3. LUBRICATION SYSTEM

Lubrication oil shall be force-fed to all compressor bearings, gears, and rotating surfaces by an external fixed or variable speed oil pump. The oil pump shall vary oil flow to the compressor based on operating and stand-by conditions, ensuring adequate lubrication at all times. The oil pump shall operate prior to start-up, during compressor operation and during coastdown. An emergency lubrication system shall be incorporated in the system to provide lubrication during coast down incase of power failure.

An oil reservoir, separate from the compressor, shall contain the submersible 2 HP or as required oil pump and a suitable capacity oil heater, thermostatically controlled to remove refrigerant from the oil. The oil reservoir shall be designed and stamped in accordance with ASME or GB pressure vessel code. A non-code reservoir is not acceptable.

Oil shall be filtered by an externally mounted 5micron replaceable cartridge oil filter equipped with service valves. Oil cooling shall be done via a refrigerant cooled or water cooled oil cooler, with all piping factory installed (No separate arrangement to be done at site). Oil side of the oil cooler shall be provided with service valves. An automatic oil return system to recover any oil that may have migrated to the evaporator shall be provided. Oil piping shall be completely factory installed and tested.

2.4. MOTOR DRIVELINE

The compressor motor shall be an 3 Phase squirrel cage induction type as required, protected against damage by means of built in protection devices. The motor shall be rigidly coupled to the compressor to provide factory alignment of motor and compressor shafts.

2.5. EVAPORATOR

Evaporator will be of the shell and tube, flooded type designed for working pressure as per ASME /GB on the refrigerant side and tested against leaks with a pressure of not less than 1.5 times of working pressure. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped in accordance with ASME or GB Pressure Vessel Code,. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller expanded into the tube sheets providing a leak-proof seal, and be individually replaceable. Water velocity through the tubes will not exceed 10 fps. The evaporator will have a refrigerant relief device sized to meet the requirements of ASHRAE 15 Safety Code for Mechanical Refrigeration. The chiller shall be insulated with 19 mm thick factory installed elastomeric insulation with vapour barrier. The insulation shall be applied in such a manner that water boxes and covers can be removed without damaging it. Pressure drop on water side shall not exceed, 10m (Ten meters) WC. Water boxes and cover plates will be removable type to permit tube cleaning and replacement. Stub out water connections having flanged connections will be provided. Vent and drain connections with plugs will be provided on each water box.

2.6. CONDENSER

Condenser will be of the shell and tube type, designed working pressure as per ASME /GB on the refrigerant side and tested against leaks with a pressure of not less than **1.15** times of working pressure. Shell will be fabricated from rolled carbon steel plate with fusion welded seams; have carbon steel tube sheets, drilled and reamed to accommodate the tubes; and intermediate tube supports spaced no more than four feet apart. The refrigerant side will be designed, tested and stamped in accordance with ASME or GB Pressure Vessel Code,. Tubes shall be high-efficiency, internally and externally enhanced type having plain copper lands at all intermediate tube supports to provide maximum tube wall thickness at the support area. Each tube will be roller

expanded into the tube sheets providing a leak proof seal, and be individually replaceable. Water velocity through the tubes will not exceed 10 fps.

Pressure drop shall not exceed 10m (Ten metres) water boxes and cover plates will be removable to permit tube cleaning and replacement. Stubout water connections having flanged connections will be provided. Vent and drain connections with plugs will be provided on each water box.

2.7. REFRIGERANT FLOW CONTROL

Refrigerant flow to the evaporator will be controlled by a variable orifice / thermostatic expansion valve for improving unloading capabilities.

COMPRESSOR MOTOR STARTER

The starter will be variable speed drive type and will be factory installed /Free standing type. It will vary the compressor motor speed by controlling the frequency and voltage of the electrical power to the motor. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part-load efficiency by analyzing information fed to it by sensors located throughout the chiller. The cooling mechanism shall be either Air Cooled or liquid cooled.

Drive will be utilizing IGBT's with a power factor of 0.95 or better at full load and speeds.

The variable speed drive will be unit mounted/ free standing type in a IP 54 enclosure with all power and control wiring between the drive and chiller, including power to the chiller oil pump.

The following features will be provided:

- Door interlocked circuit breaker capable of being padlocked.
- Ground fault protection.
- Over voltage and under voltage protection.
- 3-phase sensing motor over current protection.
- Single phase protection.
- Insensitive to phase rotation.
- Over temperature protection.
- Digital readout at the chiller unit control panel of output frequency, output voltage, 3-phase output current, input kilowatts and kilowatt-hours, self-diagnostic service parameters.

KW Meter - The unit's input power consumption will be measured and displayed digitally via the unit's control panel.

KWh Meter – The unit's cumulative input power consumption is measured and displayed digitally via the unit's control panel.

Ammeter – Simultaneous three-phase true RMS digital readout via the unit control panel. Three current transformers provide isolated sensing. The ammeter accuracy is typically +/- 3% of readning.

Voltmeter – Simultaneous three-phase true RMS digital readout via the unit control panel. The voltmeter accuracy is typically +/- 3% of reading.

Elapsed Time Meter – Digital readout of the unit's elapsed running time is displayed via the unit control panel.

2.8. GRAPHIC CONTROL CENTER

The chiller shall be controlled by a unit mounted microprocessor based control center. The chiller control panel shall provide control of chiller operation and monitoring of chiller sensors, actuators, relays and switches.

The control panel shall include a color liquid crystal display (LCD) with touch screen control or surrounded by "soft "keys. The screen shall detail all operations and parameters, using a graphical representation of the chiller and its major components. Panel verbiage shall be available in other languages as an option with English always available. Data shall be displayed in either English or Metric units.

The sophisticated program and sensor shall monitor the chiller water temperature to prevent freeze up. When needed hot gas bypass is available as an option. The panel shall display countdown timer messages so the operator knows when functions are starting and stopping. Every programmable point shall have a pop-up screen with the allowable ranges, so that the chiller cannot be programmed to operate outside of its design limits.

The chiller control panel shall also provide:

1. System operating information including:
   a. return and leaving chilled water temperature
   b. return and leaving condenser water temperature
   c. evaporator and condenser saturation temperature
   d. differential oil pressure
   e. percent motor current
   f. evaporator and condenser saturation temperature
   g. compressor discharge temperature
   h. oil reservoir temperature
   i. oil temperature
   j. operating hours
   k. number of compressor starts
2. Digital programming of setpoints through the universal keypad including:
   a. leaving chilled water temperature
   b. percent current limit
   c. pull-down demand limiting
   d.six-week schedule for starting and stopping the chiller, pumps and tower
   e. remote reset temperature range
3. Status messages indicating:
   a. system ready to start
   b. system running
   c. system shutdown
   d. system safety shutdown-manual restart
   e. system cycling shutdown-auto restart
   f. system prelube
   g. start inhibit

4. The text displayed within the system status and system details field shall be displayed as a color coded message to indicate severity.

5. Safety shutdowns enunciated through the display and the status bar, and consist of system status, system details, day, time, cause of shutdown, and type of restart required. Safety shutdowns with a fixed speed drive shall include:

   a. evaporator – low pressure

   b. evaporator – transducer or leaving liquid probe

   c. evaporator – transducer or temperature sensor

   d. condenser – high pressure contacts open

   e. condenser – high pressure

   f. condenser – pressure transducer out of range

   g. auxiliary safety – contacts closed

   h. discharge – high temperature

   i. discharge – low temperature

   j. oil – high temperature

   k. oil – low differential pressure

   l. oil – high differential pressure

   m. oil – sump pressure transducer out of range

   n. oil – differential pressure calibration

   o. oil – variable speed pump – pressure setpoint not achieved

   p. control panel – power failure

   q. motor or starter – current imbalance

   r. thrust bearing – proximity probe clearance

   s. thrust bearing - proximity probe out – of – range

   t. thrust bearing – high oil temperature

   u. thrust bearing – oil temperature sensor

   v. software reboot

5.1 Safety shutdowns with a VSD Shall include:

   a. VSD shutdown – requesting fault data

   b. VSD – stop contacts open

   c. VSD – 110% motor current overload

   d. VSD – high phase A, B,C inverter heatsink temp.

   e. VSD – high converter heatsink temperature

6. Cycling shutdowns enunciated through the display and the status bar, and consists of system status, system details, day, time, cause of shutdown, and type of restart required. Cycling shutdowns with a fixed speed drive shall include:

   a. multiunit cycling – contacts open

   b. system cycling - contacts open

c. oil - low temperature differential

d. oil – low temperature

e. control panel - power failure

f. leaving chilled liquid - low temperature

g. leaving chilled liquid - flow switch open

h. motor controller – contacts open

i. motor controller – loss of current

j. power fault

k. control panel - schedule

l. starter – low supply line voltage

m. starter – low supply line voltage

n. proximity probe – low supply voltage

o. oil - variable speed pump - drive contacts open

6.1 Cycling shutdowns with a VSD shall include all necessary parameters.

7. Security access to prevent unauthorized change of set points, to allow local or remote control of the chiller, and to allow manual operation of the prerotation vanes and oil pump. Access shall be through ID and password recognition, which is defined by three different levels of user competence: view, operator, and service.

8. Trending data with the ability to customize points of once every second to once every hour. The panel shall trend different parameters from a list of over 140, without the need of an external monitoring system.

9. The operating program stored in non-volatile memory (EPROM) to eliminate reprogramming the chiller dueto AC power failure or battery discharge. Programmed setpoints shall be retained in lithium battery-backed RTC memory for a minimum of 10 years with power removed from the system.

10. A fused connection through a transformer in the compressor motor starter to provide individual over- current protected power for all controls.

11. A numbered terminal strip for all required field interlock wiring.

12. An RS-232/RS 485 communication port to output all system operating data, shutdown / cycling message, and a record of the last 10 cycling or safety shutdowns to a field-supplied printer. Data logs to a printer at a set programmable interval. This data can be preprogrammed to print for desired time interval.

13. The capability to interface with a building automation system to provide:

a. remote chiller start and stop

b. remote leaving chiller liquid temperature adjust

c. remote current limit setpoint adjust

d. remote ready to start contacts

e. safety shutdown contacts

f. cycling shutdown contacts

g. run contacts

14 Tests at Factory:

At least one chiller shall be tested on ARI/Eurovent certified test bed at 100%, 75%, 50% and 25% load at AHRI/Eurovent/Design Conditions (to be decided by E-I-C at appropriate stage) to establish IPLV/NPLV at the manufacturer's works and shall be witnessed by client's representatives at factory. Nothing extra shall be paid in this regard.

The scope of work of Contractor shall include suitable capacity of chillers with VFDs as specified in DBR & as per meeting functional requirements complete with R - 134 A refrigerant or as per DBR (ozone friendly, HFC), open / semi hermatic / hermatically sealed single /multiple centrifugal compressors complete with single/twin refrigerant circuit, driven by suitable KW Squirrel Cage induction motor complete with water cooled shell & tube condenser, insulated shell and tube flooded chiller, with S.S braided pipe flexible connector, insulation to be mechanically protected similar to chilled water piping insulation, flanged end for chiller & condenser, electronic auto setting water flow switches at condenser & chiller outlet, factory done refrigerant piping, refrigerant and oil first charged, microprocessor based control panel with non-volatile memory & touch screen display, motor driven by chiller / floor mounted air cooled VSD/VFD with IP 54 (or more) enclosure with active harmonic filters with THDI less than 40% or nearest possible as per OEM & accessories, stainless steel braided pipe flexible connector for chiller and condenser at inlet & oulet, IP 44 enclosure for control and terminal box, factory installed electrical disconnect / isolator switch integrating main fuses etc. all mounted on M.S. frame. Motor shall be suitable for 415 volts ± 10%, 50Hz ± 5 %, three phase A.C. supply.

It should include flow switch/DP switch at chiller and condenser, vibration isolators, including oil separators, pressure relief devices, filter drier moisture indicators, refrigerant economizer, integral refrigerant piping and wiring, accessories as required and called for, automatic and safety controls mounted in central console panel.

VIII. IEEE519, 1992 recommendations shall be used for the basis of calculation of total active harmonic distortion (THD) at the point of common coupling (PCC) for VFDs.

Suitable PCC/RCC foundation (PCC foundation in PCC (1:2:4) type B-1 using 20 mm graded stone aggregate 30 cm above floor level including making connection of inlet & outlet with fittings including nut, bolts, packing etc.) with plaster to be provided.

15 CODES & STANDARDS

ASHRAE 15	Safety code for Mechanical refrigeration
ASHRAE 23	Methods of testing and rating positive displacement refrigerant compressors and condensing units
ASHRAE 30	Methods of testing liquid chilling packages
ASME SEC VIII DIV I	Boiler and pressure vessel code
ANSI B 31.5	Code for refrigeration piping
AHRI 550/590 (2003)	Standard for Air Cooled Screw water chilling packages
AHRI 575	Standard for method of measuring machinery sound within an equipments space
ISO 1940	Mechanical vibration – Balance quality requirements of rigid rotors
ISO 10816-1	Mechanical vibration – Evaluation of machine vibration of measurements on non-rotating parts. General guidelines

TEMA C/R Heat Exchanger with acceptable deviation

ASTM: C591 Specification for Polyurethane/ Poly iso cyanurate Foam.

TITLE WATER COOLED CHILLER PACKAGE – DATA SHEET A		
Sl. No.	**Description**	**Requirement**
1.	Number Required	As per DBR or meeting functional requirement
2.	Location	As per drawing
3.	Duty:- Continuous	(24 hrs/day) (Approximate)
4.	Capacity required at specified design conditions per chilling package	As per DBR or meeting functional requirement
5.	Refrigerant	As per DBR or meeting functional requirement
6.	Maximum noise level at a distance of 1 meters	85 dBA or as per codal provisions
7.	Compressor – type	Semi-hermetic/hermetic /Open /centrifugal compressor
8.	Lubrication	Forced feed with an oil pump / differential pressure
9.	Capacity control	Automatic
10.	**EVAPORATOR**	
10.1	Type	Shell and tube, flooded
10.2	Liquid to be cooled	Water
10.3	Chilled water quality	Potable water
10.4	Chilled water inlet temperature	12.2 Deg C
10.5	Chilled water outlet temperature	5.5 Deg C
10.6	Minimum chilled water flow per chilling package	@2 USGPM /TR
10.7	Fouling factor-water side (FPS unit)	0.0005
10.8	Chiller and suction line insulation	19mm Closed cell polyvinyl chloride foam or as per Chiller OEM
10.9	Maximum water side pressure drop	10m of water
11.	**CONDENSER**	
11.1	Type	Water cooled, Shell and tube
11.2	Liquid to be cooled	Water
11.3	Condenser water quality	Potable water
11.4	Condenser water inlet temperature	31 Deg C
11.5	Condenser water outlet temperature	36.6 Deg C

11.6	Minimum chilled water flow per chilling package	@3 USGPM/TR
11.7	Fouling factor-water side (FPS unit)	0.001
11.8	Maximum water side pressure drop	10m of water
12.	Motor	415 V +/- 10%, 3 phase, 50 Hz
13.	Control Panel	Microprocessor based control panel
14.	Control panel to be interfaced with building automation system	Provision to be available
15.	Type of starter	VSD
16.	COP/IPLV	As per DBR

CHILLER PACKAGE -DETAILS TO BE FURNISHED BY TENDERER			**– DATA SHEET B**
S.No		Description	Tenderer To Furnish
1.0		Water Cooled Chilling Unit	
		General Data	
	1.1	Number of chillers	
	1.2	Location	
	1.3	Make and country of origin	
	1.4	Model number and year of introduction model from same factory	
	1.5	Detailed list of installations of that model in India from same factory	
2.0		Operating Parameters	
	2.1	Minimum refrigeration capacity (TR)	
	2.2	Minimum chilled water flow rate (USGPM)	
	2.3	Maximum chiller pressure drop (Feet of water)	
	2.4	Entering chilled water temperature (deg F)	
	2.5	Leaving chilled water temperature (deg F)	
	2.6	Evaporating temperature (deg F)	
	2.7	Fouling factor for chiller	
	2.8	KW/TR at full load conditions	
	2.9	Entering Condenser water temperature (deg F)	
	2.10	Leaving condenser water temperature (deg F)	
	2.11	Fouling factor for condenser	
3.0		Compressor	
	3.1	Manufacturer	
	3.2	Model	
	3.3	Type of compressor	
	3.4	Speed	

		(operating)	
	3.5	Speed (maximum)	
	3.6	Refrigerant used	
4.0		Evaporator	
	4.1	Manufacturer	
	4.2	Model (No)	
	4.3	Shell dia. (mm)	
	4.4	Tube length (m)	
	4.5	No of tubes (No.)	
	4.6	Material of tubes (Name)	
	4.7	Dia. of tubes (mm)	
	4.8	No of integral fins / cm (No.)	
	4.9	No of refrigerant circuits (No.)	
	4.10	No of water passes (No.)	
5.0		Compressor Motor	
	5.1	Manufacturer	
	5.2	Type	
	5.3	Motor Voltage	
	5.4	Rated output	
	5.5	Power characteristics	
	5.6	No of Motors	
6.0		Starter for Compressor Motor	
	6.1	Manufacturer	
	6.2	Type of starter	
7.0		Miscellaneous Details	
	7.1	Type of capacity control	
	7.2	Noise level of chiller (in dBA) at 1 m distance	
	7.3	Equipments size (LXBXH)	
	7.4	Equipments operating weight (kg) / pounds	
	7.5	Full refrigerant charge quantity	
8.0			
	8.1	Computerized printout (certified) from chiller manufacturer indicating power consumption in IKW/TR at full load and various part load conditions as per AHRI format	
	8.2	Catalogues furnishing detailed technical data for compressor, evaporator, condenser, microprocessor or micro-computer control panel etc.	

2.9. HEAT PUMP

a) GENERAL

Heating Requirement (Actual): As per Requirement

Hot Water Entering Temperature: 40 Deg. C or as per requirement

Hot Water Leaving Temperature: 45 Deg. C or as per requirement

Fouling Factor: 0.0002 MKS or as per requirement

Air Ambient Temperature: 7 Deg. C or as per requirement

COP at AHRI Conditions: min. 3.0

Heating IKW/KW at 100% load at above duty conditions: 0.30

b) CHILLED/HOT WATER PRODUCTION

Chilled and hot water shall be produced by an air-cooled packaged liquid chiller suitable for outside installation. The chiller shall use the ecological refrigerant R410a or other CFC free refrigerant with efficient thermodynamic characteristics, and shall be equipped with scroll compressors. The chiller shall be designed, manufactured and tested in a facility with a quality assurance system certified ISO 9001 and an environment management system certified ISO 14001.All units shall undergo a complete run test in the factory before shipment.

c) COMPRESSORS

The compressors shall be quiet hermetic scroll type with low vibration levels, each equipped with a two-pole electric motor cooled by suction gas and protected by internal temperature sensors, an oil charge of synthetic polyolester oil with a level check sight glass, an electronic protection board (Scroll Protection Module) to ensure compressor control, over-temperature protection and high-pressure safety switch control.

Low noise level and low vibration level shall be guaranteed by:

- Compressor mountings that are independent from the unit chassis and installed on flexible anti-vibration blocks.

- Suction and discharge piping support on the compressor discharge side, directly attached to the compressor base to prevent the transmission of vibrations to the unit chassis.

d) WATER HEAT EXCHANGER

The unit shall be equipped with a brazed plate type or direct expansion shell and tube type evaporator with two independent refrigerant circuits. The evaporator shall be tested and stamped in accordance with the applicable pressure code. The weld-free copper tubes shall be internally finned and expanded into the tube sheets. The evaporator shall be mounted on support feet with thermal bridge rupture and shall be integrally insulated with 19-mm thick polyurethane foam. The water connections shall be VICTAULIC type connections to ensure quick mechanical disconnection between the unit and the hydronic installation.

The evaporator shall be equipped with a water drain and a purge plug.

e) AIR HEAT EXCHANGER

Fans

The low-noise direct-drive fans shall be equipped with an impeller with aerodynamic blades and a rotating shroud to ensure optimal leak-tightness between the blades and the fan mouth. The impeller shall be a one-piece type and made of a corrosion-resistant composite material, and

statically and dynamically balanced. The air shall be discharged vertically upwards.The fans shall be protected by polyethylene-coated steel wire grilles.The three-phase electric motors shall have insulation class F, IP 54 protection. They shall have individual overload protection via a disconnect switch.

Condenser

The condenser coils with integrated sub cooling shall be V-shaped with a minimum open angle of 50° to ensure optimum air distribution. The coils shall be equipped with aluminium fins mechanically expanded on to internally finned copper tubes. The condenser coils shall be leak-tested and submitted to a pressure test with dry air.

Power control boxes

The unit shall operate at 400 volts, 3 phases, 50 hertz (400 V ± 10%) without neutral and shall only have one power connection point. The control circuit voltage shall be 24 V maximum, supplied by a factory-installed transformer. The unit shall be equipped with a factory-installed interlockable disconnect/isolating switch.

Unit control

The chiller shall be equipped with microprocessor control, regulating all unit operating and safety parameters in order to optimize energy efficiency and minimize the possibility of the refrigerant circuit shutting down due to a fault. The control system shall ensure the following functions:

Entering and leaving water temperature control by PID loop with equalization of the compressor operating times and number of compressor start-ups

Protection against excessive compressor cycling by auto adaptive control algorithm acting on the leaving water setpoint deadband.

Optimization of the condensing pressure with a floating setpoint based on the outside temperature and the thermal load in order to limit power consumption

Periodic fan start-up when the unit is shut down in order to prolong the operating life of the fans.

Automatic compressor unloading when an abnormally high condensing pressure is detected to prevent the shutdown of the refrigerant circuit due to a high-pressure fault.

f) AUTOMATIC OPERATION

The chiller shall be equipped with a programming timer, permitting:

Unit on/off setting

Changeover to the second setpoint (unoccupied mode)

Demand limitation

The control shall ensure the following operating modes:

On/off mode based on the outside temperature

Setpoint reset based on the outside air temperature or the return water temperature

Master/slave control of two chillers operating in parallel with run time equalization

g) Remote control

The chiller shall include input contacts permitting:

Unit on/off setting

Demand limitation (one stage)

Changeover to the second setpoint (unoccupied mode)

Use of a customer security device

2.10. DX TYPE AIR COOLED PRECISION UNITS

i. GENERAL:-

The room air-conditioning system shall be a floor discharge unit designed specifically for high sensible heat ratio applications such as Server, Computer rooms and UPS room etc.

Each unit shall be capable of providing sensible cooling capacities at rated ambient temperatures with adequate airflow. Each unit shall be capable of providing actual cooling capacity as per requirement.

Inside Conditions: - 22+ 1 0C and relative humidity is 50 + 5% RH.

The system shall contain Scroll compressor, Evaporator, Humidifier, Condenser and an Externally Equalized Thermostatic expansion valve (TXV) all of which shall be contained within the cabinet of the unit.

ii. CABINET CONSTRUCTION:-

The frame shall be constructed of Galvanized steel & shall be double skin type. The external panel shall be constructed of 1.2mm zinc coated sheet steel. Front, rear and end panels shall be fitted with 25mm glass fibre insulation, fire rated .The cabinet shall be powder coated and have a textured finish. The hinged front panel shall be removable and include captive ¼ turn fasteners. The cabinet shall be assembled with pop rivets providing ease of disassembly.

iii. FILTRATION:-

The filter chamber shall be an integral part of the system and withdraw able from the front of the unit. Filtration shall be provided by deep V form G4 performance dry disposable media to AS1324.

iv. FANS:-

The fan section shall be designed for an external static pressure of 25 Pa. The fans shall be located downstream of the evaporator coil and be of the forward curved centrifugal type, double width, double inlet and statically and dynamically balanced to G6.3DIN ISO 1940 part I. Each fan shall be separately driven by a high efficiency electric motor with an IP55 enclosure rating. The drive arrangement shall be self-tensioning and provide for belt replacement without the use of tools. The motor base plate shall include locators to ensure optimum axial alignment of the motor.

v. HUMIDIFIER:-

Humidification shall be provided by boiling water in a high temperature polypropylene steam generator. The steam shall be distributed evenly into the bypass airstreams of the environment control system to ensure full integration of the water vapor into the supply air without condensation. The humidifier shall be capable of providing 7.5 kg of steam per hour. The humidifier shall have an efficiency of not less the 1.3 kg/kw and be fitted with an auto flush cycle activated on demand from the microprocessor control system. The humidifier shall be fully serviceable with replacement electrodes. Wastewater shall be flushed from the humidifier by the initiation of the water supply solenoid water valve via a U-pipe overflow system. Drain solenoid valves will not be used.

vi. ELECTRICAL HEATING:-

The electric heating elements shall operate at a heat density level not exceeding 60 kW/ m2. The low watt density elements shall be of finned tubular steel construction finished in high temperature paint.

The heating circuit shall include dual safety protection through loss of air and manual reset high temperature controls.

vii. COMPRESSORISED SYSTEMS:-

i. Scroll Compressor:-

The compressor shall be of the high efficiency complaint scroll design with an E.E.R. (energy efficiency ratio) of not less than 3.25) at ARI rating conditions. The compressor shall be charged with mineral oil and designed for operation on HCFC R407c or any other CFC free refrigerant. Each compressor shall have internal motor protection and be mounted on vibration isolators.

ii. Refrigeration Circuit:-

The refrigeration system shall be of the twin circuit direct expansion type and incorporate hermetic scroll compressors, complete with crankcase heaters. Cooling steps shall be a maximum of 50% of total unit cooling capacity for one and two compressor models. The system shall include a manual reset high pressure control; auto reset low temperature switch, externally equalized thermal expansion valve, high sensitivity refrigerant sight glass, large capacity filter drier and charging/access ports in each circuit. Each refrigeration circuit shall include rigidly mounted isolation valves in the discharge and liquid lines to aid servicing and installation (air cooled units only).

viii. EVAPORATOR COIL:-

The evaporator coil shall be A-shape coil (for down flow) incorporating draw-through air design for uniform air distribution. The coil shall be constructed of rifled bore copper tubes and louvered aluminum fins, with the frame and drip tray fabricated from heavy gauge aluminum. All metal parts in contacts with condensate shall be the same material to prevent electrolytic corrosion. The drip trays shall ensure the collection of condensate and be accessible for cleaning.

ix. DEHUMIDIFICATION:-

A specific dehumidification cycle (split-liquid) shall operate by reducing the operating surface temperature in a section of one of the refrigeration coils by means of a solenoid valve in the liquid line. Full airflow of the unit will be maintained at all times to ensure consistent air distribution to the conditioned space.

x. REMOTE AIR COOLED CONDENSER:-

The air cooled condenser shall be the low profile, weatherproof type incorporating high efficiency, direct drive, external rotor motors with axial blade fans. The condenser shall be constructed from heavy-duty aluminums and corrosion resistant components. Heavy duty mounting legs and all assembly hardware shall be included. Condensers shall be suitable for 24-hour operation and be capable of providing vertical or horizontal discharge. The condenser shall be fully factory wired and require a 230-volt I phase 50 hz electrical service.

xi. FAN SPEED CONTROL CONDENSER:-

The condenser fans shall be directly driven by 4 pole, 230 volt, 50 htz electric motors with an IP55 enclosure rating and class F insulation. The motor shall be equipped with permanently sealed ball bearing and high temperature grease. The motors shall be speed controlled to ensure stable operating conditions from –5oC to 45 oC ambient by a factory fitted, direct acting pressure actuated fan speed controller. The control system shall be complete with input isolation switch, transducers and pressure switches.

The high performance heat exchanger shall include mechanically expanded crosshatched copper tubes and louvered aluminum form maximum heat transfer. The coil shall be finished in a high temperature modified epoxy coating to offer increased protection in aggressive environments. the

coil shall be have maximum of 3 rows and adequate fins per meter and the face velocity shall not be more than 500 FPM.

xii. UNIT SIZE:-

The maximum footprint area of the unit shall not exceed 1.5 m 2 . The unit shall require front access (600 mm) only for routine service and installation work.

xiii. UNIT CONTROLLER:-

The unit controller shall be microprocessor based and include a large .LCD backlit graphic display for clear visibility of text and graphics. The display and control buttons shall be accessible from the unit front without removing any external panels. The controller shall feature ISP (In-system-Programming) technology to support program upload via a PC.

Control strategies shall be P-I-D with dew point compensation for accurate temperature and humidity control. A selection of return or supply air control shall be provided to suit the application. The controller shall have a user friendly menu driven interface with supporting help screens and shall use multi protocol data communications. Access to the controller settings to prevent against unauthorized access. In normal operating mode screen shall display unit number, temperature and relative humidity set points and actuals, graphs, time, date and operating status. Dynamic icons identify the systemoperating mode. A 48-hour real time log of temperature and humidity data shall be retained by the control system. All parameters and data shall be protected in memory by an onboard battery. An EIA- 232 communications interface shall provide the capability of remote monitoring with the option of EIA-485 interface on 2 or 4 wire connection.

xiv. CONTROL:-

The control system shall allow programming of the following conditions:

- Temperature set point
- Humidity Set point
- High Temperature Alarm
- Low temperature Alarm
- High Humidity Alarm
- Low Humidity Alarm
- The control system shall include the following settable features:
- Unit identification number.
- Startup Delay, Cold start Delay and Fan Run on timers
- Sensor Calibration.
- Remote shutdown & general Alarm management
- Compressor Sequencing.
- Return temperature control.
- Choice of Modulating output types.

xv. ALARMS:-

The microprocessor shall activate an audible, visual and general alarm in the event of any of the following conditions:

- High Temperature
- Low Temperature

- High Humidity
- Low Humidity
- Loss of Air
- High Pressure
- Low Pressure
- Humidifier Low Water
- Water Under Floor
- Spare Alarm 1 and 2 (Customized text)

The unit shall also incorporate the following protections:

- Single phasing preventors.
- Reverse phasing
- Phase imbalancing
- Phase failure
- Overload tripping (MPCB) of all components

2.11. VARIABLE REFRIGERANT VOLUME/ FLOW SYSTEM

I. SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of Variable Refrigerant Volume System. The system selected is a modular system, with number of indoors connected to centrally located outdoor units. The outdoor units for all the system shall be air cooled type.

ii. TYPE

Unit shall be air cooled, variable refrigerant volume air conditioner consisting of one outdoor unit and multiple indoor units. Each indoor unit having capability to cool independently for the requirement of the rooms. All indoor units shall be provided with isolation valves so that a particular unit can be isolated and removed for servicing, while system keeps functioning in normal way. All the units shall be suitable for operation with 415 V **+/-** 10%, 50 Hz + 3%, 3 Phase supply for outdoor units; & 220 V **+/-** 10%, 50 Hz +/- 3%, 1 Phase supply for indoor units.

It shall be possible to connect multiple indoor unit on one refrigerant circuit. The indoor units on any circuit can be of different type and also controlled individually. Following type of indoor units shall be connected to the system:

- Ceiling mounted cassette type.
- Ceiling mounted ductable type.
- Wall mounted Hi-Wall type.
- Floor mounted type.

The outdoor unit shall be pre-charged with first charge of refrigerant. Additional charge shall be added as per refrigerant piping at site.

iii. OUT DOOR UNIT

i. Outdoors units of the VRV/VRF system shall be compact air cooled type, factory assembled, weather proof casing constructed from heavy gauge mild steel panels with powder coated finish

ii. The outdoor unit should comprise of Inverter controlled Twin Rotary Compressor / Scroll Compressor

iii. Each module of outdoor unit must have at least 100% of Variable compressor which can work on Part load Suitable to operate at heat load proportional to indoor requirement.

iv. The ODU must deliver COP of minimum 5.8 at 50 % load.

v. The outdoor units must be suitable for up to 225 m refrigerant piping between outdoor unit & the farthest indoor units. Allowable level difference between outdoor unit & indoor units shall be 50 m in case of outdoor unit on top & 40 m in case of outdoor unit at bottom.

vi. Allowable level difference between various indoor units connected to one out door unit shall be up to 15 m.

vii. The outdoor units shall be suitable to operate within an ambient temperature range of 2 Deg C to 52 Deg C or as per OEM standard in cooling mode and heating mode.

viii. The entire operation of outdoor units shall be through independent remotes of indoor units. No separate Start/ Stop function shall be required.

ix. Complete refrigerant circuit, oil balancing/ equalizing circuit shall be factory assembled & tested

x. In case of outdoor units with multiple compressors, the operation shall not be disrupted with failure of any compressor.

xi. The noise level shall not be more than 70 dB (A) at normal operation measured horizontally 1m away and 1.5 m above ground level.

IV. COMPRESSOR

The compressor shall be high efficiency scroll /rotary type and capable for capacity controlling. It shall change the speed / refrigerant mass flow rate in accordance to the variation in cooling load requirement. Refrigerant mass flow rate can be changed by speed modulation of compressor. System shall incorporate liquid sub-cooling mechanism with liquid injection at intermediate pressure.

All inverter shall be IGBT (insulated gate bipolar transistor) type for efficient and quiet operation.

All outdoor units shall have multiple steps of capacity control to meet load fluctuation and indoor unit individual control. All parts of compressor shall be sufficiently lubricated. Forced lubrication may also be employed.

Oil heater shall be provided in the compressor casing.

v. HEAT EXCHANGER

The Heat Exchanger shall be constructed with copper tubes mechanically bonded to aluminum fins to form a cross fan coil and larger surface area.

The fins shall have anticorrosion treatment for Heat Exchanger Coil. The treatment shall be suitable for areas of high pollution, moisture and salt laden air.

The casings, fans, motors etc. shall also be with anticorrosion treatment as a standard features.

The unit shall be provided with necessary number of direct driven low noise level propeller type fans arranged for vertical / horizontal discharge. Each fan shall have a safety guard.

vi. REFRIGERANT CIRCUIT

The Refrigerant Circuit shall include an liquid receiver /accumulator, liquid & gas shut off valves and a solenoid valve. All necessary safety devices shall be provided to ensure the safety operation of the system..

vii. SAFETY DEVICES

All necessary safety devices shall be provided to ensure safe operation of the system.

Following safety devices shall be part of the outdoor unit:

- High pressure switch,
- low pressure switch,
- fuse,
- crankcase heater,
- fusible plug,
- over current protection for inverter, and
- Short recycling guard timer.

viii. REFRIGERANT PIPING

a. All connections of Refrigerant piping shall be in high grade Copper of Refrigeration quality with Eddy Current Testing and material test Certificates.

b. All connections, tees, reducers etc. shall be standard make fittings.

c. All refrigerant pipes and fittings shall be type 'L' hard drawn copper tubes and wrought copper fitting suitable for connection with silver solder. The copper thickness of wall shall be 20G/ 22G(0.7 to 1 mm)

d. All joints in copper piping shall be swaged joints using low temperature brazing and/ or silver solder. Before jointing any copper pipe or fittings, its interior shall be thoroughly cleaned be passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while construction of the joints. Subsequently, it shall be thoroughly blown out using nitrogen.

e. Refrigerant lines shall be sized to limit pressure drop between evaporator and condensing unit to less than 0.2 kg per Sq.cm.

f. After the refrigerant piping installation has been completed the refrigerant piping system shall be pressure tested using nitrogen, Pressure shall be maintained on the system for 24 hours.

g. The system shall then be evacuated and held for 24 hours

h. All refrigerant piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturers.

i. For outdoor piping, the finish shall be woven GRP Mat finished with coloured Epoxy paints to withstand outside ambient conditions and UV Radiation.

j. Insulation of pipes shall be carried out with insulation tubes of appropriate thickness so that condensation does not occur.

ix. OIL RECOVERY SYSTEM

Unit shall be equipped with an oil recovery system to ensure stable operation with long refrigerant piping.

System shall be designed for proper oil return to compressor along with the distribution of oil to individual compressor.

The refrigerant piping shall be extended upped 100 M with 50-M level difference without oil traps.

3. SPECIFICATIONS OF INDOOR UNITS :

The units include pre-filter, fan section and DX coil section. The housing of units shall be light weight powder coated galvanized steel. Units shall have external casing of ABS Plastic for supply and return air.

3.1. INDOOR UNITS

Units shall be factory assembled, wired, piped and tested.

Units shall have DX coils with copper tubes and bonded aluminium fins for highly efficient heat transfer.

Units shall have Centrifugal fans for adequate amount of Air circulation and low Noise.

Units shall have inlet filters, which are easily cleanable and replaceable.

All components of Units are easily accessible for connection, repairs and maintenance.

Units shall have very low noise.

All units with Factory manufactured Units, Grills shall have auto swing feature for proper Air distribution.

All units shall be controlled by electronic Expansion Valves operated by microprocessor thermostat based temperature control to deliver cooling/ heating as per the heat load of the room

All units mounted inside the ceiling shall have fans capable of sustaining duct connections, and special filters if necessary.

Visible indoor units shall have wireless remotes. Price of the same shall be included in cost of unit by default.

Concealed indoor units shall have sensor mounted on supply air grilles / diffusers which can be controlled with wireless remotes.

Anticorrosion treatment for avoiding corrosion of coils.

All units shall have adequate insulation or Lining to avoid condensation.

Cooling coil and refrigeration parameters shall be designed in such a way that supply air temperature shall not be less than 140C or 10C above room dew point temp, whichever is more. Contractor shall guarantee inside conditions with selected supply air temperature.

3.2. CEILING MOUNTED CASSETTE TYPE UNIT (MULTI-FLOW TYPE)

The unit shall be ceiling mounted type. The unit shall include pre-filter, fan section and DX-coil section. The housing of the unit shall be powder coated galvanised steel. The body shall be light in weight and shall be possible to suspend from four corners.

Unit shall have an external attractive panel for supply and return air. Unit shall have four way supply air grilles on sides and return air grille in centre.

Each unit shall have high lift drain pump, fresh air intake provision, low gas level detection system and very low operating sound.

Unit must be insulated with sound absorbing thermal insulation material, Polyurethane foam. The sound pressure level of unit at the highest operating level shall not exceed 46dB(A).

3.3. CEILING MOUNTED DUCTABLE TYPE UNIT

Unit shall be suitable for ceiling mounted type. The unit shall include pre filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanized steel. The unit shall have high static fan for ductable arrangement. Each unit shall have high lift drain pump.

The Sound Pressure level of unit at the highest operating level shall not exceed 38 dB (A), at a vertical distance of 1.5 m below the units with duct connected to the unit.

3.4. HIGH WALL MOUNTED UNITS

The units shall be high wall mounted type. The unit shall include pre-filter, fan section & DX-coil section. The housing of unit shall be light weight powder coated galvanized steel.

Unit shall have an attractive external casing for supply and return air.

The sound pressure level of unit at the highest operating level shall not exceed 46dB(A).

3.5. FLOOR MOUNTED UNITS

The unit shall be suitable for floor mounting. The unit shall include, pre-filter fan section, DX. Coil section. The housing of unit shall be light weight powder coated galvanized / anodized aluminum panels. Unit shall have an attractive external casing with supply & return air grilles.

3.6. CENTRAL REMOTE CONTROLLER

A multi-functional microprocessor based centralized controller (central remote controller) shall be supplied as an optional accessory.

The controller shall be able to control upto min. 64 zones of 64 groups (each group consisting of max.16 units) or 128 nos. of indoor units with the following functions.

- Temperature setting for each zone, or group, or indoor unit.
- On/Off as a zone or individual unit.
- Indication of operating condition.
- Select ON of all operation modes for each zone..

The controller shall have wide screen liquid crystal display and shall be wired by a non-polar 2 wire transmission cable to a distance of 1000m away from the indoor unit.

The controller shall be integrated to BAS system thru software for monitoring & controlling of all above parameters including start/ stop of each indoor / outdoor unit. All necessary interface cards / units should be supplied as a part of the system to integrate to the BAS Software.

3.7. CONDENSATE DRAIN PIPING:

All pipes to be used for condensate drain shall be PVC pipe conforming to IS: 4985 Class I & all joints should be Gluing or solvent cementing as per manufacturer recommendation. U-trap shall be provided at the end. Pipe insulation on drain pipe shall be preferably nitrile rubber of suitable thickness or as per OEM standard.

Mounting :- All indoor units shall be mounted with Brackets; Hangers etc. with proper size anchor Fasteners

3.8. ELECTRICAL INSTALLATION

For Variable Refrigerant flow systems, power will be provided near outdoor unit location. HVAC Contractor to provide suitable distribution panel along with 3-phase power to outdoor units and

single phase power to all indoor units fed by these outdoor units. Power / control cabling along with supports shall be included.

3.9. INSTALLATION:

a. The units shall be mounted on ribbed rubber pads for vibration isolation. The contractor shall supply the required charge of refrigerant, lubricant and other consumables, for commissioning and testing of the equipment.

b. All the equipment shall be thoroughly tested and checked for leaks. All safety controls shall be suitably set and a record of all setting shall be furnished to the project supervisor.

c. Providing and fixing M.S. structural support for condensing unit with vibration isolator pad in-between support and structure and vibration isolation suspender and pads for evaporating units shall be in scope of contractor.

4. AIR COOLED SPLIT AIR CONDITIONING UNITS

i. SCOPE

The scope of this section comprise the supply, erection, testing and commissioning of Air Cooled Split Units conforming to these specifications and in accordance with the requirements. The BEE star rating of the units shall be as per requirement.

ii. TYPE

The Split Units shall consist of hermetically sealed compressor, motor, air cooled condenser, integral refrigerant piping and wiring, all mounted on a steel frame.

Indoor unit to be installed for Split Unit within building, shall be housed in insulated cabinet consisting of cooling coil, blower with motor, filter & insulated drain pan. Split unit must deliver specified capacity after taking into account loses due to piping length & site conditions.

iii. CAPACITY

The refrigeration capacity of Packaged Unit and Room Air Conditioners, split unit shall be as shown on Drawings and as per requirements.

iv. COMPRESSOR AND MOTOR

Compressor shall be hermetically sealed rotary compressor, swing type, serviceable type and shall have dual pressure stat, and an operating oil charge. The motor shall be suction gas cooled and shall be sealed against dirt and moisture. The motor shall be suitable for 415±10% / volts or 230±6 % volts, 50 Hz, A.C. supply.

v. REFRIGERANT PIPING AND CONTROLS

Refrigerant piping and fittings interconnecting compressor condenser shall be all copper and valves shall be brass / gunmetal construction. The refrigerant used shall be ozone friendly HFC or any other CFC free refrigerant.

vi. CASING

The indoor & outdoor units shall be sectionalized / cabinet construction. Indoor units shall be consisting of fan section, coil section, filter section, and drain pan. Outdoor unit shall consist of condenser coil, fan & compressor. In case of package units, the compressor shall be mounted within the indoor units and in case of split unit, the compressor shall be mounted with the outdoor units. Each section shall be constructed of thick sheet steel all welded / bolted construction, adequately reinforced with structural members and provided with sufficient access panels for proper lubrication and maintenance. Base panel shall be constructed of fabricated steel structure provided with an under frame suitably braced. Each unit shall include one piece drain pan constructed of 20 gauge galvanized sheet steel plate or stainless steel. Drain pan shall extend

under coil and fan sections with drain connections. Removable panels in fan and coil sections shall provide access to all internal parts. Panels shall be internally lined with 2.5 cm thick fibreglass as per section "Insulation" for the thermal insulation and acoustic lining.

vii. **FAN MOTOR AND DRIVE**

Fan motor shall be suitable for 415 ± 10% volts or 230±10% volts, 50 Hz, A.C.Supply, Single phase, motors shall be provided with permanent capacitor. Motors shall be especially designed for quite operation and motor speed shall not exceed 1440 rpm.

viii. **FAN**

Fan wheels and housing shall be fabricated from heavy gauge steel. Fan wheels shall be of double-width, double inlet forward-curve, multi-blade type enclosed in a housing and mounted on a common shaft. Fan housing shall be made of die-formed steel sheets with stream-lined inlets to ensure smooth air flow into the fans, fan shaft bearing shall be oil/grease lubricated. All rotating parts shall be dynamically balanced individually, and the complete assembly shall be statically and hydraulically balanced. Fan speed shall not exceed 1000 rpm and maximum fan outlet velocity shall be 550 meters per minute.

ix. **COOLING COIL**

Cooling coils shall be of fin and tube type having aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and air velocity across each coil shall not exceed 100 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory-tested at 21 Kg. per sq.cm air pressure under water. Tube shall be mechanically / hydraulically expanded for minimum thermal contract resistance with fins. The no.of fins per cm. shall be 4 to 5.

x. **VIBRATION ISOLATORS**

The indoor and outdoor units shall be provided with ribbed rubber pad vibration isolators.

xi. **PAINTING**

Split units shall be factory finished with durable alkyd spray enamel. Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, then coated with enamel paint to match the finish over the adjoining shop-painted surface.

xii. **PERFORMANCE RATING**

The unit shall be selected for the lowest operating noise level. Capacity rating and power consumption with operating points clearly indicated shall be submitted with the tenders and verified at the time of testing and commissioning of the installation.

4.1. AIR COOLED SPLIT AIR CONDITIONING UNITS (ENERGY SAVING INVERTER TYPE COMPRESSORS)

i. **SCOPE**

The scope of this section comprise the supply, erection, testing and commissioning of Air Cooled Split Units with inverter driven compressors conforming to these specifications and in accordance with the requirements of Drawings and Design Basic Report. The proposed unit shall meet the highest possible star rating as per BEE standards.

ii. **TYPE**

The Split Units shall consist of hermetically sealed compressor, motor, air cooled condenser, strip heaters, integral refrigerant piping and wiring, all mounted on a steel frame.

Indoor unit to be installed for Split Unit within building, shall be housed in insulated cabinet consisting of cooling coil, blower with motor, filter & insulated drain pan. Split unit must

deliver specified capacity after taking into account loses due to piping length & site conditions.

iii. **CAPACITY**

The refrigeration capacity of Packaged Unit and Room Air Conditioners, split unit shall be as shown on Drawings and as per requirements.

iv. **COMPRESSOR AND MOTOR**

Compressor shall be hermetically sealed, swing type, serviceable type and shall have dual pressure stat, and an operating oil charge. The motor shall be suction gas cooled and shall be sealed against dirt and moisture. The motor shall be suitable for 415±10% / volts or 230±6 % volts, 50 Hz, A.C. supply.

v. **REFRIGERANT PIPING AND CONTROLS**

Refrigerant piping and fittings interconnecting compressor condenser shall be all copper and valves shall be brass / gunmetal construction. The refrigerant used shall be ozone friendly HFC or any other CFC free refrigerant.

vi. **CASING**

The indoor & outdoor units shall be sectionalised / cabinet construction. Indoor units shall be consisting of fan section, coil section, filter section, and drain pan. Outdoor unit shall consist of condenser coil, fan & compressor. In case of package units, the compressor shall be mounted within the indoor units and in case of split unit, the compressor shall be mounted with the outdoor units. Each section shall be constructed of thick sheet steel all welded / bolted construction, adequately reinforced with structural members and provided with sufficient access panels for proper lubrication and maintenance. Base panel shall be constructed of fabricated steel structure provided with an under frame suitably braced. Each unit shall include one piece drain pan constructed of 20 gauge galvanised sheet steel plate or stainless steel. Drain pan shall extend under coil and fan sections with drain connections. Removable panels in fan and coil sections shall provide access to all internal parts. Panels shall be internally lined with 2.5 cm thick fibreglass as per section "Insulation" for the thermal insulation and acoustic lining.

vii. **FAN MOTOR AND DRIVE**

Fan motor shall be suitable for 415 ± 10% volts or 230±10% volts, 50 Hz, A.C.Supply, Single phase, motors shall be provided with permanent capacitor. Motors shall be especially designed for quite operation and motor speed shall not exceed 1440 rpm.

viii. **FAN**

Fan wheels and housing shall be fabricated from heavy gauge steel. Fan wheels shall be of double-width, double inlet forward-curve, multi-blade type enclosed in a housing and mounted on a common shaft. Fan housing shall be made of die-formed steel sheets with stream-lined inlets to ensure smooth air flow into the fans, fan shaft bearing shall be oil/grease lubricated. All rotating parts shall be dynamically balanced individually, and the complete assembly shall be statically and hydraulically balanced. Fan speed shall not exceed 1000 rpm and maximum fan outlet velocity shall be 550 meters **per** minute.

ix. **COOLING COIL**

Cooling coils shall be of fin and tube type having aluminium fins firmly bonded to copper tubes assembled in zinc coated steel frame. Face and surface areas shall be such as to ensure rated capacity from each unit and air velocity across each coil shall not exceed 100 meters per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory-tested at 21 Kg. per sq.cm air pressure under water. Tube shall be mechanically /

hydraulically expanded for minimum thermal contract resistance with fins. The no.of fins per cm. shall be 4 to 5.

x. **VIBRATION ISOLATORS**

The **indoor** and outdoor units shall be provided with ribbed rubber pad vibration isolators.

xi. **PAINTING**

Split units shall be factory finished with durable alkyd spray enamel. Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, then coated with enamel paint to match the finish over the adjoining shop-painted surface.

xii. **PERFORMANCE RATING**

The unit shall be selected for the lowest operating noise level. Capacity rating and power consumption with operating points clearly indicated shall be submitted with the tenders and verified at the time of testing and commissioning of the installation.

Refrigerant should be R-4R10A or any other CFC free refrigerant, Noise level should be less than 40Db, with wireless remote controller LCD typewith LED panel display, with sleep mode, auto restart, auto air swing(up-down), high EER Rotary, dual protection & 3M micro protection filters.

4.2. AIR COOLED PACKAGED UNIT (INVERTER TYPE DRIVEN COMPRESSOR)

i. **SCOPE OF WORK**

The specification for Air-cooled Package Units With Scroll Compressor covers the design requirement, constructional feature, supply, installation, testing & commissioning.

ii. **TYPE**

The Air-cooled Packaged units shall be factory fabricated and supplied with factory test certificates.

iii. **CABINET CONSTRUCTION**

The cabinet of packaged units shall be fabricated out of heavy gauge corrosion resistant sheet with powder coating / enamel. The cabinet shall have removable panels to allow easy servicing of unit, giving easy access into the unit. The fan section of the packaged unit shall be acoustically insulated at works.

iv. **COMPRESSOR**

The air-cooled packaged units shall comprise of one / two number Scroll compressor inverter driven type. The compressor section shall have all four walls acoustically insulated with 50mm thick fiberglass insulation, tissue paper & perforated Aluminium sheet to keep the sound level within 50db. The compressor should be suitable to withstand voltages varying from 340 to 460 volts.

v. **AIR-COOLED CONDENSER**

The condenser frame shall be constructed from heavy duty aluminium and incorporate a copper tube and aluminium fins coil. The coil shall be minimum of 3 rows deep, with a minimum fin spacing of 2.0 mm. The copper tubes of the condenser should be integrally firmed of minimum OD of 19 mm.

vi. **REFRIGERATION CIRCUIT**

The refrigeration system shall be of direct expansion type and shall incorporate one/ two no. hermetic scroll compressors complete with crankcase heaters.

vii. **COOLING COIL**

The cooling coil shall be constructed of rifled bore copper tubes and louvered aluminium fins, with the frame and drip trays fabricated from heavy gauge aluminium. The drip tray must be double angled for condensate flow and easily removable for cleaning. The cooling coil shall be a minimum of 4 rows deep. The distance between the fins should not be less than 1.8mm and the face velocity shall not be more than 2.5m/s.

viii. **FANS**

The fans shall be of the forward curved centrifugal type, double width, double inlet and statically and dynamically balanced. Each fan shall be driven by a high efficiency motor, through a self-tensioning belt drive arrangement. Each fan shall be mounted on a vibration isolated deck.

The unit shall be factory aligned, tested and complete with starter mounted inside the cabinet, refrigerant piping, complete with charging valves, thermostatic expansion valve, distributor, liquid strainer, dehydrator, liquid line shut off valve and HP/LP cut out etc. The selector switch should be concealed behind the hinged door and be suitable for operating the fan only or along with the cooling unit. The selector switch should be able to turn the unit on cooling and air temperature should be regulated with the thermostat which automatically starts and stops the compressor as required. In case of multiple compressors installed in one cabinet each should have independent refrigerant circuit. The blower of the packaged unit should be statically and dynamically balanced and driven by three phase motor of repute make. The air quantity of packaged unit should have at least of 400 CFM / Ton capacity.

The fan & fan motor should be able to take static pressure drop in coil, ducts, grills / diffusers. The unit should be factory wired and tested.

The air filter should have large surface and duct holding capacity which must be easily removable type for cleaning purposes.

ix. **FOR HIGH CFM PACKAGED UNIT**

a) Evaporator, Condenser, Fan etc of the unit shall be designed to meet the high sensible load of the air-conditioned area.

b) Cooling coil shall have minimum four rows and fan shall be capable of delivering 500 CFM/TR.

c) Evaporator shall have large surface area as compared with normal unit.

d) Tonnage rating of unit shall be based on 35.0 deg. C ambient.

x. **REFRIGERENT PIPING AND CONTROLS**

Refrigerent piping and fittings interconnecting compressor condenser shall be all copper and valves shall be brass/ gunmetal construction. The refrigerant used shall be ozone friendly HFC -R410a or any other CFC free refrigerant.

5. COOLING TOWERS (FRP CONSTRUCTION)

a) **GENERAL**

The various items of cooling tower shall be complete in all respect and comply with the specification given below, with fan VFDs & should be CTI approved:

b) **DESIGN**

i. Rating:

The cooling tower shall be rated for the heat rejection capacity specified.

ii. Range:

The Cooling tower shall be designed to cool the requisite quantity of water through 5.5 degree C or as per requirement against the prevailing wet bulb temperature.

iii. Wet Bulb approach:

The cooling tower shall be selected for a wet bulb approach of not more than 2.77 degree C.

iv. Outlet temperature:

The Cold water temperature from the cooling tower shall match the entering temperature for which the condenser selection is made.

v. Flow rate:

The flow rate through the cooling tower shall match the flow rate of the condenser(s) & as specified in DBR.

c) **GENERAL CONSTRUCTION**

Scope of work shall include Supply, Installing, testing and commissioning of FRP Induced draft counter flow COOLING TOWER (with VFD) of suitable capacity as mentioned in DBR or as required for meeting functional requirements for air conditioning system. Each tower shall be complete with FRP water basin, FRP casing, distribution system, PVC filling with integral louvers, drift eliminators, spray nozzles or self rotating sprinklers, statically , dynamically balanced axial flow type fan direct driven or driven through reduction gear box, HDG supporters and GI / Aluminium ladders, make up quick fill arrangement, overflow & drain connections with necessary valves. Electrical isolator at cooling tower shall be provided, duly enclosed in weather proof panel. Motors shall be suitable for 415±10% Volt, 50 Cycles, 3 Phase power supply and high efficiency motor.

Cooling Tower shall be provided with twin cells. VFD designed for HVAC applications for supply air fan with built-in PID controller, control panel (keypad & display) , IP-65 enclosure for use on standard centrifugal fans. The VFDs should not cause any duration of the connected motors and must ensure that class B temperature levels of the connected motors are never exceeded. The display should be in alpha-numeric characters and programming facility should be in user-friendly HVAC terminology. VFD's shall have built in harmonic filters. Each VFD panel to be provided with digital display showing electrical parameters like voltage, current and power consumption.

Each VFD shall be installed in a dedicated external IP-65 enclosure and the inter connecting wires between driver and MCC shall be included. Operation of VFD system shall be based approach of cooling tower & fan should be working in a modulating way & it should be complete with necessary sensors& controllers. It should be complete with cement concrete foundation, steel/masonry supporting structure, anti vibration mountings etc. Electrical Isolator for each cooling tower shall be provided at terrace.

The cooling towers shall be of FRP, vertical induced draft, cross /counter flow type complete with FRP basins, FRP body, fan and motor assembly, VFD, fill media, distribution pipes, concrete-steel foundations etc. Drive Motor : The fan motor shall be premium efficiency IE3 class as per IS 12615.

All steel components including assembly hardware shall be hot dip galvanized (G-235 Grade).

The body shall be made of FRP (fibre glass reinforced plastic) sections of equal segments, all bolted together. The surface on both inside and outside shall be smooth, for minimum air resistance. The fan deck shall form an integral part of the body. The structural strength of the body shall be sufficient to withstand wind velocities upto 160 KM/HR., vibration and

earthquakes. The structural framework of the cooling tower including all members shall be designed for the load encountered during the normal operation of the cooling tower and its maintenance. The structure shall be rugged and rigid to prevent distortion and shall include tie arrangements as may be necessary. The supporting framework for the tower casing and the water basin shall be made of hot dip galvanized steel and it shall be further protected with epoxy painting.

The filling shall be of PVC. Thickness of PVC fills shall not be less than 0.2 mm. These shall be of such construction as to provide low air resistance, large wetted surface for a high heat transfer efficiency, and easy replaceability.

The water distribution shall be either through fixed type sprinklers or through balancing, sub balancing and spreader troughs (un pressurized system) "open gravity type with polypropylene nozzle", ensuring uniform water loading and distribution of water over the fill. All pipes and fittings shall be of PVC. The sprinklers shall operate from the residual velocity head at the headers. Due care shall be taken with regard to corrosive effects and maintainability in the design of the water distribution system.

Drift eliminators of PVC shall be provided for maximum removal of entrained water droplets. The spacers and tie rods used shall be of plastic material. Drift losses for the cooling tower should not be more than 0.00091%/0.02% of the circulated water.

The water basin shall also be of FRP having an auxiliary suction tank, at the bottom. The basin shall be complete with connections for drain, overflow, make up water, quick fill float valve, drain valve & a hot water bleeds connection.

A thermostat shall be provided in the sump of the Cooling Tower, to sense the water temperature and to switch off the Fan motor during night times and other favorable weather conditions.

d) **INSTALLATION**

The cooling towers will be located at a well-ventilated place on the terrace of the plant room building. The structural loading of the terrace shall be considered. Cooling towers shall be installed in such a way that their load is transferred directly to the columns for which necessary Mild steel-I sections shall be provided by the air conditioning contractor. The cooling towers shall be rested on Mild steel-I sections and not on terrace slab. Sufficient free space shall be left all around for efficient operation of the cooling tower.

The support structures for the tower shall be of mild steel duly hot dipped galvanised.

e) **WATER DISTRIBUTION SYSTEM**

The hot water shall be distributed through a gravity system having a uniform slash through removable nozzles placed at the floor of basin. It should provide full coverage of fill hot water basin suitably covered with GRP sheet to eliminate algae formation.

f) **FAN ASSEMBLY**

The fan shall be of axial flow type with cast aluminium multiple blades of aerofoil design and adjustable pitch. The fan assembly shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 10 M/S and the tip speed shall be below 4500 m/min.

The fan guard shall be hot dipped galvanized with wire mesh screen to prevent bird nesting during idling period.

The fan shall be directly mounted on the motor or through speed reduction gears. In the latter case, the housing shall be of heavy cast iron, construction with large oil reservoir.

The fan motor shall be totally enclosed fan cooled squirrel cage type conforming to I.P.55 for outdoor operation. The fan guard shall be hot dipped galvanized.

The total sound intensity with all fans in operation shall not exceed 80 DB(A) at a distance of 3 meters from the nearest face of tower. It should also be in compliance with CPWD norms or any other relevant codes.

g) **LADDER**

All towers, whose height exceeds 2.5m, shall be provided with a ladder, made out of Stainless Steel and with a safety cage and hand railing.

h) **ACCESSORIES**

Each cooling tower to include:

i) Valve at make up, quick fill, make up float valve and drain valve.

ii) A hot water bleeds connection to the drain line through a stop valve.

i) **TESTING**

Tower performance curves shall be furnished. Acceptance test to demonstrate the performance of the installed cooling tower shall be conducted in accordance with the current ASME power test code for the atmospheric water cooling equipment and test result shall show tower capacity (computed from the performance curves) within +5% of the specified capacity at the designed W.B.

TITLE COOLING TOWER – DATA SHEET A		
S.No.	**Description**	**Requirement**
1.	Number Required	As per DBR & meeting functional Requirement
2.	Location	As per drawing
3.	Duty:- Continuous	(24 hrs/day) (Approximate)
4.	Wet bulb approach	less than 2.77°C
5.	Capacity at Flow Rate: 6530 LPM or as per requirement Water Temp. IN: 36.6°C Water Temp. OUT:31.1°C	2085870 K.CAL/Hr or as per requirement
6.	Maximum noise level at a distance of 3 meters	Less than 80 dBA
7.	Motor efficiency	(IE-3) VFD Controlled
8.	Ladder material	SS ladder

TITLE COOLING TOWER – DATA SHEET B- DETAILS TO BE FURNISHED BY TENDERER		
S. No.	**Description**	**Requirement**
1.	Manufacturer	
2.	Type	
3.	Model	
4.	Wet bulb approach	
5.	No. of Fans / HP	

6.	Overall dimensions (mm)	
7.	Weight with water (kg.)	
8.	Outlet velocity (mts. Per min)	
9.	Tip speed (Mts per min)	
10.	Drift loss (LPH)	
11.	Total water loss (LPH)	
12.	Noise level at a distance of 3 meters	
13.	Capacity at Flow Rate: Water Temp. IN: Water Temp. OUT:	
14.	Motor efficiency	

6. PUMPS – SPECIFICATIONS (MOTORS EFFICIENCY IE-3 RATED WITH VFD'S)

a) SCOPE

This section of specification covers the supply, installation, testing, commissioning of water pumps along with accessories conforming to these specifications and in accordance with DBR & Functional requirements.

b) CODES AND STANDARDS

The design, materials of construction, manufacture, inspection, performance and testing of End Suction / Vertical Inline Long Coupled Centrifugal Pumps with unit mounted VFDs shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve the Contractor of this responsibility. The equipment supplied shall comply with the latest applicable Indian, American, British or equivalent standards.

c) TYPE

All chilled (primary/secondary), condensing water pumps, hot water pumps shall be of capacity and size in accordance with the requirements indicated in the drawings or DBR and as per requirements. Pumps shall conform to relevant IS standards/codes.

d) MATERIAL OF CONSTRUCTION

Centrifugal inline long coupled type with the following material of construction.

Vertical Inline Centrifugal Pump shall be selected for chilled / hot / condenser water re-circulation duty. The pump casing shall have heavily ribbed construction, suction and discharge connection shall be flanged of the same size and shall be drilled and tapped for seal flush and gauge. The impeller made of bronze shall be double shrouded, single entry, radial flow type. It shall be hydraulically balanced to minimize axial thrust. The stuffing box shall be factory fitted with mechanical seal.

The pump is to be fitted with a factory installed flush line. Supply in the flush line to the mechanical seal, a 50 micron cartridge filter (alternatively, a cyclone separator when pump differential pressure exceeds 30 PSIG) and floating ball type sight flow indicator suitable for the working pressure encountered. The mechanical contractor shall change the filters after the system has been flushed and on a regular basis until the pumps are turned over to the owner.

The axially split, spacer type rigid coupling shall be used to allow seal maintenance without disturbing the pump or motor connections. The mechanical seal shall be accessible and easily replaced.

On the discharge side of each pump factory supplied- combination Valve shall be provided to incorporate the following three functions in one body:

- Tight shut-off,
- spring-closure type silent non-slam check and
- effective throttling.

The body shall have (2) 1/4" NPT connections on each side of the valve seat. Two connections to have brass pressure and temperature metering ports, with EPDM check valves and gasketed caps. Two other connections to be supplied with drain plugs. Metering ports are to be interchangeable with drain ports to allow for measurement flexibility when installed in tight locations. The valve disc shall be bronze plug & disc type with EPDM seat to ensure tight shut-off and silent check operation. The valve stem shall be stainless steel with flat surfaces provided for adjustment with open-end wrench.

For Grooved Piping: Valve body shall be ductile iron with grooved ends and anti-rotation lugs on the inlet and outlet of the body.

Flange adapters, where necessary are to be ductile iron flanges with anti-rotation lugs and EPT gaskets. Valve body shall be Cast Iron with PN16 flanged ports.

The valve shall be selected and installed in accordance with the manufacturer's instructions and be suitable for the pressure and temperature specified.

On the suction of each pump factory supplied suction guide, with Outlet Flow Stabilizing Guide Vanes, removable Stainless Steel Strainer and Fine Mesh Start-up Strainer shall be provided. Supply suction guide with carbon steel body, carbon steel guide vanes and PN16 flanged ports.

Strainer element shall be stainless steel construction with 0.125"(3 mm) perforations. Fine mesh start-up strainer shall be 20 mesh galvanized steel. The mechanical contractor shall inspect the strainer prior to activating the pump and, further, shall remove the Fine Mesh Start-up Strainer after a short running period. (24 hours maximum). Space shall be provided for removal of the strainer and connection of a Blow-down Valve.

The construction of Vertical Inline Pumps shall be as follows and as per IS 1520

Duty	Chilled / Hot / Condenser Water
Casing	Cast Iron
Impeller	Bronze
Pump Shaft	Stainless Steel Grade 416
Bearings	Ball / Journal Bearing
Speed (Synchronous)	1500 RPM
Motor	TEFC
Mechanical seal	Factory fitted

The impellers of pumps shall be statically and dynamically balanced.

The end suction split casing pumps shall conform to ISI 1520 and the construction of the pumps shall be as follows.

S.NO.	DESCRIPTION OF COMPONENT	MATERIAL / TYPE OF CONSTRUCTION
1.	Pump Casing	Close grained cast iron of heavy section, end suction back pull out type and machined to close tolerance.
2.	Impeller	Bronze/Gunmetal machined to close tolerance.
3.	Pump Shaft	High quality alloy steel EN8 grade.
4.	Pump Bearings	Heavy duty/ball/roller/ journal bearings.
5.	Shaft sleeves	Gun metal.
6.	Base frame	Cast-iron/fabricated out of MS channel in all welded Construction.
7.	Flanges	As per ISI standards.
8.	Stuffing box	Mechanical seal.
9.	Pump coupling	Flexible steel pin and rubber bushing type protected by guard.

e) CONSTRUCTION DETAILS.

i. **End suction vertical back pull out**

The pump casing shall be end suction vertical back pull out type and the pump shall be installed such that the internal parts of the pump like impeller, mechanical seal and bearing etc can be serviced without disconnecting the pipes or disturbing the motor and pump alignment. The joining faces of the pump casing shall be machined and ground to smooth finish and sealed with leak proof gasket. The suction passages of the pump shall be volute in form thereby allowing smooth entry of water to the impeller. The impeller shall be double suction, enclosed type, statically and dynamically balanced. The impeller water passages shall be smoothly finished to ensure minimum friction loss and maximum efficiency. The pump shall be supported by two precision bearings grease or oil lubricated. The pump casing and the internal components shall be designed to withstand the discharge pressure plus the static water head + additional 50% of the total pressure.

ii. **Split casing type**

The pumps shall be radially split, single stage centrifugal type with CI/GM casing with equal size suction and discharge flanges and having separate tapped flush line and pressure gauge connections, Gunmetal Bronze (BS1400 LG2C) dynamically balanced impeller, stainless steel shaft, lower carbon throttle bushing, Outside Balanced type mechanical seal with Resin Bonded Carbon rotating face, Sintered Silicon Carbide stationary seat and Viton secondary seal.

The pump is to be fitted with a factory installed flush line. Supply in the flush line to the mechanical seal, a 50 micron cartridge filter (alternatively, a cyclone separator when pump differential pressure exceeds 30 PSIG) and floating ball type sight flow indicator suitable for the working pressure encountered. The mechanical contractor shall change the filters after the system has been flushed and on a regular basis until the pumps are turned over to the owner. The squirrel cage induction type motor, with TEFC enclosure and shall be connected to the pump through a high tensile aluminum, split type spacer coupling to permit

Servicing of the mechanical seal without disturbing pump, motor or electrical wiring. Coupling shall be protected by a guard.

f) PUMP ACCESSORIES.

The following accessories and fixture will be provided with each pump along with other standard accessories.

a. Air vent valves.

b. Drain Plug.

c. Seal Connections.

d. Lubrication fixture (Lubrication fittings) & mechanical seal.

e. Suction & delivery shut off valves.

f. Non return valve.

g. Water pressure gauges on inlet and outlet pipes. (Included in pumps)

h. Y-type strainer on suction pipe.

g) MOTOR CAPACITY

The capacity of motor shall be 10% in excess of BHP requirement of pump & shall be as per Standard Specifications. The tenderer shall provide detailed calculation for selection of pumps.

h) ACCESSORIES AND FITTINGS

Pump shall be complete with

i. Lubrication fittings

ii. Gland drains (25mm min) piping upto nearest floor drain point.

iii. Test and air vent cocks.

iv. Water seal piping connections

v. Suction, discharge pressure gauge (not less than 150 mm diameter) of appropriate range, with globe valves.

vi. Suction and discharge shut off valves.

vii. Discharge check valve

viii. Y type strainer at suction of each pump

ix. Flexible couplings (at section & discharge) with control rods.

x. However quantities of item (e) to (i) are separately quantified in 'DBR' and as such, cost of these valves should not be included in the cost of pump.

Also GI gland drain piping (Item b) upto nearest drain point will be paid under piping item; as such cost of same should not be included in the cost of pump.

i) DESIGN REQUIREMENTS

i. The pump shall be capable of developing the required total head at rated capacity for continuous operation.

ii. Pumps shall run smooth without undue noise and vibration. The noise level shall be limited to 85 db A at a distance of one meter.

iii. The guaranteed output of the pump shall be at that frequency of electric supply, which is normally available at site, instead of rated frequency of 50 Hz, if, specified in Data Sheet 'A'.

iv. Pump motor shall be suitable for 415 +/- 5% V, 3-phase 50 CPS AC power supply.

j) FEATURES OF CONSTRUCTION

i. Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. Components of identical pumps shall be interchangeable.

ii. Mechanical seals shall be provided

k) INSTALLATION & TESTS

The pump sets shall be mounted on cement concrete foundation, which shall be provided by other agencies. However, grouting nuts, bolts, channels, shims etc shall be provided by the HVAC contractor.

Pumps shall be installed as per manufacturer's recommendations. Pump set shall be mounted on concrete block which in turn is mounted on machinery isolation cork or any other equivalent vibration isolation fitting.

Concrete foundation will be made by the Contractor as per approved drawings and specifications and the isolation pad foundation bolts, etc., shall also be supplied by the Contractor. Contractor shall ensure that the foundation bolts are correctly embedded.

Pump sets shall preferably be factory aligned whenever necessary; site alignment shall be done by competent persons. Before the foundation bolts are grouted and the coupling bolted, the bed plate levels and alignment results shall be submitted to the Engineer.

l) MECHANICAL BALANCING

The impeller shall be statically and dynamically balanced.

m) VISUAL INSPECTION

Pumps shall be offered for Visual inspection (if specifically asked for) before dispatch. The components of the pumps shall not be painted before inspection.

n) MATERIAL TEST CERTIFICATE

Materials of the various pump components shall be tested in accordance with the relevant standard and Test Certificates shall be furnished along with the Pumps.

o) FIELD TESTING

After installation, the pumps shall be subjected to testing at site also. If the performance does not meet the requirements regarding capacity, power consumption, vibration and noise etc. as specified, then the equipment shall be rectified or replaced by the Contractor, at no extra cost to the HLL.

p) SHOP/G.A DRAWINGS

The following drawings shall be submitted for shop drawing azpproval: -

i. Preliminary outlines dimensional drawing of pump. (Suction and discharge connections and foundation details shall also be indicated).

ii. Performance curves (capacity vs. total head, efficiency, NPSH and KW requirement) ranging from zero to maximum capacity.

iii. Pump Catalogues.

q) NAME PLATE

Each pump shall be provided with a name plate indicating the following details:-

a) Design capacity

b) Total head

c) Speed

d) Motor rating

e) Model number

f) Manufacturer's serial number

g) Weight of equipment

h) Tag number

r) PAINTING

All ferrous surfaces shall be painted with one coat of red oxide primer paint followed by two coats of synthetic enamel paint (approved shade).

s) INSULATION

i. The Pump casings for chilled water along with its accessories and fittings shall be insulated as specified in section on insulation. The cost of this insulation should be included in the cost of the pump.

ii. Pumps shall be insulated only after they have been tested and test results have been approved by the engineer.

Note: - All the hardware required for the installation and equipments required for testing & commissioning shall be supplied by the Contractor.

7. VARIABLE SPEED PUMPING SYSTEM

i. SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of variable speed pumping package consisting of following:

a. Individual Components

b. Pump Control Panel

c. Adjustable Frequency Drive

d. Different pressure transmitted

e. Logic Programming for sequence of Operation

f. Power wiring and control wiring shall be carried out by installation contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.

ii. REFERENCES

a. ANSI - American National Standards Institute

b. NEMA - National Electrical Manufacturers Association

c. UL - Underwriters Laboratories Inc.

d. ETL - Electrical Testing Laboratories

e. CSA - Canadian Standards Association

f. NEC - National Electrical Code

g. ISO - International Standards Organization

h. IEC - International Electrochemical Commission

iii. SUBMITTALS

Submittals shall include the following and shall be specific to this project. General Submittals shall not be accepted.

a. System summary sheet.

b. Sequence of operation

c. Shop drawing indicating dimensions, required clearances and location and size of each field connection.

d. Power and control wiring diagrams.

e. System profile analysis including variable speed pump curves and system curve. The analysis shall also include pump, motor and Adjustable Frequency Drive (AFD) efficiencies, job specific load profile, staging points, horse power and kilowatt/hour consumption.

f. Pump data sheets.

iv. QUALITY ASSURANCE

a. The pumping package shall be assembled by the pump manufacturer. An assembler of pumping systems not actively engaged in the design and construction of centrifugal pumps shall not be considered a pump manufacturer. The manufacturer shall assume "Unit Responsibility" for the complete pumping package. Unit responsibility shall be defined as responsibility for interface and successful operation of all system components supplied by the pumping system manufacturer.

b. The manufacturer shall have a minimum of 20 years experience in the design and construction of variable speed pumping systems.

c. The local supplier of Chilled Water Variable Speed Pumping System (VSPS) shall have relevant expertise in all aspects of design, application engineering, installation, programming, interfacing, commissioning and after sales service. Supplier must have commissioned minimum 25 sets of chilled water VSPS in India.

d. All functions of the variable speed pump control system shall be tested at the factory prior to shipment. This test shall be conducted with motors connected to AFD output and it shall test all inputs, outputs and program execution specific to this application.

e. The manufacturer shall be fully certified by the International Standards Organization per ISO 9001. Proof of this certification shall be furnished at time of submittal.

f. Manufacturer shall be listed by Underwrite's Laboratories as manufacturer of packaged pumping systems.

g. Tenderer shall comply with all sections of this specification relating to packaged pumping systems.

v. MANUFACTURED UNITS

a. Furnish and install as shown on the plans a Variable Speed Pumping System as per approved manufacturers.

b. The control system shall include as, a minimum, the programmable logic pump controller, adjustable frequency drive(s) and remote sensor / transmitters as per requirements. Additional items shall be included as specified or as required to properly execute the sequence of operation.

c. The variable speed pump logic controller, adjustable frequency drives, AFD bypass as per requirement, and remote sensor / transmitters shall be shipped as individual components to the job site.

d. Pump logic controller, adjustable frequency drives, sensor / transmitters and related equipment shall be installed by the mechanical contractor as shown on the plans.

e. Power wiring shall be installed by the mechanical contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.

f. Low voltage wiring shall be installed by the mechanical controls contractor as shown on the field connection drawings and wiring diagrams supplied with the pumping package.

vi. PUMP LOGIC CONTROLLER

a. The pump logic controller assembly shall be listed by and bear the label of Underwriter's Laboratory INC. (UL). The controller shall meet Part 15 of FCC regulations pertaining to class A computing devices. The controller shall specifically designed for variable speed pumping applications.

b. The controller shall function to a proven program that safeguards against hydraulic conditions including:

i. Pump flow surges

ii. Hunting

iii. End of curve

iv. System over pressure.

v. NPSHR above NPSHA

vi. Motor overload

c. The pump logic controller shall be capable of receiving up to two discrete analog inputs from zone sensor / transmitter as indicated on the plans. It will then select the analogue signal that has deviated the greatest amount from its setpoint. This selected signal shall be used as the command feedback input for a hydraulic stabilization function to minimize hunting. Each input signal shall be capable of maintaining a different set point value. Controller shall be capable of controlling upto five pumps in parallel.

d. The pump logic controller shall have an additional analog input for a flow sensor. This input shall serve as the criteria for the end of curve protection algorithm.

e. The hydraulic stabilization program shall utilize a proportional-integral-derivative control function. The proportional, integral and derivative values shall be user adjustable over an infinite range.

f. The pump logic controller shall be self-prompting. All messages shall be displayed in plain English. The operator interface shall have the following features:

i. Multi-fault memory and recall last 10 faults and related operational data

ii. Red fault light, Yellow warning light and Green power on light.

iii. Soft-touch membrane keypad switches.

g. The display shall have four lines, with 20 characters on three lines and eight large characters on one line. Actual pump information shall be displayed indicating pump status.

h. Controller shall be capable performing the following pressure booster function

i. Low suction pressure cut-out to protect the pumps against operating with insufficient suction pressure.

ii. High system pressure cut-out to protect the piping system against high pressure conditions.

iii. No flow shut down to turn the pumps off automatically when system demand is low enough to be supplied by hydropneumatic tank. No flow shutdown shall require any external flow meters, flow switches, nor pressure switches to determine when a No Flow condition exists.

i. The following communication features shall be provided to BAS :

i. Remote system start / stop non-powered digital input.

ii. Failure of any system component. Output closes to indicate alarm condition.

iii One 4-20 mA output with selectable output of :

- Frequency
- Process Variable
- Output Current
- Output power.

j. The following communication features shall be provided to the building automation system via an RS-485 port utilizing Johnson Controls Metasys N2 protocol or equivalent protocol.

i. Individual Analog Input

ii. Individual Zone Set Points.

iii. Individual Pump / AFD on/off status.

iv. System percent speed.

v. System Start / Stop command

vi. System operation mode.

vii. Individual KW signals.

viii. System flow, when optional flow sensor is provided.

k. The pump logic controller shall be as per requirements & housed in a NEMA 3S / IP 54 Enclosure.

vii. ADJUSTABLE FREQUENCY DRIVE

a. The adjustable frequency drives shall be Pulse Width Modulation (PWM) type, microprocessor controlled design.

b. The Adjustable Frequency Drive (AFD), including all factory installed option, be tested to UL standard 508. The AFD shall also meet C-UL and be CE marked and built to ISO 9001 standards.

c. The AFD shall be housed in a IP 55 or nearest as per OEM standards enclosure. AFF with plastic enclosure shall not be acceptable.

d. The AFD shall employ and advanced sine wave approximation and voltage vector control to allow operation at rated motor shaft output speed with no derating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and lift. Power factor shall be near unity regardless of speed or load.

e. The AFD shall have balanced DC link reactors to minimize power line harmonics AFDs without a DC link reactor shall provide a 3% impedance line reactor.

f. Input and output power circuit switching can be done without interlocks or damage to the AFD.

g. The following customer modifiable adjustments shall be provided :

i. Accel time.

ii. Decel time.

iii. Minimum Frequency.

iv. Maximum Frequency.

h. RS-485 communication for Johnson Controls N2 shall be available and provided as an option.

i. An automatic energy optimization selection feature shall be provided. This feature shall reduce voltage when lightly loaded and provide a 3% to 10% additional energy savings.

j. The AFD shall be suitable for upto 3300 feet elevation above sea level without derating. Maximum operating ambient temperature shall not less than 104 degrees F. AFD shall be suitable for operation in environments upto to 955 non-condensing humidity.

k. The AFD shall be capable of displaying the following information in plain English via an alphanumeric display :

i. Frequency.

ii. Voltage

iii. Current

iv. Kilowatts per hour

v. Fault Identification.

vi. Percent Torque.

vii. Percent Power

viii. RPM

viii. AUTOMATIC AFD BYPASS

a. Variable speed pumping system shall be equipped with an automatic bypass in accordance with requirement.

b. Bypass shall consist of a main power disconnect with ground fault protection, a pair of interlocked contractors and a motor overload relay. All are to be mounted in a NEMA 3S / IP 54 enclosure.

c. Automatic bypass shall operate as shown in schematic drawings described in the sequence of operation.

ix. SENSOR / TRANSMITTERS

Provide field mounted differential pressure sensor transmitters as indicated in required.Unit shall transmit an isolated 4-20mA dc signal indicative of process variable to the pump logic controller via standard two wire 24 DC system. Unit shall have a corrosion resistant steel body with 1/8" NPT process connection.

It shall have a NEMA 4 electrical enclosure capable of withstanding requisite static pressure. Accuracy shall be within 0.5% of full span. The installation contractor shall ensure that these differential pressure sensor are enclosed within pilfer proof housing such MS plate housing with lockable access panel.

x. SEQUENCE OF OPERATION

a. The system shall consist of a pump logic controller, multiple pump / AFD sets, with manual and automatic alternation and pump staging.

b. The pumping system shall start upon the closure of contact when the pump logic controller Mode of Operation selector switch is in the REMOTE position.

c. When the pump logic controller selector switch is in the LOCAL position, and start command on Tech 500 is given via operator interface, the pumping system shall operate automatically.

d. Sensor / transmitters shall be provided as indicated on the plans.

e. Each sensor / transmitter shall send a 4-20 mA signal to the pump logic controller, indicative of process variable condition.

f. The pump logic controller shall compare each signal to the independent, engineer / user determined set points.

g. When all set points are satisfied by the process variable, the pump speed shall remain Constant at the optimum energy consumption level.

h. The pump logic controller shall continuously scan and compare each process variable to its individual set point and control to the least satisfied zone.

i. If the set point cannot be satisfied by the designated lead pump, the pump logic controller shall initiate a timed sequence of operation to stage a lag pump.

j. The lag pump shall accelerate resulting in the lead pump(s) decelerating until they equalize in speed.

k. Further change in process variable shall cause the pumps to change speed together.

l. When the set point criteria can be safely satisfied with fewer pumps, the Technologic pump logic controller shall initiate a timed destage sequence and continue variable speed operation.

m. As the worst case zone deviates from set point, the pump logic controller shall send the appropriate analog signal to the AFD to speed up or slow down the pump / motor.

n. In the event of a AFD fault, the pump logic controller automatically initiates a times sequence of events to start the redundant pump / AFD set in the variable speed mode. The redundant variable speed system shall be started through the pump logic controller.

o. Upon AFD fault(s), the pump controller shall display an alarm condition through a plain English message.

p. AFD fault indication shall be continuously displayed on the operator interface of the pump until the fault has been corrected and the controller has been manually reset.

q. In the event of the failure of a zone sensor / transmitter, its process variable signal shall be removed from the scan / compare program. Alternative zone sensor / transmitters, if available, shall remain in the scan / compare program for control.

r. Upon sensor failure, a plain English warning message shall be displayed on the operator interface of the pump logic controller.

s. In the event of failure to receive all zone process variable signals, a user selectable number of AFDs shall maintain a user adjustable speed; reset shall be automatic upon correction of the zone failure.

CENTRIFUGAL PUMPS-DATA SHEET A

	Sr. No	**Pump Designation**	**Primary / Secondary Chilled Water Pumps / Condenser Water Pumps / Hot Water Pumps/ reheat pumps**
Design Parameters	1	No. of Pumps	As mentioned in DBR
	2	Design Capacity	As mentioned in DBR
	3	Total Head	As mentioned in DBR
	4	Location	AC plant room & reheat pumps on terrace of hospital.
	5	Max. Rated Sped (at 50 Hz)	1450 RPM
	6	Liquid Handled	Water
Features of Construction	7	Type of Pump	As per DBR & meeting functional requirements
	8	Seal	Mechanical
	9	Nozzle Orientation	Side Suction & Side Dischrage (or as per requirement)
	10	Flange Drilling	As per ISI
Materials of Construction	11	Parts	Material
	11.1	Impeller	Bronze
	11.2	Casing	Cast Iron
	11.3	Shaft	Steel

CENTRIFUGAL PUMPS- DETAILS TO BE FURNISHED BY TENDERER–

DATA SHEET B

Sr.No	ITEM DESCRIPTION		
1.	Make		
2.	Model		
3.	Design Capacity	USGPM (M3/ Hr)	
4.	Total Head	FT WG (MWC)	
5.	Shut off head	FT WG (MWC)	
6.	Hydrostatic test pressure	KG/SQCM (MWC)	
7.	Pump efficiency at duty point	%	
8.	Power input to pump at duty point	(BHP) (KW)	
9.	Motor efficiency at duty point	%	
10.	Power input to motor at duty point	(HP) (KW)	
11.	Rated speed	RPM	
12.	NPSH required	FTWG(MLC)	
13.	Material of construction as per specification, If no, indicate deviations		YES / NO
14.	Suction size		
15.	Discharge size		
16.	Impeller type		
17.	Pump weight	Kg	
18.	Pump set weight	Kg	
19.	Pump size	Mm	
20.	Pump Foundation size	Mm	

8. HEATING SYSTEM - HOT WATER GENERATOR

1. SCOPE

This section of the specification covers the supply, installation, testing and commissioning of hot water generator along with its accessories, conforming to these specifications and in accordance with requirements of drawings.

2. CODES AND STANDARDS

The design, manufacture, testing and performance of the Hot Water Generator shall comply with all currently applicable statues, regulations and safety codes in the locality where it is to be installed. The Hot water generator shall also conform to the latest applicable Indian Standards. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

3. CONSTRUCTION

The hot water generator shall be vertical/horizontal type comprising of steel shell, heating elements, controls, control panel, mounting frame etc.

i. Shell

The shell shall be of welded construction, fabricated from 10mm thick MS sheet with electric fusion welded seams & in accordance with ASME Boiler & Pressure Vessel Code, Section IV. The shell shall be complete with baffles to provide adequate velocity to water.

ii. Mounting Frame

The hot water generator shall be mounted on a robust fabricated steel frame of 16 SWG (1.6 mm) MS sheet and complete with hinges, locks to make a compact assembly. The base frame shall be designed & fabricated out of required MS sections and shall be suitable for level foundation.

A drain shall be provided at the lower and outlet and inlet connections with flanges shall be on upper end lower side. Connections for safety wall and controls shall be provided on the top. A required no. of sockets for heater elements shall be provided. The construction shall conform to the Indian standards/international standards

iii. Heating Element

Sheathed tabular electric resistance type heater elements shall be of approved make and made of chromium coated mild steel mounted in electrically resistant u-tubes and shall be immersion type to be in direct contact with water and connected for equal loading.

i. These shall be easily removable without opening the terminal plates.

ii. Heaters shall be of adequate rating and equally distributed for uniform heat transfer.

iii. No. of Banks

UP TO 75KW	Min. 3 Banks
UP TO 200KW	Min. 4 BANKS
ABOVE 200KW	Min. 5 BANKS OR more

Heating elements shall be suitable for 415 V +/- 10%, 3 phases, 50 Hz, AC supply and conforming to IS.4159.

The Hot water generator should have at least 5% spare heater capacity, which can be used in case of failure of running heater.

iv. Control Panel

The control panel shall be fabricated out of 2mm MS sheet built in with the hot water generator.

Microprocessor based step controller with thermister sensor to control the HWG in stages. Features of this control should include dip switch programming, status LED's.. Step controller shall have built in test mode to verify Load wiring, contactors and stage operations with 1 Sec time delay. A separate power controller shall be provided for proportional control (0-100% load), in between the switching on and off of step control stages for precise temp. control up to 250KW and above 250KW a microprocessor based step controller with thermister sensor to control the HWG in stages.

The HWG shall be BMS compatible and RS-485 Communication port shall be provided for remote programming and control.

v. Insulation

The hot water generator shall be insulated with 50-mm thick fiberglass of density 32 kg/cu.mt. and cladded with 0.63mm thick aluminum sheet on MS frame welded to generator body.

vi. The hot **water** generator shall be provided with lifting lugs on top for easy transportation and handling.

4. **PRESSURE TESTING**

The Boiler Shall Be Tested In the factory for leak at a Hydraulic Pressure of 350 psi.

5. CONTROLS AND ACCESSORIES

One 100 mm dial type thermometer, mercury in bulb type, at inlet and outlet with tubing. Range of thermometer shall be 0-100 Deg c.

One dial type pressure gauge with globe valve at inlet and outlet of the boiler with tubing. Pressure gauge shall have range of 0-10 kg/sq. cm.

Spring loaded safety valve for pressure relief in case of high-pressure build up in the Hot Water Generator. The outlet of safety valve shall be piped to the nearest drain.

- Inlet and outlet connections with matching flanges.
- Drain connection with 25mm-gate valve.
- De-scaling valve
- Automatic air vent valve
- Step controller.
- High temperature cutout
- Electronic low water level switch.
- Vibration isolators with at least 90% efficiency.

6. CONTROL PANEL

The hot water generator shall be provided with electrical control panel, factory mounted directly on mainframe, completely wired and tested. The panel shall confirm to Indian I.E rules.

The panel shall be provided with accessories. Conforming to the approved list of makes. The panel shall be suitable for 415 V +/-10%, 3ph, 50 Hz AC electric supply.

The control panel shall comprise of: -

(a) Incoming MCCB of suitable rating.

(b) Copper/Al. bus bar of suitable size

(c) Ammeter with current transformers and selector switch.

(d) Voltmeter with selector switch

(e) Contactors

(f) On/ Off indication lamps for individual banks.

(g) Phase indication lamps with control fuses.

(h) Fault indication lamps.

(i) On/Off toggle switch for operating individual banks.

(j) Alarm with reset push button.

(k) Push button for lamp test and heater reset.

(l) Copper connection with cables and control cabling.

(m) Microprocessor based step controller

(n) Hot Water Generators shall be completely BMS compatible having Potential free Dry contacts for :

i. System On/Off status indication
ii. Low Water Level Trip

iii. Hi. Temp. Trip
iv. Auto/Manual Selector Mode
v. Start/Stop Command
vi. RS-485 Communication port for remote programming and control

The doors of electrical controls panel shall be openable only when incoming power supply is cut off.

7. **PAINTING**

All external welds should be de-rusted, cleaned and applied with two coats of necessary red oxide primer. Then it shall be powder coated with Siemens grey RAL-7032 shade or as per requirement.

8. **TESTING**

The unit shall be tested at site to ensure the specified output of hot water generator after satisfactory installation.

9. **DATA / INFORMATION:-**

The data sheet A, as below, indicates the parameters for manufacture/fabrication of Hot water generator. The contractor shall complete the data sheet B & submit as a part of his technical submittal at appropriate stage.

HOT WATER GENERATOR - DATA SHEET A

S. N.	**Description**	
1.0	Design Features	General Areas
1.1	Application	Winter Heating/Monsoon Reheat
1.2	Minimum capacity	As per DBR & meeting functional requirements
o	Location	AC Plant room
1.4.	Numbers Required	As per DBR & meeting functional requirements
2.0	**Features of Construction**	
2.1	Type	Vertical / Horizontal suitable for **Indoor** application
2.2	Heaters	Chromium Coated MS
3.0	**Material of construction**	
3.1	Shell	10 mm thick MS
3.2	Dished ends	15 mm thick MS
4.0	**Insulation**	
4.1	Material	Fiberglass
4.2	Thickness	50 mm

4.3	Density	32 KG / cum
4.4	Finish	(0.63 mm) 24 G Aluminium cladding
5.0	**Testing**	
5.1	Hydrostatic test	At 350 PSIG for leaks
5.2	Performance test	Standard running test

HOT WATER GENERATOR - DATA SHEET B

S.N.	**Description**		
1	Application		
2	Make		
3	Design Capacity	KW	
4	Type		
5	Model		
6	Banks	No / KW	
7	Vessel size	Mm	
8	Thickness		
8.1	Shell	(mm)	
8.2	Dished ends	(mm)	
9.0	Insulation		
9.1	Material		
9.2	Thickness	(mm)	
9.3	Density	(Kg/CUM)	
9.4	Finish		
10.0	Dimensions (L x W x H)	(mm)	
11.0	Heaters		
11.1	Make		
11.2	Model		
12.0	Electrical Characteristics		
13.0	Test Pressure		

14.0	Controls	
14.1	All provided YES / NO	
14.2	Any deviation from specification (Please indicate specifically) YES / NO	
14.3	Qty: Reqd.: Nos:	
14.4	Mandatory service clearance required.	

9. FLOOR MOUNTED AIR HANDLING UNITS

1. SCOPE

This section of the specification covers the supply, installation, testing and commissioning of double skin construction air handling units along with its accessories, conforming to these specifications and in accordance with requirement of the DBR, Drawings and functional requirement.

2. TYPE

The air handling units shall be double skin modular, draw through type comprising of various sections such as mixing chamber (wherever R .AIR and F.AIR are ducted.), pre filter section, chilled water coil section, fan section supply air plenum as per details given in Drawings and functional requirement.

3. CAPACITY

The air handling capacities, maximum motor HP, static pressure shall be as shown on Drawings and as per requirements.

4. CONSTRUCTION

I. AHU HOUSING / Casing:

i. The AHU housing shall be of double skin construction with main structure made of extruded aluminum hollow sections. The panels shall be double skin sandwich type of required thickness pre painted GSS/ pre-plasticized on the outside and of required thickness galvanized sheet inside with 23/43 mm thick PUF insulation or equivalent material injected in between. These panels shall be screwed with soft rubber gasket fixed in built in groove of aluminum frame in between to make the joints airtight.

ii. Framework for each section shall be joined together with soft Neoprene rubber gasket in between to make the joints airtight. Suitable airtight access doors /panels with nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on roller-formed GSS channel framework having pressure die cast aluminum jointers.

II. Drain Pan

The drain pan shall be of 18 G stainless steel (SS-304 grade)with necessary slope to facilitate fast removal of condensate. Necessary arrangement will be provided to slide the coil in the drain pan. The drain pan shall be insulated with 19 mm thick close cell Nitrile insulation (self adhesive)/as per manufacturer's specifications or equivalent.

III. Cooling / Heating Coil

The chilled /hot water coil shall be of seamless copper tubes not less than 0.5 mm thick and 15mm OD. Coil face areas shall be such as to ensure rated capacity from each unit and such that air

velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of airflow.

The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube for minimum thermal contact resistance with fins. Fin spacing shall be 11to 13 FPI. The coils shall be tested against leaks at a hydraulic pressure of 21-kg/sq. cm. This pressure shall be maintained for a period of at least 2 hours. No drop should be observed indicating any leaks. The water headers shall be of copper with adapter complete with water in /out connections, vent plug on top and drain at bottom and designed to provide water velocity between 2 to 6 FPS.

IV. Fan Section with DIDW centrifugal Fan or Forward/ Backward/Aerofoil or Plug Type as per requirements.

DIDW: The fan shall be backward curved, double inlet double width type. The fan shall be AMCA certified for sound and performanance The wheel & housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with spider frame or angle iron frame & pillow block heavy-duty ball bearings. The fan shall be selected for a highest efficiency, low speed and low noise. The impeller & fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 550 MPM. Fan housing with motor shall be mounted on a common extruded aluminum base mounted inside the air handling housing on anti vibration spring mounts or cushy foot mounts of at least 90% vibration isolation efficiency. The fan outlet shall be connected to casing with the help of fire retardant double canvas or Neoprene rubber of imported Origin. The fan shall be selected for a noise level of less than 75 DB (A) at two meter distance.

PLUG FANS:-Fans shall be backward curved plug fan with aerofoil design blades so as to give maximum efficiency for given duty condition. The fan shall be AMCA certified and the entire Fan + Motor assembly shall be balanced before dispatch. Multiple fans / single fan shall be used in AHU to suit available AHU Room at site & as per approved shop drawing. The supply air fan shall be as per requirements. The fan impeller shall be supported to housing with angle iron frame & pillow block heavy duty ball bearing. The fan housing with TEFC Sq. Cage motor shall be mounted on a common adjustable base frame on vibration isolators / rubber turret mounts vibration isolators. The fan motor shall be installed inside the housing of air handling unit to keep low noise level. The fan & motor assembly shall be of aluminum extruded section only.

V. FILTER SECTION

Each unit shall be provided with a factory assembled filter section containing synthetic media washable air filters with efficiency of 90% down to 10-micron particle size of MERV 8 rating. Filters shall have aluminum frame. Filter face velocity shall not exceed 150 meters per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels.

Wherever fine filters are required to be installed, AHU shall be provided with fine filter sections with filters in double skinned construction. The frame of fine filters shall be Aluminum anodized. The media for fine filters shall be non-woven synthetic supported by HDPE mesh on one side & aluminium expanded mesh on other side. The filtration efficiency shall be as per MERV 13 rating.

5. **FRESH AIR INTAKES**

Extruded aluminum construction duly anodized fresh air louvers with bird screen and extruded construction dampers shall be provided in the clear opening in masonry walls of the air handling unit room having at least one external wall. Fresh air louver, damper, pre filters, ducts and fresh air fan with speed regulator (wherever specified in DBR) shall be provided. Fresh air dampers shall be of the interlocking, opposed blade louver type. Blades shall be rattle free. Damper shall

be similar to those specified in 'air distribution'. Fresh air fans and fresh air intakes shall be as per the requirements.

6. ACCESSORIES

Each air handling unit shall be provided with manual air vent at highest point in the cooling /heating coil. In addition, the following accessories may be required at air handling units. Their detailed specifications are indicated in individual sections and quantities separately identified in DBR.

(a) Stem type thermometer at each AHU coil inlet and outlet with tubing and gauge cocks and specification as per the section, 'Automatic Controls and Instruments'

(b) Pressure gauge with globe valves at inlet and outlet of each AHU coil with tubing and specifications as per the section, 'Automatic Control and Instruments'.

(c) Butterfly valves at inlet and outlet of the each coil.

(e) Y strainer at inlet of each coil.

(f) Union and condensate drain piping from the unit up to the drain trap as described in section piping.

(g) PIB Control Valve located in chilled /hot water lines connected to the coil. This valve shall be operated by the cooling/heating thermostat / humidistat and shall control the flow of chilled/hot water as per section 'automatic controls and instruments'.

(h) Cooling /heating thermostat

(i) Automatic Controls and Instruments shall be located in return air stream.

(j) Flexible connection between the fan outlet and duct.

(k) Vibration isolators of at least 90% efficiency.

I. SAFETY FEATURES

Each handling unit must have safety features as under:-

a) The fan access door must have micro switch interlocked with fan motor to enable switching off the fan motor automatically in the event of door opening.

b) The access door shall further have wire mesh screen as an added feature, bolted on to the unit frame.

c) Fan and motor base shall be properly earthed from the factory.

d) All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

7. MOTOR & DRIVE

Fan drive shall be 3 phase-squirrel cage totally enclosed fan cooled motor, having efficiency class IE-3, suitable for 415 Volts, 50 Hz AC supply. Motor shall be specially designed for quiet operation and motor speed shall not exceed 1440 RPM & designed for continuous operation duty. Drive to fan shall be provided through belt drive arrangement with required no. of belts for power transmission without slippage. Belts shall be of oil resistant type of approved make only.Direct driven motors may also be used unless otherwise specified.

DESIGN DATA FOR AIR HANDLING UNITS

(a) Fan outlet velocity shall not exceed 500 MPM.

(b) The air velocity across coil shall not exceed 150 MPM.

(c) The air velocity across air pre filter shall not exceed 150 MPM.

Motor ratings are only tentative and shall be suitable for the duty but not less than the specified HP. The motor shall be selected with a safety factor of at least 20% over and above the brake power.

The AHU fan shall be selected for a total static pressure as indicated in DBR and as per requirements.

8. **INSTALLATION**

Air Handling Unit shall be installed inside the AHU room to permit the removal of all the parts of AHU for any maintenance work without dismantling other equipment such as plenum, pipes, ducts etc. Air handling unit installation shall be carried out as per manufacturer's recommendation and mounted on serrated rubber pads. The serrated rubber pads shall be in two layers with 16G GI sheet sandwiched in between.

9. **PERFORMANCE DATA**

Air handling unit shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing, commissioning of the installation.

10. **TESTING**

Cooling/Heating capacity of various air-handling unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and leaving the coil.

Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury in glass thermometer. Computed result shall conform to the specified capacities and quoted ratings. Consumption shall be computed from measurements of incoming voltage and input current.

11. **DATA / INFORMATION:-**

The contractor shall complete the Data Sheet & submit as a part of his technical submittal at appropriate stage.

10. HEAT RECOVERY <u>VENTILLATION</u> SECTION: (ENTHALPY WHEEL)

a. Wheel: The wheel shall be made of alternate layer of corrugated and intervening flat composite material of aluminium foil of uniform width to ensure smooth surface. The cross contamination between the two stream shall be nil and leakage less than 0.04%. The wheel medium should be bonded together to form rigid transfer medium forming a multitude of narrow channels ensuring laminar flow. The wheels shall be of proven design.

The wheel can be fully wound or on larger units, sectorised, i.e. assembled in segments. In latter case the segments are assembled between rigid spokes thus ensuring structural longevity and allowing replacement of one or specific segments only.

The wheel shall be cleanable by spraying its face surface with compressed air, low temperature steam or hot water or by vacuum cleaning without affecting its latent properties.

The face velocity across the wheel should not exceed 700 fpm (3.5 m/s).

The wheels shall be tested in accordance with AHRI (Std. 1060) or ASHRAE S4-78 method of testing air to air heat exchangers. Development an manufacturers shall meet all quality assurance criteria specified in BSEN ISO 9001.

The minimum sensible and latent efficiencies should be 75%. A computerized selection should be enclosed along with offer.

b. Casing: The casing shall be constructed as a single skin, self-supporting, galvanized sheet steel structure and include rotary wheel support beams and purging sector. The casing shall be supplied with access panels to facilitate inspection and service. Size 2150 mm and larger shall be in two sections to facilitate shipping and handling.

c. Seals: The casing shall be equipped with adjustable brush seals, which minimize the carryover to max 0.05 – 0.2%.

d. Hub and Spokes: Hub and Spokes on one piece rotor shall be Aluminium and on sectorrized rotor Hub shall be made of steel, painted with ani corosion paint and galvanized sheet steel spokes.

e. Drive: The wheel shall be belt driven along its perimeter. A constant speed fractional horsepower motor shall be used. The motor shall be mounted on a self-adjusting base to provide correct belt tension.

TESTING

The Thermal Wheel shall be tested in accordance with the parameters fixed as below.

- Supply Air Capacity - FDB/FWB.
- Exhaust Air Capacity - FDB / FWB.
- Fresh Air Capacity - FDB / FWB

Heat exchanger units(HRV) in double skin construction,constructed out of extruded Aluminium section frame with puf insulated panels,blowers,IE-3 Motor plate to plate type Aluminium heat exchanger and filters.The unit will have two separate passages one for supply of fresh air and the other for exhaust of cool air from the rooms after the revovery of energy. Efficiency of these heat exchangers shall be 60-65%.The plate to plate heat exchanger shall be rigid thermally bonded seamless Aluminium channels separated by extruded aluminium spacers of the following capacity.

11. CEILING SUSPENDED AIR HANDLING UNITS

1. SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of ceiling mounted air handling units, conforming to these specifications and in accordance with requirements of drawings and of the DBR.

2. TYPE

The air-handling units shall be double skin ceiling suspended, draw through type comprising of various sections such as pre-filter section, chilled water coil section, fan section, as per details given in drawings and functional requirement.

3. CAPACITY

The air moving and coil capacities shall be as shown on the drawings and DBR.

4. UNIT CONSTRUCTION

The ductable unit shall be ceiling suspended type. The housing/casing of the air handling unit shall be double skin construction. The framework shall be of extruded aluminum hollow sections. All the frame shall be assembled using pressure die cast aluminum joints to make a sturdy, strong & self supporting frame work for various sections.

40mm thick double skin panels shall be made of 0.8 mm pre-plasticized GSS sheet on outside and 0.8 mm galvanized sheet inside with PUF insulation injected in between. These panels shall be screwed on to the framework with soft rubber gasket on aluminium frame to make the joints air tight. Insulation material shall be of 40 Kg./m3 density (minimum). Detachable steel insulated drain pan with necessary slope to facilitate fast removal of condensate shall be provided. Necessary

outlet from the drain pan shall be provided. The unit shall be suitably insulated from inside to avoid condensation on outer surface. Necessary provision for ceiling suspension shall be provided. The drain pan shall be insulated with 19 mm thick closed cell Nitrile rubber or as per manufacturer's specifications.

5. **FAN AND MOTOR** (DIDW Centrifugal forward curved fans/plug fans as per requirements)

DIDW:- The fan shall be DIDW centrifugal forward curved fan having single-phase motor as specified. The fan shall be in 100% galvanized construction and shall be statically and dynamically balanced. The fans shall carry AMCA certification.

The fan motor shall be single-phase squirrel cage suitable for 415V +/- 10%, 50 Hz, 3-phase AC supply as specified in DBR and as per functional requirement. Fan and motor may be directly coupled or may be belt driven. Fan outlet velocity should not be more than 10 m/sec. Motor shall be of IE-3 class efficiency.

PLUG FANS:-Fans shall be backward curved plug fan with aerofoil design blades so as to give maximum efficiency for given duty condition. The fan shall be AMCA certified and the entire Fan + Motor assembly shall be balanced before dispatch. Multiple fans / single fan shall be used in AHU to suit available AHU Room at site & as per approved shop drawing. The supply air fan shall be as per requirements. The fan impeller shall be supported to housing with angle iron frame & pillow block heavy duty ball bearing. The fan housing with TEFC Sq. Cage motor shall be mounted on a common adjustable base frame on vibration isolators / rubber turret mounts vibration isolators. The fan motor shall be installed inside the housing of air handling unit to keep low noise level. The fan & motor assembly shall be of aluminum extruded section only.

6. **COIL**

The chilled water coil shall be of seamless copper tubes not less than 0.4 mm thick and 12mm OD. Coil face areas shall be such as to ensure rated capacity from each unit and such that air velocity across each coil shall not exceed 150 meters per minute. The coil shall be pitched in the unit casing for proper drainage. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of airflow. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tube for minimum thermal contact resistance with fins. .Coil size shall be selected for a max.face velocity of 500 FPM.

Fin spacing shall be 11to 12 FPI & shall be 0.17 to 0.2 mm thick. The coils shall be tested against leaks at a hydraulic pressure of 21 kg/sq.cm. This pressure shall be maintained for period of at least 2 hours.

No drop should be observed indicating any leaks .the water headers shall be completed with water in /out connections, vent plug on top and drain at bottom and designed to provide water velocity between 2 to 6 FPS. The coils exceeding 6 rows depth should be in two equal parts.

7. **FILTER**

Each unit shall be provided with a factory assembled filter section containing synthetic media washable air filters with efficiency of 90% down to 10-micron particle size of MERV 8 rating . Filters shall have aluminium frame. Filter face velocity shall not exceed 150 meters per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing number of filter cells in banks. These cells shall be held within the frames by sliding the cells between guiding channels.

8. **ACCESSORIES**

Each air-handling unit shall be provided with manual air vent at highest point in the cooling coil. In addition; following accessories may be required at air handling units.

a. Stem type thermometer at inlet and outlet of each coil with tubing and gauge cocks and as per applicable specifications .

b. Pressure gauge with globe valves at inlet and outlet of each coil with tubing and as per applicable specifications.

c. Butterfly valves at inlet and outlet of each coil.

d. Y Strainer at inlet of each coil.

e. Union and condensate drain piping from the unit up to the drain trap as described in section piping.

f. PIB Control Valve located in chilled water lines connected to the coil. This valve shall be operated through the cooling/heating thermostat and shall control the flow of chilled/hot water and as per applicable specifications.

g. Cooling /heating thermostat as per section

h. 'Automatic Controls and Instruments' shall be located in return air stream.

i. Double Flexible connection of fire retardant Hessian between the fan outlet and duct.

j. Vibration isolators of minimum 90% efficiency.

k. Motor & drive package

l. Air purge valve on top of coil header and drain valve at bottom.

9. **DESIGN DATA FOR AIR HANDLING UNITS**

i. Fan outlet velocity shall not exceed 550 MPM.

ii. The air velocity across coil shall not exceed 150 MPM.

iii. The air velocity across air pre filter shall not exceed 150 MPM.

Motor rating is tentative only and shall be suitable for the duty but not less than the specified HP. Motors shall be selected considering at least 20% margin over the break power.

The AHU fan shall be selected for a total static pressure as indicated in DBR and its functional requirement.

10. **INSTALLATION**

Unit shall be installed above the false ceiling in a manner so as to permit the removal of all the parts of AHU for any maintenance work without dismantling other equipment such as plenum, pipes, ducts etc. Air handling unit installation shall be carried out as per manufacturer's recommendation. Rubber in shear type suspension hangers shall be provided for vibration isolation.

11. **PERFORMANCE DATA**

Air handling unit shall be selected for the lowest operating noise level. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing & commissioning of the installation.

12. **TESTING**

Cooling/heating capacity of various air-handling unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of air entering and leaving the coil.

13. **DATA / INFORMATION:-**

The contractor shall complete the Data Sheet & submit as a part of his technical submittal at appropriate stage.

FLOOR MOUNTED

AIR HANDING UNITS – DATA SHEET

1.	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	
2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

CEILING SUSPENDED AIR HANDING UNITS

DATA SHEET B

	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	
2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	
3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

12. VARIABLE FREQUENCY DRIVES FOR HVAC SYSTEMS

1. GENERAL REQUIREMENTS

a. This specification covers complete variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD.

b. The frequency converter shall not be a general purpose product, but a dedicated HVAC engineered product.

c. The VFD and its options shall be factory mounted and tested as a single unit under full load before dispatch.

d. The VFD shall be tested to UL 508C. The appropriate UL label shall be applied.

e. The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.

f. The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating.

2. TECHNICAL REQUIREMENTS

2.1 The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.

When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

2.2 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.

2.3 The VFD shall have a dual 5% impedance DC link reactor (harmonic filters) on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.

2.4 VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

IEEE519, 1992 recommendations shall be used for the basis of calculation of total harmonic distortion (THD) at the point of common coupling (PCC). On request VFD manufacturer shall provide THD figures for the total connected load. The contractor shall provide details of supply transformer rating, impedance, short circuit current, short circuit impedance etc to allow this calculation to be made.

2.5 All VFDs shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The VFDs shall comply with the emission and immunity requirements of IEC 61800-3 : 2004, Category C1 with 50m motor cable (unrestricted distribution). The suppliers of VFDs shall include additional EMC filters if required to meet compliance to this requirement.

2.6 The VFD's full load output current rating shall meet or exceed the normal rated currents of standard IEC induction motors. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.

2.7 The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.

2.8 A programmable automatic energy optimization selection feature shall be provided as standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.

2.9 The VFD must be able to produce full torque at low speed to operate direct driven fans.

2.10 Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.

2.11 An Automatic Motor Adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.

2.12 Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.

2.13 VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

2.14 The VFD shall allow up to at least 100 meters of SWA (Single Wire Armour) cable to be used between the FC and the motor and allow the use of MICS (Mineral Insulated Copper Sheath) cable in the motor circuit for fire locations.

3. PROTECTIVE FEATURES

3.1 Overload protection in VFD shall automatically compensate for changes in motor speed.

3.2 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.

3.3 Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.

3.4 Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.

3.5 VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

3.6 If the temperature of the VFD's heat sink rises to 80C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.

3.7 In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

3.8 The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.

3.9 Protect from output switching : The VFD shall be fully protected from switching a contactor / isolator at the output without causing tripping e.g.: for switching on/off the isolators of the AHU / ventilation fans / pumps near the motor with VFD in ON mode.

3.10 The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.

3.11 When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

4. **INTERFACE FEATURES**

4.1 Auto keys shall be provided on the control panel to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.

4.2 There shall be an "Info" key on the keypad. The Info key shall include "on-line" context sensitive assistance for programming and troubleshooting.

4.3 The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Manual or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.

4.4 Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.

4.5 All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.

4.6 To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.

4.7 Display shall be programmable to communicate in multiple languages including English, Chinese, Korean, Japanese, Thai and Indonesian.

4.8 A Red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

4.9 A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.

4.10 A three-feedback PID controller to control the speed of the VFD shall be standard.

4.11 This controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common set point or to individual set points and to automatically select either the maximum or minimum deviating signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.

4.12 The VFD shall be able to apply individual scaling to each feedback signal.

4.13 For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.

4.14 The VFD's PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.

4.15 The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.

4.16 Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

4.17 Five simultaneous meter displays shall be available. They shall be selectable from (at a minimum), frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, feedback signals in their own units, among others.

4.18 Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.

4.19 A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.

4.20 VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F). Examples can be room temperature in 0C , return air temperature in 0C , supply air temperature in 0C, CO2 concentration in ppm, pressure in bar, differential pressure in PSI etc.

4.21 VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

4.22 Standard Control and Monitoring Inputs and Outputs

a. Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

b. Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.

c. Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.

d. Each relay shall have an adjustable on delay / off delay time.

e. Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.

f. Each shall be independently selectable to be used with either an analog voltage or current signal.

g. The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.

h. A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.

i. The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,

j. One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.

k. It shall be possible to read the status of all analog and digital inputs of the VFD through serial bus communications.

l. It shall be possible to command all digital and analog output through the serial communication bus.

4.23 Optional Control and Monitoring Inputs and Outputs

a. It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.

b. These modules shall use rigid connectors to plug into the VFD's control card.

c. The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.

d. Modules may include such items as:

e. Additional digital outputs, including relay outputs

f. Additional digital inputs

g. Additional analog outputs

h. Additional analog inputs, including Ni or Pt temperature sensor inputs

i. It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.

4.24 Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Fire mode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.

4.25 A real-time clock shall be an integral part of the VFD.

a. It shall be possible to use this to display the current date and time on the VFD's display.

b. Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. Is shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that

occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.

c. All VFD faults shall be time stamped to aid troubleshooting.

d. It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

e. The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.

f. The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

i. The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:

ii. Comparators for comparing VFD analog values to programmed trigger values

iii. Logic operators to combine up to three logic expressions using Boolean algebra

iv. Delay timers

v. A 20-step programmable structure

4.26 The VFD shall include a Cascade Controller which allows the VFD to operate in closed loop set point (PID) control mode for one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.

5. SERIAL COMMUNICATIONS

1.1 The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:

a. Metasys N2

b. Modbus RTU

1.2 VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide at no-charge- PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

1.3 The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

6. ADJUSTMENTS

6.1 The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.

6.2 Four independent setups shall be provided.

6.3 Four preset speeds per setup shall be provided for a total of 16.

6.4 Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.

Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will

cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.

If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload. The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.

An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.

Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

7. **OPTIONAL FEATURES**

7.1 All optional features shall be built and mounted by VFD manufacturer as an inbuilt factory solution. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.

8. **SERVICE CONDITIONS**

8.1 Ambient temperature at full speed, full load operation with continuous drive rated output current:

a. -10 to 45°C for ratings upto 90 kW without derating

b. -10 to 40°C for ratings 110 kW and higher without derating

c. Relative Humidity : 0 to 95%, non-condensing.

d. Elevation : Up to 3,300 feet without derating.

e. AC line voltage variation : + 10% of nominal with full output.

f. VFD Enclosure protection : IP 55, integral, with no additional cabinets.

g. Side Clearances : No side clearance shall be required for cooling.

h. All power and control wiring shall be done from the bottom.

i. All VFDs shall be plenum rated.

9. **QUALITY ASSURANCE**

9.1. To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.

9.2. All optional features shall be functionally tested at the factory for proper operation.

13. FILTERS

1. **GENERAL**

This section covers the general requirements for special type of filters to be installed in air moving equipment or air ducts.

2. **PRE-FILTERS (FABRIC TYPE)**

Synthetic fibre Pre-filters shall be in light weight aluminium framed with non woven synthetic fibre replaceable media. The filter shall have an efficiency of 90 percent down to 10 microns particles

size when tested as per B.S.2831 standards. The filter frame shall be of aluminium and shall be suitable for mounting in Air handling units or ducts as required at site. The velocity across the face of the filter shall not exceed 500 FPM and the pressure drop across the filter shall not exceed 4mm. The filters shall be suitable for operation under 100 percent relative humidity and 120 deg.C temperature conditions.

3. MICROVEE FILTERS (FINE FILTERS)

Microvee filters shall be of dry type. Filters media shall be made from washable non woven synthetic fibre replaceable media reinforced with HDPE cloth & Aluminum mesh, specially treated with antifungal and bactericidal agents to prevent growth of micro organisms. The filter media shall be treated to permit washing with water several times before discharged. The media shall be properly supported and spaced so that air flow through the filter is uniform. The filter shall be housed in aluminium frame work. Filters shall be designed to remove particle down to 5 micron size and with efficiently of 98.0 percent tested as per BS 2831 using Test Dust II. The filters shall be installed in the air handling units after the chilled water coils. They shall be capable of being replaced or removed for servicing without the use of special tools.

4. HIGH EFFICIENCY PARTICULATE ABSOLUTE (HEPA) FILTERS

HEPA filters shall be made in extended surface configuration of deep space folds of sub micron glass fibers. The filter media shall be housed in an aluminium sheet frame provided with double turned flanges and closed cell neoprene gasket. The filter media shall not absorb moisture, stretch, swell or undergo chemical change with moisture. The filter shall be resistant to fungus and bacterial growth. Filters shall be free from pin holes and other leaks.

The housing shall be designed to install the HEPA filters in the terminal locations in the false ceiling or in the duct plenum so that it is removed easily without risking the infiltration of dust whatsoever. The arrangement for filters shall be strictly in accordance with the manufacturers recommendations and shall be approved by the engineer prior to fabrication and installation. The filters shall be protected with aluminium slotted protective grille from the bottom in case of installation of filters in false ceiling air terminals. All MS parts shall be derusted and shall be epoxy painted. The aluminium grilles shall be made from 1.6 mm aluminium sheets with minimum clear area of 60 percent. The grilles shall be anodised stove enamel painted as approved by the Engineer.

5. LAMINAR FLOW HEPA TENT:

i. Introduction :

Diffusers are available for flush mounting in the ceiling. Suitable angle frames are also provided for the modular panel construction. The units are available in three standard sizes for top entry complete with opposed blade dampers.

ii. Description :

LFD laminar flow HEPA TENT are constructed from SS-304, perforated face with approx 50% perforation. The perforated front face is openable hinge type complete with key operated dampers from front.

iii. Features :

- Suitable for modular panel assemblies.
- Front Faced with opposed blade dampers.
- Pivoting type face plate for damper operation from front.
- Easy maintenance and cleaning.

iv. Finishesd Standard :

- Epoxy Polyester Powder Coated off white/pure white.
- Natural anodised.

Mini Pleat HEPA Filters:- These filters shall remove a broad range of airborne contaminants, including fine dust, smoke soot & pollen. These filters shall increase its energy efficiency due to lower pressure drop in comparison to conventional deep pleat HEPA. The filter housing shall be with a very minimal size. The performance of the filters has to be factory scanned prior to the supply .Individual testing under rigid quality control & modern assembly methods has to be used to ensure conformance to specifications.

- **Class of filters should be confirmed to**
- **ASHRAE 52.2** **MERV 16-20**
- **EN 1822** **E10-H14**
- **Eurovent 4/5** **EU 10-EU 14**
- **IEST RP CC 001.3** A,B,C D

These filters has to be with special grade micro glass fiber paper spaced with uniformly positioned hot melt adhesive beads to ensure optimum air-flow. The filter shall be with micro glass pleated media (imported). The frame shall be with extruded aluminium or SS 304 material. It shall be of hi flow box with flange.

The gasket shall be polyethylene food grade. The maximum operating temperature shall be from 100 deg C to 300 deg C and the maximum humidity shall be 100% RH at 0% condensation. The initial pressure drop shall be 20 mm wg at rated air flow capacity and the final pressure drop shall be within 50 mm wg. Efficiency on 0.3 micron shall be 99.997 %. The media shall be epoxy sealed & DOP tested.

ECBC Mandatory Requirements for HVAC Works- It needs to be complied by Contractor.

14. PAN TYPE HUMIDIFIER

1. HUMIDIFICATION ARRANGEMENT –

The humidification arrangement shall be provided by AC contractors (wherever required. This shall consist of the following arrangement.

Pan Type Humidifier

The pan type humidified shall be constructed from 1 mm thick stainless sheet SS-304 with top cover openable for maintenance. The humidifier shall be complete with quick fill, make up overflow & drain connections. The humidifier shall be insulated with fibre glass of density 32 kg/cm2 & shall be cladded with 22G thick aluminium sheet. The humidifier is divided in two chambers from inside, one bank of heater is always kept on to maintain water temperature between 60 to 70 °C with thermostat. All controls such as low level cut out, thermostat, float valve shall be provided. It shall be factory wired & tested. The humidifier shall have its own powder coated electrical panel made of 16 G CRCA sheet complete with contactors, MCB Low level cutout, Heating thermostat, fault indicating lamp, high temperature cutout etc. & internally wired.

The humidifier shall have two chambers with two banks of heaters. One bank of heaters shall always remain ON when the AHU is in operation to maintain the temperature of water between 60 - 70 deg. C and the other bank should come on when there is signal from the humidistat for humidification.

The electric heaters shall be submersible type made out of incloy sheeth and brass/bronze flanges. The heaters shall be of suitable rating to produce instant steam when required.

Controls and accessories:

The humidifier shall be complete with following controls and accessories:

a. Water proof light in the tank
b. Water level indicator
c. Low water level cutoff switch
d. Float valve with bronze ball
e. Make up , quick fill and drain connections
f. Safety thermostats.
g. Fault indication lamp.

15. FAN COIL UNITS – SPECIFICATIONS

1. SCOPE

This section covers the technical requirements for manufacture, testing at works, and delivering at site, testing after installation, commissioning of fan coil units conforming to these specifications and in accordance with the requirement of the drawings and DBR.

2. TYPE

The fan coil unit shall be horizontal type to be mounted within ceiling space draw through type complete with finned coil, fan with motor (IE-3 efficiency class), double skin insulated drain pan, one or more centrifugal fans and motors, cleanable air filters & fan speed regulator & other controls as described. Horizontal fan coil units shall be provided with auxiliary secondary condensate drain pan.

i. Capacity

The air moving and coil capacities shall be as shown on Drawings and as per requirements.

ii. Cabinets

Cabinets shall be constructed of 18 gauge die-formed cold-rolled galvanized sheet steel, bowdlerized and painted with approved shade of powder coating finish and shall have access doors to piping and controls. Access panels shall have positive locking fasteners for easy removal. Horizontal furred-in type units mounted within ceiling space shall be provided with a cabinet housing, the coil and fan section with provision to mount filters within the fan section.

iii. Interior Chassis

The interior chassis shall be constructed of not less than 16 gauge cold rolled galvanized sheet steel bowdlerized and painted with approved shade of powder coating finish. All ceiling suspended fan coil units shall be securely mounted from the building structure with top panel set dead level in both directions. In case of ceiling suspended horizontal units, fan deck and cooling coil shall be easily removable from FCU without lowering down of the FCU or disturbing the other installation.

iv. Fan Section

This shall consist of two lightweight aluminum impellers of forward curved type, both statically and dynamically balanced.

The two impellers shall be directly mounted on to a double shaft, single phase multiple winding motor capable of running at three speeds

A GI plenum shall connect fan outlet to the coil.

v. Cooling Coil

The coil shall be of seamless copper tube of minimum 10 mm OD and wall thickness shall be minimum 0.5 mm. All bends and joints shall be enclosed within insulated end sections of the base unit for protection against sweating. Each coil shall be provided with air vent. All coils shall be factory tested at 21 kg per sq.cm. (300psig) air pressure when submerged in water. Fin spacing shall be 4 to 5 fins per cm. Tubes shall be mechanically/ hydraulically expanded for minimum thermal contact resistance with fins. Air vent shall be provided in headers at a level higher than coils. The cooling coil shall be easily removable from backside of FCU without disturbing the other installations. The copper tube or pipe should not be manufactured from reprocessed or recycled copper

vi. **Drain Pans**

Primary drain pan shall be of double skin construction fabricated from 22 gauge stainless steel with all corners enclosed. An additional inner bottom panel of 22 G thick stainless steel sheet shall be provided to prevent damage to insulation. The pan shall be insulated with minimum 15mm thick expanded polyethylene insulation sandwiched between top and bottom panels to prevent condensation. The pan shall be of sufficient size to accommodate cooling coil supply and return water header and bends and control valves.

The auxiliary condensate drain pan shall be similar in construction to primary drain pan and size larger than primary drain pan to catch all overflows in case primary drain pan gets choked. Drain from auxiliary drain pan shall be connected to drain from primary drain pan through a tee connection and piped to vertical risers.

vii. **Motor**

Motor shall be 240 ± 10% volts, 50 Hz, single phase, six poles, rpm not exceeding 1000 at maximum airflow. Motor shall have three speed windings and shall be factory wired to a terminal block mounted within the fan section. Motors shall have extended shaft on both sides. A sturdy switch shall be provided with the unit complete with wiring, for ON/OFF operation & with minimum three speed control of the fan.

viii. **AIR FILTER**

The filter shall be cleanable type 12mm thick AL of MERV 8 rating wire mesh and mounted behind the pan in a filter plenum of GI sheet.

ix. **PAINTING**

The fan coil units shall be powder coated in approved colour.

3. **CONTROLS**

All units shall be complete with following controls

i. PIB Control Valve in water lines

ii. Wall mounted thermostat containing three speed and on/off control for fan, speed and temperature control for summer/ winter air conditioning

iii. 'Y' strainer, ball valve and globe valve as shown on drawings and as per requirements.

4. **PERFORMANCE DATA**

Fan coil units shall be selected for the lowest operating noise level having standard sound level rating of NC 30 at low speed and NC 35 at medium / high speed. Fan performance rating and power consumption data, with operating points clearly indicated, shall be submitted by the Contractor and verified at the time of testing and commissioning of the installation.

5. **TESTING**

Cooling capacity of various fan coil unit models shall be computed from the measurements of airflow and dry and wet bulb temperatures of entering and leaving the coil. Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury -in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

6. **DATA / INFORMATION:-**

The contractor shall complete the Data Sheet & submit as a part of his technical submittal at appropriate stage.

CEILING MOUNTED FAN COIL UNITS

DATA SHEET B

	GENERAL	
1.1	Manufacturer	
1.2	Type of Unit	
1.3	Over All Dimensions (L x W x H) (mm)	
1.4	Weight (Including Water in circulation) Kg.	
1.5	Approximate Noise Level (DBA)	
1.6	Fan Discharge Position	
2.0	FAN SECTION	
2.1	Air Quantity (CFM)	
2.2	Total Static Pressure (mm of WG)	
2.3	Fan Speed (RPM)	
2.4	Fan Diameter (INCH) and no. Of fans	
2.5	Balancing (Static and / or dynamic)	
2.6	BHP	
2.7	Motor HP, RPM, Make & Type	
3.0	COOLING COIL	
3.1	Coil Fin Material (Aluminum or copper)	
3.2	Tube Diameter (INCH) and material	
3.3	Water through coil (USGPM) and no. of circuits	
3.4	Fin Size (INCH)	
3.5	No of Fins / INCH	
3.6	Water velocity through Coil (FPS)	

3.7	Water Coil Pressure Drop (ft of WG)	
3.8	Outside Coil Surface (SQFT)	
3.9	Face Area (SQFT) of Coil	
3.10	Rows Deep	
3.11	Water Temperature IN & OUT (DEG F)	
3.12	Air In and Out DB& WB Temp (DEG F)	

16. EVAPORATIVE COOLING UNIT - DOUBLE SKIN (AIR WASHER)

1. **TYPE**

The evaporative cooling unit shall be double skin construction draw through type comprising of various sections such as filter section, humidifier section, supply air fan section, fine filter plenum, factory fabricated (wherever required) as per details given in Drawings and DBR.

2. **CAPACITY**

The cooling capacities, motor HP, static pressure shall be as shown on Drawings and in DBR.

3. **CONSTRUCTION**

i. **HOUSING/CASING**

The housing /casing of evaporative unit shall be of double skin construction. The framework shall be of extruded aluminum hollow sections. The entire frame shall be assembled using pressure die cast aluminum joints to make a sturdy, strong and self –supporting framework for various sections.

25 mm thick double skin panel shall be made of 0.6 mm plasticized /pre coated PVC sheeted GSS on outside and 0.6mm galvanized sheet inside with PUF insulation injected in between. These panels shall be screwed on to the framework with soft rubber gasket fixed in built in groove of aluminum frame in between to make the joints airtight.

Framework for each section shall be joined together with soft rubber gasket in between to make the joints airtight. Suitable airtight access doors/panels with nylon hinges and locks shall be provided for access to various sections for maintenance. The entire housing shall be mounted on extruded aluminium channel framework having pressure die cast aluminium joints.

ii. **DRAIN PAN**

Drain pan shall be constructed of 18 G stainless steel (SS-304 Grade) with necessary both way slope to facilitate fast removal of drain water.

iii. **MOTOR DRIVE**

Fan motors shall be suitable for 415(+/-) 10% volts, 50 Hz, 3 phase, squirrel cage, totally enclosed fan cooled with IP-55 protection. Motor shall be especially designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be provided through belt drive arrangement or directly coupled/driven. Belts shall be of oil resistant type. Motors shall be preferably of efficiency class IE-3.

iv. **FAN**

The fan shall be backward curved, double inlet, double width type. The wheels and housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid

shaft supported to housing with angle iron frame and pillow block heavy-duty ball bearings. The fan shall be selected for a noise level less than 75-DB (A). at a distance of 2 m.

The impeller & fan shaft shall be statically and dynamically balanced. The fan outlet velocity shall not be more than 9/10 m/sec. Fan housing with motor shall be mounted on a common extruded aluminium base mounted inside the housing on anti vibration mounts. The fan outlet shall be connected to casing with the help of double fire retardant fabric acting as a flexible connection for anti vibration.

v. **WET DECK HUMIDIFIER**

Wet deck humidifier pads shall be of cellulose paper minimum 200 mm deep to provide at least 90% saturation efficiency at 2.5 MPS or less air face velocity. The cellulose paper pads shall be housed in a galvanized steel casing complete with water distribution header and interconnecting heavy duty flexible PVC / GI pipes between pump and distribution header.

vi. **WATER CIRCULATING PUMPS**

Water circulating pumps shall be vertical type. The suction portion shall be at the bottom with proper seal arrangement to directly pick up water from the stainless steel drain pan. The pump shall be suitable to operate at 415(+/-) 10%V, 50 Hz AC supply.

Necessary water bleeding arrangements shall be incorporated with separate drain connection provided in the stainless steel drain pan to bleed small percentage of total circulated water in order to ensure compulsory water change over during running of the system.

vii. **FILTERS**

Each unit shall be provided with a factory assembled filter section containing washable air filter having bonded expanded aluminium media with aluminium frame. Filter media and frame shall be rust proof and corrosion resistant. Filter face velocity shall not exceed 150 meter per minute. Filter shall fit so as to prevent by pass. Holding frames shall be provided for installing a number of filter cells in banks. These shall be held with in the frames by sliding the cells between guiding channels.

viii. **FRESH AIR INTAKES**

Anodized extruded aluminium construction (20 microns and above) fresh air intakes louvers with bird screen and extruded aluminium low leakage construction damper shall be provided for FA. Blades shall be made of extruded aluminium. Construction shall be rattling free. Fresh air fans and fresh air intakes shall be as per the requirement.

ix. **SAFETY FEATURES**

Each evaporative unit must have following safety features:-

i. The fan access door shall be equipped with micro switch interlocked with fan motor to enable switching off the fan motor automatically in the event of door opening.

ii. The access door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.

iii. All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.

x. **PERFORMANCE DATA**

Evaporative cooling units shall be selected for optimum operating noise level. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of the system.

xi. **TESTING**

Performance of evaporative cooling unit shall be computed from the measurements of air flow and dry and wet bulb temperature of air entering and leaving the unit. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated electronic instrument. Computed result shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

17. KITCHEN EXHAUST SCRUBBER – DRY SCRUBBERS(PROPOSED IN THE CURRENT SCHEME)

1. SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of dry scrubbers comprising of electrostatic sections with auto wash module for use in kitchen exhaust / grease / exhaust air treatment.

2. TYPE

The unit shall be CE certified and of the type as indicated on Drawings and identified in DBR.

3. CAPACITY

The air-moving capacity of unit shall be as shown on Drawings and in DBR.

4. TECHNICAL PARAMETERS

The unit shall provide efficiency of 90% or better for single pass base on ASHRAE test method at flow rates of 800 – 1500 CFM per module (supported by sample test report by a US laboratory). Multiple units can be joined together for increased volume. The system shall be suitable to connect to fan section with average velocity of 500 FPM across air cleaner.

5. EQUIPMENT SPECIFICATIONS

The unit shall be designed and constructed and supplied by a manufacturer specializing in the research, design and manufacture of products specified in this section with a minimum of three years of documented experience, and capable of issuing complete catalog data on the total product.

6. UNIT HOUSING

Housing shall be 1.4mm thick galvanized steel sheet construction to protect against rust and corrosion. Each section shall include single door access, located one side of the unit. The access door shall be mounted on steel hinges and secured with adjustable, gasket sealed lever latches allowing for component access and removal. All doors shall be gasketed to prevent air and water leakage. Doors to charged high voltage components shall be equipped with electrical interlocks, for interconnection into the primary power supply, to prevent access when the components areenergized. The housing shall be furnished completely assembled for ease of shipment and installation. Between each section, a permanent 1/8" thick gasket shall be installed to prevent leakage. The bottom drain pan under ESP section containing integral washing systems shall be pitched downward 1/4"per foot minimum toward a 3" NPT drain nipple.

7. BASE CONSTRUCTION:

The sections are to be mounted on a structural C-channel or floor mounting or ceiling suspension. Lifting lugs shall be incorporated in the base channel to allow for rigging, if ordered.

8. FINISH

The external casing finish shall be a durable industrial grade semi gloss baked-on epoxy ester, not less than 3 mil minimum thickness.

9. CELLS WASH MODULE

The Cells Wash module shall incorporate mechanical filtration. The stationary filter from the direction of airflow will be a metal mesh filters with single, gasketed access doors. Wash manifolds and headers are supplied to wash the module during the normal wash cycle.

10. **ELECTROSTATIC PRECIPITATOR MODULE:**

The electronic air cleaner shall be the two-stage dual voltage plate type cells, rated at not less than 90% efficiency as per the ASHRAE test standards for dry particulate (supported by sample test report by a US laboratory).The collection cells shall be in Single Pass arrangement to provide for maximum collection efficiency.

11. **IONIZING COLLECTION CELL**

Ionizing-Collecting cell(s) shall be of one-piece construction more than 13.3 inches deep in direction of airflow. All support framing, end plates and ionizer ground electrodes shall be 0.090 inch thick aluminum. Both repelling and collector plates shall be 0.020 inch thick aluminum, 9.125 inch deep in direction of airflow and rigidly retained in place with tubular spacers and tie rods. Spacing between plates shall be no less than 0.175 inch. Ionizing electrodes shall be tungsten material wire 24 gauge stainless steel spiked design, rigidly supported both vertically and laterally. High voltage support insulators shall be of self-glazing Teflon with all surfaces, including center hole, glazed to enhance dielectric strength and retard tracking. Insulators shall be mounted out of the airstream, to reduce contaminant buildup. All high voltage electrical connections within each tier of cells, shall be between cells and automatically made when cells are installed. All electrical connections between unit tiers and high voltage connections between power packs and cells shall be located on the access door end of the cabinet and manually connected for ease of service. . Each cell shall weight not more than 16 kg with atleast 9 ioninzing wire and with maximum number of collection/repelling plates up 59 numbers per ESP cell. Minimum collection plate area per 1000 CMH of air flow through ESP Cell shall be 2.0 sqmt

12. **POWER SUPPLIES**

Power supplies shall be 100% solid state, CE/UL Listed. operate on 200 to 240 VAC, 50 HZ, 1 Phase input and provide a dual high voltage output of (+) 12 to 13 KVDC for the ionizer and (+) 6.0 to 6.5 KVDC for the collector. A regulated output of up to 5.5 MA shall be supplied to maintain the specified collection efficiency. Integrally mounted electrical interlocks shall be provided to prevent access to the high voltage components without first interrupting the primary input power. The power supply shall operate over a temperature range of -32 degrees F to 140 degrees F, be self-protecting and accommodate an LED light indicating the performance status of the ionizing/collecting cell. High voltage output leads shall be sealed and a bleed resistor incorporated to remove stored electrical charge where the power supply(s) are de-energized. Module of capacity above 3000 CFM shall be equipped with Pulse width modulating (PWM) to maintain the specified collection efficiency by maintaining a constant charge in the event of Low/High Voltage from source thus ensuring that the unit functionality is not affected with these voltage fluctuations. Power Consumption should not be more that 50 watts per ESP cell.

All power supply components shall be designed for ease of mounting and servicing. High voltage power cables shall be of one continuous length, splicing is not acceptable.

13. **SYSTEM CONTROLS**

Programmable Logic Controller (PLC) shall be housed in a NEMA-12 type enclosure. Controller shall be shipped for remote mounting and must be installed indoors or other means of weather protection provided if installed. Terminals shall be provided to interconnect the system fan and shall sequence the detergent wash, soak, rinse fan force dry and return to operation cycle. All sequence times shall be factory set. Control initiation shall be semiautomatic, push button initiated, or fully automatic by time clock, with semiautomatic push button override.

A remote mounted Sleep Mode Reset Switch (momentary contact push button type) shall be supplied to be installed at the kitchen hood location to re-energize the air cleaning system after the wash system has completed. The switch may optionally be installed on the panel of the ATS control enclosure.

14. **STATIC PRESSURE DROPS**

The pressure drop shall not exceed the following (inches H2O):

- ESP Section 0.14”
- Metal Mesh prefilter or after filter 0.10”

The ESP section must have both an internal prefilter and an after filter, select and add for each.

External losses for ductwork, exhaust hoods, manufacturing equipment with associated entry losses, kitchen hoods, etc..must be added with the above internal equipment losses to calculate total fan static pressure required.

15. **BMS INTERFACE**

The power supply (pack) shall have a 2 wire dry contacts (NO/NC) for remote link to Building Management System. This is for performance indication of the air cleaning system. Should there be a fault or if service is required, the dry contacts close and a signal is sent to the building BMS System. Should there be multiple units, all the dry contacts can be looped into a set of signal. This ensures proper monitoring of the status of each unit.

18. WET SCRUBBER (IN ANY OTHER AREA OTHER THAN KITCHEN AS REQUIRED)

1. **SCOPE OF WORK**

The specification for package type double skin scrubber for mechanical ventilation covers the design requirement, constructional feature, supply, installation, testing & commissioning.

2. **TYPE**

The scrubber shall be double skin spray type system & shall be draw through type.

3. **HOUSING**

Double skinned panels shall be 25 mm thick made of galvanized steel, pressure injected with foam insulation (density 40 Kg / m3) shall be fixed to 1.5 mm thick aluminium alloy twin box section structural framework with stainless steel screws. Outer sheet of panels shall be made of galvanized pre-plasticized sheet of 24 gauge thick and inner sheet of 22 gauge plain GI sheet. The entire framework shall be mounted on an aluminium alloy or galvanized steel(depending on size) channel base as per manufacturer’s recommendation. The panels shall be sealed to the frame work by heavy duty ‘O’ rings gaskets held captive in the framed extrusion. All panels shall be detachable or hinged. Hinges shall be made of die cast aluminium with stainless steel pivots, handles shall be made of hard nylon and be operational from both inside and outside of the unit. Units supplied with various sections shall be suitable for on site assembly with continuous foam gasket. All fixing and gaskets shall be concealed. Units shall have hinged, quick opening access door in the fan section and also in filter section where filters are not accessible from outside. Access doors shall be double skin type. Recirculation tank shall be fabricated from 18 gauge stainless steel sheet duly reinforced with all corners welded. The tank shall be complete with double brass strainers, make-up connection with float, drain and overflow connections.

4. **FAN**

The blower shall be Centrifugal Forward / Backward Curved DIDW fan wheel of totally GI Construction with Inlet Cones and shall be complete with individual motor and drive and shall be

mounted on C Channel frame and Cushy Foot or Spring Mounts. Each Scrubber shall comprise of one / two no. fans to handle air quantities. Each fan shall be driven by suitable HP TEFC motor. The fan wheel will be of the multiblade type and mounted on two self- aligning pillow block bearings of the requisite size. The fan shall be run with the help of "V" Groove drives as per the recommendation of the drive supplier.

5. **MOTOR**

The TEFC motor shall be suitable for 415 ± 10% volts, 3 phase, 50 Hz ± 5%, A.C supply. The motor shall be with class B/E insulation confirming to IS 325. The motor speed shall be 1440 RPM maximum designed and guaranteed for continuous operation at the nameplate rating. It should confirm to IP 55.

6. **FILTER SECTION**

Filters section shall incorporate metallic viscous filter (for removal of oil and grease) of thickness 50 mm in suitable aluminium frame. Velocity of air across the filters shall not exceed 2.5 m/s.

7. **SPRAY ARRANGEMENT**

The wet section will have 18 G SS Tank and body with folded construction with the bolted openable sides also in 18 G GI sheet. Spray arrangement shall be 2 bank air washer with 1/8" (3 mm) bore bronze nozzles with brass plug complete with GI pipes and spray headers. Minimum number of nozzles shall be 1 / sqft of face area. Face velocity not to exceed 500 FPM (2.5 m/s). PVC drain/overflow and bleed off outlet are to be provided on all wet sections.

8. **PUMP**

The unit will have a single phase 220 volts + 10% 50 c/s power supply monoblock self priming pump assembly to provide recirculated tank water and a pressurized flow via a piping system for proper water distribution. The pump capacity will be such that it can take care of the bank of Nozzles provided and the rigid media.

9. **INSTALLATION**

The fans, pumps, scrubber etc. shall be provided with necessary vibration isolation cushy foot mounts. All necessary accessories such as nut bolts etc. shall be arranged by the contractor. The contractor shall arrange his own labour with material for completion of assembly.

The contractor, if specifically specified in DBR , shall cast the RCC foundations for equipments. Anti-vibration pads of adequate efficiency shall be provided.

10. **TRANSIT DAMAGE**

The contractor at his own cost shall restore the unit to original conditions in case of any damages.

11. **TESTING**

The AC contractor shall compute the unit air quantity with the help of velocity meter. The computed results shall be tallied with specified capacities and power consumption shall be tallied with the indicated figures in the technical data furnished by the contractor.

All necessary instruments of proper accuracy and services needed for the tests required for the computation of capacities and power consumption as required by the Consultant shall be provided by the contractor at his own cost.

It shall also be the responsibility of the Contractor to supply the motors and starters to satisfy the local regulations pertaining to the limitation of starting current and indemnify the Department from all liabilities arising out of any objections raised by the local authorities in this regard.

19. INLINE & PROPELLER FANS

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of centrifugal and inline fans conforming to these specifications and in accordance with the requirement of drawings and DBR.

2. TYPE

Centrifugal and inline fans shall be of type as indicated in drawings and in DBR.

3. INLINE FANS

Inline fan shall incorporate SISW direct driven centrifugal fan with TEFC (IP-44) motor. The fan assembly shall be enclosed in a sheet metal housing of 22 gauge GSS and with necessary inspection cover with proper gasket assembly. The fan material shall be galvanized sheet steel. Flanges shall be provided on both sides of inline fan to facilitate easy connection. Flexible anti-vibration joints shall be provided to arrest vibration being transferred to other equipments connected to inline fan. Motor shall be single phase/three phase as per duty conditions.

All single-phase fans shall be provided with speed regulators while all three phase fans shall be provided with opposed blade dampers in GSS construction at fan outlet for air balancing.

4. PROPELLER FANS

Propeller fans shall be direct driven, three or four blade type mounted on a steel mounting plate with orifice ring.

Mounting plate shall be of steel construction, square with streamlined venturi inlet coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge steel sheet depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

Fan blades shall be constructed of aluminum or glass reinforced polypropylene. Fan hub shall be of heavy welded steel construction with blades bolted to the hub fan blades and assembly shall be statically and dynamically balanced

Shaft shall be of steel accurately ground and shall not pass through first critical speed through entire range of specified fan speed.

Motor shall be standard permanent split capacitor of shaded pole for small sizes, totally enclosed with pre-lubricated sleeve or ball bearings, designed for a quiet operation with a maximum speed of 1000 RPM for fans 60 cm dia. or larger and 1440 RPM for fans 45 cm dia. and smaller. Motors for larger fans shall be suitable for 415 $\pm$ 6% volts. 50 cycle 3-phase power supply and for smaller fans shall be suitable for 220 $\pm$ 6% volts, 50 cycles single-phase power supply. Motors shall be suitable for horizontal or vertical service as indicated in drawings and as per requirements.

Propeller fans shall be provided with following accessories: -

a. Wire guard and bird-screen

b. Gravity louvers at outlet

c. Regulator for controlling fan speed for single-phase fan motor.

d. Single-phase preventors for 3 phase fans.

e. Wiring between regulator and fan motor including termination at both ends.

5. PERFORMANCE DATA

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of installation.

6. **TESTING**

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings, power consumption shall be computed from measurements of incoming voltage and incoming current.

The Fans shall be preferably AMCA certified. Also, it should be UL & FM/EN approved.

20. FAN SECTIONS

1. **SCOPE**

The scope of this section comprises the supply, installation, testing and commissioning of ventilation fan sections conforming to these specifications and in accordance with the requirement of drawings and DBR. Fan Outlet velocity shall not exceed 610 meters per minute.

2. **TYPE**

Ventilation fan sections shall be complete with Centrifugal Fans, belt driven fans complete with motor drive and housing with weatherproof cowl.

3. **UNIT CONSTRUCTION**

i. **Housing**

The housing shall be fabricated out of 16 gauge steel sheet and shall have flange to be connected to duct. The discharge cowl shall be hinged along one edge for easy access to motor and drive, for inspection and maintenance. The entire assembly shall be weatherproof and provided with 18 gauge galvanized steel mesh bird screen of 6 mm size on all discharge cowls around the outlet areas. Shaft shall be constructed of steel, turned, ground & polished.

ii. **Fan**

Fan shall be forward / backward inclined wheel type designed for maximum efficiency, minimum turbulence and quiet operation. Fan shall be statically and dynamically balanced. Fan shall conform to specifications as given in specification No.SPC/CF – PF/01

iii. **Motor**

Motors shall be suitable for 415 +- 10% volts, 50 CPS, 3 Phase AC supply totally enclosed fan cooled motor provided with class 'F' insulation& IE-3 class efficiency. Motor shall be designed for quiet operation and motor speed shall not exceed 1440 RPM. Drive to fan shall be through belts.

iv. **Back draft Damper**

Where called for in DBR the ventilation fan section shall be provided with a rattle free back draft damper to prevent air from re-entering the fan when fan is not in operation, thus sealing completely in closed position. Damper shall be chatterproof under all conditions.

4. **VIBRATION ISOLATION**

The motor and fan assembly shall be isolated from base through Dunlop/Resistoflex vibration isolators.

5. **PERFORMANCE DATA**

All fans shall be selected for the lowest operating noise level. Capacity rating, power consumption with operating points clearly indicated shall be submitted and verified at the time of testing and commissioning of installation.

6. **TESTING**

Capacity of all fans shall be measured by an anemometer. Measured airflow capacities shall conform to the specified capacities and quoted ratings, power consumption shall be computed from measurements of incoming voltage and incoming current.

The Fans shall be AMCA certified. Also, it should be UL & FM/EN approved. Sound attenuators with/without baffles to reduce noise generated at source itself wherever feasible.

21. AXIAL FLOW FANS

1. **SCOPE**

This section covers the technical requirements for manufacture, testing at works, delivery at site, testing after installation, commissioning of axial flow fan equipments for ventilation and exhaust system. Their location shall be as given in DBR and drawings.

The fans shall be complete with all the accessories required for proper installation and performance consisting mainly of the following: -

a. Suction and discharge side flanges and counter flanges suitably drilled, complete with bolts & nuts, direct driving electric motor, suspension hangers (for ceiling hung fans only) for vibration isolation (rubber in shear type). Any structural steel and hardware required for assembly, installation, supporting of fan or accessories. 2 mm thick flexible connectors, fire resistant type at suction and discharge end, Foundation bolts and vibration isolators (in case of floor mounting only).

b. Gravity louvers

2. **APPLICABLE SPECIFICATIONS STANDARDS AND CODES**.

Documents listed below should be read along with the technical data given in the DBR and shall be applicable to the material, manufacture, testing and installation of axial flow fans and accessories.

a. I.S.S.: 3588 – 1986; specifications for electric axial flow fans.

b. ANSI/ASHRAE: standard 51

c. ANSI/AMCA: standard 210 & 300 for preparing performance curves, charts and testing of fans for air and sound performnace

d. IS-2312 – Propeller type A.C ventilation fans

e. BS – 848/ ACMA Tested – Methods of performance test for fans

3. DESIGN & MANUFACTURING

i. **Fan and Components**

a. The fan shall be designed to handle the quantity of air against the static pressure and at conditions indicated in the technical data. The fan shall have 70% efficiency at operating conditions and shall have performance characteristics to match the approved performance curves.

b. The unit shall be factory built to the highest standards to ensure rigidity, maximum mechanical and electrical reliability, quite, stable and vibration free operation at the prescribed conditions of flow, static and speed.

c. The casing shall be fabricated from heavy gauge sheet steel with suction and discharge ends flanged and complete with counter flanges, G.I. nuts and bolts. The flanges and counter flanges shall be matched and drilled suitably to receive flexible PVC connections. An inspection door

with handle and neoprene gaskets shall be provided. Support brackets for ceiling suspension shall be bolted to the casing for connection to hanger bolts.

ii. **Impeller & Blades**

The impeller shall be cast aluminum; aerofoil type with well-balanced blades made from cast aluminum alloy or cast steel construction.

4. **DRIVE**

The fan hub and blades shall be directly mounted on the shaft of a totally enclosed motor, rotor of fan motor shall be well balanced. The motor shall be TEFC, squirrel cage, IP 55 0– class H/F as per use, IE-3 class efficiency preferably and suitable for 415 +- 10% V, 50 HZ 3 phase AC power supply. The motor shall be dual speed wherever called for in DBR. The maximum motor speed shall be limited to 1450 RPM. Motor conduit box shall be mounted on exterior of fan casing and lead wires from motor to conduit box shall be protected from air stream by enclosing in a flexible metal conduit.

5. **TECHNICAL SPECIFICATIONS**

The firm shall submit the technical data and performance characteristics with operating points duly marked for approval prior to fabrication. The supplier shall supply the test certificates of all the fans.

6. **GENERAL REQUIREMENTS**

a. Static, dynamic balancing and vibration: the individual fan impeller, blades, motor shall be statically and dynamically balanced independently. After assembly the entire fan motor unit shall not give rise to any vibrations. The balancing shall be as per ISO: 1940 GR 6.3.

b. NOISE LEVEL: The tendered shall indicate the noise level generated by the fan/motor unit in terms of decibel units to be measured at 3M from the unit. This shall fall in line with best engineering standard and shall not be more than 80 db.

7. **PAINTING**

All fans and their accessories shall be painted with two coats of suitable enamel paint after one coat of Red Oxide primer.

8. **PACKING**

The fans shall be dispatched in packed condition to avoid damage during transportation to site. Transit insurance for the fans shall be included in this offer.

9. **INSPECTION & TESTING**

All fans shall be subjected to inspection and testing requirements as given below. The contactor shall be responsible for providing all inspection facilities and for conducting all tests at works and at site after erection. Test certificates for all fans shall be submitted, some fans at the discretion of CLIENT/ HLL may be tested at the factory in his presence.

The performance of the fan motor unit shall be tested by operating at design conditions. The following parameters will be tested vis-à-vis the approved performance curves.

a. Airflow capacity, Static head developed, BHP requirement, Vibration and noise levelThe Fans shall beAMCA certified. Also, it should be UL & FM/EN approved. Sound attenuators with/without baffles to reduce noise generated at source itself wherever feasible.

22. VAV TERMINAL BOXES

1. **GENERAL**

All the VAV Terminals shall be Pressure Independent type with Direct Digital Controls to regulate the primary air flow rate between the scheduled minimum and maximum values to achieve the specified comfort level within acceptable noise criteria. A separation shall be made in Induction VAV Terminals and Standard VAV Terminals as detailed in the schedule.

The Induction VAV Terminals shall induce room air, without need of an assisting fan, and mix it with conditioned primary air, maintaining a near constant air volume to the room thus providing sufficient air movement necessary to maintain occupant comfort even in extreme load variations.

The VAV terminal shall have the controls, actuators and transformers, etc. pre-fitted, wired and calibrated at the factory and supplied with its appropriate digitally communicating thermostat. The supply of the VAV Terminals and the VAV controls, as well as the commissioning at the site, shall be done by the same specialist/local supplier.

2. CONSTRUCTION OF STANDARD PRESSURE INDEPENDENT VAV TERMINALS

The casing shall be a double wall construction made from galvanized sheet steel (non spiral). Casing Leakage Rate shall be according to class II, VDI 3803/DIN 24 194. The insulation thickness shall be 25 mm. and the insulation material shall be fully enclosed by the metal casing. VAV Terminals with insulation materials in direct contact with the air flow will not be accepted.

The VAV Terminals shall have a low leakage, sandwich construction damper blade with SBR gasket and a solid aluminum damper shaft (diameter 12 mm.) with self lubricating Nylon bearings. The leakage shall be less than 2% of the nominal flow at 750 Pa. inlet static pressure. The duct sleeve connections at the inlet and outlet of the VAV Terminal shall be conform DIN 24 145 or DIN 24 146 respectively.

For large air volumes, Rectangular VAV Terminals shall be provided. These Rectangular VAV Terminals shall have a multi-leaf opposed blade damper with aluminum, aerofoil blade construction, width 50 mm. and external linkage. The damper spindle shall be made of steel (10 mm. diameter), rotating in self lubricating Nylon bearings. The VAV Terminal shall have 30 mm. flange connections at the inlet and outlet of the terminal.

Each VAV Terminal, Circular or Rectangular shall be factory fitted with a multipoint, averaging air flow sensor in the inlet of the terminal. This air flow sensor shall amplify the air pressure signal linearly with an amplification factor of at least 2.0. The air flow sensor shall contain not less than 4x12 sensing points, which shall be arranged in two perpendicular axis of sensing. The holes shall be arranged in such a way that each four points in a ring sense the air pressure across concentric circles of equal area in a round duct. The signal shall be averaged and measured from the center of the sensor. And the accuracy shall be within 2.5% even with irregular duct approach.

3. CONSTRUCTION OF INDUCTION VAV TERMINALS (PRESSURE INDEPENDENT)

The casing shall be rectangular type made from galvanized sheet steel (thickness 1.25 mm.) with a circular inlet, two Induction openings at the sides of the terminal and a rectangular outlet. The duct sleeve connections at the inlet and outlet of the VAV Terminal shall be conform DIN 24 145 or DIN 24 146 respectively. The VAV Terminal shall have internal insulation (thickness 25 mm.), tested HF-1 (UL 94) flame test and erosion proof up to 50 m/s air velocity.

The terminals shall be fitted with a specially constructed jet-tronic damper to regulate the primary air flow between the scheduled minimum and maximum values. The same damper shall also generate and control the Induction effect through the acoustically lined induction chamber of the VAV Terminal. The damper shaft shall be solid aluminum (diameter 12 mm.), rotating in self lubricating Nylon bearings. The damper shall permit proper operation of the terminal over a range of 20 to 100% of maximum flow without the requirement of special VAV diffusers or assisting fans.

The Induction VAV Terminal shall be factory fitted with a multipoint, averaging air flow sensor in the inlet of the terminal. This air flow sensor shall amplify the air pressure signal linearly with an amplification factor of at least 2.0. The air flow sensor shall contain not less than 4x12 sensing points, which shall be arranged in two perpendicular axis of sensing. The holes shall be arranged in such a way that each four points in a ring sense the air pressure across concentric circles of equal area in a round duct. The signal shall be averaged and measured from the center of the sensor. And the accuracy shall be within 2.5% even with irregular duct approach.

23. AUTOMATIC CONTROLS AND INSTRUMENTS

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of automatic controls and instruments conforming to these specifications and in accordance with requirement of drawings and in DBR.

2. PRODUCTS

i. 2 WAY MODULATING / PRESSURE INDEPENDENT/ BALANCING and FLOW CONTROL VALVE.

The Self balancing flow control valves that are pressure independent, 2-way, modulating to accept Input signals from the control system. Each Air Handling Unit / Fan Coil Unit shall be provided with a 2Way Pressure Independent Balancing and Control Valve integrated in a single Body. The valve should be a **Globe Type**. **Rolling Diaphragm based delta p controller should ensure 100% valve authority.**

Each air-handling unit/ fan coil unit shall be actuated by a space thermostat. Space conditions shall be maintained by continuous proportional modulation of the chilled/hot water through the coil. Control - Valve should be equipped with electronic modulating gear type (not thermal/wax) actuator which can accept either "4(0)-20 mA / 2(0)-10V DC signals. Operating voltage for actuator shall be 24V AC.

Minimum Pressure Drop across the valve must not exceed 30 kPa in bigger Sizes. All Valve actuators should be microprocessor based with self-calibrating feature. Valve Actuator combination should be able to give logarithmic control. Actuator shall be able to work against pump head or maximum closing pressure Manual Override Flow Balancing should only be done in Valve, not in actuator Balancing – Each Valve should have a stepless adjustable maximum flow limitation as per the designed flow rate of coils. The balancing should be done only in the valve not in the actuator so that in case of actuator failure the balancing is not lost and easily accessible. For Test ports valve shall have Needle measuring nipple.

Two way or Three-way motorized valve for each fan coil unit shall be provided in chilled water lines at each fan coil unit as shown on Drawings and included in DBR. The valve shall be actuated by space thermostat. Constant space conditions shall be maintained by allowing all of chilled water to either pass through the coil or bypass the coil and mix with the chilled water return. The valve shall revert to fully bypass position when fan is shut off.

Valve shall be similar to Honeywell two-position diverting valves 15 cm (1/2 inch) diameter with flare connection. Valve shall be selected for water flow rate of 5-6 USGPM. Pressure drop across the valve shall not exceed 2 psi. Valve shall have the facility to replace motor & actuator without removing the valve body.

ii. Flow switches shall be provided in the condensing water line (outlet) and chiller water line (outlet) only near the chilling machine. The control supply of chilling units shall be interlocked with these flow switches.

iii. Thermostats shall be electrical mode, fixed differential type with sensing element located in the return air stream.

iv. Proportional control thermostats for air conditioning application for actuating the two ways or three way modulating valve at each air-handling units, as shown on drawings and included in DBR. Range shall be 56-84 degree F, differential shall be 3 degree F.

v. SNAP acting fixed differential thermostat for FCU shall be with temperature range of 13-29 degree C differential 37 deg C with ON/OFF, HI/LOW fan switch; normal-cool setting switching off must break fan circuit.

3. **INSTRUMENTS**

i. **Thermometer:** Thermometers shall be dial type 100 mm dia or V form industrial type. Body shall be aluminum alloy, anodized gold colored surface. The casing shall be adjustable side ways for reading from the front. The glass capillary shall be triangular in shape with blue mercury filled in glass for better visibility. Scale of reading shall be of the range 0 deg C to 60 deg C & +32 deg F to 150 deg F. Graduation of scale shall be 1 deg in both readings. Ranges of scales shall be 30-90 degrees F (0-50 deg C) for all conditioning applications of cooling only.

Thermometer shall be suitable for 15mm connection. Thermometer for chilled water shall be with long stem so that thermometer is removable without damaging the insulation ms socket to be welded on pipes shall be provided with thermometer. Thermometer shall be installed of chilled water supply and return at each air handling unit, supply and return of each chiller, condenser.

ii. **Pressure gauge**: shall be installed on suction header and at discharge side of each pump in the chilled water supply and return at each air handling unit, at inlet and outlet of each chiller. Suction side gauge at pump suction header shall be compound gauge with 150 MM dia, range 75 cm vacuum to 10 kg pressure. Discharge side gauge at pumps and at all other locations shall be 150mm range 0-10 kg per sq cm (0-150 PSI) Pressure.

iii. Thermostats

Thermostats shall be electric fixed differential type as indicated below, with sensing element located in the return air stream. All thermostats shall be supplied with the standard mounting boxes as recommended by the manufacturer. The profile, mounting arrangement and exact location of the thermostat shall be such as to suit the site.

I) Proportional control thermostats shall be provided for actuating the three way modulating valve at each air handling unit. Thermostat shall provide manual switching (heat-off-cool-in heating-cooling system).

II) Snap-acting fixed differential type thermostat for actuating the three-way diverting valve at each fan coil unit.

Thermostat shall have temperature adjustments WARM-NORMAL-COOL settings and fan switch. Switching off must break fan circuit.

III) Snap-acting fixed differential heating thermostat for electric winter heating and reheat applications for putting on/off power supply to electric heating or reheat coils in air handling units.

IV) Safety thermostat shall be provided for electric winter heating and reheat application for cutting off power supply to strip heaters in case air flow across strip heater is not established.

V) Air-stat shall be provided within air handling unit containing electric heating or reheat coils to prevent heaters from energizing unless the air flow is established.

iv. Humidistats

Humidistat shall be provided with air handling unit for areas, which require humidity control. One humidistat shall activate the reheat coils in case the space humidity rises beyond the preset limit.

Another humidistat shall energize the humidifier when the humidity falls below the preset limit. These humidistats shall also de-energize these devices when the desired humidity is reached.

Humidistats shall be snap-acting type having humidifier/dehumidifier control from 20-80 percent relative humidity, with differential of 5 percent. Humidistat shall have nylon element with three bobbins, and removable knob to prevent tempering of set point.

v. **AUTOMATIC BALANCING VALVES for Chiller/condenser line: Size : 100-1000 mm size**

AUTOMATIC BALANCING VALVES WAFER type Valve shall consist of a dynamic, flow limiting device.
VALVE housing shall be constructed of ductile iron ASTM A536, Class 60-40-18; rated at no less than 3400 kPa static pressure at +175°C; shall have single or multiple, parallel-installed stainless steel cartridge assemblies (Flow regulation unit assembly shall be manufactured of stainless steel and stainless steel spring.), to provide rated flow rate.

- Valve shall be permanently marked to show direction of flow.
- Dual pressure/ temperature test plugs for verifying accuracy of flow performance shall be provided for all valve sizes.
- Flow regulation unit shall be available in four different kPa operational ranges; minimum range shall be capable of being activated by minimum 10kPaD; and shall be capable of controlling flow within +/-5% of rated flow.
- Identification tag shall be available for all valves; tag can be indelibly marked with model number, flow rate.

24. SHEET METAL WORKS AND ACCESSORIES - (MANUAL FABRICATION)

1. **SCOPE**

The scope of this section includes supply, fabrication, installation & testing of all sheet metal ducts, supply, installation, testing & balancing of all grills & diffusers as per specifications & drawings.

Except as otherwise specified all ductwork and related items shall be in accordance with these specifications.

Duct work shall mean all ducts, casings, dampers, access doors, joints, stiffeners, hangers & all accessories.

2. **DUCT MATERIALS**

The ducts shall be fabricated from galvanized steel sheets class VIII - Light coating of Zinc conforming to ISS: 277-1962 (REVISED) and with a galvanizing thickness of nominal 120 gm. per SQM surface area.

i. Only new, fresh, clean (unsoiled) and bright GI/Aluminum sheets shall be used. The CLIENT/ HLL reserve the right to summarily reject the sheets not meeting these requirements. Fabrication of ducts shall be through Lock forming machines.

ii. All duct work, sheet metal fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with Amendment-I (1971 Edition)

Longer size of Duct	Sheet Thickness GI (MM)	Type of Joints	Bracing
Up to 750	0.63	GI Flange	-
751-1000	0.80	25x25x3 mm angle iron frame with 8 mm Dia nuts & bolts	25X25X3 MM @ 1M

1001-1500	0.80	40x40x5 mm angle iron frame with 8 mm Dia nuts & bolts	40x40x5 MM @1M
1501-2250	1.00	50x50x5 mm angle iron frame with 10 mm Dia nuts & bolts at 125 mm center	40x40x3 mm @ 1.2m to be braced diagonally.
2251 & above	1.25	50x50x6 mm angle iron frame with 10 mm Dia nuts & bolts at 125 mm center	40x40x3 mm @ 1.6m diagonally braced

iii. Ducts larger than 450 mm shall be cross broken, duct sections up to 1200 mm length may be used with bracing angles omitted.

iv. Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 Deg. Angle from the axis of the main duct unless otherwise approved by the Engineer-in-Charge.

v. All ducts shall be supported from the ceiling/slab by means of M.S. rods of 10 MM Dia with M.S. angle at the bottom of size 40 mm x 40 mm x 6 mm for sizes up to 1500 mm at 3 m intervals. Above size 1500 mm upto 2250, support shall be provided with 10 mm dia. MS rod and MS angle size 50 mm x 50 mm at bottom at 2.5 m intervals. Above size 2250 mm support shall be provided with 12 mm dia MS rod and MS angle size 50 mm x 50 mm at bottom

3. **INSTALLATION**

i. All ducts shall be fabricated and installed in workman like manner, generally conforming to relevant BIS codes. Round exposed ducts shall be die formed for achieving perfect circle configuration

a. Ducts so identified on the drawing shall be acoustically lined and thermally insulated as described in the section 'Insulation' and as indicated inDBR. Duct dimensions shown in drawings are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in DBR.

b. Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made airtight.

c. All exposed ducts upto 60 cm width within conditioned spaces shall have slip joints. The internal ends of the slip joints shall be in the direction of airflow. Ducts and accessories within ceiling spaces visible from air-conditioned areas shall be provided with two coats of matt black finish paint.

d. Change in dimensions and shape of ducts shall be gradual. Air turns shall be installed in all vanes arranged to permit the air to make the turn without appreciable turbulence.

e. Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees of ample size to keep the ducts true to shape and to prevent buckling, vibration or breaking.

f. All sheets metal connections, partitions and plenums required to confine the flow of air to and through the filters and fans shall be constructed of 18 Gauge GSS thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary inspection doors as required to give access to all parts of the apparatus. Doors shall be not less than 45cm X 45cm in size.

g. Plenums shall be panel type and assembled at site. Fixing of MS angle iron flanges of duct pieces shall be with rivet heads inside i.e. Towards G.S. sheet and riveting shall be done from outside.

h. Rubber gasket 3 mm thick shall be used between duct flanges and between duct and duct supports instead of felt in all ducting installation for complete sealing.

ii. During the construction, the Contractor shall temporarily close duct openings with sheet metal covers to prevent debris-entering ducts and to maintain opening straight and square, as per direction of Engineer-in-Charge.

a. Great care should be taken to ensure that the ductwork does not extend outside and beyond height limits as noted on the drawings.

b. All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be tight and shall be made in the direction of airflow.

c. The ducts shall be reinforced where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

d. All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration. All ducts shall be fabricated and installed in accordance with modern design practice. The sheet metal gauges and fabrication procedures as given in I.S. specifications shall be adhered to and shall be considered as an integral part of these specifications.

e. The ductwork shall be varied in shape and position to fit actual conditions at building. All changes shall be in accordance with accepted duct design and subject to the approval of the engineer-in-charge.

f. Sponge rubber or approved equal gaskets shall be installed between all connections of sheet metal ducts to walls. Sheet metal connections shall be made to walls and floors by means of galvanized steel angles anchored to the building structure with anchor bolts and with the sheet bolted to the angles. Sheet metal connections shall be as shown in the drawings or as directed by Engineer-in-Charge.

g. All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angel/channel under ducts. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods and angles / channels shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats.

h. Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick TF quality thermo Cole around the duct prior to sealing of the opening.

i. All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 100 mm long but not more than 200 mm, securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

j. Flanges and supports are to be black, mild steel and are to be primer coated on all surfaces before erection and painted with aluminum thereafter. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

k. The ductwork should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling Contractors.

4. **DAMPERS**

At the junction of each branch duct with main duct and split of main duct, volume control dampers must be provided. Dampers shall be rigid in construction to the passage of air.

The volume dampers shall be of an approved type, lever operated and complete with suitable level links & quadrants, locking devices, which will permit the dampers to be adjusted and locked in any position.

The dampers shall be of opposed blade or louver type. The damper blade shall not be less than 1.25 mm (18) gauge and shall not be over 225 mm wide. Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Damper frames shall be constructed of 16 gauge steel

After completion of the ductwork, dampers are to be adjusted and set to deliver the required amount of air as specified in the drawings.

5. **ACCESS PANEL**

A hinged and gasket access panel shall be provided on ductwork before each control device that may be located inside the ductwork. Doors shall be provided with neoprene rubber gaskets. Angle joints shall be provided with neoprene rubber gaskets for leak tightness of the joints. Access door/panels shall be provided: - Near each smoke sensor Any other place specifically mentioned in the drawing or if asked by CLIENT/ HLL during execution stage.

6. **MISCELLANEOUS**

a. Sponge rubber gaskets also to be provided behind the flange of all grills.

b. Each shoot from the duct, leading to a grille, shall be provided with an air deflector to divert the air into the grille through the shoot.

c. Inspection doors measuring at least 450 mm x 450 mm are to be provided in each system at an appropriate location, as directed by Engineer-in-Charge.

d. Diverting vanes must be provided at the bends exceeding 600 mm and at branches connected into the main duct without a neck.

e. Proper hangers and supports should be provided to hold the duct rigidly, to keep them straight and to avoid vibrations. Additional supports are to be provided where required for rigidity or as directed by Engineer-in-Charge.

f. All duct supports, flanges, hangers and damper boxes etc. Shall be given 2 coats of red oxide paint before installation and one coat of aluminum paint after the erection, at no extra cost.

g. All angle iron flanges are to be welded electrically and holes to be drilled.

h. All the angle iron flanges are to be connected to the GSS ducts by rivets at 100 mm centers.

25. GRILLS / DIFFUSERS

1. **SUPPLY AND RETURN AIR DIFFUSERS**

Supply and return air diffusers shall be made of extruded aluminum section. The diffusers shall be powder coated in finish. Supply air diffusers shall be provided with screw operated opposed blade volume control devices of extruded aluminum in black anodized finish. The diffusers shall be suitable for concealed fixing arrangement and as approved by Engineer-in-charge/HLL. It should be anti smudge type. Colour code od diffuser needs to be approved by E-I-C.

The diffusers shall be provided with removable central core.

All diffusers shall be selected as per selection curves and in consultation with Engineer-in-charge / HLL. All diffusers shall have soft continuous rubber/foam gasket between the periphery of the diffusers and the surface on which it has to be mounted.

a. LINEAR GRILLS:

Linear continuous supply or return air grills shall be extruded aluminum construction with fixed horizontal bars at 15 0 inclination with flanges on both sides. The thickness of fixed bar louvers shall be 5mm in front and the flange shall be 20mm wide with round edges. The grille shall be suitable for concealed fixing and horizontal bars of the grille shall be mechanically crimped from the back to hold them.

Volume control device of extruded aluminum construction in black anodized finish shall be provided in S.A. duct collars.

b. **DOUBLE ADJUSTABLE LOUVERED SUPPLY/ RETURN AIR GRILLS WITH HORIZONTAL /VERTICAL OR VERTICAL/ HORIZONTAL LOUVER ARRANGEMENT:**

The grille shall be adjustable as each louver shall be pivoted to provide pattern with 00 to plus or minus 150 ARC upto 300 deflection down towards. The louvers shall hold deflection settings under all conditions of velocity and pressure. The rear louver of the register shall be in black shade.

Volume control device of extruded aluminum construction with black anodized finish shall be provided in S.A. grills.

c. EXHAUST AIR REGISTER:

Exhaust air register shall be made of extruded aluminum with fixed horizontal louvers at 40 degree angle setting on a 20 mm louvers pitch. The register shall have 20 mm wide flange with round edges all around. The register shall be suitable for front screw fixing.

Volume control device of extruded aluminum construction with black anodized finish shall be provided.

d. MULTI SLOT CEILING DIFFUSERS:

Multi slot ceiling diffuser shall be made of extruded aluminum with various slot width and air pattern deflectors. Deflectors in each slot provide an adjustable air pattern of 180 degree full. A special plenum shall be provided for each supply air diffuser. The linear diffuser shall have alignment strips to give straight look while installation.

Hit & miss type volume control damper of extruded aluminum construction with mill finish shall be with multi-slot supply air diffuser.

e. LINEAR CEILING MOUNTED DIFFUSERS:

Linear ceiling mounted air terminals shall be made of extruded aluminum surface mounted one way or two way pattern. The linear terminal shall have alignment strips to give straight look while installation. Volume control device of extruded aluminum construction in mill finish shall be provided in S.A. diffuser. It should be anti smudge type. Colour code needs to be approved by E-I-C.

f. FRESH AIR INTAKE LOUVERS:

Fresh air intake louvers 50 mm deep (minimum) wherever required as per shop drawing will be made of extruded aluminum construction duly anodized or powder coated. Bird/insect screen will be provided with the intake louvers. The blades are inclined at 450 on a 40 mm blade pitch to minimize water ingress. The lowest blade of the assembly shall extend out slightly to facilitate disposal of rainwater without falling in door/wall on which it is mounted.

Wherever specified, the intake louvers shall be provided with factory fitted all aluminum construction volume control dampers in black anodized finish.

g. LAMINAR FLOW DIFFUSERS

i. INTRODUCTION

Diffusers are available for flush mounting in the ceiling. Suitable angle frames are also provided for the modular panel construction. The units are available in three standard sizes for top entry complete with opposed blade dampers

ii. DESCRIPTION

LFD laminar flow diffusers are constructed from 18 swg Aluminium sheet,perforated face with approx 50% perforation. The perforated front face is openable hinge type complete with key operated dampers from front.

iii. SIZES

Available in standard sizes of 600 x 600 mm, 900 x 600 mm & 1200 x 600 mm or as per requirements.

iv. FEATURES

- Suitable for modular panel assemblies.
- Top entry with opposed blade dampers.
- Pivoting type face plate for damper operation from front.
- Easy maintenance and cleaning

v. FINISHESD STANDARD

a) Epoxy Polyester Powder Coated off white/pure white

b) Natural anodised.

c) Diffuser shall be smudge proof type.

2. MOTORIZED COMBINED SMOKE & FIRE DAMPERS – SPRING RETURN

All supply and return air ducts at AHU room crossings (or ducts as applicable) and at all floor crossings shall be provided with approved make fire and smoke dampers of at least 90 minutes fire rating certified by CBRI ROORKEE as per UL 555:1973

Fire damper blades & outer frame shall be formed of 1.6 mm galvanized sheet steel. The damper blade shall be provided on both ends using chrome-plated spindles in self-lubricated bronze bushes. Stop seals will be provided on top and bottom of the damper housing made of 16 g galvanized sheet steel. For preventing smoke leakage side seals will be provided.

In normal position damper blade shall be held in open position with the help of a 24 V operated electric actuators thereby providing maximum air passage without creating any noise or chatter.

The damper shall be actuated through electric actuator. The actuator shall be energized with the help of a signal from smoke detector installed in AHU room/R.A. duct/damper. The A/C Contractor shall also provide smoke detector. The fire damper shall also close due to Temp. rise in S.A. ducts thru the electric temp. sensor factory set at 165 Deg. F micro switches with bake lite base will be provided to stop fan motor and give open & close signal at remote panel in case of motorized actuator.

Each dampers in case of motorized smoke-cum-fire damper shall have its own panel which will incorporate necessary circuit required to step down voltage available from power supply to shown status of the damper (open or close), to allow remote testing of damper & indication in event of damper closure due to signal from smoke sensor/temp. sensor& reset button. Additional terminal will be provided to have signal (sound beep or visual) in central control room.

Damper actuator shall be spring return so as to close the damper in the event of power failure automatically and open the same in case of power being restored.

Spring return action of the actuator shall be an in-built mechanism and shall not be mounted externally.

The damper shall be installed in accordance with the installation method recommended by the manufacturer.

3. **PAINTING**

All grilles, and diffusers shall be powder coated in color as approved by Engineer-in-charge/HLL before installation.

All ducts immediately behind the grilles/diffusers etc.Are to be given two coats of black paint in Matt finish.

4. **TESTING**

After completion, all duct system shall be tested for air leakage.

The entire air distribution system shall be balanced to supply the air quantity as required in various areas and the final balance of air quantity through each outlet shall be submitted to the engineer-in-charge for approval. Measured air quantities at fan discharge and at various outlets shall be identical to or less than 5% in excess of those specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time.

26. SHEET METAL WORKS –(FACTORY FABRICATED)

1. **GENERAL**

i. The work under this part shall consist of furnishing labour materials, equipment and appliances as specified necessary and required to install all sheet metal and other allied work to make the air conditioning supply, ventilating, and exhaust system ready for operation as per drawings.

ii. Except as otherwise specified all duct work and related items shall be in accordance with these specifications.

iii. Ductwork shall mean all ducts, casings, dampers, access doors, joints, stiffeners and hangers.

2. **DUCT MATERIALS**

i. The ducts shall be fabricated from galvanized steel sheets sheets (with light coating of zinc which shall be lead free) class VIII conforming to ISS:277-1962 (revised) or aluminium sheets conforming to ISS:737-1955 (wherever aluminium ducts are specified).

ii. All duct work, sheet metal thickness and fabrication unless otherwise directed, shall strictly meet requirements, as described in IS:655-1963 with amendment-I (1971 edition)

iii. GOVERNING STANDARDS:- Unless otherwise specified here, the construction, erection, testing and performance of the ducting system shall conform to the SMACNA-1995 standards ("HVAC Duct Construction Standards-Metal and Flexible-Second Edition-1995" SMACNA)

3. **RAW MATERIAL**

i. Ducting

a. All ducting shall be fabricated of LFQ (Lock Forming Quality) grade prime G.I. row material furnished with accompanying Mill test Certificates.

b. Galvanizing shall be of 120gms/sq.m. (total coating on both sides).

c. In addition, if deemed necessary, samples of raw material, selected at random by CLIENT/ HLL's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

d. The G.I. raw material should be used in coil-form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross-section dimensions.

ii. Duct Connectors and Accessories

All transverse duct connectors (flanges/cleats) and accessories/related hardware are such as support system shall be zinc-coated (galvanized)/

4. **FABRICATION STANDARDS**

i. All ductwork including straight sections, tapers, elbows, branches, show pieces, collars, terminal boxes and other transformation pieces to provide the requisite quality of ducts and speed of supply.

ii. Coil lines to ensure location of longitudinal seams at comes/folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any face side of the duct.

iii. All ducts, transformation pieces and fittings to be made on CNC profile cutlers for required accuracy of dimensions, location and dimensions of notches at the folding lines.

iv. All edges to be machine treated using lock formers, flanges and roller for fuming up edges.

v. Sealant dispensing equipment for applying built-in sealant in Pittsburgh lock where sealing of longitudinal joints are specified.

5. **SELECTION OF G.I. GAUGE AND TRANSVERSE CONNECTORS**

Duct Construction shall be in compliance with 1" (250 Pa)w.g. static norms as per SMACNA.

All transverse connectors shall be the Rolamate 4-bolt slip-on flange system or Techno Fabriduct imported makes of similar 4-bolt systems with built-in sealant if any to avoid any leakage additional sealant to be used.

The specific class of transverse connector and duct gauge for a given duct dimensions will be 1"(250 Pa) pressure class.

Non-toxic, AC-applications grade P.E. or PVC Casketing is required between all mating flanged joints. Gasket sizes should conform to flange manufacturer's specification.

6. **DUCT CONSTRUCTION**

The fabricated duct dimensions should be as per approved drawings and all connecting sections are dimensionally matched to avoid any gaps.

7. **DIMENSIONAL TOLERANCES:**

a. All fabricated dimensions will be within +/- 1.0 mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerances shall be +/- 1.0 mm per meter.

b. Each and every duct pieces should be identified by color coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge.

c. Ducts shall be straight and smooth on the inside Longitudinal seams shall be airtight and at comers only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness.

d. Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the tum without appreciable turbulence.

e. Plenums shall be shop/factory fabricated panel type and assembled at site.

f. Factory Fabricated ducts shall have the thickness of the sheet shall be as follows.

S. No.	Size of Duct	Sheet Thickness	Fastner Size	Type of Joints		Bracing with GI tie rods of following sizes	Support Angle
1	Upto 750 mm	0.63 mm	3/8"	Fabricated out of G.I. sheet of 24 gauge at every 1.2 m internal.	The flanges shall be made out of the same duct sheet and all the four corner shall be fitted for fitting the bolt	Cross tie rods to be fitted of suitable dia GI rod for each piece of duct	25x25x3 mm
2	751 mm to 1000 mm	0.80 mm	3/8"	E-24 type flange, shall be fabricated out of 24 G sheet at every 1.2 m internal.			25x25x3 mm
3	1001 mm to 1500 mm	0.80 mm	5/8"	E-22 type flange shall be fabricated out of 22 G sheet at every 1.2 m internal.	The flanges shall be made out of the same duct sheet and all the four corner shall be fitted for fitting the bolt	Cross tie rods to be fitted of suitable dia GI rod for each piece of duct	40x40x5 mm
4	1501 mm to 2250 mm	1.00 mm	5/8"	J-16 type flange, shall be fabricated out of 16G sheet at every 1.2 m internal.			40x40x6 mm angle
5	2251 mm and above	1.25 mm	5/8"	J-16 type flange, shall be fabricated out of 16G sheet at every 1.2 m internal.			50x50x6 mm with MS rods of 12 mm dia.

g. The gauges, joints and bracings for sheet metal duct work shall further conform to the provisions as shown on the drawings.

h. Ducts larger than 600 MM shall be cross broken, duct sections upto 1200 MM length may be used with bracing angles omitted.

i. Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer-In-Charge.

j. All ducts shall be supported from the ceiling/slab by means of M.S. Rods of 10 MM (3/8") DIA with M.S. Angle at the bottom. The rods shall be anchored to R.C. Slab using metallic expansion fasteners.

8. **INSTALLATIONS**

i. During the construction, the contractor shall temporarily close duct openings with sheet metal covers to prevent debris entering ducts and to maintain opening straight and square, as per direction of Engineer-In-Charge.

ii. Great care shall be taken to ensure that the duct work does not extend outside and beyond height limits as noted on the drawings.

iii. All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending or fabrication of ducts. All joints shall be air tight and shall be made in the direction of air flow.

iv. The ducts shall be re-inforced with structured members where necessary, and must be secured in place so as to avoid vibration of the duct on its support.

v. All air turns of 45 degrees or more shall include curved metal blades or vanes arranged so as to permit the air to make the abrupt turns without an appreciable turbulence. Turning vanes shall be securely fastened to prevent noise or vibration.

The duct work shall be varied in shape and position to fit actual conditions at building site. All changes shall be subjected to the approval of the Engineer-In-Charge.

vi. Sponge rubber or approved equal gaskets of 6 MM maximum thickness shall be installed between duct flanges as well as between all connections of sheet metal ducts to walls, floor columns, heater casings and filter casings. Sheet metal connections shall be made to walls and floors by means of wooden member anchored to the building structure with anchor bolts and with the sheet screwed to them.

vii. Flanges bracings and supports are to be Rolamate or Techno Fabriduct. Accessories such as damper blades and access panels are to be of materials of appropriate thickness and the finish similar to the adjacent ducting, as specified.

viii. Joints, seams, sleeves, splitters, branches, takeoffs and supports are to be as per duct details as specified, or as decided by Engineer-In-Charge.

ix. Joints requiring bolting or riveting may be fixed by Hexagon nuts and bolts, stove bolts or buck bolts, rivets or closed centre top rivets or spot welding. Self tapping screws must not be used. All jointing material must have a finish such as cadmium plating or Galvanized as appropriate.

x. Fire retarding flexible joints are to be fitted to the suction and delivery of all fans. The material is to be normally double heavy canvass or as directed by Engineer-In-Charge. On all circular spigots the flexible materials are to be screwed or clip band with adjustable screws or toggle fitting. For rectangular ducts the material is to be flanged and bolted with a backing flat or bolted to mating flange with backing flat.

xi. The flexible joints are to be not less than 75 MM and not more than 250 MM between faces.

xii. The duct work should be carried out in a manner and at such time as not to hinder or delay the work of the other agencies especially the boxing or false ceiling contractors.

xiii. Duct passing through brick or masonary, wooden frame work shall be provided within the opening. Crossing duct shall have heavy flanges, collars on each side of wooden frame to make the duct leak proof.

9. **DOCUMENTATION FOR CHECKS**

For each drawing, all supply of ductwork must be accompanied by computer-generated detailed Quantity indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct areas by gauge and duct size range as applicable.

Check sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.

All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the Check sheet. The above system will ensure speedy and proper site verification and approvals.

10. **TESTING**

After duct installation, a part of duct section (approximately 5% of total ductwork) may be selected at random and tested for leakage. The procedure for leak testing should be followed as per SMACNA- "HVAC Air Duct Leakage Test Manual: (First Edition).

A. DUCTS

SCOPE

The scope of this section comprises the supply and application of insulation conforming to these Specifications.

Insulation material shall be non toxic , chemically inert , non combustible, non ignitable, shall have zero ozone depletion potential, zero calorific value no heat evolution and shall be inherently proof against rotting , mould and fungal growth and attack by vermin.

The materials shall comply with following standards.

BS 476: Part 4 – Non Combustible

BS 476: Part 5 – Not easily Ignitable (Class P)

BS 476: Part 6 – Fire propagation Index (I<12)

BS 476: Part 7 - Surface spread of flame (Class 1)

The material should comply to Class'O' fire rating as per BS 476 part 6&7.

The product shall be able to work effectively at ambient temperature range of -100°C to 150 °C

B. AHU / DUCT ACOUSTIC LINING (Insulation Thickness & Density as per requirements)

Insulation material for Duct Acoustic Lining shall be open cell antimicrobial nitrile rubber with self adhesive. The thermal conductivity of the material for air-conditioning application shall not exceed 0.047 W/m.K at 20 deg C. Thickness of the material shall be as specified for individual application as per requirements.

Ducts so identified and marked on drawings and included in DBR shall be provided with acoustic lining of thermal insulation material for a distance of minimum 5 meters as follows:

The inside surface for the ducts shall be covered with nitrile rubber with self adhesive, and provided with 22 gauge GI Channels 25 x 25 mm screwed back to back and fixed on the inside of duct, spaced not more than 60 cm center to form a frame work of 60 x 60 cms square. Cut panels 60 x 60 cms of resin bonded fiber glass shall be fitted in the squares.

C. PIPING / DUCT /EQUIPMENT INSULATION:

All pipe/duct insulation shall be as specified in DBR meeting functional requirements.

Insulation will be XLPE/EPS/Nitrile Rubber/Glass Wool as per requirements & as specified in DBR.

D. MATERIAL

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber.
- Density of Material shall be between 50+/-10% Kg/m^3
- Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.035 W/mP^{0P}K at an average temperature of 0P^{0P}C.
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.
- Water vapour permeability shall not exceed 0.017 Perm inch (2.48 x 10-14 Kg/m.s.Pa), i.e. Moisture Diffusion Resistance Factor or 'μ' value should be minimum 7000.
- Complete pipe insulation shall have 200 g/m^2 factory laminated, treated woven Glass Cloth coating for mechanical and UV protection.
- Thickness of the insulation shall be as specified for the individual application.
- An air gap of 25 mm shall be present between adjacent insulation surfaces carrying chilled water or refrigerant. Before applying insulation, all pipes shall be brushed and cleaned. All Pipe surfaces shall be free from dirt, dust, mortar, grease, oil, etc. Nitrile Rubber insulation shall be applied as follows:
- Insulating material in tube form shall be sleeved on the pipes.
- On existing piping, pre slit, self adhesive tube with factory laminated woven glass cloth coating shall be placed. Remove the release paper and make a seam joint. Cover the joint with integral glass cloth flap. Butt joints shall be sealed with adhesive and shall be covered with same glass cloth (slit opened tube of the insulating material (slit with a very sharp knife in a straight line) shall be placed over the pipe and) adhesive shall be applied as suggested by the manufacturer.
- Adhesive must be allowed to tack dry and then press surface firmly together starting from butt ends and working towards centre.
- Wherever flat sheets shall be used, Factory cut sheets shall be used (it shall be cut out in correct dimension.) All longitudinal and transverse joints shall be sealed as per manufacturer recommendations.
- The insulation shall be continuous over the entire run of piping, fittings and valves.
- All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.
- The detailed application specifications are as mentioned separately. The manufacturer's trained installer should only be used for installation.

E. RECOMMENDED ADHESIVE

In all cases, the manufacturer's recommended Adhesive (SR-998) should be used for the specified purpose.

F. PUMP INSULATION

Chilled water pump shall be insulated to the same thickness as the pipe to which they are connected and application shall be same as above. Care shall be taken to apply insulation in a manner as to allow the dismantling of pumps without damaging the insulation.

G. SHELL INSULATION

The chiller shells shall be factory insulated in accordance with the manufacturer's standards.

H. COLD WATER & EXPANSION TANK INSULATION

Cold water tank, and chilled water expansion tank shall be insulated as per manufacturer's standard.

I. PARAMETERS FOR SELECTION OF THICKNESS

a) Design Basis: Condensation Control

b) Region: Costal Area

c) Application: Outdoor & Indoor

d) Design Conditions: 30 Deg. C & 82 % RH

i) Thickness of Insulation

e) Chilled Water Pipe Line Temperature 7.0 Deg. C

Indoor Application (Conditioned / Semi Conditioned Space)

Up To 50 mm Pipe Size	- 25 mm Thick Insulation
Above 50 mm & Up To 150 mm Pipe Size	- 32 mm Thick Insulation
Above 150 mm Pipe Size	- 38 mm Thick Insulation
Chilled Water Tank	- 32 mm Thick Insulation

Outdoor Application / Non Conditioned Space

Up To 50 mm Pipe Size	- 32 mm Thick Insulation
Above 50 mm & Up To 150 mm Pipe Size	- 38 mm Thick Insulation
Above 150 mm & Up To 600 mm Pipe Size	- 44 mm Thick Insulation
Chilled Water Tank	- 44 mm Thick Insulation

ii) Drain Water Pipe Line Temperature 15.0 Deg. C

Up To 50 mm Pipe Size	- 19 mm Thick Insulation

iii) Refrigerant Pipe Line Temperature 3.0 Deg. C

Up To 50 mm Pipe Size	- 25 mm Thick Insulation
Above 50 mm & Up To 100 mm Pipe Size	- 32 mm Thick Insulation

J. PRE-INSULATED DUCT WORK :- PRE-INSULATED ALUMINIUM POLYISOCYANURATE /POLY URETHANE FOAM DUCTWORK

The following preferred ductwork system to be installed:

Pre-insulated aluminium ductwork made of Poly isocyanurate sandwich panels, comprising an expanded Poly isocyanurate rigid foam board faced on both sides by aluminium foil.

Physical characteristics of the panels shall be as follows:

Thickness of Panels	**Air Conditioned Areas**		**Plant Rooms**		**Exposed To Weather**	
	20mm		**30mm**		**30mm**	
Thickness of aluminium	80/80	Microns	80/200	Microns	80/200	Microns
Density of the foam	45	Kg/m3	48	Kg/m3	48	Kg/m3
Finishing of aluminium	Embossed	Embossed	Embossed	Embossed	Embossed	Embossed

Both sides of the aluminium foils shall be lacquered with a 3g/m2 weatherproof and ultraviolet rays protection polyester lacquer.

All the panels shall have to be embossed with the name of the manufacturer and production date.

Thermal insulation characteristics shall be as follows:

Insulating material: Close cell rigid expanded polyurethane foam, CFC free, density 45 to 48 Kg/m3, material physiologically and chemically inert and insoluble, vermin proof,fungus proof, non metabolisable.

Thermal conductivity: 0.022 W/mK or better.

Water absorption shall be less than 0.5% by 24 hours immersion test.

Water vapour diffusion: M= infinity resistance.

The aluminium foil covering the panel to be maintained intact after installation to ensure vapour barrier continuity.

Proposed material should have minimum 5 years installation reference in the region.

The panel manufacturer should be of European/Foreign origin.

All the panels to be used should be labelled by authorised international fire laboratories.

The panel manufacturer shall comply with Fire Mideast Product Listing (MPL) and Factory Production Control Certificate (FPC), by authorised international laboratories.

The panel shall be tested and comply with the following standards:

a. NFPA 101 Life Safety Code Class 'A'
b. ASTM E84 Class "1"
c. NFPA 255
d. UL 723
e. Toxicity Index shall not exceed 5.7 according to NES 713
f. Class 'O' according to BS 476 Part 6 & 7

Temperature Range:

No relevant reduction of insulation, chemical or physical characteristics of the panels to be measurable, when conveying air in the temperature range of –35oC to +110oC.

Installation shall be supervised & certified by the manufacturer's representative.

5-years warranty shall be offered for the insulation material characteristics.

Joint System:

The joints between the ducts shall be using tiger connectors or male – female connection system for small sizes up to 500mm and for bigger sizes more than 500mm aluminium /polymer invisible flanges and slide-in-channel to be used and to be connected by special cover corners, having a holding pin, which goes inside the flange and the insulation, to avoid any field connection and to give the system more strength.

Ductwork shall be installed, using supports, as described in DW144 & according to manufacturer's requirements. Maximum distance between supports shall not exceed:

- 4000mm for ducts with section not exceeding 1200 x 1000mm
- 2000mm for ducts with section exceeding 1200 x 1000mm.

EPS Insulation:- Expanded poltstyrene (TF) quality shall be used as speified in DBR & meeting functional requirements. Minimum density shall be 20 kg/cum & maxm. Thermal conductivity shall be 0.035 K cal/hr degree C / m at 10 Degree C mean temperature. It shall eb in compliance with latest ECBC & GRIHA norms. For pipe size below 150 mm dia., insulation thickness will be 50 mm & above 150 mm dia. piep, it will be 75mm.

Application of Insulation on Pipe (including suction pipe insulation):-

(i) The surface to be insulated shall be first cleaned & a coat of zinc chromate primer shall be given. The insulation shall eb fixed tightly to the surface cold setting adhesive, CPRX compound. All joints shall be staggered & sealed. The second layer of insulation wherever required shall be similarly applied over first layer.

(ii) Pipes shall be preferably pre insulated at factory, meeting the requirement or the insulation shall eb finished at site as under:

(a) For pipe laid outside the building, above ground, the finishing over the pipe insulation shall be finished with 0.63 mm GS sheet cladding over vapour barrier of 120 gm/sqm polythene sheet with 50 mm overlap & tied down with lacing wire & complete with type 3 grade I roofing feltstrip applied by means of cold setting CPRX compound.

(b) For pipes outside the building alid underground, the insulation shall be covered with 500 gauge polythene faced hessian (polythene facing outwards), with 50 mm overlap. All joints shall be sealed with bitumen. A layer of 0.50 mm x 20 mm G.I wiremesh netting shall be provided over it butting all joints & it shall be laced down with GI wire, sand cement plaster (1:4) 20 mm thick shall be provided in 2 layers of each 10 mm & shall be waterproofed by applying hot bitumen & fixing tarfelt over the plaster. It shall be finally finsied with a coat of hot bitumen. In case of factory peinsulated pipe, buried underground, a water leakage sensing wire shall also be provided to detect the location of water leakage at later date.

(c) In case of factory pre insulated pipe, all joints shall be properly insulated at site as per recommendation of manufacture.

(iii) All valves, fittings, stariers etc. shall eb insulated to the same thickness and in the same manner as for the respective piping, taking care to allow operation of valves without damaging the insulation.

27. DUCT ACOUSTIC LINING

1. Open Cell Nitrile Rubber

Duct acoustic lining material shall be Nitrile Rubber open cell foam. Thermal conductivity of the insulation material shall not exceed 0.047 W/m°K at an average temperature of 20°C. Density of the nitrile rubber shall be 140 – 180 Kg/m^3. The material should withstand maximum surface temperature of +85°C and minimum surface temperature of -20°C. The material should conform to Class 1 rating for surface spread of Flame in accordance to BS 476 Part 7 & HBF, HF 1 & HF 2 in accordance to UL 94, 1996.

Insulation should have antimicrobial product protection, and should pass Fungi Resistance as per ASTM G 21 and Bacterial Resistance as per ASTM E 2180. The insulation should pass Air Erosion Resistance Test in accordance to ASTM Standard C 1071-05 (section 12.7).

Thickness of the material shall be 15 mm thick specified for the individual application and with noise absorption proprieties as per IS: 8225 / ISO 354 / ASTM423C. The insulation should be installed as per manufacturer's recommendation.

2. Checks for Insulation

Unless otherwise specified checks for duct and pipe insulation for the project shall be on the basis of center line measurements described herewith

a. Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers are not separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

b. Duct Insulation and Acoustic Lining shall be measured on the basis of surface area along the centre line of insulation thickness. Thus the surface area of externally thermally insulated or acoustically lined be based on the perimeter comprising centre line (of thickness of insulation) width and depth of the cross section of insulated or lined duct, multiplied by the centre-line length including tapered pieces, bends, tees, branches, etc. as measured for bare ducting.

3. Duct Insulation Material

Thermal insulation material for Duct insulation shall be with factory laminated black fiber glass cloth closed cell Elastomeric UV resistant or Plain polyethylene material. Thermal conductivity as per BS 874 part 2 – 86 (DIN 52613 52612) / DIN EN 12667 / EN ISO8497 of the insulation material shall not exceed 0.038 W/moK or 0.212 BTU / (Hr-ft2-oF/inch) at an average temperature of 30oC. Density of the nitrile rubber shall be 40-60 Kg/m3 & for polyethylene material it shall be 25-30 Kg/m3 and shall be plain material. The product shall have temperature range of –40 oC to 105oC.

The insulation material shall be fire rated for Class 0 as per BS 476 Part 6 : 1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapour permeability shall be not less than 0.024 per inch (2.48 x 10-13 Kg/m.s.Pa i.e. μ>7000: Water vapour diffusion resistance) as per DIN 53122 part 2, DIN 52615 / EN 12086 & EN13469.

In addition to above properties the insulation material for ducts shall be anti-microbial. Microbiological growth on insulation surface shall be in accordance with ASTM G-21 and bacterial resistance to ASTM2180.

The Material shall comply to ISO 5659 / BS 6853 / ABD 0031 for smoke density and toxicity values. The thermal conductivity of insulation material shall not be effected by aging as per DIN 52616 standard.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for density and thickness. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested for thermal conductivity and density at Contractor's cost. Adhesive used for sealing the insulation shall be non-flammable and with low VOC content (maximum 850 gm/l as per IGBC guide lines) strictly as per manufacturer's recommendations.

DUCTING INSULATION THICKNESS SHALL BE AS PER TABLE BELOW.

Ducting position	Thk. for non-coastal places
SA duct in RA path	13 mm
Ducted return air system	SA duct: 19 mm RA duct: 13 mm
Both SA & RA exposed	Both 25 mm

4. DUCT INSULATION

External thermal insulation shall be provided as follows :

The thickness of insulation material shall be as per DBR/ drawings. Following procedure shall be adhered to:

- Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work.
- Material shall be fitted under compression and no stretching of material shall be permitted. All longitudinal and transverse joints shall be sealed by providing 50 mm wide Fibre glass cloth laminated tape as per manufacturer recommendations. The insulation installers shall be certified by manufacture.
- Where ducts/pipes penetrates walls / floor it shall be insulated with intumescent properties insulation material for fire protection. The treatment shall be minimum 500 mm extended on both sides.

QUALITY CHECKS ON DUCTING

Sl. No.	DESCRIPTION	YES - OK NO - X	REMARKS
1	Whether material adheres to Fabrication Standards as specified (Look form Quality Sheets)		
2	Valid for construction Drawings. at site.		
3	Cross breaking, bracings / reinforcements are as per standard.		
4	Air tightness of transverse / Longitudinal Joints ensured.		
5	Grease and heat resistant sealant for kitchen exhaust duct.		
6	Neoprene gaskets for pharmaceutical and clean room projects used		
7	Check following aspects of duct supporting system		

Sl. No.	DESCRIPTION	YES - OK NO - X	REMARKS
7.1	Hanger spacing		
7.2	Anchor bolts size and quality		
7.3	Primer painting of supports		
7.4	Check allowable load on trapeze angle for bigger ducts		
8	Check whether contractor has provided		
8.1	Vanes in elbows		
8.2	Clinched collar at take Offs		
8.3	Splitters		
9	Check transitions & offsets slopes & fabrication.		
10	Whether the installed ducting is as per layout approved, check locations, headroom etc.		
11	Whether grilles / diffusers are as per approved shade.		
12	Check the method of installation for Grilles / Diffusers		
13	Repair / paint damaged surfaces.		
14	Check the coordination of following activities as per the given sequence:-		
14.1	Main Ducts Cut for taking collars		
14.2	Match / Fabricate collar taking false ceiling framework for diffuser into account		
14.3	Fix grilles / diffuser framework in false ceiling		
14.4	Install the collar		
14.5	Install diffuser		
15	All elbows / turning points and branches to be properly supported		
16	Access door is provided at serviceable position for fan and fire damper		
17	Air balancing for room is studied		
18	Air replacement is considered for air exhausted from room.		
19	PVC or stainless steel material is used for corrosive fume exhaust system.		
20	Anti vermin netting installed for louvers removable and serviceable.		
21	Water or gas vent outlet is not installed near air intake louver.		
22	Kitchen exhaust is not short circuited to outdoor air intake louver.		

Sl. No.	DESCRIPTION	YES - OK NO - X	REMARKS
23	Kitchen room pressure is slightly below the surrounding area.		
24	Sound level of fan is studied.		
25	Face velocity for louvers / grills / diffusers is studied.		
26	Air distribution of the room is studied.		
27	Cross break all flat surfaces to prevent vibrations or buckling due to air flow.		
28	Sides of ducts having collar for grills should not be cross broken to facilitate alignment of grills.		
29	All bends and collars should have vanes.		
30	If duct passes through fire chamber increase sheet thickness.		
31	Kitchen exhaust ducts to be tapered at bottom for oil / grease collection.		
32	Avoid flanged joints in kitchen exhaust duct above false ceiling.		
33	When aluminum ducts are used with steel angles, steel to be painted with Zinc chromate paint		
34	Provide check nuts with duct hangers		
35	Ducts below 250 mm should not be more than 1 m long to facilitate proper joining.		
36	Plenums should have flanged and bolted ends for rigidity and easy maintenance.		
37	Avoid 'U' bends in ducts		
38	Provide long radius bends and offsets.		
39	No collars to be taken from top.		
40	Install duct spool pieces near equipment for easy removal.		

28. PIPING AND FITTINGS

1. SCOPE

The scope of this section comprises the supply and laying of pipes required for chilled water; condenser water & drain water conforming to these specifications and in accordance with the functional requirement and DBR.

2. WATER PIPING

i. MATERIAL

Water piping fittings and valves shall be of the following makes or approved equal make and shall conform to IS standards as indicated below.

a. Pipes

- UPTO 150 mm :- MS, Class C (Heavy Class) as per IS 1239 (Part I & II) 1990/1992
- 200 mm & ABOVE:- Welded Black Steel Pipe Class 2 (6.35 mm Thickness) As per IS 3589 (LATEST)

All welding shall be done by qualified welders and shall strictly conform to Standard Code of practice for manual metal arc, welding of Mild Steel.

First butt weld of each welder shall be fully radio graphed by HVAC contractor under guidance of HLL for testing purposes. Upon approval of welding joints the concerned welder shall be allowed to carry further welding of pipes. Rest of the welds shall have 100% visual inspection.

All welded joints (except pipe welded end-to-end) shall be made by use of forged one-piece welding flanges, caps, nozzles, elbows, branch outlets and tees of approved make. Cut samples shall be submitted for approval, if directed. All such fittings etc., shall be of a type which maintain full wall-thickness at all points, simple radius and fillets, and proper bevels or shoulders at ends. All jobs welding shall be done by the electric arc welding process in accordance with the following: -

All joints shall have 45-degree bevel type, pipe mill-beveled or machine-beveled by the contractor.

All scale and oxides shall be removed with hammer, chisel or file and bevel left smooth and clean.

Pipe lengths shall line up straight with abutting pipe ends concentric.

Both conductors from the welding machine shall be extended to locations at which welding work is being done. The leads from welding machine to location of welding work shall be held together with tape or other approved means as to prevent induced

current in structural steel, in piping or in other metals within the building. The ground lead shall be connected to length of pipe through joints in pipe, structural steel of building or steel pipe supports.

b. GATE & GLOBE VALVES

Make: As approved shall be heavy duty non rising spindles as per IS 780, 778 and flanges as per IS 1536 and factory tested for 10 Kg/ sq cm test pressure

S.No	Size	Construction	Ends
A	15 TO 40 MM	Gun metal body	Screwed
B	50 MM and above	Cast Iron Body & spindle valve, seat wedge etc., of Brass or Gun Metal	Flanged

c. BALANCING VALVES

The balancing valves control and shut off valves with built in pressure drop and flow measuring facility shall be provided in the water outlet pipes of condensers and chillers, AHUs or wherever shown in tender drawings.

i. **15-50 mm Size:** Gunmetal ASTM B-6 2 Screwed ends conforming to BS 5154

ii. **65mm and above:** Cast iron, flanged ends with stainless steel trim.

The valves shall have PTFE/SS disc with special erosion/corrosion proof sealing. The valves shall have temper proof adjustable and lockage arrangement for required water quantity after commissioning. The valves shall be complete with pressure test cock and drain cocks.

To enable accurate and practical operation, measurement of flow and differential pressure shall be made with a computerized balancing instrument which shall enable the operator to read the flow directly without the use of diagrams or tables. In addition to measuring flow rate, differential pressure and temperature, computerized balancing instrument shall have a computer programs to provide the following functions:-

To balance the HVAC installation and calculate the necessary valve settings, based on system measurements.

To store the results of balancing.

To log measured values from a valve (differential pressure, flow rate or temperature)

To printout saved data in computerized measurement protocol (CMP) consisting of:-

- Name and size of Balancing Valve (BV)
- Presetting position of BV
- AP at BV
- Flow at BV
- Design Flow

Flanges shall be of approved make. The supply of flanges shall form part of piping (not separately identified in DBR) and shall also include supply of bolts, washers, nuts and suitable rubber insertion gaskets (minimum 3 mm thick).

d. BUTTERFLY VALVES

Butterfly valves of various dia. as per requirements shall be of wafer type, conforming to PN-16 rating with SS disc. It shall be lever operated. The rubber lining shall be integrally moulded with EPDM/Nitrile rubber. The O-ring sall be made of nitrile rubber. The lever shall be made preferably of carbon steel.

The test pressure of Shell- 24 Bar, Seat:17.6 bar & maximum working pressure-16 bar,maximum working temperature :90 degree celcius. In case of any discrepencies between manufacturer's standards & above specified values, these parameters shall be in compliance with relevant IS codes.

e. BALL VALVES

The ball valve of various dia. shall be of forged brass construction & shall have screwed female ends. It shall be lever operated with quarter turn & shall be provided with forged brass hard chrome plated ball. It shall be complete with premium quality PTFE gland packing & seating. The ball valve shall be with chrome finish wherever required. Test Pressure (Hydrostatic): Shell: 25 kg, Seat:16 kg/sqcm, maximum operating temperature- 220 degree C. In case of any discrepencies between manufacturer's standards & above specified values, these parameters shall be in compliance with relevant IS codes.

f. SLUICE VALVES

Sluice valve shall be of CI construction. The seat shall be of bronze. Hand Wheel shall be of cast iron. It should be of min. PN-16 rating.

g. NON RETURN VALVES

Non-return valves/ Dual plate check valve of various dia. as per requirements shall be of cast iron body. It should have Nitrile Rubber/EPDM Seal & Disc of stainless steel. They shall be swing check type/wafer type in horizontal runs and lift check type in vertical runs of piping. It should be of min. PN-16 rating. Test Pressure (Hydrostatic) :Shell: 24.50 kg, Seat:16 kg/sqcm, maximum operating temperature- 80 degree C. In case of any discrepencies between manufacturer's

standards & above specified values, these parameters shall be in compliance with relevant IS codes.

h. STRAINERS

Strainers shall be 'Y' type or Pot type Strainers as shown on drawings and as per requirements. 'Y' Strainer shall be fabricated out of MS 'C' class pipe two sizes higher than that of Strainer pipe size. Flanges as per B.S. 10 shall be provided at inlet and outlet connectors. The body shall be pressure tested at 10 kg/cm2 and shall be hot dip galvanized. Permanent magnet shall be provided in the body of the Strainer to arrest MS particles. Filter element shall be of non-magnetic 20 gauge SS sheet with 3 mm perforation. Strainers shall be provided at in let of each Air Handling Unit and Pump as shown in drawings and as per requirements.

Pot Strainers body shall be fabricated out of MS plate IS 226. Thickness of sheet shall be as per size of the strainer chamfered pipes with flanges shall be provided at inlet / outlet connections of the strainer. The tangential entry of water shall create a centrifugal action and due to velocity shall separate sediments and deposit on the inner surface of Filter Element and at bottom of the Strainer. Butterfly valves shall be provided at inlet/outlet connections as shown in drawing and as per requirements. The strainer body shall have two separate chambers properly sealed to avoid mixing of filtered and unfiltered water. A powerful magnet shall be provided in the body to arrest MS particles. Filter element of Pot Strainer shall be of non-magnetic 18 gauge SS sheet properly reinforced to avoid damage of the element. A cone with sufficiently to flush out foreign particles. This arrangement shall avoid frequent opening of Pot Strainer for cleaning of filter element. Gage connection shall be provided at inlet and outlet connection. A set of MS flanges with tongue and groove arrangement and neoprene rubber gasket shall be provided on the top cover and Pot Strainer flange with sufficient bolts and nuts to make the joint watertight. Bearing loaded top cover lifting and swinging arrangement shall be provided. The Pot strainer body shall be properly de-rusted and epoxy coated from inside and outside. Manufacturers Test Certificate shall be provided with each Pot Strainer.

Size of various Pot Strainer, Filter Element and Thickness of MS sheet shall be as detailed below:-

Size (mm)	Pot Dia. (mm)	Pot HT (mm)	Element Dia. (mm)	Element HT (mm)	MS Plate Thickness (mm)
50	300	400	200	240	6
80	350	450	250	250	6
100	450	500	300	280	6
125	500	600	330	340	8
150	540	700	360	390	8
200	610	815	400	470	8
250	800	955	550	510	8
300	1000	1105	750	580	8
350	1190	1300	895	678	12
400	1350	1500	1020	785	12
450	1518	1700	1060	890	12
500	1690	1800	1100	900	12
600	2000	2200	1500	1160	12

The Y-Strainer & Pot Strainer confirming to SSPL 107 & SSPL 106 shall have cast iron body and factory tested at works at 16 Kg/sq.cm pressure. The screen shall be made out of 3 mm perforated stainless steel sheet. It should be easily removable when required to be cleaned. Isolating butterfly valves at either end of the pot strainer shall be provided.

Each pot strainer shall be provided with a Test Certificate.

All chilled water piping and fittings shall be pressure tested, painted and then insulated as described under the section "Insulation".

i. AUTO AIR VENT VALVES

Air vent valves shall be provided at all higher points in piping system for venting and of following sizes:-

Up to 100 mm dia pipes : 25 mm dia.

Air vent valves shall be Gun metal and tested up to pressure of Class I pressure rating.

j. FITTINGS

The dimensions of the fittings shall conform to IS 1239/69 Part II (as per latest amendment) unless otherwise specified in specification.

All bends in sizes up to and including 150 mm dia shall be readymade of heavy-duty, wrought steel of appropriate class.

All fittings such as branches, reducers etc in all sizes shall be fabricated from pipes of same dia and thickness and length at least twice the dia of pipe.

The branches may be welded straight to main line.

Blank ends are to be formed with flanged joints and 1 mm thick blank insertion of rubber gasket between flange pair for 150 mm and over in case where a future extension is to be made otherwise blank end discs of 6 mm thickness are to be welded on with additional cross stiffeners.

The tender drawings show schematically the size and location of pipes but this is for contractor's guidance only. Pipe runs may be changed to meet the site conditions.

3. **PIPING INSTALLATION**

a. All piping work shall be carried out in workman like manner causing minimum disturbance to the existing services.

b. Piping shall be of steel, primer coated with rust preventive paint and finished with approved shade. Pipe supports shall not exceed the following spacing: -

MAXIMUM SPACING OF PIPE SUPPORTS

Pipe Size (MM)	Spacing (Mtr)	Rod Size
25	2	10 mm
30 to 75	2.5	10 mm
100 and above	3.0	12.5 mm

Pipe hangers shall be fixed on walls and ceiling by means of metallic Raw bolts or approved shear fasteners.

c. Piping shall be properly supported on, or suspended from, stands, clamps, and hangers as specified and as required. The contractor shall adequately design all the brackets, saddle, anchors, clamps and hangers and be responsible for their structural sufficiency.

d. Vertical risers shall be parallel to walls and columns. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 10 mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be

provided to prevent water leakage. Risers shall also have a duck foot elbow or steel support welded to the pipe at the lowest point. On risers drain valves shall be provided at heels.

e. Pipe sleeve of 50 mm larger than the pipe diameter shall be provided wherever pipes pass through walls and the annular space filled with felt and finished with retaining rings. In case of an insulated pipe the diameter shall be inclusive of insulation.

f. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. Metal sheet shall be provided between the insulation and clamp, saddle or roller extending at least 150 mm on both sides of clamp, saddle or roller.

i. PRESSURE GAUGES AND THERMOMETERS

a. Pressure gauge (Bourdon Type) shall be of suitable range with SS 304/316 Construction, case of 150/100mm diameter. The gauges shall have brass cocks. The accuracy range of pressure guage shall be in the range of +- 0.5 % to 1%. It shall conform to IP 67 protection. The dial shall be Aluminium white background with black letters. The windows shall be made of plain & toughend glass. The suitability of pressure gauge shall be in the temperature range of (-) 20 degree Celcius to 60 degree celcius. The gear mechanism shall be of SS 304 & the connection material shall be of SS-316 L. Pointer shall be of black aluminium. It shall be complete with all accessories such as siphon, gauge cock, snubber & needle valve etc. Pressure range shall be between 0 to 20 Kg/sqcm.

b. Thermometer shall be stem type and shall be provided at inlet and outlet of each cooling coil.

4. **TESTING**

a. All water piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure but not less than 10 kg/sq cm for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the HLL.

b. Pipes repaired subsequent to above pressure shall be retested in same manner.

c. Piping may be tested in section and such sections shall be securely capped.

d. The Contractor shall ensure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipments in the system concerned. If proper circulation is not achieved due to air bound connections, the 'Contractor' shall rectify the defective connections. He shall bear all the expenses for carrying out above rectifications involving tearing up and refinishing of floor walls etc as required.

e. The Contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Engineer in-charge at site.

f. The contractor shall provide temporary pipe connections to initially by-pass condenser/chiller and circulate water through condenser / chilled water pipe lines for minimum 8 hours. Water should be drained out from the lowest point. The temporary lines shall be removed and blanked with dead flanges. Pot strainers and Y strainers shall be cleaned and fresh water filled in the circuits.

g. After the piping has been installed, tested and run for at least three days of eight hours each, all un-insulated exposed piping in plant room shall be given two finish coats, 3 mills each of approved colour, conforming to relevant BIS Codes. The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows. For painting of insulated and clad pipes refer to insulation section.

h. After testing, all systems shall be chemically cleaned. After cleaning, the pipe work should be rinsed multiples times until the system is neutral. The contractor shall make a report conforming the above to Engineer in charge for records.

i. The Contractor shall provide all materials tools equipments, services and labour required to perform the test and to remove water resulting from cleaning and testing.

5. **BALANCING**

a. After completion of the installation, all water systems shall be adjusted and balanced to deliver water quantities as specified.

b. Instruments required for the water balancing (computerized balancing instrument) shall be accurately calibrated in an approved manner before taking any measurements. Calibrated orifices and portable flow meters shall be used to balance the water flow. Orifices used for testing and balancing shall be installed with straight length up stream and down stream as recommended by the manufactures and shall be left permanently installed in the system.

c. Automatic control valve and three way valves shall be set for full flow conditions during balance by procedure. Water circuit shall be adjustable by balancing cocks provided for balancing. These shall be permanently marked after balancing is completed so that they can be restored to their correct positions of disturbed.

6. **PAINTING**

In case of pipes to be insulated after thorough anti grease and rust removal treatment, clean the pipe and then apply two coats of epoxy primer before applying in insulation treatment as specified elsewhere. All uninsulated pipes after de rusting will be provided with two coats of epoxy primer followed by epoxy paint of approved shade.

7. **FIRE BREAKS INSULATION**

Firebreaks shall be provided in all ducts for internal lining/external thermal insulation after a run of 10 m center to center. There shall be a discontinuity of the insulating material in the form of MS angle of a minimum of 50 mm x 50 mm x 3 mm size. At the interface of the MS angle and insulating material, proper care of tucking in of the insulating material shall be taken so as to prevent erosion.

29. VACUUM DEGASSER , AIR & DIRT SEPARATOR & DIRT SEPARATOR

1. **VACUUM DEGASSER**

The vacuum degasser shall be of a solid and a robust construction. The Vacuum degasser shall work on the Principle of pressure differential dearation. Vacuum degasser shall be installed in a by pass line to CHW header. It shall be able to degas a minimum of 1CMH or 1000 l/h of water at system working pressure.

The degasser shall be capable of refilling the CHW pipeline with degassed water to compensate the volume of vented gases, unit shall be selected as per system's highest working pressure with following features

- Fully automated degassing and water make-up
- The Deagasser shall be able to switch itself off when the pipeline achieves desired Pressure & degassed levels of water.

- Works on pressure differential deaeration principle
  - Built in flow meter to measure degassed and make-up water volumes
  - Microprocessor based control panel
  - BMS compatible

- All Components, i.e. pump, vacuum tube, valves, interconnecting piping and control panel mounted on a compact steel frame, It should be with a Multi-stage Centrifugal pump

The Degasser shall be of Plug & play type & shall be of automatic operation. Vacuum degasser shall consist of

- Vacuum tube with high capacity automatic airvent with an ingress preventer.
- Multistage centrifugal pump.
- Make-up water and system inlet water connections with motorised valves.
- Water outlet connection with motorised valve to enable degasser operation even at low system pressure.
- (Manual preset flow control valves at inlet and outlet are not acceptable.)
- Pressure transmitter to regulate pressure / vacuum in the vacuum tube
- Built in flow meter to measure degassed and make-up water volumes.
- Microprocessor based, BMS compatible, control panel with IP54 protection.
- All Components, i.e. pump, vacuum tube, valves, interconnecting piping and control panel mounted on a compact steel frame.

2. **DIRT SEPARATOR**

The Dirt separator shall be of a solid and robust construction (Mild Steel). It shall be able to remove solid particles upto 5 microns from water at Velocity between 2-3m/s. All connections, fittings and heads shall be of carbon steel. The medium used to de-aerate and remove dirt shall be manufactured of Steel Tube & a mesh made of copper wire. This medium should be non clogging in nature. The flow should not be obstructed by the dirt collected. A Drain valve should be present at the bottom to remove the accumulated dirt without the need of shutting down the operation of the system. The Dirt Separator shall be insulated depending upon its location (outdoor or indoor). The pressure drop on account of the dirt separator shall not exceed 21 kPa at maximum flow of the chilled water system.

3. **AIR & DIRT SEPARATOR**

The Air and Dirt separator shall be of a solid and robust construction (Mild Steel). It shall be able to remove free air and microbubbles as well as remove solid particles upto 5 microns from water at Velocity between 2-3m/s. Removal of Air & dirt shall be through coalescence. The unit shall be able to condition the water to make it highly absorptive at all points in the system .This ensures that microbubbles can no longer exist at any point in the system. All connections, fittings and heads shall be of carbon steel. The medium used to de-aerate and remove dirt shall be manufactured of Steel Tube & a mesh made of copper wire. This medium should be non clogging in nature. An automatic air vent of at least 100mm free area to be connected at the top for the release of the air separated from the water. The flow should not be obstructed by the dirt collected. A Drain valve should be present at the bottom to remove the accumulated dirt without the need of shutting down the operation of the system. The Air & Dirt Separator shall be insulated depending upon its location (outdoor or indoor). The pressure drop on account of the air and dirt separator shall not exceed 21 kPa at maximum flow of the chilled water system.

4. **CONDENSER WATER CONDITIONING EQUIPMENT**

- Equipment to increase condenser circuit efficiency

Water conditioning equipment shall be non intrusive type which can be mounted on the periphery of the common condenser header and should help in Dissolves and removes existing lime-scale, Prevent new lime-scale accumulation, Enhances filtration efficiency, treats bacteria and algae & Inhibits corrosion

The water conditioning equipment shall induce a decaying sine oscillation of ±150 kHz into the water system, essentially making the water in the pipe a part of an electric circuit. The process with charge Hard water which draws the bicarbonate negative (-) ions and calcium positive (+) ions together. The ions should form a microscopic cluster within micro-seconds. The cluster should be stable as long as the signal is present and shall be removed from the system at cooling tower level.

The signal should have the capability to travel at least 2,000 rmt pipeline.

The signal should be capable to travel in the pipe of any material of construction. PVC, MS, SS.

It should help to maintain the following parameters under control:

i. Condenser approach should be maintained less than 5Deg F and monitored which will help in direct savings in power at chiller.

ii. Stop use of anti-scalant, softener, chemicals etc. Biocide level should be reduced by 75% of the standard to take care of areas where the water has low or no flow

iii. This equipment shall remove legionella, e-coli, Klebsiella, pseudomonas.

The equipment should be with CE Marking & ISO Certification

UVGI (Ultra Violet Germicidal Irradiation)

Supply, Installation , testing , commissioning and handing over of the duct mounted/ AHU mounted Ultra Violet Germicidal Irradiations (UVGI) System for maintaining indoor Air Quality in AHU unit. The lamp shall have 9000 hrs life, ballasts shall be electronic type, life rated grater than 15000 starts. An hour meter shall be provided in the remotely mounted electrical box to indicate Lamp change and should be designed to achive kill rate of not less than 90% per pass. The prices to include all inter connected wiring between the UVGI Lamps.

The system shall be applied downstream of duct length and on the side of the AHU coil to ensure no mold growth.

Installation of UVGI frame in the duct shall be with factory provided Guide Rails and Installation Rails. Cover Plates and all necessary hardware required for installation shall be factory provided by Manufacture " All wetted parts shall be Stainless Steel to render it suitable for use in Hospitals, Health Care Facilities, and in Food Processing Plants. All non wetted parts shall be powder coated.

The Lamps shall be 9000 hrs. life with not less than 25% derating provide Rated Average Life of 9000 hrs. Lamps shall be environmentally friendly.

Ballasts shall be electronic type, life rated for greater than 15,000 starts.

An Hour Meter shall be provided in the remotely mounted Electrical Box to indicate Lamp change. The Hour Meter shall have at least Two normally Open (NO) Dry Contacts, one to activate unit mounted indicating lamp to warn Lamp change, and the other for remote indication or interface to BMS.

It Should be designed to achieve Kill Rate not less than 90% per pass.

Appropriate Safety and Caution Notice shall be screen printed on the cover plate of UVGI frame and on the electrical box. Placing adhesive labels shall not be accepted, so as not to compromise on safety.

Proper supporting system of UVGI to be provided & will be in contractor's scope.

Air Ionizers:- (STP cum ETP Plant & STP Plant –Indoor Air quality):-

Air Ionizers of suitable CFM & adequate No. shall be provided as per relevant standards & norms by the EPC Contractor as per ACPH requirement of Plant Room of STP cum ETP and

STP (2 No. of Plant) to control the odor to acceptable level & maintain desirable indoor air quality inside the plant room. Ionizers will be placed after the fresh air fan & air will be supplied uniformly through perforated duct. It shall target the obnoxious /toxic/pungent smell gases & convert it into non-harmful gases. It should also target microorganisms & particle counts, VOC, static charges, mold growth, outside air contaminants etc.

The Air Purification System shall be a product of an established manufacturer. It shall be designed using ASHRAE Standard 62.1. The EPC contractor needs to provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1 to validate acceptable indoor air quality. The Air Purification Technology shall have been tested by UL or Intertek/ETL preferably to prove conformance to UL 867 for electronic devices. EPC Contractor shall submit their certifications along with their submittal.

Ionization system shall be capable of:

1. Effectively killing microorganisms downstream of the ionization equipment (mold, bacteria, virus, etc.).
2. Controlling gas phase contaminants generated from human occupants, building structure, furnishings and outside air contaminants.
3. Reducing space particle counts.
4. Reducing space static charges.
5. When mounted to the air entering side of a cooling coil, keep the cooling coil free from pathogen and mold growth.
6. EPC contractor shall provide documentation that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:
    a) MRSA: 99.5% in 60 minutes or less preferably
    b) E. Coli: 93.5% in 30 minutes or less preferably
    c) H1N1: 86.6% in 60 minutes or less preferably
    d) Aspergillus: 74.8% in 60 minutes or less preferably

30. PRESSURISED EXPANSION TANK WITH PRESSURIZATION UNIT

1. SCOPE OF WORK

This section deals with supply, erection, testing and commissioning of pressurized expansion tank for chilled water conforming to general specification and suitable for the duty selected as required.

PRESSURIZED EXPANSION TANK WITH PRESSURIZATION UNIT

2. CLOSED EXPANSION TANK

The closed expansion tank will be of M.S. construction with interchangeable EPDM-BUTYL rubber membrane. The expansion tank shall be complete with safety relief valve, pressure reducing valve and pressure gauge. The tank will be of pressure rating to suit the system pressure and will be sized to adequately compensate for water expansion due to operating temperature variations.

The tank shall be fabricated as per IS 2825-1969 for “non-fired pressure vessels” and the flanges shall be as per IS 6392-1971.

For chilled water application, it will be insulated with 50mm thick insulation to the specifications and cladded with 26G-aluminium cladding. The expansion tank shall be supplied along with pressurization unit.

3. PRESSURIZATION UNIT

Pressurization unit shall be with 2 nos. (1 working + 1 stand by) horizontal/vertical multi-stage pumps of suitable rating & capacity, as indicated hereunder, factory mounted on a steel frame along with interconnected piping, valves, strainer, pressure gauge, pressure transmitter, flow meter to measure the make-up water quantity, control panel with duty cycling and dry-run protection, electrical relays/contactors and interconnecting wiring:

Protection - IP55

Insulation class - F

Liquid temperature range - 0°C - 50°C

The unit shall be capable of Pressurising the system to the required pressure with suction from a break-tank located at least 1m above pump level. The control unit shall be housed in a metal box, IP 54 protection with BMS compatibility via an RS485 cable interface.

4. **CENTRIFUGAL AIR SEPARATOR**:- It will be of M.S construction with preferably suitable for grooved connection. The Air separator will be of pressure rating to suit the system pressure & will be sized to achieve maximum air separation.

The Air Separator will be complete with Automatic Air vent at the top & drain valve in the centre of the bottom. The Air separator will be insulated.

5. OPEN TYPE EXPANSION TANK

Unless mentioned otherwise, an expansion tank of PVC double layered contain twice the maximum expansion likely to place in the system, shall be provided. The bottom of the tank shall be at least 600mm above the highest point of the system. Tank shall be insulated, if required and be complete with float valve, gauge glass, drain, overflow and make up connections, with gate valves and vent piping as required.

31. CO & CO2 SENSOR FOR BASEMENT CAR PARK VENTILATION

1. SCOPE OF WORK

The scope of this section comprises the supply, installation, testing & commissioning of CO & Co2 Sensor for basement Car Park Ventilation in auto mode conforming to these specifications and in accordance with DBR and functional requirements.

2. TYPE

Sensor should have single Unit for CO and CO2 monitoring with dedicated measuring sensor cell. It should be BMS compatible with analogue output of 4-20mA / 2-10 Volts. Sensor should not be cross-sensitive or respond to other ambient gases, including gases like SO2, acetone, ammonia, Nitrogen dioxide, Nitric oxide & should be wall mountable without need of further mounting brackets etc. It should have auto recovery to zero point with replaceable sensor cell. Sensor must have reverse polarity and short circuit protection along with over-flooding protection. Sensor should have IMMUNITY TO RF/FM INTERFERENCE as per the guidelines of EMC- Directive 2004/ 108/ EEC & should have enclosure flammability in accordance to UL 94: VO. The sensor should be UL, CE certified.

Should have minimum IP65 protected housing, with provision of dust and moisture protection with hydrophobic filter arrangement.

3. SPECIFICATIONS FOR CARBON MONOXIDE DETECTION SENSOR

It should be capable of continuous, online detection and measurement of carbon monoxide and carbon monoxide radicals & should have Electro-chemical type sensor cell. The same should have Gel based (not watery – for longer shelf life, no mounting orientation problem). Electrolyte sensor

cell. It should have 0-300ppm measuring range, taking care of over range detection. Response time should be < 15 sec & accuracy should be ≤ 1% of measuring range. It should have low warm up time ≤ 3 minutes. It should have plug-in, easy replaceable sensor cell (simple push – pull arrangement) and PCB for easy service and replacement (no need to change the whole unit).It should have manual trim-pot calibration facility, with annual calibration frequency

4. SPECIFICATIONS FOR CARBON DIOXIDE DETECTION SENSOR

It should capable of continuous, online detection and measurement of carbon dioxide (CO2) concentration. It should have Gold plated non-dispersive infra-red (NDIR) sensor cell. It should have 0-2000ppm measuring range, taking care of over range detection. It should have low response time < 10 sec & should have low warm up time, ≤ 3 minutes

5. SPECIFICATIONS FOR VERY EARLY FIRE & SMOKE DETECTION TRANSMITTER

It should capable of continuous, online detection and measurement of smoke & fire radicals. It should be unaffected by dust, moisture, vibration, temperature & other external factors. It should have low zero point drift along with modular plug in technology. It should be BMS compatible & should provide an analogue output of 4-20mA.There should be an option to provide Alarm Relay output. The Sensor should comply to EMC Directive 89/336/EEC & should be compliant to UL 94 V2.

32. TESTING, ADJUSTING AND BALANCING

The AC Contractor shall have a dedicated experienced, specialized, approved, testing and commissioning (T&C) team /agency responsible for coordination with other trades, preparation of T&C plan method statement & T&C procedures, organizing & scheduling the T&C activities along with the progress of works, supervision any re-testing, coordination with third parties for commissioning & certification, organizing & performing testing for satisfaction of all Statutory Bodies, T&C record documentation & handover

(a) GENERAL

a. Testing, adjusting and balancing of heating, ventilating and air-conditioning systems at site.

b. Testing, adjusting and balancing of HVAC Hydronic system at site.

c. Testing, adjusting and balancing of exhaust system at site.

Comply with current editions of all applicable practices, codes, methods of standards prepared by technical societies and Assoc.ciations including:

ASHRAE	:	2007 HVAC Application or latest version.
SMACNA	:	Manual for the Balancing and Adjustment of air distribution system.

d. AC Contractor shall submit a Test, adjust, balance procedure/method statements/charts for approval to Client.

(b) PERFORMANCE

a. Verify design conformity.

b. Establish fluid flow rates, volumes and operating pressures.

c. Take electrical power readings for each motor.

d. Establish operating sound and vibration levels.

e. Adjust and balance to design parameters.

f. Record and report results as per the formats specified.

(c) DEFINITIONS

a. Test : To determine quantitative performance of equipment.

b. Adjust : To regulate for specified fluid flow rates and air patterns at terminal equipment (e.g. reduce fan speed, throttling etc.)

c. Balance : To proportion within distribution system (submains, Branches and terminals) in accordance with design quantities.

(d) TESTING, ADJUSTING AND BALANCING (TAB) PROCEDURES

The following procedures shall be directly followed in TAB of the total system. Before commencement of each one of the TAB procedure explained hereunder, the AC Contractor shall intimate the Client about his readiness to conduct the TAB procedures in the format given in these specifications.

(e) DESCRIPTION OF SYSTEM AND REQUIREMENTS

Adjust and balance the following system to provide most energy efficient operation compatible with selected operating conditions.

a. All supply, return and outside air systems.

b. All exhaust air systems.

c. All chilled water systems.

d. All cooling tower (condenser) water systems.

e. Emergency purge systems.

(f) AIR SYSTEMS

I. Air Handlers Performance

The TAB procedure shall establish the right selection and performance of the AHUs with the following results :

a. Air-IN DB and WB temperature.

b. Air-OUT DB and WB temperature.

c. Dew point air leaving.

d. Sensible heat flow.

e. Latent heat flow.

f. Sensible heat factor.

g. Fan air volume.

h. Fan air outlet velocity.

i. Fan static pressure.

j. Fan power consumption.

k. Fan speed.

II. Air distribution

Both supply and return air distribution for each AHU and for areas served by the AHU shall be determined and adjusted as necessary to provide design air quantities. It shall cover balancing of air through main and branch ducts.

III. The Preparatory Work

To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals:

a. All outside air intake, return air and exhaust air dampers are in proper position.

b. All system volume dampers and fire dampers are in full open position.

c. All access doors are installed & are air tight.

d. Grilles are installed & dampers are fully open.

e. Provision and accessibility of usage of TAB instruments for traverse measurements are available.

f. All windows, doors are in position.

g. Duct system is of proper construction and is equipped with turning vanes and joints are sealed.

h. Test holes and plugs for ducting.

(g) HYDRONIC SYSTEM BALANCING

I. The Hydronic system shall involve the checking and balancing of all water pumps, piping network (main & branches), the heat exchange equipment like cooling and heating coils, condensers and chillers and cooling towers in order to provide design water flows.

II. The essential preparation work, must be done by the HVAC Contractor prior to actual testing, adjusting and balancing of HVAC system and ensure following :

- Availability of co-ordinated drawings and approved submittals and system sketch with design water flows specified thereon.
- Hydronic system is free of leaks, is hydrostatically tested and is thoroughly cleaned, flushed and refilled.
- Hydronic system is vented.

III. The AC Contractor shall confirm completion of the basic procedures and prepare check lists for readiness of system balance.

a. Check pumps operation for proper rotation and motor current drawn etc.

b. Confirm that provisions for TAB measurements (Temperature, pressure and flow measurements) have been made.

c. Open all shut-off valves and automatic control valves to provide full flow through coils. Set all balancing valves in the preset position, if these values are known. If not, shut all riser balancing valves except the one intended to be balanced first.

Balancing work for both Chilled Water System and Condenser Water System shall be carried out in a professional manner and test reports in the specified format shall be prepared and presented to the Client / Consultant for endorsement.

(h) READINESS FOR COMMENCEMENT OF TAB

Before starting of any of the tests, the readiness to do so should be recorded as per the prescribed check list.

(i) TAB INSTRUMENTS

I. Air Measuring Instruments

a. For measuring DB and WB temperature, RH and dew point, microprocessor based TSI USA make VelociCalc Plus Meter, Model 8386, or equivalent shall be used. This

instrument shall be capable of calculating the sensible, latent total heat flows, sensible heat factor and give printouts at site and have data logging/downloading facility.

b. For measuring Air velocity, DB temperature and Air volume, TSI USA make VelociCalc meter model 8386/ 8345 or equivalent shall be used. It shall be able to provide instant print out of recorded Air volume readings.

c. Pitot tube.

d. Electronic Rotary Vane Anemometer TSI make or equivalent.

e. Accubalance Flow Measuring Hood TSI make or equivalent.

[All above instruments shall have a valid certification from a reputed testing institution.]

II. Hydronic Measuring Instruments

a. For measurement of water flow across balancing valves, instruments as provided by the manufacturer of the valves specific to the type of valves shall be need. This shall include but not be limited to differential pressure manometers. Temperature shall be measured using electric thermometers from thermowells provided at strategic location by the HVAC Contractor. The water balancing shall be carried out being computer simulation program provided / certified by the balancing valve manufacturer.

III. Rotation Measuring Instrument

a. Electronic Digital Tachometer.

IV. Temperature & RH Measuring Instrument

a. TSI VelociCalc model 8386 / VelociCalc model 8345 or equivalent.

V. Electrical Measuring Devices

a. Clamp on Volt ammeter.

b. Continuity Meter.

VI. Vibration and Noise Levels

Vibration and alignment field measurements shall be taken for each circulating water pump, water chilling unit, air handling unit and fan driven by a motor over 10 HP. Readings shall include shaft alignment, equipment vibration, bearing housing vibration, and other test as directed by the PMC.

Sound level readings shall be taken at ten (10) locations in the building as selected by the Contractor / Client. The readings shall be taken on an Octave Band analyzer in a manner acceptable to him. The AC Contractor shall submit test equipment data and reporting forms for review. In order to reduce the ambient noise level the readings shall be taken at night. All test shall be performed in the presence of Client / Consultant or his authorized representative.

SYSTEM READY TO BALANCE CHECK LIST (NOT LIMITED TO FOLLOWING)

Description	Ready		Date Corrected
	Yes	No	
1. HVAC Units (AHU) a. General Louvers installed Manual dampers open & locked Automatic dampers set properly Housing Construction leakage Access doors-leakage Condensate drain piping and pan			

Free from dirt and debris Nameplate data b. Filters Type and size Number Clean Frame-Leakage c. Coils (Hydronic) Size and rows Fin spacing and condition Obstructions and / or debris Airflow and direction Piping leakage Correct piping Connections and flow Valves open or set Air vents or steam traps Provision made of TAB Measurements d. Fans Rotation Wheel clearance and balance Bearing and motor lubrication Drive alignment Belt tension Drive set screws tight Belt guard in place Flexible duct connector alignment Starters and disconnect switches Electrical service & connections. Nameplate data e. Vibration Isolation Springs & Compression Base Level & Free 2. Duct System a. General Manual dampers open & locked Access doors closed and tight Fire dampers open and accessible Terminal units open and set Registers and diffusers open and set Turning vanes in square elbows Provisions made for TAB measurements. Systems installed as per plans. Ductwork sealed as required b. Architectural Windows installed and closed. Doors closed as required. Ceiling plenums installed and sealed. Access doors closed and tight Air shafts and openings as required 3. Pumps a. Motors.			

Rotation Lubrication Alignment Set screws tight Guards in place Tank level and controls. Starters and disconnect switches Electrical service & connections. Nameplate data. b. Piping Correct flow Correct connections Leakage Valves open or set Strainer clean Air vented Flexible connectors Provisions made for TAB measurements c. Bases Vibration isolation. Grouting Leveling 4. Hydronic Equipment a. Heat Exchangers/ HW coil Correct flow and connections Valves open or set Air vents or steam traps Leakage Provisions made for TAB measurements Nameplate data. 5. Refrigeration Equipment Crankcase heaters energized Operating controls and devices. Safety controls and devices. Valves open Piping connections and flow Flexible connectors Oil level and lubrication Alignment and drives. Guards in place. Vibration isolation. Starters, contactors and disconnect switches. Electrical connectors. Nameplate data. 6. Hydronic Piping systems. Leak tested. Fluid levels and make-up Relief or safety valves. Compression tanks and air vents. Steam traps and connections. Strainers clean			

valves open or set Provisions made for TAB measurements. Systems installed as per plans. 7. Controls System Data centers. Outdoor return air reset Economizer Static pressure Room controls. 8. Other Checks. a. Other trades or personnel notified of TAB work requirements. b. Preliminary data complete c. Test report forms prepared.			

INSTRUMENT CALIBRATION REPORT

PROJECT _____

S/No	INSTRUMENT/ APPLICATION	DATES OF USE	CALIBRATION TEST DATE
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
REMARKS			
TEST DATE _____ READINGS BY _____			

CHILLER TEST REPORT

PROJECT_____UNIT_____

LOCATION_____

MANUF._____ MODEL _____ SERIAL NO. _____

CAPACITY_____ REFRIG_____ STARTER_____ HEATER SIZE _____

Description	Design	Actual
a) COMPRESSOR		
Make / Model		
Serial No.		
Type (Reciprocating, Centrifugal, Screw, Scroll)		
Piping Material		
Suction Pr / Tem.		
Discharge Pr/Temp		
Refrigerant		
Oil Pump Type		
Oil Pressure		
Oil Failure Switch Pressure		
Unload Arrangement		
Unload Set Points		
Drive		
Compressor Speed		
Oil Level		
Oil Temperature		
L P Setting		
H P Setting		
Anti Freeze Setting		
Purge Unit Type		
Purge Operation Checked		
b) COMPRESSOR MOTOR		

Make / Model		
Type		
Voltage		
Motor Rated Current		
Motor F L Current		
c) MOTOR STARTER		
Make / Model		
Type		
Voltage		
Amps		
O/L Release Range		
d) EVAPORATOR		
Make / Model		
No. of Passes		
Ref : Level		
Ref : Pressure / Temperature		
Ent. Water Temp/Pressure		
Leaving Water Temp/Pressure		
Temperature Difference		
Pressure Difference		
Water Quantity		
Relief Valve Setting		
IKW / Ton		
REMARKS		
TEST DATE _____ READINGS BY _____		

COOLING TOWER TEST REPORT

PROJECT_____ **SYSTEM**_____

LOCATION_____

MANUF._____**MODEL**_____ **SERIAL NO.**_____

NOM. CAPACITY _____ **WATER TREAT.**_____

Description	**Design**	**Actual**
a) TOWER / MOTOR		
Make / Model		
Type		
Tons		
No. of Fan Motors		
Motor HP / RPM		
Motor / Drive		
Motor Speed		
Motor Rated Current		
Motor FL Current		
O/L Release Setting		
CT Range		
CT Approach		
b) TOWER / FAN		
No. of Fans		
Type/ Drive of Fan		
Fan Dia		
Fan Speed		
Air Inlet Temperature		
Air Outlet Temperature		
Fan Air Quantity		
Water Bleed GPM		
c) TOWER / AIR DATA		

Fan CFM		
Outlet S.P.		
Avg. Ent. W.B.		
Avg. Lvg. W.B.		
Ambient W.B.		
Fan RPM		
Voltage		
Amps		
d) TOWER / WATER DATA		
Ent//Lvg./Water Pressure		
Ent//Lvg./Water Temperature		
Water Temperature – T		
GPM		
Bleed GPM		
Voltage		
Amps		
REMARKS		
TEST DATE _____ **READINGS BY**_____		

PUMP TEST REPORT

PROJECT_____

DATA	**PUMP NO.**	**PUMP NO.**	**PUMP NO.**	**PUMP NO.**
Location				
Service				
Manufacturer				
Model Number				
Serial Number				
GPM/Head				
Req. NPSH				
Pump RPM				
Impeller Dia.				
Motor Mfr. / Frame				
Motor HP/RPM				
Volts/Phase/Hertz				
F.L Amps				
Seal Type				
Pump Off-Press.				
Valve Shut Diff.				
Act.Impeller Dia.				
Valve Open diff.				
Valve Open GPM				
Final Dischg. Press.				
Final Suction Press.				
Final Ap				
Final GPM				
Voltage				
Amperage				
REMARKS				
TEST DATE _____ **READINGS BY** _____				

AIR HANDLING EQUIPMENT TEST REPORT

PROJECT_____

SYSTEM/UNIT_____**LOCATION**_____

Description	**Data**
a) UNIT	
Make/Model No.	
Type/Size	
Serial Number	
Arr./Class	
Discharge	
Pully dia/Bore	
No. Belts/make/size	
No.Filters/type.size (Pre.)	
No.Filters/type/size (secondary)	
b) MOTOR	
Make / Frame	
H.P / RPM	
Volts/Phase/cycles	
F.L amps.	
Pully Dia/Bore	
Pully /Distance.	
Total Cfm	
Total S.P	
Fan RPM	
Motor Volts. T	
Outside air Cfm	
Return air Cfm	
Discharge S.P	
Cooling Coil S.P	
Filters S.P	
REMARKS	
TEST DATE_____ **READINGS BY** _____	

COOLING / HEATING TEST REPORT (AHU)

PROJECT_____

COIL DATA	**COIL NO.**	**COIL NO.**	**COIL NO.**
System Number			
Location			
Coil Type			
No. Rows Fins/In			
Manufacturer			
Model Number			
Face Area, Sq.Ft.			
TEST DATA	**DESIGN/ACTUAL**	**DESIGN/ACTUAL**	**DESIGN/ACTUAL**
Air Qty. CFM			
Air Vel.FPM			
Press.Drop In.			
Out.Air DB/WB			
Ret. Air DB/WB			
Ent.Air DB/WB			
Lvg.Air DB/WB			
Air AT			
Waer flow. GPM			
Press.Drop.PSI			
Ent.Water Temp			
Lvg .Water Temp			
Water AT			
Exp.Valve/Refrig			
Refrig.Suction Pr.			
Refrig.Suct.Temp			
Inlet Steam press.			
REMARKS			
TEST DATE _____ **READINGS BY** _____			

FAN COIL TEST REPORT

PROJECT_____

DATE_____**LOCATION**_____

MANUFACTURER_____

AREA SERVED	**FCU MAKE**	**CAPACITY TR**	**TEMPERATURE DEG. F**
GRILLE ROOM			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
REMARKS			
TEST DATE _____ **READINGS BY** _____			

FAN TEST REPORT

PROJECT_____

FAN DATA	**FAN No.**	**FAN No.**	**FAN No.**
Location			
Service			
Manufacturer			
Model No.			
Serial No.			
Type / Class			
Motor Make / Style			
Motor H.P/RPM/ Frame			
Volts/Phase/Cycles			
F.L Amps.			
Motor pully Dia./Bore			
Fan pully Dia./Bore			
No. Belts/ Make/Size			
Pully Distance.			
CFM			
FAN RPM			
S.P IN/OUT			
TOTAL S.P			
Voltage			
Amperage			
REMARKS			
TEST DATE _____ **READINGS BY** _____			

RECTANGULAR DUCT TRAVERSE REPORT

PROJECT_____SYSTEM_____

LOCATION / ZONE_____ACTUAL AIR TEMP. _____DUCT S.P_____

DUCT REQUIRED ACTUAL

SIZE_____SQ.FT._____ FPM_____CFM_____ FPM_____CFM_____

POSITION	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
VELOCITY											
SUBTOTALS											
REMARKS											
TEST DATE_____ READINGS BY _____											

GRILLES AND DIFFUSERS TEST REPORT

PROJECT_____ SYSTEM _____

OUTLET_____MANUFACTURER_____

TEST APPARATUS_____

S/No	AREA SERVED	OUT LET NO./ TYPE/ SIZE	DESIGN CFM/VEL	PRLIMINARY CFM/VEL	FINAL CFM/VEL
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
REMARKS					
TEST DATE_____ READINGS BY _____					

33. PAINTING WORK

This section deals with painting of various equipment / material supplied under this contract. It gives basic guidance for painting as specified below:-

Application: The original colour of all equipments like water chilling machines, air-handling units etc. which if get damaged during transportation or during installation shall be painted in original shade with the two coat of paint to give a final finish.

All chilled water pipes shall be painted as per standard code of practice and arrows shall be marked to indicate direction of flow of water.

Colour Scheme For The Equipments / Materials

Description	Standard Colour & Reference	Lettering Colouring
Exposed Duct Work (other than plant room)	As per E-I-C Directions	As per E-I-C Directions
Air Conditioning Duct Work (Plant Rooms)	BSS 111 Pale Blue	Black
Ventilation Duct Duct Work (Plant Rooms)	BSS 111 Pale Blue	Black
Conditioner Casings Air Handling Units, Filter Plenums	BSS 111 Pale Blue	Black
Electrical (Conduit Ducts and Motors)	BSS 557 Light Orange	Black
Chilled Water Pipe	Jade Green	Black
Drains	Black	White
Vents	White	Black
Fans	BSS 111 Pale Blue	Black
Valves and Pipe Line Fittings	White with black handles	Black
Beltquards	Black and yellow diagonal stripes (45 25 mm wide)	
Switchboards- exterior – interior	BS 366 Light Beige	White
Machine Bases, Inertia Bases and Plinths	Charcoal	Grey
Chilling M/C	As Per Manufacturer's Standard	
Pump-sets	Battle ship grey	
Condenser water pipes	Light green	Black
Electrical panels/sub-panel/ remote control console	Light grey powder coated RAL 7032 as per DIN	
Supports for ducts		Silver

34. IDENTIFICATION OF SERVICES

GENERAL

This section comprises of identification of services for each piece of equipment

VALVE LABELS AND CHARTS

Each valve shall be provided with a label indicating the service being controlled, together with a reference number corresponding with that shown on the Valve Charts and " as fitted" drawings. The labels shall be made from 3 ply (black / white/ black) Traffolyte material showing white letters and figures on a black background. Labels to be tied to each valve with chromium plated linked chain. The labels shall be suitable for minimum 40 characters with font size of 24 minimum. Labelling scheme of each equipment to be submitted for approval from Client / Consultant.

A wall mounted, glass covered plan to the endorsement of the Client / Consultant shall be provided and displayed in each plant room showing the plant layout with pipe work, valve diagram and valve schedule indicating size, service, duty, etc.

All AC equipments shall be provided with permanent mounted identification labels and unique tagging numbers. The shop drawings shall also include these tagging numbers for easy identification on site. It should be co-ordinated with BMS also to ensure consistent equipment tagging among drawings, BMS display and site installation.

IDENTIFICATION OF SERVICES

Pipe work and duct work shall be identified by colour bands 150 mm. wide or colour triangles of at least 150 mm. / side. The bands of triangles shall be applied at termination points, junctions, entries and exits of plant rooms, walls, in ceiling spaces, ducts and control points to readily identify the service, but spacing shall not exceed 4.0 metres.

PIPE WORK SERVICES

For pipe work services and its insulation the colours of the bands shall comply with BS.1710: 1971.Basic colours for pipe line identification:

Pipe Line Contents	BS. 4800 Colour Reference	Colour
Water	12 D 45	Green
Steam	10 A 03	Grey
Oils	06 C 39	Brown
Gas	08 C 35	Yellow / Brown
Pipe Line Contents	BS. 4800 Colour Reference	Colour
Air	20 E 51	Blue
Drainage	00 E 53	Black
Electrical	06 E 51	Orange

Colour code indicator bands shall be applied as colour bands over the basic identification colour in the various combinations as listed below :-

Pipe Line Contents	**Colour Bands to BS. 4800**
Water Services :	
Cooling	00 E 55
Fresh / drinking	18 E 53
Boiler feed	04 D 45/00 E 55 / 04 D 45
Condensate	04 D 45/14 E 53 / 04 D 45
Chilled	00 D 55/14 E 53 / 00 D 45
Central Heating Services :	
Below 100 Deg. C	18 E 55/04 D 45/18 E 53
Above 100 Deg. C	04 D 45/18 E 53 /04 D 45
Cold Water Storage	
Tanks:	00 E 55/18 E 53/00 E 55
Hot Water Supply	00 E 55/04 D 45/00 E 55

Pipe Line Contents	**Colour Bands to BS. 4800**
Hydraulic Power	04 C 33
Sea / River Untreated	Basic Colour only
Fire Extinguishing	04 E 53
Steam Services :	Basic Colour only
Air : Compressed	Basic Colour only
Vacuum	White
Town Gas : Manufactured	14 E 53
Natural	10 E 53
Oils :	
Diesel	00 E 55
Lubricating	14 E 53
Hydraulic Power	04 C 53
Transformer	04 D 45
Drainage and other fluids :	Basic Colour only
Electrical Services :	Basic Colour only

In addition to the colour bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow, identified as follows:-

High Temperature Hot Water	HTHW
Medium Temperature Hot Water	MTHW
Low Temperature Hot Water	LTHW
Chilled Water	CHW
Condenser Water	CONDW
Steam	ST
Condensate	CN

Pipe shall have the letters F and R added to indicate flow and return respectively as well as directional arrows.

DUCT WORK SERVICES :

For Duct work services and its insulation the colours of the triangles shall comply with BS.1710 : 1971. The size of the symbol will depend on the size of the duct and the viewing distance but the minimum size should not be less than 150 mm. length per side. One apex of the triangle shall point in the direction of airflow.

Services	**Colour**	**BS.4800 Colour Reference**
Conditioned Air	Red and Blue	04 E 53 / 18 E 53

Ward Air	Yellow	10 E 53
Outdoor air	Green	14 E 53
Exhaust / Extract / Recirculated Air	Grey	AA 0 09
Foul Air	Brown	06 C 39
Dual Duct System Hot Supply Air	Red	04 E 53
Cold Supply Air	Blue	18 E 53

In addition to the colour triangles specified above all duct work shall be legibly marked with black or white letters to indicate the type of service, identified as follows:-

Supply Air	S
Return Air	R
Outdoor Air	O
Exhaust Air	E
Smoke Extract Duct	M
Spill Air	A

The colour banding and triangles shall be manufactured from self adhesive cellulose tape, laminated with a layer of transparent ethyl cellulose tape.

LIST OF ABBREVIATIONS

Followings List of Abbreviations shall have been used in preparing the Tender Specifications, DBR & Drawings.

AABC	:	AMERICAN AIR BALANCING COUNCIL
ACH	:	AIR CHANGE PER HOUR
AC	:	AIR CONDITIONING
ACMV	:	AIR CONDUCTING AND MECHANICAL VENTILATION
AHU	:	AIR HANDLING UNIT
ANSI	:	AMERICAN NATIONAL STANDARD INSTITUTE
ARI	:	AMERICAN REFRIGERATION INSTITUTE
ASHRAE	:	AMERICAN SOCIETY OF HEATING, REFRIGERATION AND AIRCONDITIONING ENGINEER
ASME	:	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTA	:	ASSOC.CIATION OF SHORT - CIRCUIT TESTING AUTHORITIES
ASTM	:	AMERICAN SOCIETY OF TESTING AND MATERIALS
ATG	:	AIR TRANSFER GRILLE
AWS	:	AMERICAN WELDING SOCIETY
BAS	:	BUILDING AUTOMATION SYSTEM
BIS	:	BUREAU OF INDIAN STANDARD
BMS	:	BUILDING MANAGEMENT SYSTEM
BTU	:	BRITISH THERMAL UNIT
CDW	:	CONDENSER WATER

CFM	:	CUBIC FEET PER MINUTE
CHW	:	CHILLED WATER
CMS	:	CENTRAL MONITORING SYSTEM
CRCA	:	COLD ROLLED COLD ANNEALED
CSA	:	CANADIAN STANDARD ASSOC.CIATION
CT	:	COOLING TOWER
CTI	:	COOLING TOWER INSTITUTE
DB	:	DISTRIBUTION BOARD
DDC	:	DIRECT DIGITAL CONTROLLER
DOL	:	DIRECT ON LINE
DFA	:	DELHI FIRE AUTHORITY
DIA	:	DIAMETER
DIDW	:	DOUBLE INLET DOUBLE WIDTH
DX	:	DIRECT EXPANSION
EA	:	EXHAUST AIR
EEPROM	:	ELECTRICAL ERASABLE PROGRAM
ELCB	:	EARTH LEKAGE CIRCUIT BREAKER
ETL	:	ELETRICAL TESTING LABORATORIES
EPA	:	ENVIRONMENTAL PROTECTION ACT
FCU	:	FAN COIL UNIT
F/A	:	FLOOR ABOVE
F/B	:	FLOOR BLOW
FCC	:	FIRE COMMAND CENTRE
FD	:	FIRE DAMPER
FFL	:	FINISHED FLOOR LEVEL
FPM	:	FEET PER MINUTE
FPS	:	FOOT PER SECOND
FRP	:	FIBERGLASS REINFORCED PLASTIC
GI	:	GALVANISED IRON
GPM	:	GALLON PER MINUTE
GSS	:	GALVANIZED STEEL SHEET
H/L	:	HIGH LEVEL
HDG	:	HOT DIP GALVANIZED
HDPE	:	HIGH DENSITY POLY ETHANE
HFC	:	HYDRO FLURO CARBON
HP	:	HORSE POWER
HVAC	:	HEATING, VENTILATION & AIR CONDITIONING

IAQ	:	INDOOR AIR QUALITY
IEC	:	INTERNATIONAL ELECTROCHEMICAL COMMISSION
IKW	:	INDICATED KILO WATT
IPD	:	INITIAL PRESSURE DROP
ISO	:	INTERNATIONAL STANDARD ORGANIZATION
KW	:	KILO WATT
L	:	LITRE
LCD	:	LIQUID CRYSTAL DISPLAY
L/L	:	LOW LEVEL
L/S	:	LITRE PER SECOND
LSZH	:	LOW SMOKE ZERO HALOGEN
LT	:	LOW TENSION
M	:	METER
MAX.	:	MAXIMUM
MCB	:	MINIATURE CIRCUIT BREAKER
MCC	:	MOTOR CONTROL CENTRE
MFD	:	MOTORIZED FIRE DAMPER
MIN	:	MINIMUM
MM	:	MILLIMETER
NBC	:	NATIONAL BUILDING CODE
NC	:	NOISE CRITERIA
NEC	:	NATIONAL ELECTRIC CODE
NFPA	:	NATIONAL FIRE PROTECTION ASSOC.CIATION
NPLV	:	NET PART LOAD VALUE
NIST	:	NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY
NEMA	:	NATIONAL ELECTRICAL MANUFACTURERS ASSOC.CIATION
NPSH	:	NET POSITIVE SUCTION HEAD
NTS	:	NOT TO SCALE
OA	:	OUTDOOR AIR
PHE	:	PUBLIC HEALTH ENGINEERING
PLC	:	PROGRAMMABLE LOGIC CONTROLLER
P.C.	:	PERSONAL COMPUTER
PSIG	:	POUNDS PER SQUARE INCH GAUGE
PUF	:	POLYURETHANE FOAM
RA	:	RETURN AIR
RAD	:	RETURN AIR DUCT
RCC	:	REINFORCED CEMENT CONCRETE

RH	:	RELATIVE HUMIDITY
RPM	:	REVOLUTIONS PER MINUTE
SA	:	SUPPLY AIR
SAD	:	SUPPLY AIR DUCT
SMACNA	:	SHEET METAL & AIR CONDITIONING CONTRACTORS NATIONAL ASSOC.CIATION INC
STD	:	STANDARD
T/A	:	TO ABOVE
TAB	:	TESTING, ADJUSTING AND BALANCING
T/B	:	TO BELOW
TCC	:	TERMINAL CONTROL CENTRE
TFA	:	TREATED FRESH AIR
TOA	:	TREATED OUTDOOR AIR
TP	:	THREE PHASE
TR	:	TONS OF REFRIGERATION
TVOC	:	TOTAL VOLATILE ORGANIC COMPOUNDS
VAV	:	VARIABLE AIR VOLUME
VFD	:	VARIABLE FREQUENCY DRIVES
VIP	:	VIBRATION ISOLATING PAD
VSPS	:	VARIABLE SPEED PUMPING SYSTEM
XLPE	:	CROSS -LINKED POLYETHYLENE
SISW	:	SINGLE INLET SINGLE WIDTH
UL	:	UNDERWRITERS LABORATORIES INC.
WG	:	WATER GAUGE

35. NOISE & VIBRATION CONTROL

1. SCOPE OF WORK

This section deals with design, supply, installation, testing and commissioning of noise and vibration control equipment and accessories.

2. STANDARDS

The testing of all noise control equipment and the methods used in measuring the noise rating of air conditioning plant and equipment shall be in accordance with the relevant sections of the following British Standards, unless otherwise stated:

BS 4718: 1971	Methods of Test of Silencers for Air Distribution Systems
BS 2750:	Laboratory and Field Measurement of Airborne Sound
Parts 1-9:1980	Insulation of Various Building Elements
	Recommendations for Field Laboratory Measurement of Airborne and Impact Sound Transmission in Buildings
BS 3638: 1987	Methods of Measurement of Sound Adsorption in a Reverberation

	Room
BS 4773: Part 2: 1976	Acoustic Testing.
BS 4856: Part 2: 1976 Part 5: 1976	Acoustic performance without additional ducting of forced fan convection equipment. Acoustic performance with additional ducting of forced fan convection equipment
BS 4857: Par 2:1978 (1983)	Acoustic Testing and Rating of High Pressure Terminal Reheat Units.
BS 4954: Par 2:1978 (1987)	Acoustic Testing and Rating of Induction Units.
BS 5643:	1984 Glossary of Refrigeration, Heating, Ventilating and Air Conditioning Terms

3. GENERAL

The air conditioning contractor must take all necessary precautions to have minimum noise generation and its transmission generated by moving plant and equipment to achieve acceptable limits for occupied areas. In addition to the noise level criteria particular attention must be given to the following details at time of ordering plant and equipment and their installation :-

All moving plant / equipment shall be statically and dynamically balanced at manufacturers works and certificates issued.

The isolation of moving plant, machinery and apparatus including lines equipment from the building structure.

Where duct work and pipe work services pass through walls, floors and ceilings, or wherever supported shall be surrounded with a resilient acoustic absorbing material to prevent contact with the structure and minimize the outbreak of noise from plant rooms.

The reduction of noise breakout from plant rooms and the selection of externally mounted equipment and plant to meet ambient noise level requirements of the Specifications.

Electrical conduits and connections to all moving plant and equipment shall be carried out in flexible conduit and cables to prevent the transmission of vibration to the structure and nullify the provisions of anti-vibration mountings.

All duct connections to fans shall incorporate flexible connections, except in cases where these are fitted integral within air handling units.

All resilient acoustic absorbing materials shall be non flammable, vermin and rot proof and shall not tend to break up or compress sufficiently to transmit vibration or noise from the equipment to the structure.

Where practicable, attenuators shall be built into walls and floors to prevent the flanking of noise the duct work systems and their penetrations sealed in the manner previously described. Where this is not feasible, the exposed surface of the duct work between the attenuators and the wall subjected to noise infiltration shall be acoustically clad as specified.

Ambient noise from cooling tower also shall be assessed to determine the suitable attenuators that can reduce the noise so as not affecting the adjoining public area.

4. SOUND ATTENUATORS

Attenuators shall be provided in ducts in accordance with acceptable noise level criteria. Attenuators shall be constructed from high quality pre-galvanised steel sheet casings with lock formed joints along the casing length. Angle iron cross jointing flanges shall be fitted to silencer casings, drilled as required and finished with red oxide primer paint. Acoustic splitters shall be formed by chancel section pre-galvanised sheet steel framework retaining acoustic fill of a density to attain the required performance. Splitters shall

have round Nos., ends to give smooth entry and exit conditions to minimise air pressure drops. The acoustic fill shall be protected from the air flow by 22 swg minimum perforated galvanized sheet steel. All attenuators shall be selected against a maximum allowable air pressure drop of 100 Pa. It will be the responsibility of the AC Contractor at the time of placing orders for fan equipment to obtain from the manufacturers, certified sound power levels to enable the selected duct silencers to be checked against the original design information, prior to orders being placed.

5. ANTI-VIBRATION MOUNTINGS.

All items of rotating and reciprocating plant and equipment shall be isolated from the structure by the use of anti-vibration materials, mountings or spring loaded supports fixed to either concrete bases, inertia blocks or support steels. Centrifugal fans and motors within air handling units shall be isolated from the frame of the air handling unit by suitable anti-vibration mountings. Fan discharge air connections shall be fitted with approved flexible connections. Axial flow fans shall be mounted on steel legs as diaphragm plates supported on neoprene in shear anti-vibration mountings, or suspended using spring loaded hangers to suite the application. Centrifugal pumps shall be mounted on inertia bases consisting of reinforced concrete sub-base, anti-vibration mountings and concrete filled steel upper plinth. The AC Contractor shall be responsible for providing the steel upper plinth and mountings. Pipe work connections to circulating pumps, chillers, cooler coils and other heat exchanger equipment shall be made with flexible connections as per piping Specifications. The construction of the anti-vibration mountings shall generally comply with the following: -Enclosed Spring Mounting (Caged or Restrained Springs) Each mounting shall consist of cast or fabricated telescopic top and bottom housing enclosing one or more helical steel springs as the principle isolation elements, and shall incorporate a built- in leveling device. The springs shall have an outside diameter of not less than 75% of the operating height, and be selected to have at least 50% overload capacity before becoming coil bound. The bottom plate of each mounting shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs. Mountings incorporating snobbery of restraining devices shall be designed so that the snubbing damping or restraining mechanism, is capable of being adjusted to have no significant effect during the normal running of the isolated machine. The manufacturers shall provide restrained isolator on chillers subject to approval.

6. OPEN SPRING MOUNTINGS

Each mounting shall consist of one or more helical steel springs as the principal isolation elements, and shall incorporate a built-in leveling device. The spring shall be fixed or otherwise securely located to cast or fabricated top and bottom plates, and shall have an outside diameter of not less than 75% of the operating height, and shall be selected to have at least 50% overload capacity before becoming coil-bound. The bottom plate shall have bonded to it a neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

7. NEOPRENE-IN-SHEAR MOUNTINGS

Each mounting shall consist of a steel top plate and base plate completely embedded in oil resistant neoprene. Each mounting shall be capable of being fitted with a leveling device, and bolt holes in the base plate and tapped holes in the top plate so that they may be bolted to the floor and equipment where required.

8. INERTIA BASES FOR PUMPS

The inertia base shall be an all welded mild steel channel frame the minimum depth of which shall be 1/12 of the longest span between isolator but not less than 150 mm. filled with concrete the density of which shall be 2300 kg/m3.

The inertia base shall be sufficiently large to provide support for all parts of the equipment, including any component, which overhands the equipment base, such as suction, and discharge elbows on centrifugal pumps.

The frame shall include pre-located equipment anchor bolts fixed into position and housed in a steel sleeve allowing minor bolt location adjustment.

Isolator support brackets shall be welded into the corners of the base and suitably re-enforced for the load of the equipment and base.

Additional reinforcing roads shall be provided at 200 mm. centres to ensure the concrete and frame is adequately stiffened against distortion.

9. REFERENCE DESIGN STANDARD

Following standard & guidelines shall be adopted while designing the HVAC System.

i) National Building Code of India (NBC 20016) with latest revision.

ii) Energy Conservation Building Code (ECBC 2007) or latest

iii) ASHRAE latest Hand Books.

a) Fundamentals

b) HVAC Systems and Equipment

c) HVAC Applications

d) Refrigeration

e) HVAC Design Guidelines for Health Care Facilities ASHRAE Standard 170.

iv) Duct construction standards as per relevant latest BIS codes & SMACNA standards.

v) Air filters as per ASHRAE 52.1-1992 or latest and 52.2-2007 or latest

vi) Indoor Air quality as per ASHRAE 62.1-2010 or latest

vii) Motors, Cabling, Wiring and accessories as per latest BIS codes.

viii) National Electric Codes (NEC) latest version

ix) ANSI / ASHRAE / IESNA standard 90.1-2009 or latest: Energy standard for building except low rise residential buildings.

x) ASHRAE standard 55: Thermal Comfort.

10. BIS CODE & GUIDELINES

Followings are the few list of Bureau of Indian Standards Codes for guidelines.

IS : 277 - 1992	Galvanized steel sheet (Plain & Corrugated) wire for fencing.
IS : 554 - 1985 (Reaffirmed 1996)	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS : 655 - 1963 (Reaffirmed 1991)	Metal air ducts.
IS : 659 – 1964 (Reaffirmed 1991)	Air conditioning (Safety Code)
IS : 660 – 1963 (Reaffirmed 1991)	Mechanical Refrigeration (Safety Code)
IS : 694 - 1990 (Reaffirmed 1994)	PVC insulated (HD) electric Cables for working voltage unto and including 1100 volts.
IS : 732 - 1989	Code of practice for electrical wiring.
IS : 780 - 1984	Sluice valves for water works purposes.
IS : 822-1970 (Reaffirmed 1991)	Code of procedure for inspection of welds.
IS : 1239 (Part - I) - 1990	Mild steel tube
IS : 1239 (Part - II) - 1992	Mild steel Tubulars and other wrought steel pipe fittings.
IS : 1255 - 1983	Code of Practice for installation and maintenance of Power Cables unto and including 33 KV rating (Second Revision)
IS : 1554 - 1988 (Part – I)	PVC insulated (Heavy Duty) electric cables for working

	voltages unto and including 1100 volts.
IS : 1897 – 1983 (Reaffirmed 1991)	Copper bus bar / strip for electrical purposes
IS : 2379 - 1990	Colour code for the identification of Pipelines.
IS : 2551 - 1982	Danger notice plate
IS : 3043 - 1987	Code of practice for earthing.
IS : 3103 – 1975 (Reaffirmed 1999)	Code of practice for Industrial Ventilation.
IS : 3837 – 1976 (Reaffirmed 1990)	Accessories for rigid steel conduit for electrical wiring.
IS : 4736 – 1986 (Reaffirmed 1998)	Hot-dip zinc coatings on steel tubes.
IS : 4894 - 1987	Centrifugal Fan.
IS : 5133 - 1969 (Part-I)	Boxes for the enclosure of electrical (Reaffirmed 1990) accessories.
IS : 5216 - 1982	Guide for safety procedure and practices (Part-I) (Reaffirmed 1990) in electrical work.
IS : 5312 (Part-I) - 1984	Swing - check type reflux non (Reaffirmed 1990) return valves for water works
IS : 5424 – 1989 (Reaffirmed 1994)	Rubber mats for electrical purposes.
IS : 5578 & 11353-1985	Marking and identification of conductors
IS : 6392 – 1971 (Reaffirmed 1988)	Steel pipe flanges.
IS : 8623 - 1993	Low voltage switchgear and control gear assemblies (Requirement for type / partly type tested assemblies)
IS : 8623 - 1993	Bus Bar trunking system (Part - II)
IS : 8828 - 1996	Circuit Breakers for over current protection for house hold and similar installation.
IS : 9537 – 1981 (Part II)	Rigid Steel Conduits for electrical wiring
IS : 10810 - 1988	Methods of test for cables.
IS : 13947-1993 (Part-I)	General rules for low voltage switch gears and control gears.
IS : 13947-1993 (Part-II)	Circuit Breakers IEC 947 - 2
IS : 13947 - 1993 (Part-III)	Switches, disconnectors and fuse for low voltage switch gear and control gear.
IS : 13947 - 1993 (Part-IV)	Low voltage switch gear and control gear for contactors and motor starters
IS : 13947 – 1993 (Part-V)	Control Circuit Devices.
BS : EN:779 – 1993	Filters
IEC	Relevant Sections.

36. SAFETY CODES

1. **SCOPE**

The scope of this sub-section is the minimum safety requirements to be observed during manufacture and erection of the HVAC system as specified herein in addition to the safety norms generally followed:-

2. **I.S. STANDARDS**

The safety code for mechanical refrigeration IS: 660 and safety code for air conditioning IS: 659 shall be observed.

3. **SAFETY REQUIREMENTS**

Some of the important safety requirements are as under but not limited to the same:-

a. There shall be maintained in a readily accessible place, first aid appliances including adequate supply of sterilized dressings and cotton wool.

b. The injured person shall be taken to a public hospital without loss of time.

c. Suitable and strong scaffolds shall be provided for workmen for all works that cannot be safely done from ground.

d. No portable single ladder shall be over 8 meters in length. The width between side rails shall not be less than 30 cm (clear) and the distance between two adjacent rings shall not be more than 30 cms, when a ladder is used, an extra mazdoor shall be engaged for holding the ladder.

e. The excavated material shall not be placed within 1.5 meters of the edge of the trench or half of the depth of trenches whichever is more. All trenches and excavations shall be provided with necessary fencing and lighting.

f. Every opening in the floor of a building or in a working platform to be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be one meter.

g. No. Floor, roof or other part of the structure shall be so overloaded with debris or material as to render it unsafe.

h. Workers employed on mixing and handling materials such as asphalt, cement mortar or concrete & lime mortar shall be provided with protective footwear and rubber hand gloves.

i. Those engaged in welding works shall be provided with protective eye shields and glove.

j. No paint containing lead or lead products to be used except in the form of paste or readymade paint.

k. Suitable facemasks shall be supplied for use of workers when the paint is applied in the form of spray or surface having lead paint dry rubbed and scraped.

l. Overalls shall be supplied by the Contractor to the painter and adequate facilities shall be provided to enable the working painter to wash during cessation of the work.

m. The ropes used in hoisting or lowering material or as a means of suspension, shall be of adequate quality and adequate strength and free from defects.

n. All site personnel shall wear safety helmets whenever they are in the construction/ erection areas.

TEST READINGS

CHILLER TEST REPORT

PROJECT_____

UNIT_____

LOCATION_____

MANUFACTURER_____

MODEL_____SERIAL NO._____

CAPACITY_____REFRIGERANT_____

STARTER_____HEATER SIZE_____

COMPRESSOR	**DESIGN**	**ACTUAL**	**MOTOR STARTER**	**DESIGN**	**ACTUAL**
Make/Model			Make/Model		
Serial No.			Type		
Type (Reciprocating / Centrifugal / Screw / Scroll)					
Piping Material			Amps		
Suction Pr/Tem			O/L Release Range		
Discharge Pr/Temp					
Refrigerant			EVAPORATOR	DESIGN	ACTUAL
Oil Pump Type			Make/Model		
Oil Pressure			No. of Passes		
Oil Failure Switch Pressure			Ref. Level		
Unload Arrangement			Ref: Pressure/ Temperature		
Unload Set Points			Ent. Water Temp/ Pressure		
Drive			Leaving Water Temp/ Pressure		
Compressor Speed			Temperature Difference		
Oil Level			Pressure Difference		
Oil Temperature			Water Quantity GPM		
L P Setting			Relief Valve Setting		

H P Setting			IKW / Ton		
Anti Freeze Setting					
Purge Unit Type					
Purge Operation Checked					
Make/Model			Make/Model		
Type			No. of Passes		
Voltage			Ref: Pressure/ Temperature		
Motor Rated Current			Ent. Water Temp/ Pressure		
COMPRESSOR MOTOR	DESIGN	ACTUAL	CONDENSER	DESIGN	ACTUAL
			No. of Fans		
Motor F L Current			Fan Material		
			Fan Diameter		
REMARKS					
TEST DATE _____					
READING BY _____					
Note : Please Furnish test report for all chillers separately.					

PUMP TEST REPORT

PROJECT _____				
DATA	PUMP NO	PUMP NO	PUMP NO	PUMP NO
Location				
Service				
Manufacturer				
Model Number				
Serial Number				
GPM/Head				
Req. NPSH				
Pump RPM				
Impeller Mfr./Frame				
Motor Mfr./Frame				
Motor HP/RPM				
Volts/Phase/Hertz				
F.L Amps				
Seal Type				
Pump Off-Press				
Valve Shut Diff				
Actual Impeller Dia				
Valve Open differential				
Valve Open GPM				
Final Dischg.Pressure				
Final Suction Pressure				
Final Δ p				
Final GPM				
Voltage				
Amperage				

REMARKS

TEST DATE _____ READINGS BY_____

Note : Please Furnish test report for all CHW pumps.

AIR HANDLING EQUIPMENTS TEST REPORT

PROJECT _____SYSTEM / UNIT _____			
LOCATION _____			
UNIT	**DATA**	**MOTOR**	**DATA**
Make/Motor No.		Make / Frame	
Type/Size		H.P / RPM	
Serial Number		Volts/Phase/Cycles	
Arr./Class		F.Lamps.	
Discharge		Pulley Dia/Bore	
Pulley dia/ Bore		Pulley/ Distance	
No. Belts/make/Size			
No.Filters/type.Size (Pre.)			
No.Filters/type.Size (secondary)			

TEST DATA	DESIGN	ACTUAL	TEST DATA	DESIGN	ACTUAL
Total Cfm			Discharge S.P		
Total S.P					
Fan RPM			Cooling Coil S.P		
Motor Volts			Filters S.P		
Out air Cfm					
Return air Cfm					
REMARKS.					
TEST DATE _____					

READINGS BY _____

Note : Please Furnish above report for all AHU.

RECTANGULAR DUCT TRAVERSE REPORT

PROJECT_____SYSTEM_____

LOCATION / ZONE_____ACTUAL AIR TEMP. _____DUCT S.P_____

DUCT	REQUIRED	ACTUAL
SIZE_____ SQ.FT._____	FPM_____ ___ CFM_____ ___	FPM_____ CFM_____

POSITION	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1												
2												
3												
4												
5												
6												
7												
8												
VELOCITY SUBTOTALS												

GRILLES AND DIFFUSERS TEST REPORT

PROJECT _____

SYSTEM _____

OUTLET MANUFACTURER _____

TEST APPARATUS _____

REA		OUT LET			DESIGN		INITIAL		FINAL	
SERVED	NO	TYP	SIZE	VEL	CFM	VEL	CFM	VEL	CFM	VEL

REMARKS.

TEST DATE _____**READINGS BY**_____

Note : Please Furnish above report for all grills/diffusers with S.No. marked on respective drawings

37. MODES OF MEASUREMENTS:- The scope of measruement indicated herein below shall be maintained by the Contractor for the purpose of record measurement. The E-I-C, if required, may seek the details of these measurements for verification etc.

i. THE SCOPE OF WORK SHALL INCLUDE THE FOLLOWING:

All equipments, machinery, apparatus and materials required as well as the cost of any tests which the HLL may request in addition to the tests generally required to prove quality and performance of the equipments.

All the labour required supplying and installing the complete installation in accordance with the specifications.

Use of any tools, equipments, machinery, lifting tackle, scaffolding, ladders etc. Required by the Contractor to carry out his work.

All the necessary measures to prevent the transmission of vibration.

The necessary material to isolate equipments foundations from the building structure, wherever necessary.Storage and insurance of all equipments apparatus and materials.

The Contractor's quoted price shall include all equipments, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipments, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

ii. MEASUREMENTS OF SHEET METAL DUCTS, GRILLES/DIFFUSERS ETC.

a. Sheet Metal Ducts

Duct Work shall be measured on the basis of external surface area of ducts. Duct measurements shall be taken before application of the insulation. The external surface areas shall be calculated by measuring the perimeter comprising overall width and depth, including the corner joints, in the center of each duct section, multiplying with the overall length from flange face to flange face of each duct section and adding up areas of all duct sections. Plenums shall also be measured in similar manner.

For tapered rectangular ducts, the average width and depth shall be considered for perimeter, whereas for tapered circular ducts, the diameter of the section midway large and small diameter shall be adopted, the length of tapered duct section shall be the center line distance between the flanges of the duct section.

For special pieces like bends, tees, reducers, branches and collars, mode of measurement shall be identical to that described above using the length along the centerline.

The quoted unit rate for external surface of ducts shall include all wastage allowances, flanges and gaskets for joints, nuts and bolts, hangers and angles with double nuts for supports, rubber strip 3 mm thick between duct and support, vibration isolator suspension where specified or required, inspection chamber / access panel.

Splitter damper with quadrant and lever for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the Specifications. These accessories shall NOT be separately measured nor paid for.

b. Grilles/Diffusers

Grilles and registers - width multiplied by height, excluding flanges. Volume control dampers shall form part of the unit rate for registers and shall not be separately accounted.

Diffusers - cross section area for airflow at discharge areas, excluding flanges. Volume control dampers shall form part of unit rate for supply air diffusers and shall not be separately accounted.

Linear diffusers - shall be measured by cross - sectional areas and shall exclude flanges for mounting of linear diffusers. The supply air plenum for linear diffusers shall be measured with ducting as described earlier.

Fire dampers - shall be measured by their cross sectional areas perpendicular to the direction of airflow. Quoted rates shall include the necessary collars and flanges for mounting, inspection pieces with access door, electrical actuators and panel No special allowance shall be payable for extension of cross section outside the air stream.

Flexible connection - shall be measured by their cross sectional areas perpendicular to the direction of airflow. Quoted rates shall include the necessary mounting arrangement, flanges, nuts and bolts and treated-for-fire requisite length of canvas cloth.

Exhaust Hoods - shall be measured by their cross sectional area at the capture point of fumes, parallel to the surface of kitchen equipments. Quoted rates shall include the grease filters, provision for hood light, suspension arrangement for the hood, profile to direct the air to ventilation ducts and provision for removable drip tray.

c. DAMPERS:- Measurement of dampers shall be as per internal cross sectional area of the damper

d. MEASUREMENTS OF PIPING, FITTINGS, VALVES, FABRICATED ITEMS

I. PIPES

All pipes shall be measured in linear meter (to the nearest cm) along the axis of the pipes and rates shall be inclusive of all fittings e.g., tees, bends, reducers, elbows etc. Deduction shall be made for valves in the line.

The rate quoted shall be inclusive of cutting holes, exposing reinforcement in wall and ceiling and floors and making good the same and inclusive of all items as specified in specifications and DBR.

Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces. Wherever specified or required by the project engineer.

Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter with no additional allowance being made for providing the same.

The length of the pipe will be taken through the centerline of the pipe and all through the fittings (e.g., tees. Bends, reducers, elbows, etc.) As through the fittings are also presumed to be pipe lengths.

II. Valves and Flanges

All the extra CI & CM flanged valves shall be measured according to the nominal size in mm and shall be measured by number. Such valves shall not be counted as part of pipe length hence deduction in pipe length will be made wherever valves occur.

All gun metal (gate & globe) valves shall include two nos. Of flanges and two numbers 150 mm long ms nipples, with one side threaded matching one of the valves and other welded to the MS Slip-on-flange. Rate shall also include the necessary number of bolts, nuts and washers, 3 mm thick insertion gasket of required temp., grade and all items specified in the specifications.

III. Structural Supports

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and DBR.

IV. Insulation

Unless otherwise specified measurement for duct and pipe insulation for the project shall be on the basis of centerline measurements described herewith.

V. Pipe Insulation

This service shall be measure be measured in units of length along the centerline of the installed pipe, strictly on the same basis as the piping measurements described earlier. The linear measurements shall be taken before the application of the insulation.

It may be noted that for piping measurement, all valves, orifice plates and strainers are separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including cladding, valves, orifice plates and strainers shall be considered strictly by linear measurements along the centerline of pipe.

VI. DUCT INSULATION AND ACOUSTIC LINING:

This service shall be measured on the basis of surface area along the centerline of insulation thickness. Thus the surface areas of externally thermally insulated or acoustically lined duct shall be based on the perimeter comprising centerline (of thickness of insulation) width and depth of the cross section of insulated or lined duct, multiplied by the centerline length including tapered pieces, bends, tees, branches etc. as measured for bare ducting.

38. SYSTEM TESTING ADJUSTMENT AND BALANCING

1. SCOPE

a) Testing, adjusting and balancing of heating, ventilating and air-conditioning systems at site.

b) Testing, adjusting and balancing of HVAC Hydronic system at site.

c) Testing, adjusting and balancing of exhaust system at site.

Comply with current editions of all applicable practices, codes, methods of standards prepared by technical societies and associations including:

ASHRAE: 1999 HVAC Application

SMACNA: Manual for the Balancing and Adjustment for air distribution System

2. PERFORMANCE

a) Verify design conformity.

b) Establish fluid flow rates, volumes and operating pressures.

c) Take electrical power readings for each motor.

d) Establish operating sound and vibration levels.

e) Adjust and balance to design parameters

f) Record and report results as per formats specified.

3. DEFINITIONS

Test: To determine quantitative performance of equipments.

Adjust: To regulate for specified fluid flow rates and air patterns at terminal Equipments (e.g. reduce fan speed, throttling etc.)

Balance: To proportion within distribution system (sub mains, branches and Terminals) in accordance with design quantities.

4. TESTING, ADJUSTING AND BALANCING (TAB) PROCEDURES

The following procedures shall be directly following in TAB of the total system.

Before commencement of each one of the TAB procedure explained hereunder, the contractor shall intimate the Engineer-In-Charge about his ready to conduct the TAB procedures in the format given in these specifications.

5. DESCRIPTION OF SYSTEM AND REQUIREMENT

Adjust and balance the following system to provide most energy efficient operation compatible with selected operating conditions.

- All supply, return and outside air systems.
- All exhaust air systems
- All chilled water systems.
- All cooling tower (condenser) water systems.
- Emergency purge systems

6. AIR SYSTEMS

a) Air Handlers Performance

The TAB procedure shall establish the right selection and performance of the AHUs with the following results.

- Inlet air Dry and Wet bulb temperatures.
- Outlet air Dry and Wet bulb temperatures.
- Air leaving dew point temperature
- Sensible heat Pickup
- Latent heat Pickup
- Sensible hat factor

b) Air distribution

Both supply and return air distribution for each AHU and for areas served by the AHU shall be determined and adjusted as necessary to provide design air quantities. It shall cover balancing of air through main and branch ducts utilizing telescoping probes of Electronic Rotating Vane Anemometers and Accubalance for grilles and diffusers.

c) The Preparatory work

To conduct the above test, following preparatory works are required to be carried out including the availability of approved for construction shop drawings and submittals.

All outside air intake return air and exhaust air dampers are in proper position.

All system volume dampers and fire dampers are in full open position.

All access doors are installed & are airtight.

Grilles are installed & dampers are fully open.

Provision and accessibility of usage of TAB instruments for transverse measurements are available.

All windows, doors are in position.

Duct system is of proper construction and is equipped with turning vanes and joints are sealed.

7. HYDRONIC SYSTEM BALANCING

The Hydronic system shall involve the checking and balancing of all water pumps. Piping network (main & branches), the heat exchange equipments like cooling and heating coils, condensers and chillers and cooling towers in order to provide design water flows.

The essential preparation work, must be done by the HVAC contractor prior to actual testing, adjusting and balancing of HVAC system and ensure following:

a. Availability of co-ordinate drawings and approved submittals and system sketch with design water flows specified thereon.

b. Hydronic system is free of leaks, is hydrostatically tested and is thoroughly cleaned, flushed and refilled.

c. Hydronic system is vented.

d. The contractor shall confirm completion of the basic procedures and prepare checklists for readiness of system balance.

e. Check pumps operation for proper rotation and motor current drawn etc.

f. Confirm that provisions for TAB measurements (Temperature, pressure and flow measurements) have been made.

g. Open all shut-off valves and automatic control valves to provide full flow through coils. Set all balancing valves in the preset position, if these values are known. If not, shut all riser balancing valves except the one intended to be balanced first.

h. Balancing work for both Chilled Water System and Condenser Water System shall be carried out in a professional manner and test reports in the specified format shall be prepared and presented to the HLL / Engineer-In-Charge for approval.

8. READINESS FOR COMMENCEMENT OF TAB

Prior to commencement of any test, the readiness to do so should be recorded as per the prescribed checklist.

9. TAB INSTRUMENTS

i. Air measuring Instruments

For measuring DB and WB temperature, RH and dew point, microprocessor, suitable instrument shall be used. This instrument shall be capable of calculating the sensible, latent total heat flows, sensible heat factor and give printouts at site and have data logging/downloading facility.

For measuring Air velocity, DB temperature and Air volume, suitable instrument shall be used. It shall be able to provide instant print out of recorded Air Volume readings.

Pitot tube.

Electronic Rotary Vane Anemometer.

Accubalance Flow Measuring Hood.

ii. Hydronic Measuring Instruments

For measurement of water flow differential pressure and temperature, The instrument shall have a built-in-microcomputer capable of giving readings for pressure differential flow rate and temperature.

iii. Rotation Measuring Instrument

- Electronic Digital Tachometer

iv. Temperature & RH Measuring Instrument

v. Electrical Measuring Devices

- Clamp on Volt ammeter
- Continuity Meter

10. VIBRATION AND NOISE LEVELS

Vibration and alignment field measurements shall be taken for each circulating water pump, water chilling unit, air handling unit and fan driven by a motor over 10 HP. Readings shall include shaft alignment, equipments vibration, bearing housing vibration, and other test as directed by the Engineer-In-Charge.

Sound level readings shall be taken at ten (10) locations in the building as selected by the Engineer-In-Charge. The readings shall be taken on an Octave Band Analyzer in a manner acceptable to him. The contractor shall submit test equipments data and reporting forms for review. In order to reduce the ambient noise level the readings shall be taken at night. All tests shall be performed in the presence of HLL / Engineer-In-Charge.

LIST OF BUREAU OF INDIAN STANDARD CODES

IS 1239 (Part– I) 1979	Mild Steel Tube
IS 1239 (Part – I) 1982	Mild Steel Tubular and Other Wrought Steel Pipe Fittings
IS 4736 – 1986 (Reaffirmed)	Hot Dip Zinc Coatings of Steel Tubes
IS 823-1964	Code of Procedure For Manual Metal Arc Welding of Mild Steel
IS 780-1984	Service Valves For Water Works Purpose
IS 778-1980	Copper Alloy Gate, Globe and Check Valves For Water Works Purpose
IS 1536-1976	Flanges Configuration
IS 5312 (Part –I) 1984	Swing Check Type Reflux Non Return Valves For Water Works
IS 2379-1963	Color Code For Identification of Pipelines
IS 554-1975	Dimension For Pipe Thread Where Pressure Tight Joints Are Required On Threads
IS 655-1963 (Reaffirmed 1991)	Metal Air Ducts
IS 277-1992	Galvanized Steel Sheet For Fencing
IS 4064 Part II-1978	Specific Requirements For Direct Switches of Individual Motors
IS 3854-1969	Switches For Domestic & Similar Purpose
IS 732 (Part III-1902)	Inspection and Testing of Installation
IS 659 – 1964 (Reaffirmed 1991)	Air Conditioning Safety Code
IS 660 – 1963 (Reaffirmed 1991)	Mechanical Refrigeration (Safety Code)
IS 4894 – 1991	Test Code For Centrifugal Fan
IS 3103 – 1975 Reaffirmed 1994	Code of Practice For Industrial Ventilation
IS 7240 – 1981	Application & Finishing of Thermal Insulation Material
IS 325	Specifications For Three Phase Induction Motor

IS 3142 – 1993	V Grooved Pulley
BS-EN-779 – 1993	Particulate Air Filters For General Ventilation
IS 702 – 1988	Industrial Bitumen
IS 8183 – 1993	Bonded Mineral Wool
IS 2494 – 1993	V Belts For Industrial Purposes
IS 2062 – 1992	General Purpose Steel
ASHRAE Hand Books	American society of heating, refrigeration and air conditioning books - Applications 1999 - Fundamentals 1997 - System and equipments 1996 - Indoor air quality 62 – 1999

39. SPECIFICATIONS FOR ELECTRICAL WORKS

1. **GENERAL:**

All Electrical works including but not limited to motors, switchgears, power & control/signal cables, earthing, terminations etc. required for various items shall generally be as per specifications given in electrical specifications.

All electric motors shall be suitable for 3 phase, 50 cycles 415 volts a.c. supply.

2. **CONTROL PANEL:**

2.1 These panels should be floor/wall mounted, sheet steel clad, modular construction, cubicle design, compartmentalised .These panels shall comprise of incoming & outgoing feeders (circuit breakers, fuse switch units/switch fuse units, contactor starters with overload relays, single phasing preventor etc.

2.2 The panels shall be provided wherever necessary with necessary interlocks designed to prevent incorrect operation and to ensure safety of operating personnel and equipment.

2.3 All feeders are to be operated from the front and they shall be interlocked suitably. Padlocking arrangement and interlock defeating device shall also be provided. Each module shall have separate door and partition plate. The feeder incomer switches shall be interlocking with the door so that the door can only by opened when switch is in `off' position. The doors and covers shall be provided with thick gaskets to make it dust tight. All the door covers shall be provided with synthetic rubber gaskets to make it dust tight. Feeder name tags shall be provided.

3. **CONTACTOR STARTERS:**

3.1 **Star Delta Starter**

The star delta starter shall be air break automatic contactor starter provided with main contactor, star contactor, delta contactor, timer and automatic change over from start to delta, bimetallic over load relay, operating coil, start/stop push button, single phasing preventor, auxiliary make and break contacts, indicating lamps etc. The contactor shall quick make, quick break, double break consisting of robust silver contacts. The coil voltage shall be 415 volts ac at 50 hz. The starter shall be provided with trip indication light and overload reset push button for overload relay.

3.2 **DOL Contactor Starter**

The contactor shall be air break type coil operated, DOL contactor starter, provided with cables entries, ambient temperature compensated bimetallic over load relay, single phasing preventor, solenoid coil, start and stop push buttons, 8 auxiliary make and break contacts, indicating lamps etc. The contactors shall be quick make and quick break, double break type consisting of robust silver contacts. The coil voltage shall be 440/240 volts at 50 c/s. The starter shall be provided with trip indication light and over load reset bush button for overload relay.

4. SQUIRREL CAGE INDUCTION MOTORS:

4.1 The motor shall be of well tried out and design and of reputed make. The motors provided on the equipment shall conform to IS:325 in general. The motors shall be squirrel cage indication motors rates for operation at 415 volts, 3 phase, 50 hz a.c. supply. The motor for various equipments shall have the following enclosure level.

(a) Cooling tower & exhaust blower - IP:55(tefc)

(b) Compressor and A.H.U. motor-IP:55(TEFC).

(c) Pumps IP:55(TEFC/SPDP).

4.2 The horse power and speed of the motor shall match that of driven equipment and the motor shall be suitable for star delta starting or direct on line starting with class `3' insulation. The motors of 10 HP and above shall be suitable for star delta starting and below 10 H.P suitable for DOL starting. The compressor motor shall be provided with automatic star delta starter

The console shall contain on/off push bottons and indication lamps for all the items as required. Indicating light for strip heaters, if any shall be provided on the switch board, in the respective unit room.

The requirements given for the main panel are for one unit only. The actual number of switches and lights shall correspond to the number of units being installed. All controls and alarms shall be suitable for 230 volts on the panel.

The alarms shall be with reset buttons.

All controls circuits shall be functionally tested.

The red indicating lamps should switch on only in case of fault. Thus, the red light should come on in case of tripping of starter on overload or single phasing.

A common alarm shall be connected to all red indicating lamps through individual relays.

Lamp testing arrangements shall be provided in console.

All the airconditioning equipments shall be interlocked in sequence for safe and trouble free operations of the plant. Following should be the sequence of operation

- Airhandling units
- Chilled / condenser water pumps
- Water chilling units.

During switch off operations the sequence shall be reverse.

- For winter heating the following should be the sequence of operations
- Airhandling unit
- Hot water pumps.

- Hot Water Generator/Boiler

During switch of operations the sequence shall be reverse.

CHAPTER- M

TECHNICAL SPECIFICATIONS -FIRE FIGHTING SYSTEM

1. FIRE FIGHTING WORKS- FIRE PROTECTIONS-GENERAL

Scope of work shall include design, engineering, supply, installation, testing & commissioning of fire fighting system. All material shall be of conforming to relevant IS specifications wherever exists and subject to approval of Engineer in charge. The fire fighting shall be carried out strictly as per NBC -2016. Testing, commissioning & getting approvals from various inspection authorities and obtaining No objection certificate(NOC) for occupation of buildings.

1.1. TENDER DRAWINGS

For guidance of the bidder, drawings (Schematic Fire Fighting Layout/External Fire Layout, Plant Room Layout etc.) are enclosed with these tender documents. These drawings are broadly indicative of the work to be carried out. The contractor on award of work will furnish detailed stage-wise working drawings as required in advance for approval of Engineer and get the same approved by Local Fire Authority/other statutory bodies. No claim whatsoever shall be admissible on account of changes that may be introduced by the Engineer/ Local Fire Authority.

1.2. SHOP DRAWINGS/TECHNICAL DATA SHEETS

The contractor shall prepare and furnish all shop drawings including floor plans & Terrace, Schematic Fire Fighting Layout/External Fire Layout showing sprinklers, Fire Hydrants/First Aid Hose, Zonal Control Valves, Extinguishers, Signages, Terrace layout with OHT & Terrace pump.

Plant Room Layout illustrating UG sump details, piping details, valves, pressure vessel, pressure switch, ICV, strainers, diesel tank with its piping & other accessories, foundation details, pump locations, sloping pattern inside pump room, drain/ sumps, fire panel, cable trays etc. at no extra cost for approval by the Engineer before commencing fabrication/ manufacture of the equipment. Such shop drawings shall be based on the Architectural drawings/Tender Drawings and requirements laid down in the specifications, Design Basis Report and as per site conditions. The manufacturing of equipment shall be commenced only after the shop drawings/GA Drawings/ technical data sheet along with pump curves are approved in writing by the Engineer. Such drawings shall be co-ordinated with other services work. These shop drawings will be approved by HLL which will be considered as base for execution of fire fighting work.

1.3. COMPLETION / AS BUILT DRAWINGS

On completion of the work and before issuance of certificate of virtual completion, the contractor shall submit to the Engineer –in-Charge, General layout drawings, drawn at approved scale indicating layout of pump house piping and its accessories "As installed". As built drawings shall be prepared taking approved shop drawings as base & incorporating all changes/ modifications as per site conditions. These drawings shall include the following:-

a. General Layout of Pump House including all details mentioned in clause 1.2.

b. Panels and other equipment/accessories location and their dimensions etc.

c. Fire fighting floor layout including terrace indicating internal hydrants, sprinklers complete with pipe dia. , pipe spacing interval etc.

d. Complete schematic as installed.

e. UG Sumps, Location of External Hydrants, 2-way/4-way fire brigade inlet connection, Draw out connection, Earth pipes, route of earthling conductors etc.

f. Route of all cables and pipes run along with detail sizes and mode of installation.

1.4. DRAWINGS & DOCUMENTS

The contractor shall submit to the Engineer, the following documents on completion of the work and before issuance of virtual completion.

a. Warranty for required equipment installed like Pumps, Panels etc.

b. As Built Drawings

c. Material Test Certificates

d. Catalogues/Brochures

e. Operation and Maintenance Manuals

f. List of recommended spares and consumables

g. All approvals including technical approvals and sanctions

h. NOC from Fire authority before commencement of execution & after completion of entire work etc.

1.5. SANCTION/ APPROVALS FROM STATUTORY AUTHORITIES/ LOCAL FIRE AUTHORITY

The contractor shall be fully responsible and shall carry out following activities:-

a. Preparation & submission of working drawings

b. Obtaining the approval of drawings

c. Arranging inspection of site by officials of the Authority

d. Obtaining the final No objection/ completion certificate after submitting required documents.

e. Any other statutory approvals required.

1.6. MANUFACTURING

The responsibility for ensuring the manufacture of the equipment as per the specifications shall be solely that of the contractor. The contractor shall be responsible for selection of materials as per agreed specifications.

1.7. MAKE OF MATRIALS/MANUFACTURER'S INSTRUCTION

Only approved makes as mentioned in our approved make list of tender documents of material shall be used. The Contrcator shall furnish Technical data sheets / GA drawings of all items before placing P.O. The contractor shall get the samples of required items approved from the HLL as conveyed by E-I-C before commencing the supply. In case of any discrepancy/anomolies wrt specifications, prior intimation from Contractor to E-I-C to be given. Final decision lies with HLL for according approvals.

Any specific instruction furnished by manufacturer covering the points not mentioned in technical specifications of the tender shall be brought to the notice of E-I-C in writing for further instructions in this regard at appropriate time.

1.8. MATERIAL TESTING

The E-I-C shall have full power to get any material of work to be tested by an independent agency at contractor's expense in order to prove the soundness and adequacy.

1.9. INSPECTION AND TESTING

a. All equipment shall be inspected and tested as per an agreed Quality Assurance Plan before the same is packed and dispatched from the contractor's works. The contractor shall carry out tests as specified/ directed by engineer.

b. Contractor shall perform all such tests as may be necessary to meet requirements of Local Authorities, Municipal or other statutory laws/ bye-laws in force. Nothing extra shall be paid for these.

c. The E-I-C may, at his sole discretion, carry out inspection at different stages during manufacturing and final testing after manufacturing.

d. Approvals or passing of any inspection by the engineer or his authorized representative shall not, however, prejudice the right of the engineer to reject the plan if it does not comply with the specification when erected or give complete satisfaction in service.

1.10. TRAINING OF DEPARTMENT PERSONNEL

a. The contractor shall train the CLIENT/ HLL's personnel to become proficient in operating the equipment installed. Training shall be done before the expiry of the defects liability period (one year after completion & handing over).

b. The period of training shall be adequate and mutually agreed upon by the Engineer and contractor.

c. The CLIENT/ HLL's personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing, minor repairs and replacement.

d. Nothing extra shall be paid to the contractor for training CLIENT/ HLL's personnel.

1.11. PERFORMANCE GUARANTEE

At the close of the work and before issue of final certificate of virtual completion by the engineer, the contractor shall furnish written guarantee indemnifying the CLIENT/ HLL against defective materials and workmanship for a period of one year after completion and handing over. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the CLIENT/ HLL.

c. Any defective material or equipment supplied by the contractor.

d. Any material or equipment supplied by the CLIENT/ HLL which is proved to be damaged or destroyed as a result of defective workmanship by the contractor.

2. PIPING FOR WET RISER SYSTEM

2.1. SCOPE

This section covers the details of requirement of piping used in wet riser system, including the associated auxiliary equipment.

2.2. GENERAL

The wet riser system shall remain pressurized at all times during operation, and as such the piping work shall be carried out to withstand the same.

2.3. PIPES AND FITTINGS

Pipes and fittings means tees, elbows, couplings, flanges, reducers etc. and all such connecting devices that are needed to complete the piping work in its totality.

Screwed fittings shall be approved type malleable or cast iron with reinforced ring on all edges of the fittings suitable for screwed joints.

Forged steel fittings of approved type with "V" groove for welded joints.

Fabricated fittings shall be not being permitted for pipe diameters 50 mm and below. When used, they shall be fabricated, welded and inspected in workshops whose welding procedures have been approved by the TAC as per TAC rule 4102 for sprinkler system and applicable to hydrant and sprinkler System under the supervision of Engineer-In-Charge. For "T" connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted.

Pipes for Wet Riser system shall be of black steel MS conforming to IS: 1239/3589 (Heavy Class/ Class C).

Fittings for black steel pipes shall be malleable iron suitable for welding or tapered screwed threads.

2.4. JOINTING

2.4.1. Screwed (50 mm dia pipes and below)

Joint for black steel pipes and fittings shall be metal to metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked.

2.4.2. Welded (65 mm dia and above)

Joints between M.S. pipes and fittings shall be made with the pipes and fittings having "V" groove and welded with electrical resistance welding in an approved manner. Butt welded joints are not acceptable.

2.4.3. Flanged

Flanged joints shall be provided on:

a. Straight runs not exceeding 30 m on pipe lines 80 mm dia and above.

b. Both ends of any fabricated fittings e.g. bend tees etc. of 65 mm dia or larger diameter.

c. For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and required as per good engineering practice.

d. Flanges shall be as per Table 17 of IS-6392. with appropriate number of G.I. nuts and bolts, 3 mm insertion neoprene gasket complete.

2.4.4. Unions

Approved type of dismountable unions on pipes lines 65 mm and below in similar places as specified for flanges. Joint for black steel pipes and fittings shall be metal to screw grid up to 50 mm dia and above 65 mm dia welded joints. A small amount of red lead may be used for lubrication and rust prevention in threaded joints. Hold tight will be use for threaded pipes joint.

All the welding shall be radiographic ally tested. Joints between MS pipes, valves and other appurtenances, pumps etc. shall be made with M.S. flanges with appropriate number of bolts. Flanged joints shall be made with 3mm thick insertion rubber gasket.

2.5. DIA OF FLANGE AND HOLE CONFORMING IS:

Size of pipe →	80 mm	100 mm	150 mm	200 mm
Dia of flange →	200 mm	220 mm	285 mm	340 mm
Flange thickness →	20mm	20mm	22mm	24mm
Dia of bolt →	16 mm	16 mm	16 mm	16 mm
No. of hole →	4 mm	4 mm	8 mm	8 mm

2.6. PIPE PROTECTION

a. All pipes above ground and in exposed locations shall be painted with one coat of red oxide primer and two or more coats of synthetic enamel paint of approved shade.

b. Pipes in chase or buried underground shall be painted with two coats of hot bitumen, wrapped with bituminous pypkote or Hessian cloth and finished with one coat of hot bitumen paint.

c. Pipe passing through structural members will be provided with M.S. pipes.

2.7. PIPE SUPPORTS

All pipe clamps and supports shall be galvanized mild steel. When fabricated from M.S. steel sections, the supports shall be factory galvanized before use at site. Welding of galvanized clamps and supports will not be permitted.

Pipes shall be hung by means of expandable anchor fastener of approved make and design (Dash Fastners or equivalent). The hangers and clamps shall be fastened by means of galvanised nuts and bolts. The size/diameter of the anchor fastner and the clamp shall be suitable to carry the weight of water filled pipe and dead load normally encounted. For pipe spacing, the stringent of the IS Code- clause no. 10.3.10, table -11 & below mentioned table should be opted.

2.8. ORIFICE PLATES

Contractor shall provide orifice flanges fabricated from 6 mm thick SS plates on the branch lines feeding different zones/ floors (as required) so as to allow required flow of water at 3.5 Kg/ sq.cm. Pressure. The contractor shall furnish design for these orifice flanges. The orifice shall be plain central hole without burs, diameter not less than half of the internal diameter of pipe to which it is fitted.

2.9. AIR CUSHION TANK AND AIR RELEASE VALVE

Air vessel on top of each wet riser/ sprinkler piping shall be installed before execution for approval fabricated out of at least 8 mm thick steel to withstand the pressure, with dished ends and supporting legs. This shall be of 250 mm dia and 200mm high. This shall be completed with necessary flange connection to the wet riser/ sprinkler piping and air release valve with necessary piping to meet the functional requirement of the system. The air vessel shall be of continuous welded construction and painted with red Colour. This shall be tested for twice the working pressure. The drain arrangement will have 25mm dia GM valve with required accessories and pressure gauge. ARV shall be of 25 mm of forged brass body & chrome plated & its components shall be of anticorrosive material. Test Pressure (Hydrostatic) for Shell : 15 bar (220 psig), Seat: 10 bar(150 psig) & Maxlmum Worklng Temperature : 110 degee C.

2.10. VALVES, GAUGES

Butter-fly, Sluice valves and NRV above 65 mm shall be of cast iron body .They shall conform to type PN 16 of IS: 13095,780. Valve wheels shall be of right hand type and have an arrowhead engraved or cast thereon the direction for turning open and closing.

Butterfly valves of various dia. as per requirements shall be of wafer type, conforming to PN-16 rating with SS disc. It shall be lever operated. The rubber lining shall be integrally moulded with EPDM/Nitrile rubber. The O-ring sall be made of nitrile rubber. The lever shall be made preferably of carbon steel.

The test pressure of Shell- 24 Bar, Seat:17.6 bar & maximum working pressure-16 bar,maximum working temperature :90 degree celcius. In case of any discrepencies between manufacturer's standards & above specified values, these parameters shall be in compliance with relevant IS codes.

Non-return valves/ Dual plate check valve of various dia. as per requirements shall be of cast iron body. It should have Nitrile Rubber/EPDM Seal & Disc of stainless steel. They shall be swing check type/wafer type in horizontal runs and lift check type in vertical runs of piping. It should be of min. PN-16 rating. Test Pressure (Hydrostatic) :Shell: 24.50 kg, Seat:16 kg/sqcm, maximum operating temperature- 80 degree C. In case of any discrepencies between manufacturer's standards & above specified values, these parameters shall be in compliance with relevant IS codes.

Sluice valve shall be of CI construction. The seat shall be of bronze. Hand Wheel shall be of cast iron. It should be of min. PN-16 rating.

The ball valve of various dia. shall be of forged brass construction & shall have screwed female ends. It shall be lever operated with quarter turn & shall be provided with forged brass hard chrome plated ball. It shall be complete with premium quality PTFE gland packing & seating. The ball valve shall be with chrome finish wherever required. Test Pressure (Hydrostatic): Shell: 25 kg, Seat:16 kg/sqcm, maximum operating temperature- 220 degree C. In case of any discrepencies between manufacturer's standards & above specified values, these parameters shall be in compliance with relevant IS codes.

Pressure gauge (Bourdon Type) shall be of suitable range with SS 304/316 Construction, case of 150/100mm diameter. The gauges shall have brass cocks. The accuracy range of pressure guage shall be in the range of +- 0.5 % to 1%. It shall conform to IP 67 protection. The dial shall be Aluminium white background with black letters. The windows shall be made of plain & toughend glass. The suitability of pressure gauge shall be in the temperature range of (-) 20 degree Celcius to 60 degree celcius. The gear mechanism shall be of SS 304 & the connection material shall be of SS-316 L. Pointer shall be of black aluminium. It shall be complete with all accessories such as siphon, gauge cock, snubber & needle valve etc. Pressure range shall be between 0 to 20 kg/sqcm.

Double flanged MS pot strainers of required dia. with M.S. body and SS 40-grade mesh strainer, PN 16 shall be provided either at tank suction line or at individual pump suction line.

Orifice plates shall be made of 6mm thickness Brass material to reduce pressure on individual hydrants to operating pressure of 3.5-kg/ sq.cm. Design of the same shall be given by the contractor as per location and pressure condition of each hydrant.

2.11. EXTERNAL YARD HYDRANTS

External yard hydrants shall be of 'Stand Post' type conforming to IS: 908 and comprise stand post for single or double outlet, duck foot bend, flange riser and single headed brass/ gunmetal valve conforming type A/ type-B and conforming to IS: 5290.

The stand post column shall be of cast iron, cast in one piece, conforming to grade 20 of IS: 210 or M.S. pipe. The internal diameter at the top shall be at least 80 mm.

The outlet shall be angled towards ground, with instantaneous spring lock type gunmetal female coupling of 63 mm dia. for connecting to hose pipe. It shall be with ISI marked with Sl. No. clearly mentioned. The landing valve shall be of oblique pattern shall be complete with GI twist

release chain with cap. The manufacturer's name & trademark along with year of manufacture & other details like size & type shall, be clearly mentioned. Valves shall be provided with one coat of primer & subsequently painted with 2 coats of red paint with shade no. 536 conforming to IS 5. The paint shall conform to IS 2932. Hand Wheel shall be painted black. It shall be BIS approved. Blank caps shall be made of gun metal. Hydrostatic pressure test shall be carried out at 21 kg/sqcm for 2.5 mins.

The flow test shall be at 7 kg/sqcm at 900 lpm. The water tightness seat test shall be at 14 kg/sqcm. In case of any discrepencies between manufacturer's standards & above specified values, these parameters shall be in compliance with relevant IS codes. RRL Hose pipe shall be controlled percolating (CP) type, ISI marked (IS:8423), 63 mm dia x 15 m long (2 Nos.) complete with instantaneous type gunmetal 63 mm dia ISI marked Male & Female couplings (IS:903) bound and riveted to hose pipe with copper rivets and 1.5 mm copper wire.

Brusting pressure not less than 22 Kg/Sqcm. External Hydrant post shall also include standard short size 63mm dia. gunmetal branch pipe with gun metal nozzle of 20 mm nominal bore outlet with instantaneous type 63 mm dia coupling complete & confirming to IS:903. M.S. fire hose weather proof cabinet (750x600x250mm approx.) made out of 16 gauge M.S. sheet capable of accommodating landing valve, hose pipes, fittings & accessories. The box shall have a front glass door with lock and key arrangement & shall be painted with one coat of primer & two coat of finished stove enamelled post office red colour paint & "FIRE HOSE" written on front.

2.12. INTERNAL HYDRANTS

The landing valve shall be of oblique pattern shall be complete with GI twist release chain with cap. The manufacturer's name & trademark along with year of manufacture & other details like size & type shall, be clearly mentioned. Valves shall be provided with one coat of primer & subsequently painted with 2 coats of red paint with shade no. 536 conforming to IS 5. The paint shall conform to IS 2932. Hand Wheel shall be painted black. It shall be BIS approved. Blank caps shall be made of gun metal. Hydrostatic pressure test shall be carried out at 21 kg/sqcm for 2.5 mins. The flow test shall be at 7 kg/sqcm at 900 lpm. The water tightness seat test shall be at 14 kg/sqcm. In case of any discrepencies between manufacturer's standards & above specified values, these parameters shall be in compliance with relevant IS codes. RRL Hose pipe shall be non percolating type, ISI marked (IS:8423), 63 mm dia x 15 m long (2 Nos.) complete with instantaneous type gunmetal 63 mm dia ISI marked Male & Female couplings (IS:903) bound and riveted to hose pipe with copper rivets and 1.5 mm copper wire.brusting pressure not less than 22 Kg/Sqcm. External Hydrant post shall also include standard short size 63mm dia. gunmetal branch pipe with gun metal nozzle of 20 mm nominal bore outlet with instantaneous type 63 mm dia coupling complete & confirming to IS:903. Internal hydrant shall be with firemans axe with heavy rubber handle. Swing type First Aid hose reel in red colour with 36 mts long and 20 mm dia heavy duty rubber water hose, 20 mm dia globe valve stop cock, terminating with G.M. coupling & nozzle of 5mm outlet with shut off valve confirming to IS 8090 - 1976 complete with drum and brackets for fixing on wall, bolts & nuts conforming to IS:884-1969 complete as required to be provided. MS door made up of 16 gauge MS Sheet capable of accommodating fire hose reel, landing valve, hose pipes, fittings, 1 No. CO2 & 1 No. Dry podwer type portable fire extinguishers & accessories. The door shall have a front glass with lock and key arrangement & shall be painted with one coat of primer & two coat of finished stove enamelled post office red colour paint & "FIRE HOSE" written on front.

(Approx. size of door: 2100 mm Height, Width of Door as per Shaft size)

2.13. FIRE BRIGADE INLET CONNECTIONS/ DRAW OFF CONNECTION

One set of 2/4 ways collector head Fire Brigade connection shall be provided at under ground tank, Ring Main, Sprinkler system and individual wet risers as specified conforming to IS 904.

The inlet to the wet riser sprinkler header shall be with 150 mm dia butterfly or sluice valve and non-return valve. The scope shall include necessary reducers, tees bends and special fittings as required.

It should be provided with M.S. enclosure fabricated from 1.5 mm thick M.S. sheet, front glass locking arrangement supported on M.S. structural members, painting with two coats of postal red enamel.

Fire brigade inlet connection (fire department connection) consisting of 4 Nos. 63 mm dia instantaneous inlet arranged on a 50 mm dia header, 1 No. 150 mm diameter sluice valve, with in built Non-return valve and wall mounted box of M.S. construction made out of 16 gauge MS Sheet with glass door to house the above mentioned components.

Fire brigade draw out connection (fire department connection) with suction pipe MS class 'C' 100 mm dia. & 100 mm dia. foot valve & steel chain including wall mounted box M.S. construction made out of 16 gauge MS Sheet with glass door to house the above mentioned componenets.

Inlet breeching having C.I. body Two way gun metal 63 mm dia instantaneous inlets conforming to IS 903 fitted with non return valves, 25 mm dia gun metal drain cock, blank cap, brass chains and 150 mm dia flanges with all accessories suitable for local fire tender complete as required.

3. ELECTRIC DRIVE, HORIZONTAL FIRE PUMPS

Without restricting to the generality of the foregoing, the pumps and ancillary and accessories.

i. Electrically operated pumps with motors, base plates and accessories.

ii. Alarm system with all accessories wiring and connections.

iii. Pressure gauges with isolation valves and piping bleed and block valves.

iv. M.S. pipes, valves, suction strainers, delivery headers and accessories.

v. Foundations, vibration eliminator pads and foundation bolts.

3.1. QUALITY CONTROL

These shall comply with the IS codes as specified.

3.2. SUBMISSIONS

a. Product Manuals

b. Hydraulic Details

3.3. STORAGE

These shall be stored as delivered in original packing.

4. FIRE, SPRINKLER AND JOCKEY PUMPS ELECTRIC DRIVE AND DIESEL ENGINE

4.1. PUMPING SETS

a. All pumps (main sprinkler & hydrant pumps, jockey pumps, diesel driven pump) shall be of suitable capacity & head to meet the requirements of NBC 2016 .

b. Pumping sets shall be multi stage horizontal split casing/end suction type centrifugal Pump having single outlet with cast iron body and bronze dynamically balanced impellers with mechanical seals. Connecting shaft shall be stainless steel with bronze sleeve and grease- lubricated bearings. The centrifugal pumps shall conforming to IS 1520.

c. Pumps shall be connected to the drive by means of spacer type love joy couplings, which shall be individually balanced.

d. The coupling joining the prime movers with the pump shall be provided with a sheet metal guard. Pump and motor engine shall be mounted on a common base plate fabricated from MS section.

e. Pumps shall be provided with approved type of mechanical seals.

f. Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of the rated head.

g. The pump shall meet the requirements of N.B.C. 2016 and N.F.P.A. and the unit shall be design proven in fire protection services.

4.2. ELECTRIC DRIVE

a. Electrically driven pumps shall be provided with totally enclosed fan ventilated induction motors of efficiency rating IE-3. For fire pumps the motors should be rated not to draw starting current more than 3 times normal running current.

b. Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.

c. Motors shall be wound for class F insulation and winding shall be vacuum impregnated with heat and moisture resistant varnish glass fiber insulated.

d. Motors for fire pumps shall meet all requirements and specifications of N.B.C.-2016 and N.F.P.A.

e. Motors shall be suitable for 415 volts, 3 phase 50 cycles A/c supply and shall be designed for 38 deg. C ambient temperature. Motors shall conform to I.S. 325.

f. Motors shall be designed for two-start system.

g. Motors shall be capable of handling the required starting torque of the pumps.

h. Contractor shall provide inbuilt heating arrangements for the motors for main pumps to ensure that motor windings shall remain dry.

i. Speed of the motors shall be compatible with the speed of the pump.

j. Suitable PCC/RCC foundation with plaster, Antivibration arrangement of cushy foot mounting for all pumps needs to be provided.

4.3. PRESSURE VESSEL

a. Air vessel shall be fabricated from 10 mm M.S. plate with dished ends and suitable supporting legs. Air vessel shall be provided with a 100 mm dia flanged connection from pump, one 25 mm dia. drain with valve, one gunmetal water level gauge and 15 mm sockets for pressure switches. The vessel shall be 450 mm dia x 2000 mm high In Plant Room & 250 mm dia. & 2000 mm high at Terrace or as per requirement and tested to 20 kg/ sq. cm pressure. One pressure vessel for Hydrant system & one for sprinkler system to be provided.

b. The fire pumps shall operate on drop of pressure in the mains. The pump operating sequence shall be arranged in a manner to start the pump automatically but should be stopped manually by starter push buttons only for Electric Pumps.

4.4. VIBRATION ELIMINATORS

All individual suction and delivery lines shall be with double flanged reinforced neoprene flexible pipe connectors (double arch of min. PN 16 rating). Connectors should be suitable for

a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufacturer's details.

It shall be resilient rubber lined single arch vibration eliminators suitable for raw water up from (-) 10 deg. C to 150 degree celcius temperature, working pressure 8.8 Kg/cm2 (approx.) and test pressure 24 bar (approx.). It shall be preferably without gaskets & it should compensate for any mis alignment/offset.

4.5. INSTALLATION

a. Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations. Angle iron frame of size 35mmx35mmx3mm shall be provided on the edge of foundation.

b. Pumps and motors shall be truly aligned by suitable instruments.

c. All pumps connections shall be standard flanged type with appropriate number of bolts. In case of non-standard flanges companion flanges shall be provided with the pumps.

d. Manufacturer's instructions regarding installation, connections and commissioning shall be followed with respect to all pumps and accessories.

e. Contractor shall provide necessary test certificates and performance charts with NPSH requirement of the pumps from the manufacturer. The contractor shall provide facilities to the Engineer-in-charge or their authorized representative for inspection of equipment during manufacturing and also to witness various tests at the manufacturer's works without any cost to the HLL.

f. Each pump shall be provided with a 150 mm dia pressure gauge, isolation cock and connecting piping, bleed and block valve.

g. Provide vibration eliminating pad and connectors for each pump.

h. A minimum clearance of 1M around the pumps shall be provided.

4.6. DIESEL ENGINE

a. Diesel engine shall be of multi cylinders (4/6 cylinder AS PER REQUIREMENTS) with individual head assemblies. The engine shall be water-cooled and shall include heat exchanger/radiator cooled and connecting piping, strainer, isolating and pressure reducing valves, bye-pass line complete in all respects.

b. Engineer shall be direct injection type with low noise and exhaust emission levels and shall conform to BS649/IS 1601/IS10002 as amended upto date.

c. The speed of the engine shall match the pump speed for direct drive.

d. The engine shall be capable of being started without the use of wicks, cartridge heater, plugs or either at engine room temperature of 7 deg. C and shall take full load within 15 seconds from the receipt of the signal to start.

e. The Engine shall efficiently operate at 38 deg. C ambient temperature at 50 m above mean sea level.

f. Noise level of the engine shall not exceed 105 DBA (free field sound pressure) at 3 m distance.

g. The engine shall be self starting type up to 4 deg. C and shall be provided with one 24 V heavy duty DC battery, starter, cut-out, battery leads complete in all respects. One additional

spare battery shall be provided. The battery shall have a capacity of 180 to 200 ampere hours and 640 amps cold cranking amperage.

h. A battery recharger of 10 to 15 amperes capacity with trickle and booster charging facility and regulator shall be provided.

i. Annunciation panel shall be suitable for working on 24 volts D.C. Arrangement for starting shall be automatic on receiving the signal but shutting off shall be manual.

j. The engine shall be provided with an oil bath or dry type air cleaner as per manufacturer's design.

k. Engine shall be suitable for running on high speed diesel oil.

l. The system shall be provided with a control panel with push button starting arrangement also and wired to operate the engine on a differential pressure gauge.

m. The entire system shall be mounted on a common structural base plate with ant vibration mountings and flexible connections on the suction and delivery piping.

n. One fully mounted and supported day oil tank fabricated from 5mm thick M.S. sheet electrically welded shall be provided alongwith level indicating gauge glass on the day oil tank and low fuel indication of the control panel. The capacity of tank should be sufficient to allow engine to run on full load for at least 2 hours. The fuel pipe from diesel tank to pump should be of robust construction, preferably of hard rubber.

o. Exhaust pipe shall be provided with suitable muffler (residential type) to discharge the engine gases to outside open air as per site conditions. The piping shall be duly insulated with 50mm thick glass wool/rockwool of suitable density & K value and 1.0mm thick aluminium sheet cladding.

p. All accessories fittings and fixtures necessary and required for a complete operating engine set shall be provided.

4.7. OPERATING CONDITIONS FOR JOCKEY ,ELECTRIC& DIESEL PUMPS

a. Jockey pump shall start automatically when the Water Pressure in the System falls to a pre-set value and shut down when the system pressure reaches the set value. Both Limits shall be adjustable. The Pressure switch settings for Jockey Pump shall be determined as per relevant codes and Site Conditions.

b. Main Electric Fire Pump shall operate on account of sudden pressure loss. So, long as Main Electric Fire Pump is working, other Fire Pumps will not operate. The Pump shall start when the water pressure falls to a pre-set value in the system The Pressure switch settings for Jockey Pump shall be determined as per relevant codes and Site Conditions.

c. The Diesel Fire Pump will start on sudden pressure loss, only in case supply to main electric Fire Pump is not available or within a pre-set time the main Electric Fire Pump fails to start or fails during operation. No other pump will be working when Diesel Engine fire Pump is in operation. Audio-Visual Alarm shall be available to indicate failure of Main Electric Fire Pump.

d. A three attempts starting facility will be provided for diesel Pump.

e. If within a pre-set time, the pump also fails to start or fails to develop pressure, the diesel pump shall also be shut down and locked out. An audio visual alarm indication shall be given at the Control Panel.

f. The Terrace Pump will start on sudden pressure loss of pressure only when both the Fire Pumps have either failed to start or exhausted water.

g. Only one pump will be working at a time. In manual mode, more than one Pump can be started.

h. Water Level in UG and Terrace Tanks shall be monitored and in case of low water level, pumps connected with the tank shall not operate (even on manual mode) or stop operation as the case may be. An audio-visual alarm shall be given at the Control Panel. The Terrace Fire Tank shall be provided with Baffles to ensure proper circulation of water before overflow/discharge into domestic tank.

5. ELECTRICAL INSTALLATIONS

5.1. POWER AND CONTROL PANEL AND OTHER CONTROL COMPONENTS

For Fire Fighting Panel & Control Panel, specifications under Technical Specifications for LT Panel under Electrification shall be followed. Power /Control cable of various sizes shall be XLPE insulated & PVC sheathed.

5.2. CABLE LAYING:

Cable shall be laid generally in accordance with CPWD Specifications (Electrical) External & Internal amended upto date . Cables shall be laid on 14 gauge perforated MS sheet cable trays and cable drops/risers shall be fixed to ladder type cable trays fabricated out of steel angle. Access to all cables shall be provided to allow cable withdrawal/ replacement in the future. Where more than one cable is running, proper spacing shall be provided to minimize the loss in current carrying capacity. Cables shall be suitably supported with Galvanized saddles when run on walls/trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifted sand & protected with bricks, tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable 1.1 KV cable shall be buried 600 mm below ground level. For additional details pertaining to Cable Laying, Refer the Electrical Works Specifications under the relevant Head.

5.3. WIRE SIZES:

For all Single phase/ Three phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by means of insulated aluminum conductor wires of adequate size. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated single strand aluminum conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification in control wiring.

The minimum size of control wiring shall be IS marked 2C/5C x 1.5 mm^2 PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power wiring cabling shall be of the following sizes:

i. Upto 5 HP motors :- 3.5C x 6 mm^2 Al conductor wires or meeting functional requirement

ii. Above 5HP upto to 15 HP motors :- 1 No. 3.5C x 10 mm2 Al conductor wires or meeting functional requirement

iii. From 20 HP to 25 HP motors :- 2 Nos. 3.5C x 25 mm2 Al conductor armoured cables or meeting functional requirement

iv. From 60 HP to 75 HP motors. :- 2 Nos.3.5C x 50 mm2 Al conductor armoured cables or meeting functional requirement

v. 100 HP motors. :- 2 No. 3.5C x 100 mm^2 Al conductor armoured cables or meeting functional requirement.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors.

The motor starter shall conform to IS 1822 as amended upto date.

5.4. EARTHING:

For Earthing details, Refer the CPWD Electrical Works Specifications 2013and electrical specification.

5.5. DRAWINGS:

Shop drawings for control panels and wiring of equipment showing the route of conduit/ cable shall be submitted by the contractor for approval of Engineer-in-Charge before starting the fabrication of panel and starting the work. On completion, four sets of complete "As-installed" drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.

5.6. TESTING:

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS Codes and test report furnished by a qualified and authorized person. The entire electrical installation shall be got approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Supervisor.

5.7. PAINTING:

All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be backed in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

5.8. LABEL AND TAGS

Engraved PVC labels shall be provided on all incoming and outgoing feeders switches. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel and covered with transparent plastic sheet. All cables terminations at panels and at equipments shall be provided with tags as approved by Project Manager.

1. All panels to have provision for padlocking and all MCCB's/ MCB's to have provision for locking in off position.

5.9. ELECTRIC FIRE PUMP PANEL : -

The main switch board shall be floor mounted/ wall mounted fabricated from 2mm thick CRCA sheet powder coated with IP 42 protection

3Ph 415V Normal supply for fire pumps near UG tank and Essential supply for terrace pump and jockey pumps

The panel shall incorporate the following facilities.

a. TP &N Moulded case circuit breaker of appropriate fault level

b. Control system components and equipment such as relays, contractors, and timers etc. for automatic operation.

c. Starter unit, current transformer and ammeter

d. Indication lamps, their fuses, terminal block, push button, control and selector switches etc. as required.

e. Pump lock out devices due to faults or abnormalities as specified.

f. Visual/ audio alarms, indications and communications facility as specified.

g. Necessary inter-connection control and power cable work, cable glands, lungs and internal wiring and connections.

5.10. ENGINE SECTION: -

The engine section shall incorporate the following facilities.

a. Control system components and equipment such as relays, contractors, and timers etc. for automatic operation.

b. Instruments, indicator lamps, fuses, terminal blocks, push buttons, control and selector switches etc. as are required.

c. Engine shut down and block out devices due to faults or abnormalities as specified.

d. Visual/ audio alarm indication and enunciator facility as specified.

e. Inter- connection control and power cable work, cable glands, lungs, all internal wiring and connection etc.

5.11. AUXILIARY PUMP SECTION: -

Each of the auxiliary pump section for priming pump shall incorporate the following:

a. TP&N Moulded case circuit breaker

b. Control system components such as relays, timers, contractors etc. as are necessary for functional requirements.

c. Starter unit, current transformer and ammeter

d. Indication lamps, fuses, terminal blocks, push buttons selector, switch etc. as required.

e. Inter-connections, power and control cable work, cable plants lugs, internal wiring and connections.

f. Low water level alarm for terrace tank, where provided.

5.12. SYSTEM CONTROLLER : -

The system controller shall consist of relay timer, contactor etc for interlocking of fire pump and fault isolation and incorporate the following:

a. Control components integrating the various sections, so as to satisfy the functional requirements.

b. Battery charger unit with boost/ float charge facility with voltmeter, capable of independently charging 1 set of battery at a time.

c. Visual/ audio alarms not covered in individual sections.

d. Lamps healthy test facility.

e. Instruments, indicating lamps, push buttons, fuse terminal blocks etc. as are required.

f. Test facility to stimulate operation of hydrants.

5.13. OTHER CONTROL COMPONENTS

5.13.1. Pressure Switches:

Pressure switches shall be provided for switching on and off the jockey pump at present pressures and also for switching of the fire pump at priest pressure. Being the main component for initiating the signal for the operation of the pumps, the pressure switches shall be totally reliable, sturdy in construction and of long life. The pressure settings shall be adjustable.

5.13.2. Low water level indication and switch:

To prevent the dry running of the fire pumps due emptying of the static tank, water level indication and switch shall be provided. This shall trip the electric motor or stop the diesel engine, as the case may be when the water level goes below a present level. This shall also furnish a distinct low water level audiovisual alarm. This should indicate the level of water at different stages is the power and control panel.

5.13.3. Power Supply for Controls:

In order ensure that the control systems remains operational at all times, the control system shall be designed for 24V DC operation, fed from 24 V wet battery. This shall be independent of the starting battery for the engine i.e., battery shall remain trickle charged at the times from the common battery, charges at the control section.

6. GAS BASED FIRE SUPPRESSION SYSTEM:

6.1. For Low Voltage equipment /Laboratories,& other Critical Areas:

The Total Room Flooding system of fire detection and quenching is proposed in all Low Voltage Equipment rooms where Water sprinklers cannot be used. The Gas cylinder assembly should be UL/FM approved with seamless CCOE approved cylinder and will be connected to discharge nozzles through metal Piping. The master cylinder Kit fitted on Gas cylinder will be operated through separate Fire detection Panel and will release zero Ozone depletion potential Gas through the nozzles in case of fire.

6.2. For Electrical panels:

Tube based Fire protection system is used in the Electrical Panels to be installed in substations. UL listed fire detection Tube shall be installed throughout the compartment of panels. The location and spacing of tube shall be above the hazard to be protected. Cylinder equipped with brass valve, pressure Gauge isolation valve will be fitted on the wall of the panel with suitable brackets and will be connected to the detection tube. in case of fire the tube shall rupture at a point. The rupture Tube shall result in formation of discharge point and release Gas Agent in Uniform pattern.

7. PORTABLE FIRE EXTINGUISHERS:

ABC Powder stored pressure type Fire Extinguishers of 6 KG capacity IS : 15683 & CO2 gas based Fire Extinguisher of 4.5 Kg capacity with IS : 15683 is proposed for all floors near internal hydrant locations.

4.5 kg carbon dioxide extinguisher, IS marked shall be complete with high pressure discharge tube, horn, control valve & CCE approved cylinder. It shall be suitable for extinguishing Class B & C fires.It shall be provided with Wheel type /Squeeze grip type with discharge hose & horn. It shall be suitable for operation within the temperature range of (-)20 degree celcius to 55 degree celcius.The test pressure shall be 250 Bar.The minimum effective discharge shall be 95 percent.

6 kg & 9 kg Mono Ammonium Phosphate (ABC) type cartridge operated extinguishers. The minimum effective discharge shall be 85% & the minimum jet length shall be between

2-3 meters. The discharge pressure time shall be between 8-13 seconds. The hydraulic test pressure shall be 35 kg/sqcm & the charge test pressure shall be 15 kg/sqcm & the operating range shall be within (-)5 to 55 degree C. The operating valve shall be squeeze grip type with discharge hose & nozzle.

Higher capacity Trolley mounted Dry Chemical; Powder type Fire Extinguisher of capacity 25 kg. confirms to IS 10658, bearing ISI mark, (Outside Cartridge). CO2 type Fire Extinguisher of capacity 22.5 kg filled with Co2 Gas as per IS 15222 with controll discharge mechanism fitted with Hose, Horn & Trolley confirms to IS 2878 bearing ISI mark. Co2 Cylinder as per IS 7285. The hydraulic test pressure shall be 250 Bar. The Operating range shall be between (-) 30 to 55 degree C. It shall be suitable for extinguishing fires of class B &C.

50 Lit. trolley mounted cartridge type fire extinguisher (foam) :- It shall be suitable for extinguishing fire of class A & B. The minimum effective discharge shall be 90% & minimum jet length shall be 10 meters. The discharge pressure time shall be between 60-180 seconds. The hydraulic test pressure shall be 30 kg/sqcm & type of extinguisher media shall be water & AFFF (3 lit. of 6% concentrate).

The ISI marked Extinguisher and their installations shall be in accordance with acceptable standard of NBC 2016. These units shall be mounted at a convenient height to enable to its quick Access. The requirement shall be as per NBC 2016 Part – 4 Table -7.

8. FIRE SIGNAGES :-

Various types of signage are proposed in the complex as per NBC 2016 Part -4. At every floor near Lift landing diagram showing stairways shall be provided mentioning instructions - 'IN CASE OF FIRE USE STAIRS UNLESS INSTRUCTED OTHERWISE'. The signage shall be above call button in Lift Lobby. Floor Signage indicating Exit path will be provided in each floor within the staircase. The Numerical shall be Bold Type of minimum 75 MM height. Each corridor of every floor will have directional signage indicating Fire Escape route. These Signage may be LED lit with UPS power backup or of Photo Luminescent paint. So that they will be visible in dark in case of power failure. Fire related signages shall be printed on Photoluminescent U1000 aluminium sheet of 1.0 mm (+-10%)/Acrylic Board containing Lumigen II as base chemical, covered under UV stablized coating and of appropriate size including fixing on wall, door, ceiling etc. with proper clamps, hangers, cleats, anchor fasteners etc. complete in all respects. Text shall be double sided or single sided as per requirements.

9. CLEAN AGENT FIRE EXTINGUISHERS

Clean Agent Fire Extinguishers are proposed to be provided in areas proposed in DBR for extinguishing fire of sensitive equipment, the HFC 236fa or equivalent Clean Agent Extinguisher shall be the most eco-friendly extinguisher. FE36 Clean Agent Extinguishers shall leave no residue, pack in mega power and shall be absolutely safe for use on any sensitive electronic equipment.

They should have zero ODP (Ozone Depletion Potential). They shall be extremely lightweight, yet packed with tremendous power and shall throw, to penetrate past even the finest grills and meshes.

It shall be Residue free: It shall leave no residue making it safe for use on sensitive equipment.

Valve Construction : Forging & Machining

Internal Coating of Can : Epoxy Powder coating

External Coating of Can : Epoxy Polyester Powder coating

Tests: Helium Leak Detection

Sheet metal thickness: 1.60 mm (approx.),

It shall be Lightweight: Extremely lightweight, yet packed with tremendous power and throw, to penetrate past even the finest grills and meshes.

It shall be Easy snap safety seal: A completely tamper proof safety seal that can be broken in seconds.

It shall be complete with pressure gauge, discharge mechanism with Easy Snap Lever Lock, EPDM rubber hose & shall Fight Class A , B and electrically started Fire, extinguisher has ISO 9001 and CE certifications, preferably UL listed & FM approved, and conforms to ISI standards & shall have preferably 5 years of warranty.

It shall be preferably of 4 kg (minimum) capacity with Discharge time: 8 Secs (approx.) & Range: 2 Meters (approx.)

10. INSTALLATION , TESTING AND COMMISSIONING

10.1. SCOPE

This section covers the requirements of installation of the various components of the wet riser system.

A survey of the site of the work shall be made by the contractor before preparation of the detailed drawings for submission to the department for approval. The installation shall be carrier out strictly in accordance with the approved drawing.

The scope of installation work shall include the following, where or not expressly mentioned in the schedule or work.

i. Cement concrete (1:2:4 Mix) foundation for all pump sets. Iron Angle framing around the Pump foundation (at the edges/periphery) to protect it from chipping/damage etc.

ii. Vibration isolation arrangement for all pump sets

iii. Filling up the hole in flooring with cement concrete, after laying the wet riser pipes

iv. Necessary supports and clamps for wet riser pump room

v. Necessary supports and camps for wet riser plumbing in the building

vi. Supporting bracket/ frame work for the fuel oil tank of the Diesel engine.

vii. Excavation of the earth, consolidation and refilling after laying of wet riser piping in ground.

viii. Provision of necessary brick base or intermediate support as required in approved manner in case of soils which are no strong enough to support the pipes, thereby likely to case different settlement.

ix. Necessary anchor block of ample dimensions in 1:2:4 cement concrete at all bends, tee connections, foot of the wet riser, and other places as required to stand the pressure thrust in pipes.

x. Necessary masonry work/ steel work for supporting hose cabinets near external (yard) hydrants.

xi. Valve chambers of approved design with external (yard) hydrant.

xii. Ground level hydrants of approved design, where specifies.

xiii. Cutting and making good the damages for the installation work of the riser system

xiv. All the required control piping, exhaust piping from engine to outside, oil piping for fuel oil and lubricating oil for the engine, drain piping from the pumps to the drain

point in the pump room, overflow piping from priming tank to the sump. The piping work shall include all necessary fittings, valve and accessories for effective functional requirements.

xv. Inter-connecting cable work with controls, control panel, batteries etc. including battery leads.

xvi. Orifice plates at individual hydrants as required.

Where provision of MS pipe shall below ground become inescapable, it shall be protected from soil corrosion by two coats of bitumen painting and wrapped with bituminous Hessian cloth and finish with hot bitumen paint.

Each MS pipe shall be subjected to hydraulic pressure test before installation, in presence of the Engineer or his authorized representative.

External (yard) hydrants shall be located at least 2m away from the face of the buildings but not more than 15m and be accessible. Distance between the two hydrants should not be more than 45 metre.

Where external hydrants are below ground level , they shall be enclosed in masonry trenches of size 75sqcm and 8cm above ground level. The hydrant shall be with in 8cm from the top of the enclosure.

Landing Valve of Internal hydrant at each floor shall be located at about 1m above floor level.

Valve chambers in ground shall be of 1sqm in size, with cover.

10.2. PAINTING

Painting of the entire wet riser piping over the ground shall be done with anticorrosive primer and 2 coats of approved paint. The color shall be red to shade No. 536 of IS: 5, Paint shall conform to IS:2932.

The pumps and engine shall be painted after installation with a coat of approved paint to similar shade as per original supply.

10.3. APPROVAL BY LOCAL BODIES

It shall be the responsibility of the contractor to obtain the approval of drawings and to get the installation inspected and approved by the concerned authorities as may be necessary as per local by-laws.

10.4. PIPE WORK ASSOCIATED WITH DIESEL ENGINE

a. Pipe works for fuel system, lube oil system and exhaust system shall be complete with all required supports, clamps, hangers etc. for a complete work.

b. Fuel feed is by gravity and the fuel tank shall be located at least 60cm above the fuel injection pump.

c. Fuel pipe of copper shall not be soldered but brazed or welded.

d. No valves or cocks shall be provided in the fuel feed line to engine from the fuel tank.

e. Precautions shall be taken to prevent any air locks in any part of the fuel system. No air relief cock shall be permitted and where inescapable, screwed plugs shall be provided for the purpose.

f. The installation of the fuel supply system shall be such that a completely primed condition is maintained, free from air lock.

g. Filters shall be provided in fuel oil and lube oil circuits allocations that are easily accessible for maintenance.

11. TECHNICAL SPECIFICATIONS FOR SPRINKLER SYSTEM

All the piping for sprinkler work shall be with MS Class C & shall conform to IS 1239/3589.

11.1. SPRINKLER HEADS

a. Side wall/pendant/upright sprinklers to be provided as per requirements which shall be quick response type, shall be UL & FM certified, complete with rosette plate, glass bulb temperature rating of 68 degree celcius (red colour),Quick response type, chrome plated finish & in compliance with NBC 2016 & relevant IS codes. Wherever false ceiling is there, upright sprinklers to be provided at requisite distance as per codal provisions.

b. Types

i. Conventional Pattern

The sprinklers shall be designed to produce a spherical type of discharge with a portion of water being thrown . The sprinklers shall be suitable for erection in upright position or pendant position. The designing of installation will be as per IS 15105.

ii. Spray Pattern

The spray type sprinkler shall produce a hemispherical discharge below the plane of the deflector.

iii. Ceiling (Flush) Pattern

These shall be designed for use with concealed pipe work. These shall be installed pendant with plate or base flush to the ceiling with below the ceiling.

c. Side Wall Sprinklers

i. These shall be designed for installation along with the walls of room close to the ceiling. The discharge pattern shall be similar to one quarter of sphere with a small proportion discharging on the wall behind the sprinklers.

d. Constructions

i. **Bulb:**- Bulb shall be made of corrosion free material strong enough to with stand any water pressure likely to occur in the system. The bulb shall shatter when the temperature of the surrounding air reaches a predetermined level.

ii. **Valve Assembly**: - Water passage of the sprinkler shall be closed by a valve assembly of flexible construction. The valve assembly shall be held in position by the quartzoid bulb. The assembly be stable and shall withstand pressure surges or external vibration without displacement.

iii. **Yoke:** - The yoke shall be made of high quality gun metal. The arms of yoke shall be so designed as to avoid interference with discharge of water from the deflector. The sprinkler body shall be coated with an approved anti-corrosive treatment if the same is housed in corrosive conditions.

iv. **Deflector:** - The deflector shall be suitable for either upright or pendent erection. The deflector shall be designed to give an even distribution of water over the area protected by each sprinkler.

e. Colour Code

The following color code shall be adopted for classification of sprinkler according to nominal temperature ratings:

Sprinkler Temperature Rating	Color of the Bulb
68 deg. C	Red

f. Size of Sprinklers Orifices

The following sizes of sprinklers shall be selected for various classes or hazards.

Moderate hazard	15 mm nominal bore

g. Stock of replacement sprinkler

The following spare sprinklers shall be supplied along with the system free of cost to be treated as spare.

Moderate hazard systems	24 sprinklers

h. Temperature Rating

For normal conditions in temperature climates rating of 68 deg. C shall be used. However the temperature rating shall be as closed as possible to, but not less than 30 deg. C above the highest anticipated temperature conditions.

i. Maximum & Minimum Distance between sprinklers, between sprinklers & boundary wall shall be as per hazard classification of building & relevant IS codes.

j. Zoning of sprinklers with ICV to be placed in Plant Room in required buildings to be done as per relevant IS codes/NBC 2016/CPWD specifications. The required buildings as specified in DBR (Design Basis Report) where sprinkler provision is to be considered shall be with min. one independent ICV.

k. In order to avoid any kind of leakage from sprinklers, it shall be wound with Teflon tape & any other suitable water resistant sealing material.

l. All measures to be considered so that sprinkler bulb is cleaned & free from any blemishes.

m. Sprinkler type (pendant/upright/sidewall) shall be conforming to requirements & relevant IS codes.

11.2. PIPES AND FITTINGS

a. Pipes

i. Pipes less than 25mm dia shall not be used and shall be Black Steel conforming to IS: 1239 (Heavy Class) upto 150mm.

ii. Welded Black Steel Pipe, Heavy Class conforming to IS:3589 for size greater than 150mm.

iii. Fittings for black steel pipes shall be malleable iron suitable for welding or approved type cast iron fittings with tapered screwed threads.

b. Jointing

Joint for black steel pipes and fittings shall be metal to metal tapered thread or welded joints. A small amount of red lead may be used for lubrication and rust prevention in threaded joints. For Pipe size upto 50mm, Thread Joints are to be considered and for Pipe size above 50mm, Welded joints are to be considered.

Joints between MS pipes, valves and other appurtenances, pumps etc. shall be made with M.S. flanges with appropriate number of bolts. Flanged joints shall be made with 3mm thick insertion rubber gasket.

c. Pipe Protection

i. All pipes above ground and in exposed locations shall be painted with one coat of red oxide primer and two or more coats of synthetic enamel paint of approved shade.

ii. Pipes in chase or buried underground shall be painted with two coats of hot bitumen, wrapped with bituminous Hessian cloth and finished with one coat of hot bitumen paint.

d. Pipe Supports

All pipes shall be adequately supported from ceiling or walls from existing inserts by structural clamps fabricated from M.S. structurals e.g. rods, channels, angles and flats. All clamps shall be painted with one coat of red and two coats of black enamel paint. Where inserts are not provided, the contractor shall provide anchor fasteners.

e. Orifice Flanges

Contractor shall provide orifice flanges fabricated from 6mm thick Brass plates on the branch lines feeding different zones/ floors so as allow required flow of water at 3.5 kg/ sq.mm pressure. The contractor shall furnish design for these orifice flanges.

f. Valves

Butterfly or Sluice valves of size 80mm and above shall be double-flanged cast iron conforming to IS: 780.

Check valve shall be of cast iron double flanged conforming to IS: 5312.

Valves on pipes 65mm and below shall be heavy pattern gunmetal valves with cast iron wheel seat tested to 20 kg/ sq.mm pressure. Valves shall conform to IS: 778.

g. Drain Valves

50 m dia black steel pipe conforming to IS: 1239 heavy class with 50 mm gunmetal full way valve for draining water in the system in low pockets.

11.3. INSTALLATION CONTROL VALVE:-

Installation control valves shall comprise of the following.

a. One main stop valve of full way pattern with gunmetal pointer to indicate where open/ shut

b. One automatic alarm valve, fitted with handle and cover.

c. One hydraulic alarm motor and gong for sounding a continuous alarm upon out-break of fire.

d. One combined waste and testing valve including 5 mtr of tubing and fittings

e. Alarm stop valve

f. Strainer

g. Drain plug

h. Padlock & strap

i. Wall box for installation of valve

11.4. ZONAL CONTROL VALVE :-

Zonal Control Valve Assembly shall comprise of the following:

a. Butterfly Valve

b. Non-Return Valve

c. Flow Switch

d. Pressure Gauge

e. Drain Valve

f. Sight Glass

g. Necessary MS piping

Flexible connection for sprinklers shall be braided type of various lengths as per site requirements & shall be UL listed & FM approved.

9.5 ANNUNCIATION SPRINKLER PANEL

The equipment for control panel should be compact neatly wired and enclosed in a suitable 2 mm M.S. sheet that is suitably treated against corrosion. The control panel should be painted with enamel paint. The panel shall consist of:

a. Panel should be made in a module of suitable nos. of zones e.g. each module will have audible and visual indications and will monitor the circuit conditions with 24V DC battery.

A.C. Power Supply

Fault and Fire indication lamp

Alarm acknowledgment push buttons

b. The circuits provided in the control panel for each zone shall indicate the following conditions:

i. Open Circuit in zone wiring

ii. Short Circuit in zone wiring

iii. Normal conditions

iv. Power failure

v. Low battery

c. The Automatic annunciation panel shall suitable for operation on 24V DC and shall be provided with power supply unit suitable to operate on A.C. mains of 230 V with a variation of 10%. The system shall be so designed that in case of failure of A.C. main supply it shall automatically change over to battery supply.

d. Suitable protection may be provided against charging of the battery over and above the specified values.

9.6 BATTERY UNIT

i. The system shall be powered by lead acid storage stationery complete with automatic duel rate charger boost and trick operating form 220 V, 50 Hz, single phase, mains supply. The battery capacity should be adequate for operation of the system connected to it for at least 24 hours in the non-alarm state followed by 30 minutes operation of all sounders and other connected equipments after a power (mains) failure.

ii. The automatic charger should operate at the boost charge when the battery terminal voltage is less than about 2.1 V 20 per cell, and operate at a trickle charge rate of 100 to 200 AH, when the battery terminal voltage exceeded about 2.25 per cell.

iii. The power unit should have the following.

a. Voltmeter of suitable range

b. Ammeter of suitable range

c. Indicator lights for mains

d. Indicator lights for DC output

iv. The preferred nominal DC voltage shall be 24 V and shall preferably be isolated. (IF and isolated supply is provided a line earthing indicator should also be provided).

v. The DC system and the detection and sounder circuits shall be protected against their attaining a voltage to earth exceeding 50V.

vi. The connection to the 230 V, 50 Hz, single phase system shall be through a three pin plug socket especially provided for the connection to the annunciation panel. This connection should in addition utilized for earthling all non-current carrying metal parts of the sprinkler system, except those that are either doubly insulate or mounted at a height exceeding 2.2 meters.

vii. The battery unit shall be housed in a steel cabinet at least 2 mm thick suitably painted with two coats of Post Office Red, Enamel necessary vent holes should be provided for proper ventilation.

12. PRESSURE GAUGES

It shall be provided at the following locations.

a. Just above alarm valve

b. Just below alarm valve, on the installation stop valve

c. One pressure gauge on delivery side of each pump

d. One Pressure Gauge, part of Pressure vessel installation.

e. On the Common Delivery Header of Fire Pumps, one on either side of the Non Return Valve.

f. On the Wet Riser in every Fire Hose Cabinet Shaft.

g. Any other location as per requirement.

13. INSTALLATION OF PIPING

A. BELOW GROUND PIPING:

Under ground piping should be installed in masonry trenches with cover or reinforced concrete. The pipe work shall be supported at regular intervals of 2.5m with masonry or RCC supports. All pipes shall be protected against corrosion with two coats of bituminous painting and wrapped with pypkote or bitumen Hessian cloth and finish with one coat of hot bitumen paint.

B. ABOVE GROUND PIPING:-

a. All above ground piping shall be installed on suitable pipe hangers/ supports as required. The hangers shall be made of MS angles, channels, channels etc. and painted to the required finish (with suitable synthetic enamel paint). The spacing supports shall be as follows.

i. 25 mm - 50 mm dia. 1.5mtr.

ii. 65mm – 100mm dia. 1.75 mtr.

iii. Above 100mm 2 mtr.

iv. Vertical Piping 2 mtr.

b. Piping shall be screwed type up to 50 mm dia. Welding of joints will be allowed for pipes of 65mm mm of larger diameters.

14. TESTING & COMMISSIONING:-

12.1.1 PRESSURE TESTING OF PIPES

During laying of pipes, the same shall be subjected to 10 Kg/cm2 hydraulic pressure for a period of 24 hrs , in sections. After completion of the work, all valves/fittings shall be installed in position and entire system shall be tested for 24 Hrs. at a pressure of 10 Kg/cm2.The drop of pressure up to 0.5 Kg/cm2 shall be accepted. The pressure Testing may be carried out by means of Electric Driven Pump or Manually operated Test Pump.

All leaks and defects in different joints, noticed during the testing and before commissioning shall satisfaction of engineer.

Testing of fittings/ equipments shall be carried out either at site or at works in the presence of a representative of the engineer. Test certificates shall also be furnished by the contractor.

The automatic operation of the system and alarms for the various functional requirements, as laid down in this specification, shall be satisfactory carried out in the presence of Engineer-in-charge.

12.1.2 INTERNAL HYDRANT/SPRINKLER & EXTERNAL HYDRANT SYSTEM:-

After laying and jointing, the entire piping shall be tested to hydrostatic test pressure. The pipes/sprinkler heads shall be slowly charged with water so that the air is expelled from the pipes. The pipes shall be allowed to stand full of water for a period of not less than 24 hours and then tested under pressure. The test pressure shall be 12 kg/cm2. The test pressure shall be applied by means of manually operated test pump or by a power driven test pump to be provided by the contractor. The Lines shall be flushed before completion of building work so that any foreign matter which might have entered the system is taken out. The Jockey Pump should be operated and Valves must be open at different locations.

After completion of work, all valves/ fittings shall be installed in position & entire system shall be tested for 24 hours at a pressure of 10 kg/sqcm. The drop of pressure upto 0.5 kg/sqcm shall be accepted.

After completion, all operation checks (operation scheme of pumps & pressure swtich settings) needs to be carried out for automatic operation of the system. landing valves may be opened at different locations repeated couple of times to ensure trouble free operation.

Flow Test -The design flow of pumps shall be checked. The pump shall be operated after opening a number of Landing Valves at different locations. Design pressure is to be maintained in the Pump House. Water discharge is to be measured by drop in level in UG Tank for a certain period. All pumps shall be tested one by one. The flow rate shall not be less than as specified while maintaining the design pressure in pump house.

12.2 FINAL TESTING

After completion, all operation checks shall be carried for automatic operation of system including flow test. The exercise shall be repeated couple of time to ensure trouble free operation.

Commissioning:- Before commissioning , entire system be flushed properly. As soon as the work is completed the system shall be commissioned and made available for use. If required, isolate the system of under construction portion of the buildings.

For automatic operation sprinkler system by using inspection testing valve. In this case annunciation panel of that particular zone and mechanical gong valve should work.

Overhead Tanks shall be so designed so that the Pipe Inlet & Outlet Spout of Tank and the opening lid is not at the same level so as to ensure smooth filling of Tanks and subsequent overflow.

All other testing & commissioning methods to be adopted & performed as per relevant IS Codes/ CPWD Specifications & NBC 2016 norms.

13. PAINTING

Painting of the entire wet riser piping & sprinkler piping over the ground shall be done with 1 coat of anticorrosive primer and 2 or more coats of approved paint till the satisfaction of engineer-in-charge ensuring that one coat of paint is done after final painting of the pump house & buildings. The color shall be post office stove enameled red with shade No. 536 of IS: 5, Paint shall also conform to IS:2932. The pumps/ engine shall be painted after installation with a coat of approved paint to similar shade as per original supply.

CHAPTER - N

TECHNICAL SPECIFICATIONS - BUILDING MANAGEMENT SYSTEM (BMS)

1. GENERAL

1.1. SYSTEM DESCRIPTION

A. The entire Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers communicating via BACNET/ ModBus/ Profibus/ LonMark/Lon Talk communication protocols to a Network Area Controller (NAC) / Router.

B. The entire Integrated Control and Monitor Management System (IBMS) shall be comprise of a network of interoperable, stand-alone digital controllers communicating on an open protocol communication network to a host computer within the facility (when specified) and communicating via the Internet to a host computer in a remote location. The IBMS shall communicate to third party systems such as Chillers, Boilers, Air-Handling Systems, Energy metering systems, Lighting Management System & other energy management systems, Fire-Life safety systems and other building management related devices with open, interoperable communication capabilities.

C. The IBMS framework shall utilize JAVA/dotnet based automation products and services with built-in Internet connectivity to a broad range of distribution partners in the building automation, energy services, power/utility, and industrial sectors. The Framework shall bring together the computerization of control applications under the umbrella of single integrated system architecture. The suite of component software applications shall support true plug-and-play, multi-vendor interoperability, resulting in lower automation and information infrastructure costs. The Network Area Controllers (NAC's) shall run a JAVA Virtual Machine (JVM) platform and use a common set of tools for accessing and integrating multiple protocols.

D. The Building Management System (BMS) shall be comprised of Network Area Controller or Controllers (NAC) / Routers. The NAC / Router shall connect to the local or wide area network, depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network. Each NAC shall communicate to LonMark/LonTalk and/or BACnet/Modbus/Ethernet Direct Digital Controllers (DDC) and other open protocol systems/devices.

E. The following software packages shall be loaded into the system as minimum standard :-

a. Complete system operational software

b. Site specific data manipulation software

c. Active graphics software

d. Energy management system software

e. Alarm indication software

g. Data Visualization Package

h. Internet Enabled Remote Monitoring Package.

1.2. SUBMITTAL

A. Eight copies of shop drawings of the components and devices for the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions for all controllers, valves, dampers, sensors, routers, etc. Shop drawings shall also contain complete wiring and

schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation shall also be included with the submittal package. BMS contractors supplying products and systems, as part of their packages shall provide catalog data sheets, wiring diagrams and point lists to other contractors for proper coordination of work.

B. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol. BMS contractors shall provide these diagrams for their portions of work; the Systems Integrator shall be responsible for integrating those diagrams into the overall trunk cable schematic diagrams for the entire Wide Area Network (WAN).

C. Submittal shall also include a complete point list of all points to be connected to the BMS.

D. Upon completion of the work, provide a complete set of 'as-built' drawings and application software on compact disk. Drawings shall be provided as AutoCAD™ compatible files. Eight copies of the 'as-built' drawings shall be provided in addition to the documents on compact disk. BMS contractors shall provide as-built for their portions of work. The BMS contractor shall be responsible for as-built pertaining to overall BMS architecture and network diagrams. All as-built drawings shall also be installed into the BMS server in a dedicated directory.

2. Operator Workstation Requirements:-

i. General

- The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this project provide a minimum of 10 concurrent operator users and/or 2 concurrent engineering users within the Software.
- The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Software database.
- All configuration workstations shall be personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
- A minimum of 1 Workstation shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.

ii. Administration/Programming Workstation & Software Requirements

a) The Software shall consist of the following:

- Processor : Minimum 2.0 GHz
- Memory : Minimum 4GB
- Operating systems: Microsoft Windows 2008 R2 64-bit
- 100MB PS Ethernet NIC

- 250 GB hard disk
- License agreement for all applicable software

b) The workstation shall consist of the following:

- Processor : 2.0 GHz or higher
- Memory : Minimum: 32 GB
- Operating systems: Microsoft Windows 2008 R2 64-bit
- Serial port, parallel port, USB port
- 100MBPS Ethernet NIC
- 20 GB hard disk
- DVD drive
- High resolution (minimum 1280 x 1024), 32" or higher flat panel display
- Optical mouse and full function keyboard
- Audio sound card and speakers
- License agreement for all applicable software.

iii. Web-Based Operator PC Requirements

a) Any user on the network can access the system, using the following software:

- Windows 2000/XP and above
- Internet Explorer 8 (32-bit)
- Internet Explorer 9 (32-bit)
- Firefox 4.0 (32-bit) and above
- Java-enabled

iv. General Administration and Programming Workstation Software

a) System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.

b) The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.

c) Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.

v. User Interface:

a) The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall

be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user's "PC Desktop" – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.

b) System shall be able to automatically switch between displayed metric vs. imperial units based on the workstation/webstations localization.

c) The BMS workstation/webstations shall be capable of multiple language display, including English, Spanish, German, French, Japanese, Finnish, Swedish, and traditional and simplified Chinese.

d) Servers and clients shall have the ability to be located in different time zones, which are then synchronized via the NTP server.

vi. User Security

a) The software shall be designed so that each user of the software can have a unique username and password. This username/password combination shall be linked to a set of capabilities within the software, set by and editable only by, a system administrator. The sets of capabilities shall range from View only, Acknowledge alarms, Enable/disable and change values, Program, and Administer. The system shall allow the above capabilities to be applied independently to each and every class of object in the system. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the Client IT department to assist in user access.

vii. Configuration Interface

a) The workstation software shall use a familiar Windows Explorer□-style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a "network map" of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.

b) The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created form the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all "child" objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

viii. Color Graphic Displays

a) The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.

b) Requirements of the color graphic subsystem include:

- At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
- It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
- The editor shall use Scalable Vector Graphics (SVG) technology.
- A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, ad graphs which can be "dropped" on a graphic through the use of a software configuration "wizard". These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
- Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
- Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.
- Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
- It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
- Graphics should rescale based on whatever monitor or viewing device is being used.
- Be able to create graphics on varying layers the can be moved and repeated.
- Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.

c) Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:

- Create and save pages.
- Group and ungroup symbols.
- Modify an existing symbol.

- Modify an existing graphic page.
- Rotate and mirror a symbol.
- Place a symbol on a page.
- Place analog dynamic data in decimal format on a page.
- Place binary dynamic data using state descriptors on a page.
- Create motion through the use of animated .gif files or JavaScript.
- Place test mode indication on a page.
- Place manual mode indication on a page.
- Place links using a fixed symbol or flyover on a page.
- Links to other graphics.
- Links to web sites.
- Links to notes.
- Links to time schedules.
- Links to any .exe file on the operator work station.
- Links to .doc files.
- Assign a background color.
- Assign a foreground color.
- Place alarm indicators on a page.
- Change symbol/text/value color as a function of an analog variable.
- Change a symbol/text/value color as a function of a binary state.
- Change symbol/text/value as a function of a binary state.
- All symbols used by Manufacturer in the creation of graphic pages shall be saved to a library file for use by the owner.

ix. Automatic monitoring

a) The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.

x. Alarm Management

a) The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.

b) Alarm management features shall include:

- A minimum of 1000 alarm notification levels. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.

- Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement)
- Playing an audible sound on alarm initiation or return to normal.
- Sending an email or alphanumeric pager to anyone listed in a workstation's email account address list on either the initial occurrence of an alarm and/or if the alarm is repeated because an operator has not acknowledged the alarm within a user-configurable timeframe. The ability to utilize email and alphanumeric paging of alarms shall be a standard feature of the software integrated with the operating system's mail application interface (MAPI). No special software interfaces shall be required and no email client software must be running in order for email to be distributed.
- Individual alarms shall be able to be re-routed to a user at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.
- It shall be possible to re-route an alarm if a user-defined response time has been exceeded. For example, if a critical alarm has an acknowledgment time of 5 minutes and that acknowledgement does not occur, the alarm can be re-routed to a secondary receiver.
- An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
- The font type and color, and background color for each alarm notification level as seen in the active alarm viewer shall be customizable to allow easy identification of certain alarm types or alarm states.
- The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
- The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
- The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.
- An operator shall have the capability to assign an alarm to another user of the system. Such assignments shall be tracked to insure alarm response.

xi. Report Generation

a) The Reports Server shall be able to process large amounts of data and produce meaningful reports to facilitate analysis and optimization of each installation.

b) Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.

c) A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations

made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future used.

d) It shall be possible to create reports standard tools, such as Microsoft Report Builder 2.0 or Visual Studio, shall be used for customized reports.

e) Additional reports or sets of reports shall be downloadable, transferrable, and importable

f) All reports shall be able to be set up to automatically run or be generated on demand.

g) Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.

h) Reports can be of any length and contain any point attributes from any controller on the network.

i) Image management functionality shall be possible to enable the system administrators to easily upload new logos or images to the system.

j) It shall be possible to run other executable programs whenever a report is initiated.

k) Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.

l) Minimum supplied reports shall include:

- Activities Per Server Report
- Activities Per User Report
- Alarm Amount by Category Report
- Alarm Amount by Type Report
- Alarms Per Sever Report
- Current Alarm Report
- Most Active Alarm Report
- System Errors Per Server Report
- Top Activities Report
- Top Alarms Report
- Top System Errors Report
- Trend Log Comparison Report
- User Logins Report
- Users and Groups Reports

m) Minimum Energy Reports shall include:

- Energy Monitoring Calendar Consumption Report: Shall provide an interactive report that shows the energy usage on one or multiple selected days.
- Energy Monitoring Consumption Breakdown Report: Shall provide a report on energy consumption broken down using sub-metering.

- Energy Monitoring Consumption Report: Shall show the energy consumption against a specified target value.

n) Reports Server Hardware Requirements

a. Processor

a) Minimum: 2.0 GHz

b) Recommended: 2.0 GHz or higher

b. Memory

a) Minimum: 6 GB

b) Recommended: 8GB or higher

c. Hard Disk: 500 GB

15. Reports Server Software Requirements

a. Operating System: Microsoft Windows Server 2008 R2 (64-bit)

b. SQL Versions:

a) Microsoft SQL Server 2008 R2 Express with Advanced Services (64-bit)

b) Microsoft SQL Server 2008 R2 Standard (64-bit)

xii. Scheduling

a) From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.

b) Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.

c) Schedules shall be programmable for a minimum of one year in advance.

d) To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.

e) Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.

f) Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.

g) It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.

h) It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.

i) It shall be possible to view combined views showing the calendar and all prioritized exemptions on one screen.

j) It should accommodate a minimum of 16 priority levels.

k) Values should be able to be controlled directly from a schedule, without the need for special program logic.

xiii. Programmer's Environment

a) Programming in the NSC shall be either in graphical block format or line-programming format or both.

b) The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.

c) NSC devices will support both script programming language as well as the graphical function block programming language. For both languages, the programmer will be able to configure application software off-line (if desired) for custom program development, and write global control programs.

d) It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.

e) It shall be possible to view graphical programming live and real-time from the Workstation.

f) The system shall be capable of creating 'binding templates' allowing the user to bind multiple points to multiple objects all at once.

g) Key terms should appear when typing (IntelliType).

h) Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different function.

i) The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programmingor configuration setups.

xiv. Saving/Reloading

a) The workstation software shall have an application to save and restore NSC and field controller memory files.

b) For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.

xv. Audit Trail

a) The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.

b) It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.

c) It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.

xvi. Fault Tolerant Software Operation (Top level NSC)

a) A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.

xvii. Web-based Operator Software

a) General:

- Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.
- The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.

b) Graphic Displays

- The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
- Through the browser interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.

c) Alarm Management

- Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
- Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.

xviii. Groups and Schedules

a) Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.

b) Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.

xix. User Accounts and Audit Trail

a) The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.

b) All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.

xx. Web Services

1. The installed system shall be able to use web services to "consume" information within both the Network Server/Controllers (NSCs) and the Administration and Programming Workstations (APWs) with other products and systems. Inability to perform web services within BOTH NSCs and APWs will be unacceptable.

a. Shall be able to "consume" data into the system via SOAP and REST web services.

b. Shall be able to "serve" and "consume" data from other systems such as:

i) StruxureWare Data Center Expert

ii)Struxure Ware Power Monitoring Expert

xxi. Network Server Controllers (NSCs)

- Network Router Controllers shall combine both network routing functions, control functions, and server functions into a single unit.
- The BACnet NSC shall be classified as a "native" BACnet device, supporting the BACnet Network Server Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NSCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Network Server Controllers (B-BC).
- The Network Server Controller shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NRS.
- They shall also be responsible for monitoring and controlling their own HVAC equipment such as an AHU or boiler.
- They shall also contain graphics, trends, trend charts, alarm views, and other similar presentation objects that can be served to workstations or web-based interfaces. A sufficient number of NSCs shall be supplied to fully meet the requirements of this specification and the attached point list.

It shall be capable of executing application control programs to provide:

a) Calendar functions

b) Scheduling

c) Trending

d) Alarm monitoring and routing

e) Time synchronization by means of an Internet site including automatic synchronization

f) Native integration of LonWorks controller data and Modbus controller data or BACnet controller data and Modbus controller data

g) Network Management functions for all LonWorks based devices

xxii. Hardware Specifications

a) Memory:

- The operating system of the controller, application programs, and all other portions of the configuration database, shall be stored in non-volatile, FLASH memory. Servers/Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.

b) Each NRC shall provide the following on-board hardware for communication:

- One 10/100bT Ethernet for communication to Workstations, other NRCs and onto the Internet

- Two RS-485 ports for communication to BACnet MSTP bus or serial Modbus (software configurable)
- One TP/FT port for communication to LonWorks devices.
- One Device USB port
- Two host USB Ports

c) The NSC shall conform to a small footprint no larger than 100W x 125H x 75D mm (3.94W x 4.92H x 2.95D in).

xxiii. Modular Expandability:

a) The system shall employ a modular I/O design to allow expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.

b) One shall be able to "hot-change" (hot-swap) the I/O modules preserving the system on-line without any intervention on the software; addressing and configuration shall be automatic

xxiv. Hardware Override Switches:

a) All digital outputs shall, optionally, include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range, when the 3 position manual override switch is placed in the ON position.

xxv. Universal Input Temperatures

a) All universal inputs directly connected to the NSC via modular expansion shall be capable of using the following thermistors for use in the system without any external converters needed.

- 10 kohm Type I
- 10 kohm Type II
- 10 kohm Type III
- 10 kohm Type IV
- Linearized 10 kohm Type V
- Linearized 10 kohm
- 1.8 kohm
- 1 kohm
- 20 kohm
- 2.2 kohm

b) In addition to the above, the system shall be capable of using the below RTD sensors, however it is not required that all universal inputs be compatible with them.

- PT100

- PT1000
- Ni1000

xxvi. Local Status Indicator Lamps:

a) The NSC shall provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each input or output, provide LED indication of the value of the point (On/Off). The LED indication shall support software configuration to set whether the illumination of the LED corresponds to On or Off or whether the color when illuminated is Red or Green.

xxvii. Real Time Clock (RTC):

a) Each NSC shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. Each NSC will allow for its own UTC offset, depending upon the time zone. When the time zone is set, the NSC will also store the appropriate times for daylight savings time.

xxviii. Power Supply:

a) The 24 VDC power supply for the NSCs shall provide 30 watts of available power for the NSC and associated IO modules. The system shall support the use of more than one power supply if heavily power consuming modules are required.

b) The power supply, NSC, and I/O modules shall connect power wise and communication wise via the separate terminal base allowing for ease of replacement and no separate or loose wiring.

xxix. Automatic Restart After Power Failure:

a) Upon restoration of power after an outage, the NSC shall automatically and without human intervention update all monitored functions, resume operation based on current, synchronize time and status, and implement special start-up strategies as required.

xxx. Battery backup:

a) The NSC shall include an on-board battery to back up the controller's RAM memory. The battery shall provide accumulated backup of all RAM and clock functions for at least 30 days. In the case of a power failure, the NSC shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the NSC shall restart itself from its application program stored in its FLASH memory.

xxxi. Software Specifications

a) The operating system of the controller, application programs, and all other portions of the configuration database such as graphics, trends, alarms, views, etc., shall be stored in non-volatile, FLASH memory. There will be no restrictions placed on the type of application programs in the system. Each NSC shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.

b) Each NSC shall have an available capacity of 4 GB of memory. This shall represent 2 GB for application and historical data and 2 GB dedicated for backup storage.

xxxii. User Programming Language:

a) The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be either a script-based structured text or graphical function block based and fully programmable by the user. The language shall be structured to allow for the configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, and histories. Users shall be able to place comments anywhere in the body of either script or function block programs.

b) Network Server Controllers that use a "canned" program method will not be accepted.

xxxiii. Control Software:

a) The NSC shall have the ability to perform the following pre-tested control algorithms:

- Proportional, Integral plus Derivative Control (PID)
- Two Position Control
- Digital Filter
- Ratio Calculator
- Equipment Cycling Protection

xxxiv. Mathematical Functions:

a) Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

b) NSCs shall have the ability to perform any or all of the following energy management routines:

c) Time of Day Scheduling

d) Calendar Based Scheduling

e) Holiday Scheduling

f) Temporary Schedule Overrides

g) Optimal Start

h) Optimal Stop

i) Night Setback Control

j) Enthalpy Switchover (Economizer)

k) Peak Demand Limiting

l) Temperature Compensated Duty Cycling

m) CFM Tracking

n) Heating/Cooling Interlock

o) Hot/Cold Deck Reset

p) Hot Water Reset

q) Chilled Water Reset

r) Condenser Water Reset

s) Chiller Sequencing

xxxv. History Logging:

a) Each NSC controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable either over user defined time intervals ranging from 1 second to 1440 minutes or based upon a user configurable change of value. A minimum of 1000 logs, with a minimum of 100,000 records, shall be stored. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to a higher level NSC long term archiving based upon user-defined time intervals, or manual command.

b) For extended trend logging a minimum of 1500 trends shall be capable, with a minimum number of 600,000 records within.

c) Management of a power meter replacement to ensure meter log data is accurate shall be possible in the NSC.

d) Every hardware input and output point shall be trended automatically without the requirement for manual creation, and each of these logs shall log values based upon a change of value and store at least 500 trend samples before replacing the oldest sample with new data.

e) The presentation of logged data shall be built into the server capabilities of the NSC Presentation can be in time stamped list formats or in a chart format with fully configurable pen colors, weights, scales and time spans.

xxxvi. Alarm Management:

a) For each system point, alarms can be created based on high/low limits or in comparison to other point values. All alarms will be tested each scan of the NSC and can result in the display of one or more alarm messages or reports.

b) There is no limit to the number of alarms that can be created for any point

c) Alarms can be configured to be generated based upon a single system condition or multiple system conditions.

d) Alarms will be generated based on an evaluation of the alarm conditions and can be presented to the user in a fully configurable order, by priority, by time, by category, etc. These configurable alarm views will be presented to a user upon logging into the system regardless of whether the log in takes place at a WorkStation or a Webstation.

e) The alarm management system shall support the ability to create and select cause and action notes to be selected and associated with an alarm event. Checklists shall also be possible in order to present to an operator a suggested mode of troubleshooting. When acknowledging an alarm, it shall be possible to assign it to a user of the system such that the user is notified of the assignment and is made responsible for the alarm resolution.

f) Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.

xxxvii. Embedded Web Server

a) Each NSC must have the ability to serve out web pages containing the same information that is available from the WorkStation. The development of the screens to accomplish shall not require any additional engineering labor over that required to show them at the WorkStationitself.

xxxviii. BACnet Fieldbus and BACnet SDCUs

i. Networking

a) IP Network: All devices that connect to the WAN shall be capable of operating at 10 megabits per second or 100 megabits per second.

b) IP To Field Bus Routing Devices

- A Network Server Controller shall be used to provide this functionality.
- These devices shall be configurable locally with IP crossover cable and configurable via the IP network.
- The routing configuration shall be such that only data packets from the field bus devices that need to travel over the IP level of the architecture are forwarded.

ii. Field Bus Wiring and Termination

a) The wiring of components shall use a bus or daisy chain concept with no tees, stubs, or free topology.

b) Each field bus shall have a termination resistor at both ends of each segment.

c) The field bus shall support the use of wireless communications.

iii. Repeaters

a) Repeaters are required to connect two segments.

b) Repeaters shall be installed in an enclosure. The enclosure may be in an interstitial space.

iv. Field Bus Devices

a) General Requirements

- Devices shall have a light indicating that they are powered.
- Devices shall be locally powered. Link powered devices (power is furnished from a central source over the field bus cable) are not acceptable.
- Application programs shall be stored in a manner such that a loss of power does not result in a loss of the application program or configuration parameter settings. (Battery backup, flash memory, etc.)

v. Network Server Controllers (NSCs)

- If NSCs have embedded I/O, all of the requirements for I/O that are described under Advance Application Controllers shall apply.
- Shall support the export of data to NSCs from other vendors that support the data sharing, read property service.
- Shall support the export of data using Change of Value (COV) initiation to NSCs from other vendors that support the subscription to data using the COV concept.

- Shall support the export of data to any BACnet OWS that supports the data sharing, read property service.
- Shall support the export of data using Change of Value (COV) initiation to any BACnet OWS that supports the subscription to data using the COV concept.
- Shall provide trend log support for all of the devices on the field bus. They shall provide sufficient memory to store up to 300 samples for each variable required to be trended by the sequence of control.
- Shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
- Shall provide time schedule support for all of the devices on the field bus.
- Shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
- Shall provide alarm message initiation for all alarms conditions from any of the field bus devices.
- Shall deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient of the notification.
- Shall support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement.
- Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
- Shall support the receipt and response to Time Synchronization commands from any device that supports the BACnet service for initiating time synchronization commands.
- Shall support the "Who is?" and "I am." BACnet service.
- Shall support the ""Who has?" and "I have." BACnet service.
- Shall support Backup and Restore commands from any BACnet OWS that supports the initiation of Backup and Restore commands.
- Shall be BTL certified.

vi. Advance Application Controllers (B-AAC)

a) The key characteristics of a B-AAC are:

- They have physical input and output circuits for the connection of analog input devices, binary input devices, pulse input devices, analog output devices, and binary output devices. The number and type of input and output devices supported will vary by model.
- They may or may not provide support for additional input and output devices beyond the number of circuits that are provided on the basic circuit board. Support for additional I/O shall be provided by additional circuit boards that physically connect to the basic controller.

- The application to be executed by a B-AAC is created by an application engineer using the vendor's application programming tool.
- If local time schedules are embedded, the B-AAC shall support the editing of time schedule entries from any BACnet OWS that supports the BACnet service for writing of time schedule parameters.
- If local trend logging is embedded, the B-AAC shall support the exporting of trend log data to any BACnet OWS that supports the read range BACnet service for trending.
- If local alarm message initiation is embedded, the B-AAC shall:
  - Deliver alarm messages to any BACnet OWS that supports the BACnet service for receiving alarm messages and is configured to be a recipient off the alarm message.
  - Support alarm acknowledgement from any BACnet OWS that supports the BACnet service for executing alarm/event acknowledgement,
- Shall support the reading of analog and binary data from any BACnet OWS or Building Controller that supports the BACnet service for the reading of data.
- Shall support the control of the out of service property and assignment of value or state to analog and binary objects from any BACnet OWS that supports writing to the out of service property and the value property of analog and binary objects.
- Shall support the receipt and response to Time Synchronization commands from a BACnet Building Controller.
- Shall support the "Who is" and "I am." BACnet services.
- Shall support the "Who has" and "I have." BACnet services.

b) Analog Input Circuits

- The resolution of the A/D chip shall not be greater than 0.01 Volts per increment. For an A/D converter that has a measurement range of 0 to 10 VDC and is 10 bit, the resolution is 10/1024 or 0.00976 Volts per increment.
- For non-flow sensors, the control logic shall provide support for the use of a calibration offset such that the raw measured value is added to the (+/-) offset to create a calibration value to be used by the control logic and reported to the Operator Workstation (OWS).
- For flow sensors, the control logic shall provide support for the use of an adjustable gain and an adjustable offset such that a two point calibration concept can be executed (both a low range value and a high range value are adjusted to match values determined by a calibration instrument).
- For non-linear sensors such as thermistors and flow sensors the B-AAC shall provide software support for the linearization of the input signal.

c) Binary Input Circuits

- Dry contact sensors shall wire to the controller with two wires.

- An external power supply in the sensor circuit shall not be required.

d) Pulse Input Circuits

- Pulse input sensors shall wire to the controller with two wires.
- An external power supply in the sensor circuit shall not be required.
- The pulse input circuit shall be able to process up to 20 pulses per second.

e) True Analog Output Circuits

- The logical commands shall be processed by a digital to analog (D/A) converter chip. The 0% to 100% control signal shall be scalable to the full output range which shall be either 0 to 10 VDC, 4 to 20 milliamps or 0 to 20 milliamps or to ranges within the full output range (Example: 0 to 100% creates 3 to 6 VDC where the full output range is 0 to 10 VDC).
- The resolution of the D/A chip shall not be greater than 0.04 Volts per increment or 0.08 milliamps per increment.

f) Binary Output Circuits

- Single pole, single throw or single pole, double throw relays with support for up to 230 VAC and a maximum current of 2 amps.
- Voltage sourcing or externally powered triacs with support for up to 30 VAC and 0.5 amps at 24 VAC.

g) Program Execution

- Process control loops shall operate in parallel and not in sequence unless specifically required to operate in sequence by the sequence of control.
- The sample rate for a process control loop shall be adjustable and shall support a minimum sample rate of 1 second.
- The sample rate for process variables shall be adjustable and shall support a minimum sample rate of 1 second.
- The sample rate for algorithm updates shall be adjustable and shall support a minimum sample rate of 1 second.
- The application shall have the ability to determine if a power cycle to the controller has occurred and the application programmer shall be able to use the indication of a power cycle to modify the sequence of controller immediately following a power cycle.

h) Local Interface

- The controller shall support the connection of a portable interface device such as a laptop computer or unique hand-held device. The ability to execute any tasks other than viewing data shall be password protected. Via this local interface, an operator shall be able to:
  - Adjust application parameters.
  - Execute manual control of input and output points.
  - View dynamic data.

vii. Application Specific Devices

a) Application specific devices shall have fixed function configurable applications.

b) If the application can be altered by application programmable tool, the device is an advanced application controller and not an application specific device.

c) Application specific devices shall be BTL certified.

h) Field Hardware - DCUs

1. DCUs (Distributed Control Units) - All points in the system shall be monitored and/or controlled through "intelligent" Distributed Control Units (DCU's). Each DCU in the system shall contain its own microprocessor and memory with a minimum 300 hours battery backup. Each DCU in the system shall be a completely independent stand-alone "master" with its own hardware clock calendar and all firmware and software to maintain complete control on an independent basis. Each DCU shall include the following capabilities:

a) Acquire, process, and transfer information to the PC operator work stations or other DCU's on the network.

b) Accept, process, and execute commands from the other DCU's or other input devices, or multiple PC work stations.

c) Allow access to both data base and control functions by multiple work stations at the same time.

d) Record, evaluate, and report the changes of state and/or value that occur among points associated with the DCU. If any operator work station or transmission network fails, but the power to the DCU does not, the DCU shall continue to perform all control functions associated with the points to which the DCU remains connected.

e) Specifically, a DCU shall contain memory and processing capability to perform in a stand-alone mode:

i. Scheduled stop/start
ii. Adaptive optimized start/stop
iii. Duty cycling
iv. Automatic temperature control
v. Demand control
vi. Event initiated control
vii. Calculated point
viii. Scanning and alarm processing
ix. Full direct digital control
x. Trend logging
xi. Global communications
xii. Maintenance scheduling

2. Each DCU shall have the ability to transmit any or all 110 points as global points onto the network for use by other DCU's and to utilize data from other panels as part of its data base. To maximize system throughput, and minimize unnecessary network traffic, analog inputs shall be transmitted only after an operator

specified change of value has occurred since the last broadcast value. This change of value threshold shall be operator selectable on a per point basis.

3. DCU Field Input/Output Capability: The following point types must be supported by the DCU's.

- Discrete digital input (contract status)
- Discrete digital output (maintained, momentary, dual momentary, floating)
- Analog input (0-20 mA, or 0-5 VDC or 0-IOVDC with 12-bit AID conversion resolution minimum)
- Analog output (0-1 0 VDC with 8-bit DIA resolution minimum)
- Pulse input capable of accepting 10 pulses/second and accumulating total.
- Pulse Width Modulation (PWM) output capable of producing a pulse anywhere between 0-655 seconds in duration with 0.01 second resolution.
- Every discrete digital output and PWM output shall have an HOA switch with individual feedback as to the position of the switch, unless the DCU has an integral keypad display device.

4. Each DCU shall have the ability to monitor, control or address not less than 300 data points.

5. DCU Point Scanning: It shall be possible to independently set the scan or execution speed for each point in the DCU to an operator selected time from 1 to 254 seconds.

6. DCU Diagnostics: provide diagnostics which support the following dynamic (one second refresh) parameters:

   a. Processor loading
   b. LAN Loading
   c. Memory data

7. DCU Test Mode Operation: Each DCU shall have the ability to place input/output points in a test mode. The test mode shall allow control algorithms to be tested and developed on line without disrupting the field hardware and controlled environment. The treatment of all 110 points in the test mode shall be as follows:

   a. Scanning and calculation of all input points in test mode shall be inhibited. Manual control of input points in test mode will allow setting the analog or digital input point to an operator determined test value, which can be issued from any fixed or portable operator console.

   b. It shall be possible to control all output points, but only the data base state/value shall be changed, the external field hardware is left unchanged. Failure to provide test mode capability will preclude acceptance.

8. Field Hardware – MCs

i. MicroControllers (MCs) shall be connected to the Controller LAN via a Micro Controller Interface (MCI). The MCI shall be a DCU without any directly connected points. MCs shall be connected to the MCI via a high speed, RS-485 sub-network. For system reliability, distribution of risk, and high throughput, not more than 64 MCs shall be connected to any single MCI, and this MCI shall not share processors or Controller LAN interfaces with a DCU that is hardwired to primary equipment.

ii. The MCI shall provide common and memory intensive functions for locally connected MCs, including: time scheduling, custom or global calculations, and historical data collection. The operator interface for all MCI database entry and application programs shall be fully integrated and consistent with other DCUs.

iii. The MCI shall support sub-networks consisting of counter-scanning loops for increased system availability. Upon a single break (i.e., severed wire) the MCI shall scan the loop in both the primary and secondary directions and maintain communications with all MCs -not just those located between the MCI and the fault.

iv. Micro Controllers (MCs) shall be utilized for zone or terminal equipment only. Applications requiring more than 8 inputs and 8 outputs are not considered zone or terminal and must be treated as "Primary" equipment applications, which require direct connection to a DCU on the Controller LAN. Micro applications include:

   a. Fan-coils, unit ventilators, unit heaters, small packaged AHUs, split system AHUs, rooftop AHUs

Xxxix DDC Sensors and Point Hardware:

a) Temperature Sensors

b) All temperature devices shall use precision thermistors with accuracy level and range corresponding to the best OEM Standards.

c) Room Sensor: Standard space sensors shall be available in an [off white][black]enclosure made of high impact ABS plastic for mounting on a standard electrical box.

- Where manual overrides are required, the sensor housing shall feature both an optional sliding mechanism for adjusting the space temperature setpoint, as well as a push button for selecting after hours operation.
- Where a local display is specified, the sensor shall incorporate an LCD display for viewing the space temperature, setpoint and other operator selectable parameters. Using built in buttons, operators shall be able to adjust setpoints directly from the sensor.

d) Duct Probe Sensor: Sensing element shall be fully encapsulated in potting material within a stainless steel probe.

e) Duct Averaging Sensor: Averaging sensors shall be employed in ducts which are larger than 14 square feet. The averaging sensor tube shall contain at least one thermistor for every 3 feet, with a minimum tube length of 6 feet. The averaging sensor shall be constructed of rigid or flexible copper tubing. Pipe Immersion Sensor: Immersion sensors shall be employed for measurement of temperature in all chilled and hot water applications as well as refrigerant applications. Provide sensor probe length suitable for application.

f) Outside Air Sensor: Provide the sensing element on the building's north side. Sensing element shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure. It shall have operating range corresponding to best OEM Standards..

g) A pneumatic signal shall not be allowed for sensing temperature.

h) Humidity Wall Transmitter

- Transmitters shall have accuracy level corresponding to best OEM Standards.
- Transmitter shall have replaceable sensing element.
- Sensor type shall be thin-film capacitive.
- Sensor element shall contain multipoint calibration on-board in nonvolatile memory
- Operating range shall as per best OEM Standards.
- Output shall be field selectable with range corresponding to best OEM Standards.
- Transmitter shall accept 12-30 VDC or 24 VAC supply power.
- Transmitter shall be available in an off white/black enclosure made of high impact ABS plastic for mounting on a standard electrical box.
- Transmitter shall have LCD display
- Transmitter shall have integrated temperature sensor

i) Humidity Duct Transmitter

- Transmitters shall have accuracy level corresponding to best OEM Standards.
- Transmitter shall be fully encapsulated in potting material within a stainless steel probe.
- Transmitter shall have replaceable sensing element.
- Sensor type shall be thin-film capacitive.
- Sensor element shall contain multipoint calibration on-board in nonvolatile memory
- Operating range shall as per best OEM Standards.
- Output shall have range corresponding to best OEM Standards.

- Transmitter shall accept 12-30 VDC or 24 VAC supply power.
- Transmitter shall be available with a certification of NIST calibration
- Transmitter shall have integrated temperature sensor

j) Humidity Outdoor Transmitter

- Transmitters shall have accuracy level corresponding to best OEM Standards.
- Transmitter shall be fully encapsulated in potting material within a stainless steel probe. Probe shall be encased in PVC solar radiation shield and mounted in a weatherproof enclosure.
- Transmitter shall have replaceable sensing element.
- Sensor type shall be thin-film capacitive.
- Sensor element shall contain multipoint calibration on-board in nonvolatile memory
- Operating range shall be as per best OEM Standards.
- Output shall be 4-20 mA or 0-5/0-10 VDC.
- Transmitter shall accept 12-30 VDC or 24 VAC supply power.
- Transmitter shall have integrated temperature sensor

k) Liquid Differential Pressure Transmitters:

- Transmitter shall be microprocessor based
- Transmitter shall use two independent gauge pressure sensors to measure and calculate differential pressure
- Transmitter shall have minimum 4 switch selectable ranges
- Transmitter shall have test mode to produce full-scale output automatically.
- Transmitter shall have provision for zeroing by pushbutton or digital input.
- Transmitter shall have field selectable outputs of 0-5V, 0-10V, and 4-20mA.
- Transmitter shall have field selectable electronic surge damping
- Transmitter shall have an electronic port swap feature
- Transmitter shall accept 12-30 VDC or 24 VAC supply power
- Sensor shall be 17-4 PH stainless steel where it contacts the working fluid.

l) Performance:

- Accuracy shall be as per best OEM Standards.
- Long term stability shall be as per best OEM Standards.
- Sensor temperature operating range shall be as per best OEM Standards.
- Operating environment shall be as per best OEM Standards.
- Proof pressure shall shall be as per best OEM Standards.
- Burst pressure shall be shall be as per best OEM Standards.

m) Transmitter shall be encased in a NEMA 4 enclosure

CHAPTER- O

TECHNICAL SPECIFICATIONS -WTP/STP/ETP/SOLAR HOT WATER SYSTEM/HEAT PUMP

A. WATER TREATMENT PLANT GENERAL REQUIREMENTS

A.1. SCOPE OF WORK

Design, Engineering Supply, Installation, Testing & Commissioning of WTP shall be carried out by the Contractor on EPC Basis & as directed by Engineer-in-charge.

A.1.1. Work shall consist of furnishing all labour, materials, equipment and appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialised services as described hereinafter and as specified in the DBR and/or shown on the plumbing drawings.

A.1.2. Without restricting to the generality of the foregoing, this section shall include the following:-

i. Hydropneumatic/Monoblock Water supply Pumps

ii. Filters (dual media/activated carbon/pressurized sand), Softeners, UV dosing etc.

iii. Pumps & Allied Equipment

iv. STP & ETP

v. Solar Hot Water System

vi. RO System (Centralized & Portable)

vii. Heat Pumps

A.2. SPECIFICATION

A.2.1. Work under this Contract shall be carried out strictly in accordance with specifications attached with the tender.

A.2.2. Items not covered under these specifications or due to any ambiguity or misprints, or additional works, the work shall be carried out as per specifications of the latest Central Public Works Department with up to date amendments as applicable in the Contract.

A.2.3. Works not covered under Paras above shall be carried out as per relevant Codes & Bureau of Indian Standards and in case of its absence as per British Standard Code of Practice.

A.3. EXECUTION OF WORK

A.3.1. The Contractor should visit and examine the site of work and satisfy himself as to the nature of the existing roads and other means of communication and other details pertaining to the work and local conditions and facilities for obtaining his own information on all matters affecting the execution of work.

A.3.2. The work shall be carried out in conformity with the Plumbing drawings and within the requirements of architectural and coordinated with all services drawings.

A.3.3. The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction schedule. All supports to the civil structure shall be provided with dash fasteners.

A.3.4. On award of the work, Contractor shall submit a schedule of construction in the form of a PERT chart or BAR chart for approval of the Engineer-In-Charge/ HLL. All dates and time schedule agreed upon shall be strictly adhered to within the stipulated time of

completion/ commissioning along with the specified phasing, if any.

A.4. DRAWINGS

A.4.1. Tender drawings/Schematic of WTP/ETP/STP/Hot water system are provided to the Contractor. On the basis of these, shop drawings will be prepared & submitted to Engineer-in-charge/HLL for approval. The execution of work shall be done in–line with the approved shop drawings.

A.4.2. Architectural drawings shall take precedence over plumbing or other services drawings as to all dimensions.

A.4.3. Contractor shall verify all dimensions at site and bring to the notice of the Engineer-In-Charge all discrepancies or deviations noticed. Decision of the Engineer-In-Charge shall be final.

A.4.4. Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small scale drawings.

A.4.5. Any drawings issued by the Engineer-in-charge/HLL for the work are the property of the Engineer-in-charge/ HLL and shall not be lent, reproduced or used on any works other than intended without the written permission of the Engineer-in-charge/HLL.

A.5. REFERENCE DRAWINGS

A.5.1. The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site. All important drawings shall be mounted on boards and placed in racks indexed. No drawings shall be rolled.

A.5.2. All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings to be submitted by the contractor in fulfilment of the conditions of this contract.

A.5.3. On award of the work the contractor shall be issued, one set of HLL's working drawings stamped "tender drawings" by the Engineer-In-Charge. The HLL's drawings shall be the basis of contractor's shop drawings. Upon submission of shop drawings to HLL, Final approved drawings will be stamped as "Good for Construction" drawings, based on which execution work will be done.

A.5.4. Shop drawings are detailed working drawings which incorporate the contractor's details for execution of the work and incorporate equipment manufacturer's details and dimensions to ensure that the same can be installed in the space provided.

A.5.5. All shop drawings should detailed pipe routing and levels, showing location of other services at crossings etc., cable runs, route cable trays and all allied works and must be fully co-ordinated with other services and approved by the Engineer-In-Charge before execution of the works. The Contractor shall submit services drawings (if required for coordination of services) from their respective contracting agencies. All drawings will valid only when stamped and issued by the Engineer-In-Charge.

A.5.6. Shop drawings shall be furnished for detailed layout of all equipment, foundation, bolting and vibration elimination details along with information on dead and dynamic load, vibration etc.

A.5.7. Two sets of manufacturer's equipment drawings, roughing in and wiring diagrams shall be submitted.

A.5.8. Contractor shall submit shop drawings furnishing all details of MCC panels, cable routes, wiring diagrams and connection details as required.

A.5.9. Two copies of each set of shop drawings shall be submitted for initial scrutiny, discussion

and approval.

A.5.10. Each submission shall be accompanied by contractor's certificate stating that the shop drawings meet all the contract requirements and that the piping and equipment can be satisfactorily installed without any obstructions in the space available.

A.5.11. On approval of the above the contractor shall furnish three sets of the approved shop drawings for execution of the work.

A.6. INSPECTION AND TESTING OF MATERIALS

A.6.1. Contractor shall be required, if requested, to produce manufacturers test certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Bureau of Indian Standards.

A.6.2. For examination and testing of materials and works at the site Contractor shall provide all testing and gauging equipment necessary but not limited to the following:

a) Steel tapes

b) Weighing machine

c) Plumb bobs, sprit levels, hammer

d) Micrometers

e) Hydraulic machine

A.6.3. All such equipment shall be tested for calibration at any approved laboratory, if required by the Engineer-In-Charge. All testing equipment shall be preferably located in special room meant for the purpose.

A.6.4. Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Engineer-In-Charge.

A.7. METRIC CONVERSION

A.7.1. All dimensions and sizes of materials and equipment given in the tender document are commercial metric sizes.

A.7.2. Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

A.8. COMPLETION DRAWINGS

A.8.1. On completion of work, Contractor shall submit one complete set of original tracings and four prints of "as built" drawings to the Project Manager. These drawings shall have the following information.

a) Run of all piping, diameters on all floors, vertical stacks and location of external services.

b) Ground and invert levels of all drainage pipes together with location of all manholes and connections up to outfall.

c) Run of all water supply lines with diameters, locations of control valves, access panels.

d) Location of all mechanical equipment with layout and piping connections and mechanical equipment.

e) All shop drawings shall be updated from time to time for the purpose of making completion drawings.

A.8.2. Contractor shall provide four sets of catalogues, service/operation & maintenance manuals, manufacturer's drawings, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.

A.8.3. All "warranty cards" of pumps & other major equipment given by the manufacturers shall be handed over to the Engineer-In-Charge.

A.9. TESTING

A.9.1. Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.

A.9.2. Tests shall be performed in presence of the Engineer-In-Charge and test records for the tests shall be duly signed by Contractor and the Engineer-In-Charge.

A.9.3. All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

A.9.4. Contractor shall perform all such tests as may be necessary and required by the local authorities to meet municipal or other bye-laws in force.

A.9.5. Contractor shall provide all labour, equipment and materials for the performance of the tests.

A.10. SITE CLEARANCE AND CLEANUP

A.10.1. The Contractor shall, from time to time, clear away all debris and excess materials accumulated at the site.

A.10.2. After the fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints, stains, stickers and other foreign matter or discolouration leaving the same in a ready to use condition.

A.10.3. On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done by the Engineer-In-Charge at the Contractor's risk and cost. Cost of the cleanup shall be deducted from the contractor's bills on pro-rata basis in proportion to his contract value.

A.11. LICENCE PERMITS AND AUTHORITIES

A.11.1. Contractor must hold a valid plumbing or any other as required licence by the municipal authority or other competent authority under whose jurisdiction the work falls.

A.11.2. Contractor must keep constant liaison with the local development, municipal /statutory authority and obtain approval of all drainage, water supply, fire suppression and other works carried out by him.

A.11.3. Contractor shall obtain, from the municipal and other authorities 'C' & 'D' & other forms as required for approval of drainage and water supply works during execution and the completion certificate with respect to his work as required for occupation of the building. Contractor shall obtain permanent water supply and drainage connections from authorities concerned. CLIENT/ HLL shall reimburse the fees paid to the authorities towards the connection charges on production of receipts for money paid.

A.11.4. Contractor shall get any materials tested from the appropriate authority if so required with no cost to the CLIENT/HLL.

A.12. CUTTING OF WATER PROOFING MEMBRANE:

A.12.1. No walls terraces shall be cut for making and opening after water proofing has been

done without written approval of Engineer-In-Charge. Cutting of water proofing membrane shall be done very carefully so as other portion of water proofing is not damaged. On completion of work at such place the water proofing membrane shall be made good and ensured that the opening/cutting is made fully water proof as per specifications and details of water proofing approved by Engineer-In-Charges.

A.13. MATERIALS

A.13.1. Unless otherwise specified and expressly approved in writing by the Engineer-In-Charge, only materials of makes and specification as mentioned in the list of approved makes attached with the specifications shall be used.

A.13.2. If required, the Contractor shall submit samples of materials proposed to be used in the works. Approved samples shall be kept in the office of the Engineer-In-Charge.

B. WATER SUPPLY,FLUSHING/ IRRIGATION PUMPS & EQUIPMENT

B.1. GENERAL REQUIREMENTS

B.1.1. All materials shall be new of the best quality conforming to specifications and subject to the approval of Engineer-In-Charge.

B.1.2. All equipment shall be of the best available make manufactured by reputed firms.

B.1.3. All equipment shall be installed on suitable foundations true to level and in a neat workmanlike manner.

B.1.4. Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.

B.1.5. Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.

B.1.6. Each pumping set shall be provided with a butterfly valve on the suction and delivery side and a flap type non return valve on the delivery side

B.1.7. All pump couplings and belt guards for air compressors shall be totally enclosed with 5 mm mesh.

B.2. SYSTEM OF WATER SUPPLY

B.2.1. The water supplied by the authorities will be stored in the domestic U.G. tank.

B.2.2. Water from this U.G. tank shall be pumped to O.H. Tanks at terrace of each building by separate pumps/sump.

B.2.3. Each toilet and kitchen shall be fed with water from terrace tanks by gravity. Top two floors of the Hospital Building will be fed by Hydro-pneumatic System from terrace.

C. RISING MAINS & LEVEL CONTROL SYSTEM

C.1. Water from the pumps described above will fill each tank by a rising main to each tower.

C.2. To control the level in each tank and enable it to fill as the water demand so requires, each tank will be provided with a ball cock to shut off the water supply when the tank is full.

C.3. A set of electronic level sensing probes will be installed in each tank The probes installed in each pumping system will be wired to a central electronic panel which will activate the pump when any one of the tank probe signals low water conditions and top up all tanks. No excess flow will occur due to the ball cock in the tank.

D. LEVEL CONTROLLERS

D.1. Level controllers shall be electronic magnetic type using required number of stainless steel type probes, shrouded in PVC sheath or encapsulated in a stainless steel pipe. The level

controller will be used for following applications:-

D.1.1. Provide a audible high water alarm when water level in the sump reaches a pre-determined high level in the sump location at MCC panel installed in wall near sump location

D.2. Overhead tank level controller cum indicators

D.2.1. Each OHT to be provided with required number of stainless steel electronically operated probes (housed in a stainless steel protective housing) and connected by a control cable to a central junction box connected to MCC panel located in the pump house at basement. A common multi-core cable from each group of buildings will be laid to the pump room in basement. The probes will function as follows:

D.2.2. To cut off the water supply pumps when all the OHT is full and to start the pump if any OHT level reaches at pre-determined low level.

D.2.3. Provision shall be made to enable the operation of the second duty pump in case the water level does not rise above a pre-determined level in the tank due to water demand which is higher than capacity of duty pump no.1 to meet.

D.2.4. Indicate the water level in each OHT in the level indicating panel installed in the pump room

D.2.5. Each OHT are also provided with motorized valve for filling of Over Head Water tank complete with high and low level control switches to control the valve. The level controllers shall be installed in overhead tanks. The level switch will close the valve when water level is high (Top Water Level) in over head tank and open the valve when over head water tank level is low (30% of storage capacity). The system should be complete in all respects with accessories, 220 V AC / 24 V DC, IP67 electrical water level control unit, copper control wiring in whether proof casing etc.

D.3. Control & Indicating Panel (For overhead and underground water tanks)

D.3.1. A centralized indicating stand–alone wall mounted panel fabricated from 14 g. with seven tank process MS sheet and painted inside and outside with stove enamelled finish with clear vertical panels for each group of buildings & tanks shall indicate water level in each tank by means of digital display unit to indicate water level in each tank in four levels (¼th, ½, ¾ and full). The panel shall be installed on the control console panel located in the pump room or as directed by the Project Engineer. The panel shall have:

D.3.2. Digital level indicator panel meter for each water tank.

D.3.3. Etched plate identification plates.

D.3.4. Control cabling from MCC to the panel installed in the control room as directed by the Engineer-in-Charge.

D.3.5. Cabling from PHT sensing probes to the panel

E. FILTERS-DUAL MEDIA/ACTIVATED CARBON/PRESSURIZED SAND TYPE & SOFTENER

E.1. Pressure filters for Water Supply System

E.1.1. Pressure filters shall be manufactured with factory made bobbin wound polyester fibre glass multilayer filters fitted with internal GI distribution pipe with polypropylene diffusers on top, collector pipes and arms, inlet and outlet header vertical water pressure dished ends complete with initial charge of filter media,

G.I. face piping, accessories testing and commissioning complete, Working Pressure 3.5 kg/cm2 (Test pressure 5 kg/cm2). Along with Butterfly Valve/NRV or Dual Plate Check Valve & Gauge etc.

E.1.2. Each vessel will be provided with suitable pressure tight manhole cover appropriately located for inspection and repairs.

E.1.3. The diameter and height of each vessel shall be as per the design requirement and as per site conditions.

E.2. Multi-Port Valves

E.2.1. Each vessel will be provided with multi-port valves to operate and regulate the normal flow, backwash and rinsing, rapid washing, on the face piping.

E.2.2. Provide suitable sampling cocks to draw water samples for raw water and treated water.

E.3. Face Piping

E.3.1. Each vessel shall be provided with non-corrosive face piping from the inlet to the outlet. Face piping shall be CPVC (IS 4985)/UPVC/GI 10 kg/cm2 all CPVC/UPVC/GI fittings are heavy grade to pipe and solvent weld and flanged joints

E.3.2. All valves shall be butterfly valves as specified in the piping section over 50 mm dia. And above and for pipe dia. below 50 mm dia. shall be provided with ball valves.

E.4. Water Filtration Plant (For Domestic Water)

E.4.1. Design parameters for the proposed filter shall be as follows:

i. Filter media:- Graded aggregate of required size selected coarse and fine silica sand as per latest water treatment practice. Aggregate and sand to be acid washed and having purity of 99.9%.

ii. Depth of filter media:- Approx. 750-900 mm deep (as per manufacturer's design)

iii. Back washing :- By air scouring through air blower (approx. 5.1 lpm/m^2 of filter surface area and water supply from raw water pumps by reverse flow

iv. Output Water Quality for Domestic Filters: To conform to IS 10500 for the relevant design criteria.

E.5. Chemical Dosing Pumps

E.5.1.1. Dosing system comprising of an electronic metering pump with, 100 lit capacity uPVC/HDPE solution tank with level gauge and lid on top.

E.5.2. Electronic driven metering pumps with mechanically actuated diaphragm with oil lubricated gear mechanism. The output of the pump should be adjustable for operation from 10-100%. Pump construction shall be corrosion resistant polypropylene or similar material. Pump electrical circuit shall be interlocked with the main raw water /pool recirculation pumps so that they operate only when the pumps are operating.

E.6. Air Blower for Back Washing

E.6.1. Low pressure air blower with TEFC electrical motor, belt driven or direct drive, all mounted on a common structural based plate with oil and water separator.

E.6.2. Air blowers will be used for back washing operations. The air blower shall be

designed for operation of one filter at a time. Blowers will be designed for air flow of approx 5.1 lpm/m2 air capacity at 0.5 kg/cm2 pressure. (This may be modified to suit manufacturer's requirement for filters offered.)

E.6.3. The electrical switchgear shall be included in the respective MCC panel of the system

E.7. Softener:-

E.7.1. Specifications shall be as per requirements. As per discharge & head, HOS shall be decided, dimension of shell shall be accordingly selected, optimum Resin quantity should be selected with required OBR provisions to be considered. Softener shall be of MS with inner shell FRP lined. It should be provided with back wash, regeneration facility.

Max. Working pressure : 3.5 Kg/cm^2

Min. Working pressure : 2.0 Kg/cm^2

E.7.2. Output water parameters should be as per GRIHA norms & relevant IS standards.

F. PUMPS

F.1. WATER TRANSFER PUMPS

F.1.1. Water supply pumps shall be suitable for clean filtered water. Pumps shall be single stage, monobloc vertical/horizontal,centrifugal pumps with cast iron body and bronze/gun metal impeller, stainless steel shaft and mechanical seal and coupled to a TEFC electric motor. Each pump should be operating to a curve required by the operating conditions. MOC stated in DBR for pumps will be deemed as final.

F.1.2. All parts in contact with water shall be corrosion resistant stainless steel DIN-Nr.1.4401.

F.1.3. Each pump shall be provided with a totally enclosed fan cooled induction motor of suitable H.P. The motors shall be suitable for 410 volts, 3 phases, 50 cycles A.C. power supply and shall conform to IS 325 operating at 1450 RPM nominal speed.

F.1.4. Each pumping set shall be provided with 100-mm dia gunmetal "Bourden" type pressure gauge with gunmetal valve and connecting piping.

F.1.5. Pump or the whole set shall be stable on rubber vibration eliminating pads appropriate for each pump as recommended by the manufacturer and accepted by the Engineer-In-Charge.

F.2. SUBMERSIBLE PUMPS

F.2.1. Submersible pumps for clear water transfer shall be single stage, submersible centrifugal Pump of closed coupled construction with C.I. casing and Gun Metal/ bronze impeller connected toa fully submersible water/ oil cooled motor.

F.2.2. Stuffing box shall be provided with mechanical seals.

F.2.3. Each pump shall be provided with water cooled Squirrel Cage Induction Motor suitable for 415 Volts, 3 phase, 50 cycles AC power supply.

F.2.4. Each pump shall be provided with liquid level controller for automatic operation of the pump between predetermined levels. Operation of level controller shall be similar to as discussed in subsequent paras below.

F.2.5. The pumping set shall be for stationary application and shall be provided with pump connector in it. The delivery pipe shall be joined to the pump through a rubber

diaphragm, and bend and guide pipe for easy installation, without disturbing delivery pipe the pump unit shall have a back pull out design. A rust proof chain shall be provided for each pump.

F.2.6. Pump shall be provided with all accessories and devices necessary and required for the pump to make a complete working system.

F.2.7. The Pump shall be located at a position directly beneath the manhole to ensure proper accessibility.

G. HYDROPNEUMATIC SYSTEM

G.1. PRESSURISED WATER BOOSTING SYSTEM USING VARIABLE SPEED DRIVE

i. The booster set shall consist upto a maximum of six identical vertical multistage in - line pumps in cast iron GG20 pump head & base c/w cataphoresis coating, cartridge type mechanical seal, all internals in AISI 304 stainless steel, mounted on common galvanised steel base frame and controlled by variable frequency drives & a PFU (Pump Functional Unit) logic controller, which have features like application optimised software, regular optimization of operating conditions and read-out of operating data, Bus Communication possibility, Digital remote-control functions, pump & system monitoring functions, Display, Alarm & signal functions and clock programs. Panel to have 2x24 character LCD display, green & red LED's for operating & fault indication, potential free contacts for remote interfacing, an inbuilt lifetime battery backup for all clock functions.

ii. Booster set should include non return valves, isolating valves, pressure transmitter on discharge side, non-return valve, pressure gauge all mounted on a factory assembled SS manifolds.

iii. Booster set should ensure constant pressure on discharge side through continuously variable adjustment of speed of one of the pumps, while the remaining pumps in operation are running on mains operating at full speed to bring about pump performance to meet consumption levels. Also provision should be made for alternate change over between pumps in operation once every 24 hours & frequency converter operation of pumps by rotation - all should be built in, cyclically, in the controls to ensure equal wear and tear of all pumps in the booster set. Means should be provided for friction loss compensation for increased consumption rate.

iv. Booster set should incorporate following "Power saving features" as standard.

- Selection of 3 basis set points for pressure relative to time.
- Pipe compensation i.e. Change of set point depending on water consumption.
- Compulsory change of staring of sequence, i.e. Equal operating time for pump, both for frequency control and ON/OFF regulation.
- Inputs and outputs for external communication.

A small sized pressure tank, (accumulator) to provide for reducing impact of water hammer and minimize short cycling of the pumps. The accumultors are piped to allow for in service maintenance.

The functions of the Controller should incorporate the following features.,

- Closed loop control.
- On / Off operation at low flow.
- Automatic cascade control of pumps

- Selection of switching sequences , automatic pump change and pump priority.
- Manual Operation.
- Analog set point influence
- Friction loss compensation
- Set point adjustment

The remote control functions should have the following features.,

- System On / Off
- Set point control
- Switching of individual pumps
- The monitoring functions should have the following features.,
  - Min / Max Levels
  - Pre pressure
  - Motor protection
  - Water shortage monitoring

Enclosure Class : Control Box IP 54

Motors : IP 55

G.2. PIPE & FITTINGS (FOR HEADERS AND CONNECTIONS)

G.2.1. Pump suction and delivery headers shall be Galvanized iron pipes/MS heavy class with matching fittings. The pipe joints shall be threaded as per manufacturer's instructions.

G.2.2. **Vibration Eliminators**

All suction and delivery lines as shown on the drawings shall be provided with double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connectors shall be as per site requirements in accordance with manufacturer details.

G.2.3. **Valves**

G.2.3.1. Sluice valves

i. Full way Sluice Valves shall be used on the suction connection to pumps and headers.

ii. Sluice valves (80 mm dia. and above) shall be C.I. double flanged sluice valves with rising stem. Each sluice valve shall be provided with wheel in exposed positions and cap top for underground valves. Contractor shall provide suitable operating keys for sluice valves with cap tops.

iii. Sluice valves shall be of approved makes conforming to I.S.780 PN1.6 class

G.2.3.2. Butterfly Valves (PN 1.6 rating)

i. Butterfly Valves shall be used in all other locations as required conforming to IS 13095.PN 1.6

ii. They shall have a cast iron body.

iii. Disc shall be Stainless Steel

iv. The shaft to be Stainless Steel

v. The seat shall be drop tight constructed by bonding resilient elastomer inside a rigid backing.

vi. Built in flanged rubber seals.

vii. Actuator to level operated for valves above ground and T Key operated for valves below Ground.

viii. Built in flanges for screwed on flanged connections. Manufacturer's details on fixing and Installation will be followed.

G.2.3.3. Non Return Valves (NRV PN 1.6 rating)

Non-return valves/ Dual plate check valve of various dia. as per requirements shall be of cast iron body. It should have Nitrile Rubber/EPDM Seal & Disc of stainless steel. They shall be swing check type/wafer type in horizontal runs and lift check type in vertical runs of piping. It should be of min. PN-16 rating. Test Pressure (Hydrostatic) :Shell: 24.50 kg, Seat:16 kg/sqcm, maximum operating temperature- 80 degree C. In case of any discrepencies between manufacturer's standards & above specified values, these parameters shall be in compliance with relevant IS codes.

***7.2.3.4* Pressure gauge (Bourdon Type)**

Pressure Guage shall be of suitable range with SS 304/316 Construction, case of 150/100mm diameter. The gauges shall have brass cocks. The accuracy range of pressure guage shall be in the range of +- 0.5 % to 1%. It shall conform to IP 67 protection. The dial shall be Aluminium white background with black letters. The windows shall be made of plain & toughend glass. The suitability of pressure gauge shall be in the temperature range of (-) 20 degree Celcius to 60 degree celcius. The gear mechanism shall be of SS 304 & the connection material shall be of SS-316 L. Pointer shall be of black aluminium. It shall be complete with all accessories such as siphon, gauge cock, snubber & needle valve etc. Pressure range shall be between 0 to 20 Kg/Sqcm.

***7.2.3.5* Ball Valves**

The ball valve of various dia. shall be of forged brass construction & shall have screwed female ends. It shall be lever operated with quarter turn & shall be provided with forged brass hard chrome plated ball. It shall be complete with premium quality PTFE gland packing & seating. The ball valve shall be with chrome finish wherever required. Test Pressure (Hydrostatic): Shell: 25 kg, Seat:16 kg/sqcm, maximum operating temperature- 220 degree C. In case of any discrepencies between manufacturer's standards & above specified values, these parameters shall be in compliance with relevant IS codes.

***7.2.3.6* 'Y' Strainers (PN 1.6 rating)**

Cast iron 'Y' type strainers (with double flanged construction) with gunmetal internal strainers, CI screwed plug to be provided on all water tank suction connections to pumps. It shall have large screening areas to increase efficiency & it shall have minimum pressure drop inside the body due to streamlined body contours. The test pressure for shell shall be 15 Kg/Sqcm. The maximum working pressure shall be 16 kg/sqcm & maximum working temperature shal be 220 degree celcius.

7.3 PAINTING AND CLEANUP

a) On completion of the installation contractor shall scrub clean all pumps, piping, filters and equipment and apply one coat of primer.

b) Apply two or more coats of synthetic enamel paint of approved make and shade on steel pipes.

c) Provide painted identification legend and direction arrows on all equipment and piping as directed by Engineer-in-Charge.

d) On final completion of the work, contractor should cleanup the site, filter room of all surplus materials rubbish and leave the place in a broom-clean condition.

7.4 CABLES

a. Contractor shall provide all power and control cables from the motor control centre to various motors, level controllers and other control devices.

b. Cable size shall be as per functional requirements.

c. XLPE Cables shall be provided conforming to I.S. 7098.

d. Wiring cables shall conform to IS 694.

e. All power /control wiring & cables shall be aluminum conductor XLPE insulated armoured and PVC sheathed of 1100 volts grade.

f. All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.

g. All cable joints shall be made in an approved manner as per standard practice.

7.5 EARTHING

All equipment installed by the contractor shall be suitably earthed by making proper connection by means of G.I. Wires to the main earthing system laid by the electrical contractors.

7.6 MOTOR CONTROL CENTRES

i. Switchboard cubicles of approved type shall be fabricated from 2 mm M.S. Sheet with dust and vermin proof construction. It shall be painted with stove enamelled paint of approved make and shape. It shall be fitted with suitable etched plastic identification plates for each motor. The cubicle shall comprise of the following: - (switchgear as given in the DBR).

a. Incoming main switch fuse unit of required capacity.

b. Isolation switch fuse unit, one for each motor.

c. Fully automatic DOL/star delta starters suitable for motor H.P. with push buttons one for each motor and on/off indicating neon lamps.

d. Single phasing preventer of appropriate rating for each motor.

e. Rotary duty selector switch.

f. Panel type ampere meters one for each motor.

g. Panel type voltmeter on incoming main with rotary selector switch to read voltage between phase to neutral and phase to phase.

h. Neon phase indicating lamps and indicating lamp for each motor.

i. Rotary switch for manual or auto operation for each pump.

j. Fully taped separate aluminium bus bars of required capacity for normal and emergency supply where specified.

k. The panel shall be prewired with colour coded wiring. All interconnecting wiring from incoming main to switch gear, meters and accessories within the switch board panel. All switch gears and accessories shall be approved make.

ii. Switchboard cubicles shall be floor or wall mounted type as recommended by manufacturers.

iii. All switch gears and accessories shall be approved make.

H. INSTALLATION, COMMISSIONING & GUARANTEES

8.1 INSTALLATION

8.1.1 Contractor shall supply required number of copies of foundation drawings giving weight, vibration and other loads required for the proper designing of the foundations.

8.1.2 All equipment shall be installed in a true workman like manner true to level and grade in accordance with the best current practice.

8.1.3 Contractor shall employ sufficient and proper equipment for lifting and placing of heavy equipment and in a manner which shall not strain or cause damage to the existing structures. If any damage is done, the same shall be made good to the satisfaction of the Engineer-In-Charge without any additional cost.

8.1.4 All equipment and pipes shall be painted with one coat of red oxide before dispatch to the site.

8.2 COMMISSIONING

8.2.1 On completion of the work in all its aspects, the contractor shall start up the equipment in a manner normally done for the continuous operation for a period of not less than 48 hours and shall rectify and adjust the equipment for leakages and balancing the system.

8.2.2 After satisfactory commissioning of the plant, the contractor shall conduct performance tests on the equipment to satisfy the Engineer-In-Charge that all equipment is performing to the rated outputs. Any or all equipments shall be rectified or replaced if the same is are not performing in accordance with the specifications.

8.3 GUARANTEES

8.3.1 On completion of the work contractor shall submit a guarantee covering the quality and performance of all materials supplied and installed under the contract. This guarantee shall cover each and every material whether manufactured by the contractor or not.

8.3.2 Contractor shall specify a suitable procedure to test the rated performance of the equipments and shall provide all necessary equipments, gauges etc. for conducting such tests.

8.3.3 The guarantee shall cover a period of one year from the date of installation and handing over.

8.4 COMPLETION

8.4.1 On completion of the job, the contractor shall hand over to the Engineer-In-Charge the following:-

8.4.1.1 One flow chart drawn in ink on thick paper and mounted in a glass frame showing the flow diagram of the process including legend showing valves to be normally open or closed and instructions for back washing, operation and maintenance of chlorination & other chemical feeding pumps and other equipments.

8.4.1.2 Five sets of operating and maintenance instructions with spare parts list and their

manufactures and/or suppliers.

8.4.1.3 Five sets of catalogues and drawings for all equipment supplied.

I. WATER TREATMENT PARAMETERS

Expected Treated Water Characteristics after Filtration (Domestic Water Requirements for all Buildings)		
Sl. No.	**Parameters**	**Characteristics**
1	pH	6. 5 – 8.5
2	Total Dissolved Solids	400 ppm
3	Suspended solids	< 1 mg/ litre
4	Turbidity	Nil
5	Total Hardness	Less than 150 ppm

Expected Treated Water Characteristics after Filtration and Softener (For Cooling Tower Make-up)		
Sl. No.	**Parameters**	**Characteristics**
1	pH	6. 0 – 7.0
2	Total Dissolved Solids	200 ppm
3	Suspended solids	< 1 mg/ litre
4	Turbidity	Nil
5	Total Hardness	Less than 50 ppm

Expected Treated Water parameters shall be in conformance to relevant IS standards & GRIHA Norms.

J. TECHNICAL INFORMATION

Please furnish full details separately

All information should be on the following format

PUMPS

Sr.No	Description	Domestic Water Pump	Irrigation Pump
1	Design basis		
1.1	Quantity/ No. of units offered		
1.2	Capacity lit/lpm		
1.3	Flow Range		
1.4	Pumping Head (where applicable)		
1.5	Make & Model No.		

1.6	Power		
1.7	Pump Type		
1.8	Material (body)		
1.9	Material (Impellers)		
1.10	Material (shafts)		
2	**Accessories**		
3	**Valves**		
3.1	Type		
3.2	Material (body)		
3.3	Material (Internal parts)		
3.4	Material (Lining)		
4	**Pipes**		
4.1	Type		
4.2	Material		
4.3	Max. working pressure		
4.4	Max. test pressure		

PIPE COLOUR CODE

This Colour Code is as per I.S. 2379.

Ground Colour

1st Colour Band

2nd Colour band

Proportional width of band 4:1

Pipe lines

Ground Color

1st Color

2nd Color

1.

Drinking water (all cold water lines after filter)

Sea green

French blue

Signal red

2.

Treated water (soft water)

Sea green

Light orange

3.

Domestic hot water

Sea green

Light grey

4.

Drainage Sewer /SWD

Black

5.

Fire services

Fire red - This Color Code is as per I.S. 2379

Final design for colour coding will be of CLIENT/ HLL only.

TECHNICAL SPECIFICATIONS OF STP

Design, Engineering Supply, Installation, Testing & Commissioning of STP shall be carried out by the Contractor on EPC Basis & as directed by Engineer-in-charge.

Note: GRIHA norms & relevant IS standards (output water for irrigation/ flushing/ sewer/ portable) for output water parameters should be complied with.

The Sewage Treatment Plant shall be designed on MBBR technology for the following raw sewage flow rate and characteristics:

1. SEWAGE GENERATION AND CHARACTERISTICS & TREATED WATER PARAMETERS:-

CLUSTER I/CLUSTER II

Flow Rate : As per DBR or meeting functional requirements

1.1 DESIRED QUALITY AFTER TREATMENT

a. DESIRED EFFLUENT QUALITY (AFTER TREATMENT):

Sl. No	Parameter	Unit	Treated water
1	pH	-	6.5 - 8.5
2	Suspended solids	Mg/l	< 100
3	BOD	Mg/l	< 150
4	COD	Mg/l	< 300
5	Oil &Grease	Mg/l	<5

b. DESIRED SEWAGE QUALITY (AFTER TREATMENT):

Sl. No	Parameter	Unit	Treated water
1	pH	-	6.5 - 8.5
2	Suspended solids	Mg/l	<5
3	BOD	Mg/l	< 5
4	COD	Mg/l	<10
5	Oil &Grease	Mg/l	Nil

c. EXPECTED TREATED WATER CHARACTERISTICS AFTER FILTRATION AND SOFTENER (FOR COOLING TOWER MAKE-UP)

Sl. No.	Parameters	Characteristics
1	pH	6. 0 – 7.0
2	Total Dissolved Solids	200 ppm
3	Suspended solids	< 1 mg/ litre
4	Turbidity	Nil

5	Total Hardness	Less than 50 ppm

Table Given above is Indicative & Treated Discharge Effluent/Sewage Water shall meet all relevant norms including BIS standards & GRIHA compliances.

2. TECHNICAL EQUIPMENT SPECIFICATIONS

i. PRIMARY TREATMENT

a. SCREENS

Quantity	:	2 Nos. or as required
Dimension	:	Wide: 600mm X Height: 1200mm
MOC	:	Stainless Steel
Type	:	Perforated
Screening Size	:	20mm & 10mm
Lifting Arrangement	:	Yes

ii. PUMPSET

a. RAW SEWAGE TRANSFER PUMPSET (Collection Tank to Aeration Tank)

Quantity	:	3 Nos. (2W + 1S) or as required
Type	:	Submersible, Vertical
MOC of Body / Impeller	:	CI / Bronze
Capacity	:	As Required
Head	:	As Required
Solid Handling Capacity	:	As Required
Motor Rating parameters	:	As required fulfilling technical
Lifting Arrangement	:	Manual MSEP

b. PLANT ROOM SUMP PUMPSET

Quantity	:	2 Nos. (1W + 1S) or as required
Type	:	Submersible, Vertical
MOC of Body / Impeller	:	CI / Bronze
Capacity	:	As Required
Head	:	As Required
Solid Handling Capacity	:	As Required
Motor Rating parameters	:	As required fulfilling technical
Lifting Arrangement	:	Manual MSEP

c. LUDGE TRANSFER / RECIRCULATION PUMPSET

Quantity	:	3 Nos. (2W + 1S) or as required
Type	:	Monoblock. Centrifugal

MOC of Body / Impeller	:	CI / Bronze
Capacity	:	As Required
Head	:	As Required
Solid Handling Capacity	:	As Required
Motor Rating	:	As required fulfilling technical parameters

Providing, installation, testing & commissioning of screw Sludge disposal pump for the disposal of sludge to tanker or to sludge dry beds. The pumps shall have CI casing, bronze Impeller & SS shaft & sleeve with mechanical rotary shaft seal connected by a flexible tier type coupling to TEFC induction motor mounted on a common channel base-plate with coupling guard, 150 mm dia pressure gauge with GM isolation cock, suitable vibration eliminator pads of approved design. Motor to be suitable for including all necessary piping, valves and other accessories and concrete foundation complete as required. (2Working + 1 Stand-by or as required).

d. SLUDGE DISPOSAL PUMP PUMPSET

Quantity	:	1 Set (2W+1S) or as required
Type	:	Screw, Horizontal
MOC of Body / Impeller	:	CI / Bronze
Drive	:	V – Belt
Direction of Rotation	:	Clockwise
Capacity	:	As Required
Head	:	As Required
Solid Handling Capacity:	Sludge - STP	
Motor Rating	:	As required fulfilling technical parameters

e. FILTER FEED PUMPSET

Quantity	:	2 Nos. (1W + 1S) or as required
Type	:	Monoblock. Centrifugal with Mech. Seal
MOC of Body / Impeller	:	CI / Bronze
Capacity	:	As Required
Head	:	As Required
Solid Handling Capacity:	As Required	
Motor Rating	:	As required fulfilling technical parameters

iii. AIR DIFUSSION SYSTEM

a. AIR BLOWER

Quantity	:	3Nos. (2W + 1S) or as required
Type	:	Twin Type Rotary
MOC of Body	:	Cast Iron
Drive	:	V – Belt
Direction of Rotation	:	Clockwise

Suction Silencer with Air Filter:	Yes	
Pressure Gauge / Relief Valve:	1 Each	
Capacity	:	As Required
Discharge Pressure	:	As Required
Motor Rating	:	As required fulfilling technical parameters

b. AIR DIFFUSER

Type	:	Fine Bubble Tube Aerator
Air Transfer Capacity	:	3 – 5cfm or as required
Length of Diffuser	:	1000mm or as required
Dia. of Diffuser	:	63mm or as required
Connection Size	:	20mm or as required
MOC of Membrane	:	High Grade EPDM or as required
MOC of Pipe Support	:	SS / EPDM or as required
Fitting Material	:	PVC Shaddle

iv. MEDIA

a. FLUDISED MEDIA (FOR AERATION TANK)

Quantity	:	As Required or required quantity as per capacity of STP selected
Type	:	Random Bio Media
MOC of Media	:	Virgin PP with UV Stabilized
Specific Surface Area of Media	:	160.0 SQM/ CUM or as required
Protected Surface Area of Media	:	102.4 SQM/ CUM or as required

b. TUBE PAC MEDIA (FOR TUBE SETTLER)

Quantity	:	Required Qty. to meet functional parameters
Type	:	Hexagonal Chevron Shape Self Supporting
MOC of Media	:	Virgin PVC, UV Stabilized

v. TERTIARY TREATMENT (AS PER REQUIREMENTS)

a. DUAL MEDIA FILTER

Quantity	:	1 No or as required
Capacity	:	As Required
Working Pressure	:	3.0kg/cm2 or as required
Type	:	Down Flow
MOC of Vessel	:	MS IS – 226 Duly Painted
Thickness of Shell / Dish	:	8 / 10mm or as required
Thickness of Dish Plate	:	6mm or as required
Diameter	:	1750mm or as required

Height of Straight	:	1500mm or as required
Distribution System	:	Dish Plate with PVC Nozzles
Controls	:	Frontal Piping with Butterfly Valves
Frontal Piping	:	MS Welded
Manhole / Handhold Cover	:	1 Each
Air / Drain Valve	:	1 Each
Pressure Gauge / Sampling Cock	:	1 Each

Filter Media

River mesh sand supported coarse sand and fine sand.

b. ACTIVATED CARBON FILTER

Quantity	:	1 No. or as required
Capacity	:	As Required
Working Pressure	:	3.0kg/cm2 or as required
Type	:	Down Flow
MOC of Vessel	:	MS IS – 226 Duly Painted
Thickness of Shell / Dish	:	8 / 10mm or as required
Thickness of Dish Plate	:	6mm or as required
Diameter	:	1750mm or as required
Height of Straight	:	1500mm or as required
Distribution System	:	Dish Plate with PVC Nozzles
Controls	:	Frontal Piping with Butterfly Valves
Frontal Piping	:	MS Welded
Manhole / Handhold Cover	:	1 Each
Air / Drain Valve	:	1 Each
Pressure Gauge / Sampling Cock	:	1 Each

Filter Media

River mesh sand supported coarse sand and Granular Activated Carbon 1000IV.

c. ULTRA VIOLET UNIT (AS PER REQUIREMENTS)

Quantity	:	2 No. or as required
Capacity	:	As per Requirements
MOC Reactor	:	Stainless Steel 316L
MOC Quartz Jacket	:	High Purity Quartz (UVT > 95%)
UV Dosage	:	60mJ/cm2 (65% UVT)
Voltage	:	220 – 240V / 50 – 60Hz
End Connection	:	65mm or as required
Max. Operating Pressure	:	80psig or as required
Max. Operating Temperature	:	45 Degree C

	Control Panel Rating	:	IP54
	Control Panel MOC	:	Sheet Steel with Electrophoretic Dipcoat
	Priming and Textured Powder		
	Coating Ballast Type	:	Electronic with Programmed Soft Start
	Lamp Replacement Reminder	:	Yes
	Lamp Running Hour Counter	:	Yes
	Lamp Failure Indication	:	Yes
	UV Monitoring System	:	Yes

vi. SLUDGE DEWATERING

a. FILTER PRESS

Quantity	:	1 No.
Type	:	Hydraulic
Type of Element	:	P.P. Recess
Type of Delivery	:	Slide & Open
Closing Device	:	Motorized
Drainage Surface	:	Pips
Plate Size	:	300 X 300 (mm)
No of Recess Chamber	:	18 Nos.
Operating Pressure	:	3 – 5 Kg/Cm2
Max. Operating Temp.	:	80 Deg. C
Filter Cloth	:	1 Set

vii. INSTRUMENTATION

a. LEVEL INDICATOR & CONTROLLER

Quantity	:	2 Set or as required
Dimension	:	As Required within CCT & FWT
Type	:	Electronic
High / Low level Alarm	:	Yes Auxiliary NO/NC

b. AIR FLOW METER

Quantity	:	2 Nos.
Type	:	Vertical - Rotameter
MOC of Body	:	High Grade Acrylic
Capacity	:	20M3/Hr.
Operating Temperature	:	Ambient
Operating Pressure	:	6PSI
MOC of Float	:	SS 316

c. WATER FLOW METER

Quantity	:	1 No. or as required

Type	:	Electromagnetic
Capacity	:	15M3/Hr. or as required
Operating Temperature	:	Ambient
Operating Pressure	:	6PSI or as required
Connection Size	:	50mm or as required
MOC of Connection	:	SS

d. pH METER

Quantity	:	1 No. or as required
Type	:	Flow Through / Tank (Optional)
Sensor O/P	:	Milli Volt
Application / Fluid	:	Treated Sewage
Range	:	00.00 – 14.00 pH

e. ENERGY METER

Quantity	:	1 No. or as required
Type	:	Electronic
Range	:	10 – 40 Amps.

viii. INTERCONNECTING PIPE & FITTINGS

a. PIPING

Submerged Air Pipe Line	:	SS 304
Diffuser Line	:	Flexible
Air Line	:	MS Epoxy Painted
Effluent & Submerged Water Pipe Line	:	PVC Heavy Class
Water Line	:	MS Duly Painted
Pipe Class	:	Medium Class
MOC of Fittings	:	As Required

ix. ELECTRICAL WORK

a. ELECTRICAL CONTROL PANEL

Quantity	:	1 Set or as required
Fabrication Material	:	14Gauge CRCA Sheet Steel duly

Anticorrosive Paint & Powder Coated Gland Plate: Top & Bottom

Description	:	As required
Electrical Accessories	:	ISI Approved

b. CABLE & CONDUITING

Quantity	:	1 Lot within Plant Room
Type	:	Flexible – Triple Layer ISI Marked

B. EFFLUENT TREATMENT PLANT:

Design, Engineering Supply, Installation, Testing & Commissioning of ETP shall be carried out by the Contractor on EPC Basis & as directed by Engineer-in-charge.

The specifications for ETP Capacity shall be as defined in Design Basis Report, meeting functional requirements & as per directions of the Engineer –In -Charge. The Contractor shall submit shop drawing illustrating the detailed piping & instrumentation details of entire ETP system, which shall be approved by HLL prior to start of execution work at site.

The ETP shall be of compact type & housed in common pump room of STP for Cluster 1. The ETP shall be constructed with MS (FRP) coated with min. 3 mm. The ETP shall be designed as water retaining structures, with necessary chemical dosing as required by the manufacturer's design. All the Equipment, piping, pumps, air blowers & electrical panel shall be housed in the ETP skid including MS puddle flange (galvanized), inlet , outlet, overflow, vent, moving ladders & railing. The plant shall be complete with a central electric panel fully pre/site wired & with all power & control cables to all pumps & equipments including all instrumentation, level & other controllers.

ETP shall be complete with SS perforated basket screen with chain lifting arrangement, Flash Mixer, Flocculator, tube Settler, media inside tube settler, lime/alum/polyelectrolye dosing system with HDPE tank & pumping system, all valves, strainers, pressure gauges, air blower, agitator & all required pumps.

PVC pipes (10 kg/sqcm)- For all submerged waste water piping, MS (C class)- For all exposed air piping & flexible stainless steel pipe for submerged air pipe, GI (C class)- for all other water piping shall be used in ETP.

Approval of Technical datasheet & Shop drawings for ETP shall be sought from Contractor before commencement of work.

C. SOLAR WATER HEATING SYSTEM

Design, Engineering Supply, Installation, Testing & Commissioning of Solar Water Heating system shall be carried out by the Contractor on EPC Basis & as directed by Engineer-in-charge. Solar Hot water system shall include flat plate solar collector panels as per OEM standards, absorber coating shall be suitably selected, coating absorptivity should be greater than 90% & coating emmisivity should be less than 20% with fins, laser/ ultrasonic welded with brass flanges & EPDM rubber gaskets. Absorber will be Cu-Cu type of suitable dimensions. It shall be provided with rockwool or any other suitable insulation at sides & bottom of suitable thickness, density & K value. Make up water tank of suitable capacity shall be of PVC construction & shall be provided with soft water provison & to refill at particular interval.

For Hospital Building Close Coupled Solar Hot Water System coupled with Heat Pumps shall be used. In a "close-coupled" SWH system the storage tank is horizontally mounted immediately above the solar collectors on the roof. No pumping is required as the hot water naturally rises into the tank through thermosiphon flow. Solar water heating system produces hot water at a temperature of 60 Deg. C and In accordance with the IS-12976:1990 and IS-12933:1990 (Part 1 to part 5). Solar hot water system may be with recirculation pump & heat exchanger system, pump to supply water from raw water storage tank to solar storge tank if height of storage tank is higher than raw water storage tank. Heat bank of suitable capacity & MOC of MS with special resin bonded FRP lining of required shell & dish thickness. It shall be provided with suitable insulation of required thickness, K value & density.

Plate type heat exchangers shall be made of SS 316 plates of suitable capacity with primary & secondary pumps which shall be horizontal centrifugal type of suitable head & discgarge with motor conforming to IE3 class efficiency with brass impeller, SS 304 shaft & CI casing. Mixing Tank of suitable capacity made of SS 304 with quartz coating & insulation of suitable thickness of required K value, density & 24 G Aluminium cladding. Electrical heater back up & recirculation centrifugal pumps of suitable capacity with primary & secondary pumps which shall be horizontal centrifugal type of suitable head & discgarge with motor conforming to IE3 class efficiency with brass impeller, SS 304 shaft & CI casing. Cold water tank for providing water o solar mixing tank of suitable capacity made out of PVC with low & high level controllers. Electrical control panel for the entire system with necessary cabling, level controllers, sensors, wires & other accessories shall be provided.

System to ensure that the solar hot water generated during the sunshine hours of the day is stored in a Solar Insulated tank (Heat Bank) & then the Heat is transferred to the Mixing tank as & when required (HTC application), so that the **Hot Water is made available at the Controlled Temperature** for final usage.

In other buidings, conventional Solar Hot Water System shall be used with/without any recirculation pumps. It supplies the hot water by gravity as a preheated water to the electric geysers at all user points. Wherever, pumps are provide, one standby provision to be considered.

TESTING: All G.I pipes of Primary Circuit (Collector Circuits) shall be tested to hydrostatically for a period of 30 minutes to a pressure of 2 kg/Sq.cm without drop in pressure and all other G.I pipes for a pressure of 6 Kg/Sq.cm.

HOT WATER STORAGE TANK

SS-304 horizontal/vertical hot water storage tank with the required thickness(as Required) to withstand working pressure of 5 kg/sqcm.The hot water storage tank is provided with a manhole, cover, drain, vent, overflow, inlet and outlet connections etc as required and as per direction of Engineer in Charge.

Each hot water storage tank shall be provided with the following:

- Thermostatic control valve
- Safety valve
- One AIR Release valve
- Pressure and temperature relief valve
- High limit Temperature sensor
- Primary flow connection
- Hot water supply connection
- Hot water return connection
- Drain connection
- Thermometer fitted (inserted) in thermo well
- Pressure gauge
- Make up tank
- Ball valve

The hot water storage tank shall be hydrostatically tested to one and half times the working pressure of a system for a period of 24 hours without any leak. Field tests are to be performed at site to satisfy the capacity and operation of the unit by the CLIENT/ HLL/project in-charge.

PIPING

a. HOT WATER PIPING

Supply and return pipes of the hot water system complete with necessary pipes, bends, flanges, fittings, gaskets and valves are to be provided to connect Solar water heating system , hot water storage tank.

The hot water supply and return pipes are insulated with Rock wool and cladded with aluminium sheets of 24SWG.

b. HOT WATER SOLAR PIPING

GI/CPVC/UPVC solar hot water piping complete with bends, flanges, fittings, gaskets and valves to connect the solar panels to the hot water storage tank with necessary valves and fittings.

This also includes the solar circulation pumps as per requirement to circulate the hot water to the tank from the solar panels.

The hot water piping insulated with Rock wool and cladded with aluminium sheets.

c. PIPE INSULATION

Pipe insulation shall be as required under "HOT INSULATION".

d. INSTALLATION

Pipe installation shall be carried out with proper workmanship in accordance with approved drawings/ Engineer in Charge. Pipe shall be aligned parallel to walls and ceiling and not across the room. Change of direction shall be through hydraulically formed welding fittings as specified.

Alignment shall follow the approved drawings/ Engineer in Charge and wherever necessary pipe shall be rerouted under the instructions of Engineer in Charge in order to meet the site conditions and or interference from other services.

e. **PAINTING**

Pipe supports shall be of steel with a prime coat of red oxide and two finish coats of matt black paint after installation. Supports shall be spaced as follows:

Size	Horizontal	Vertical
Upto 15 mm	1.25 m	1.8 m
20 to 25 mm	2.00 m	2.5 m
32 to 125 mm	2.50 m	3.0 m
150mm & Over	3.00 m	3.0 m

f. **SUPPORTS**

- Additional supports shall be provided at the bends, at heavy fittings like valves, near equipment and as directed by Engineer in Charge. Pipe hangers shall be from structural steel, steel inserts in concrete, wall brackets or floor supports as decided by the Engineer in Charge depending upon the location of the support.

Hangers shall not be secured to light weight roof, wall, false ceiling or any other member which is not structurally meant for such loading. Hangers from structural steel shall be from suitably designed clamps or attachments and in no case should drilling or punching of such steel members be allowed. All pipe supports shall be capable of being adjusted in height to the tune of 50 mm.

- Pipe clamps shall be specially fabricated fittings for pipes. All clamps shall be of galvanized steel and finish coated with matt black paint. Clamps shall take into account pipe movement owing to temperature variations & anchors, and in no case shall the clamping arrangement induce stresses beyond the safe load limits of the pipe under fully filled conditions. Where pipes are insulated, the clamping shall interpose a hard insulation material or shall be designed so that the insulation is not compressed for more than 60 % of its compression strength.
- Vertical pipe risers shall be supported at each floor and in addition, the riser shall have a duck-foot support.
- All pipe joints shall be welded except where flange joints are specified hereinafter. Pipes upto 40 mm NB shall use socket - weld fittings of 150 lbs rating with fillet welding and larger sizes shall used with butt-welding type single V 35 deg weld preparation. Flange joints shall be provided at the following positions:

  a. Pair of flanges for isolation of equipment

  b. Mating flange for equipment flange connections

  c. Mating flange for valves, strainers as the case may be

  d. Pair of flanges at every 40 m continuous run of piping

  e. All piping shall be laid and tack welded in position with flanges, valves etc. After inspection and approval by the Engineer in Charge as to the alignment and height, the piping shall be full welded. Piping may be presented for such approval in sections. Slip-on flanges shall be demounted for welding. Random samples of valves shall be tested for leaks and seating. Necessary hand pump and blank flange facilities with pressure gauge, valves etc. should be provided at site.

  f. All pipe insulations shall be carried out in sections after duly testing.

g. TESTING

Piping shall be hydrostatically tested to 1.5 times more than the rated pressure for a minimum period of 24 hours without any leak and loss of pressure.

D. SOLAR COLLECTOR PANELS

1. The scope of work covers supply, erection, testing and commissioning of the Solar Collector Panels meeting the requirements and the intent of this specifications.
2. Manufacturer's catalogues and guaranteed performance details to be submitted for Approvals before ordering the supply of the equipment.

a. COLLECTOR:

Type: copper type with minimum size of 2 sqr mtr of each type.

- Collector Frame Extruded - Aluminum 1.4 mm thick or as required

- Gasket for Glass (Beading) - EPDM "U" Type
- Glazing (Cover) - Toughened clear glass
- Collector Body - Aluminum
- Bottom Insulation - 40 mm Rockwool (Minimum)
- Side Insulation - 20 mm Rockwool (Minimum)
- Absorber Plate - Copper
- Riser Copper - Dia- 12.7 mm or as required
- Inlet Header Copper - Dia- 25.4 mm or as required
- Reflective Foil - Aluminum or as required
- Grommet - EPDM or as required
- Collector Back sheet - Aluminum or as required
- Absorber area - 2 Sq. Mtr. or as required
- No. of Riser tubes per collector 9 per collector
- No. of Absorber Plate per collector 9 per collector
- Glazing transmissivity > 80%
- Coating absorptivity > 0.90
- Coating emissivity < 0.20
- Absorber riser bonding- Ultrasonic/Laser Welding
- Collector efficiency at ambient temp. > 65% or as required
- Finish - (Powder Coating)Golden yellow for frame, Black for Glass retaining angle
- Working Pressure -5 Kg./cm2 or as required
- Operating Conditions T > 50deg.C or as required

b. COLLECTOR SUPPORT FRAME

The structure should be in a position to withstand a wind velocity of 100 Kms/hr. It shall be made of angle iron 40mm x40mmx5mm and shall have vertical support at top and bottom edge of the inclined plane of the collector at a distance of 2.5 m or less. The vertical support shall be firmly grouted to the roof in the ground in case of ground mounted system. The grouting blocks shall be of minimum equal to 250 mm x 250 mm x 150 mm and finished properly. In case the grouting is carried out on roof already water proofed with asphalt the back support of the collectors may be anchored to the parapet or the size of the grouting block shall be increased to provide for a dead weight anchoring of 75 kg per leg of the vertical support. Any other alternative method of grouting/supporting shall be submitted the documents to Engineer-In-Charge / Project In charge for their approval prior to execution.

c. ABSORBER

(1) The absorber shall consist of riser, header and sheet for absorber. The diameter of header shall be 25.4 mm and Thickness 0.71 mm. The diameter of the riser shall be 12.7 mm and thickness 0.56 mm and made of copper only. The distance between the riser from centre to centre shall be 120 mm. Type, Grade, Size,

Workmanship and Finishes shall be as per IS: 12933. The riser and header pipes shall be of copper. The welding between Copper tube riser and Copper Sheet should be Laser-Welding or Ultrasonic-Welding

(2) The sheet shall be coated with selective coating to satisfy solar absorption of more than 0.90&solaremissivity < 0.12. or as required.

(3) The selective coating shall not get damage when the sample is raised to 1250 Degree C temperatures.

(4) All tests such as solar absorption test, emissivity test and temperature tests are to be carried out as per standard tests.

(5) Riser and header assembly designed for working pressure up to 2.5 Kg/cm2 and shall be tested for leakage at the Min. hydraulic pressure of 3.5 kg/cm2.

(6) Sheet for absorber shall be made of copper only.

d. STAND

The stand for the collector and hot water storage tank are to be designed taking into consideration the load to be carried by the stand. The collector becomes vulnerable to wind dust. The collector may be up-listed by wind striking the underside. This wind load should be determined according to accepted engineering practices and procedures. The material for collector stand shall be of size 32 x32 x 3 mm M.S. Angle iron with one coat of red oxide primer and two or more coats of enamel paint.

e. SOLAR HEAT BANK TANK

The material of the Solar Heat Bank shall be MS Sheet. & capacity shall be 10,000 Liters. The thickness of the Solar Heat Bank Tank shall be 6 mm shell and 8 mm dish ends. The tank shall have a Manhole of dia. min. 450mm & have a special layer of Resin Bonded Fiberglas Coating inside the tank to prevent corrosion. The tank shall be semi-pressurized type with air vents

f. SOLAR MIXING TANK

The material of the Solar Mixing Tank shall be SS-304 Sheet. & capacity shall be as per requirements. The thickness of the Mixing Tank shall be 3mm shell and 4 mm dish ends. A special layer of QUARTZ coating inside the tank to prevent corrosion shall be provided. The tank shall be non-pressurized type with air vents

g. TANK INSULATION

Both the Hot Water Tanks shall be insulated with 100 mm thick rock/glass wool of 48 Kg/m3 of density & clad with 24 SWG Aluminium cladding.

h. PLATE HEAT EXCHANGER

The Plate Heat Exchanger for Heat Transfer & Control (HTC) application shall be made of SS-316 plates. The capacity for heat transfer should be as per requirements.

i. SYSTEM INTERCONNECTING PIPING

G.I. Pipe of Medium class as per IS: 1239 duly insulated with 13mm Nitrile Tube & clad with polyshield outer mechanical protection on nitrile rubber insulation, comprising of wrapping with poly-glass tape helically wound and subsequently applying 2 coats of polyshield material(resin & hardener)as per manufacturer specification and approved by Engineer-in-charge.

j. MAKEUP TANK

The capacity of Makeup tank for solar circuit shall be 200 Ltr. or as required complete with float valve and interconnection piping as required. Soft water is to be provided for the makeup tank by client

k. ELECTRICAL HEATER

Electrical Heater shall be ISI Marked. Electrical heater shall be of 12 nos. each of rating 5 KW for the 5000 Liter Mixing Tank or as required.

l. ELECTRICAL HEATER CONTROL PANEL

The Electrical Heater System shall be split in 2 zones of 30KW each or as required & shall be having Thermo-Sensor based operation. Electric Heater Control Panel of total 60kW rating shall be part of the main Control Panel as the Heater Control Zone.

m. PUMPS FOR FORCED CIRCULATION, HTC & RE_CIRCULATION OPERATIONS

All Pumps used in the solar system for Forced Circulation, HTC & Re-Circulation Systems shall be Horizontal type with Centrifugal operation & having SS Impeller & Shaft and with CI Body. All Pumps shall be suitable for 3-Phase Operation & shall be for 1Working &1Standby mode.

n. CONTROL PANEL FOR PUMP OPERATION

The Operation of the Pumps in the above operations shall be DOL Starter based with adequate rating. The Main Control Panel Shall be sub-divided into sub-Zones for foll. Operations

- Forced Circulation Zone
- Heat Transfer & Control Zone (for Primary & Secondary Pump sets)
- Hot Water Re-Circulation in Building Zone

Note: Contractor shall provideControl Panel with makes as specified in the list of approved makes with digital differential temperature controller / PLC including necessary electronic parts like Contractors,Relays, Indicators, MCBs, Control fuses etc. for satisfactory working of pumps.

o. TEMPERATURE GAUGE

DIAL Type temperature gauge duly calibrated and suitable for temperature range 0-120 deg. Celsius shall be provided.

Contractor shall provide all valves, strainer, float valves and NRV etc. as per requirement.

Contractor shall provide 1:2:4 cement concrete foundation of size 300x300x250 mm (1 cement: 2 coarse sand: 4 stone aggregate of size 20 mm nominal size) for each and every footing of system. This will be scope of Civil Contractor with complete guidance from Solar Contractor.

p. PAINTING OF STANDS

Proper cleaning and degreasing of the surface should be done before painting. Two coats of zinc chromate red oxide primer shall be applied followed by one coat of epoxy paint and approved colour recommended by the CLIENT/ HLL.

q. PIPING

a) Material : Medium class (B class) GI as per IS 1239 shall be used for piping.

b) Back insulation : Insulation of R value = 1.67 m2 °C/W to withstand a temperature of 100°C shall be used.

Typical insulation detail shown below and also conforming to ECBC standards.

Thin plastic sheet shall be used as covering between glass wool and aluminum cladding besides other retaining material like chicken mesh etc.

24 SWG aluminium sheet shall be used for cladding the insulated pipe.

r. VALVES / NIPPLE / TEES / BENDS

Gun metal valve as per IS 780 specifications shall be used.

Nipple / Tees and bends shall be of GI as per IS 1239 Part II.

Gun metal ball valve shall be provided in each row outlet with Air vent.

s. VALVES

Gate valves or butterfly valves for shut-off or sectionalizing service, globe or ball valves for flow modulation. For on-site control, use gate valves. Specialty valve shall be employed where appropriate, such as check valves on a pump discharge, pressure regulating valves for equipment requiring lower-than-available system pressure, solenoid valves, etc. Flanged or threaded end valves are preferred. Locate valves in accessible locations, not more than six feet above the floor, if frequently used, and with a union on the downstream side of threaded end valves.

Provide each valve with brass, aluminum or plastic disc not les than 32mm diameter engraved with numbers, piping service and normal operating position (i.e. NO, NC) corresponding to valves shown on the diagram. Fasten disc to valve with 14gauge brass wire or 16gauge jack chain.

t. GATE VALVE

The primary function of a gate valve is for starting and stopping of flow. It has a disc actuated by a stem screw and hand wheel, moves up and down at right angles to the path of flow of fluid and seats against two faces to shut of flow. As the disc of the gate valve presents a flat surface to the direction of flow, this valve is only for starting and shutting the flow in the pipe.

These valves are of Gun Metal (GM) make. Supplying, fixing and testing correspond to IS 778-1984, Specifications for Copper Alloy Gate, Globe and Check Valves for Water Works.

All globe and check valves shall have working parts suitable for hot and cold water, as required. Valves shall be tagged with permanent label under hand wheel indicating type or duty.

All valves should have manufacturer's test certificate indicating the date of shop test and other quality control tests with the material used for the same.

u. BALL VALVE

The ball valve shall be of high-pressure type and shall be of sizes as specified and/or shown in the drawings the normal size of a ball valve shall be that, corresponding to the size of the pipe to which it is fixed. Ball valves shall have body of carbon steel. The ball and the shaft shall be of stainless steel. The seat shall be of PTFE.

The valve shall be complete with socket weld ends and the float of copper sheet. The minimum thickness of copper sheet used for making the float shall be 0.45mm for a float exceeding 115mm dia. The body of the high-pressure ball valve when assembled in

working condition with the float immersed to not more than half of its diameter shall remain closed against a test pressure of 3.5kg/sqcm.

The ball valve shall generally conform to IS specification No.1703: 1977. The weight of ball cock and the size of the ball cock shall be as per IS specification.

v. SYSTEM LAYOUT AND DESIGN

Maximum number of collector in series shall be not more than Ten for Thermosyphon system and not more than 15 for force circulation system.

Maximum number of collector in parallel in one row with header to header connections should not be more than Six.

Air venting at appropriate places without hindrance of a spring loaded valve to prevent air locking in the system should be provided. For this purpose system shall have at a suitable point atmospheric pressure conditions preferably in the high temperature zone.Flow rates commensurate with optimum heat removal from collector plates.

System shall have a suitable expansion / make up tank at a high point in the system to ensure that collectors run full all the times. Capacity of this expansion make up tank should be 1% of the system capacity.

For all systems above the capacity of 5000 LPD and 1.5% of the system capacity for the systems of capacity ranging from 1000 LPD to 5000 LPD.

Expansion cum make-up tank is for closed loop system and make up tank is for open loop system.

E. HEAT PUMPS

The Packaged type Air to Water Heat Pump. shall be completely factory assembled including required Nos. of Scroll Hermetically Sealed Scroll / Reciprocating Compressor(s), evaporator, Condenser and Microprocessor Control Panel etc with R134a / 410 a/ 470 c or any other CFC free Referigerant and COP between 3-4.

The Heat Pump shall have inbuilt hot water heat exchanger, vibratipon isoltors, pumps, valves, expansion valve, Copper / Aluminium fins, and other accessories.The Heat Pump should be capable of producing hot water at minimum 55°C temperaure at outlet (condenser circuit) temperatures at approx. 40°C ΔT. The Machine should have an operating ambient temperature range of 0°C to 40°C.

Heat Pump shall have built in electric panel as per safety norms as manufacturer standard. It shall be Suitable for electric supply of 415 + 10% volts & 50 Hz. The Heat pump shall have an in-built facility to start / stop depending on variation in demand at different periods. All interconnecting wiring / cabling between heat pump and electrical panel shall be part of the equipment. The heat pump should be designed at ambient temperature at 7 degree celcius considering de-aeration of Equipment.

SS 304 horizontal hot water storage tank of required capacity suitable for minimum 7 kg/sqcm operating pressure. Tank shall be provided with hot water flow meter at inlet & outlet, inlet/outlet, overflow/drain connections with MH cover, pressure relieve valve, pressure gauge at inlet/outlet with isolation cock & thermometer. Tank shall be provided with 24 G aluminium cladding. It shall eb provided with 15 mm dia. testing spout with valve.The Heat Pumps shall be installed in N+1 condition at terrace level of hospital building.

Testing , Commissioning & Opeartion: After satisfactory installation of all the systems, entire system shall be tested, commissioned as per procedure laid down & operated for continuous 30 days as directed by E-I-C.

CHAPTER-P

TECHNICAL SPECIFICATIONS- RO PLANT (Portable & Centralized)

1. SCOPE OF WORK:

Work shall consist of furnishing all labour, materials, equipment,appliances necessary and required. The Contractor is required to completely furnish all the plumbing and other specialized services as described hereinafter and as specified in the DBR and/or shown on the plumbing drawings for RO Plant.

1.1. EXECUTION OF WORK

1.1.1. The Contractor should visit and examine the site of work and satisfy himself as to the nature of the existing roads and other means of communication and other details pertaining to the work and local conditions and facilities for obtaining his own information on all matters affecting the execution of work.

1.1.2. The work shall be carried out in conformity with the Plumbing drawings and within the requirements of architectural and coordinated with all services drawings.

1.1.3. The Contractor shall cooperate with all trades and agencies working on the site. He shall make provision for hangers, sleeves, structural openings and other requirements well in advance to prevent hold up of progress of the construction schedule. All supports to the civil structure shall be provided with dash fasteners.

1.1. On award of the work, Contractor shall submit a schedule of construction in the form of a PERT chart or BAR chart for approval of the Engineer-In-Charge/ CLIENT. All dates and time schedule agreed upon shall be strictly adhered to within the stipulated time of completion/ commissioning along with the specified phasing, if any.

1.2.DRAWINGS

1.2.1.Shop drawings will be prepared & submitted to Engineer-in-charge for approval. The execution of work shall be done in–line with the approved shop drawings.

1.2.2.Architectural drawings shall take precedence over plumbing or other services drawings as to all dimensions.

1.2.3.Contractor shall verify all dimensions at site and bring to the notice of the Engineer-In-Charge all discrepancies or deviations noticed. Decision of the Engineer-In-Charge shall be final.

1.2.4.Large size details and manufacturers dimensions for materials to be incorporated shall take precedence over small scale drawings.

1.2.5.Any drawings issued by the Engineer-in-charge for the work are the property of the Engineer-in-charge and shall not be lent, reproduced or used on any works other than intended without the written permission of the Engineer-in-charge.

1.3.REFERENCE DRAWINGS

1.3.1.The Contractor shall maintain one set of all drawings issued to him as reference drawings. These shall not be used on site. All important drawings shall be mounted on boards and placed in racks indexed. No drawings shall be rolled.

1.3.2.All corrections, deviations and changes made on the site shall be shown on these reference drawings for final incorporation in the completion drawings to be submitted by the contractor in fulfilment of the conditions of this contract.

1.3.3.On award of the work the contractor shall be issued, one set of CLIENT's working drawings

stamped "tender drawings" by the Engineer-In-Charge. The CLIENT's drawings shall be the basis of contractor's shop drawings. Upon submission of shop drawings to CLIENT, Final approved drawings will be stamped as "Good for Construction" drawings, based on which execution work will be done.

1.3.4. Shop drawings are detailed working drawings which incorporate the contractor's details for execution of the work and incorporate equipment manufacturer's details and dimensions to ensure that the same can be installed in the space provided.

1.3.5. All shop drawings should detailed pipe routing and levels, showing location of other services at crossings etc., cable runs, route cable trays and all allied works and must be fully coordinated with other services and approved by the Engineer-In-Charge before execution of the works.

1.3.6. Shop drawings shall be furnished for detailed layout of all equipment, foundation, bolting and vibration elimination details along with information on dead and dynamic load, vibration etc.

1.3.7. Two sets of manufacturer's equipment drawings, roughing in and wiring diagrams shall be submitted.

1.3.8. Contractor shall submit shop drawings furnishing all details of MCC panels, cable routes, wiring diagrams and connection details as required.

1.3.9. Two copies of each set of shop drawings shall be submitted for initial scrutiny, discussion and approval.

1.3.10. Each submission shall be accompanied by contractor's certificate stating that the shop drawings meet all the contract requirements and that the piping and equipment can be satisfactorily installed without any obstructions in the space available.

1.3.11. On approval of the above the contractor shall furnish three sets of the approved shop drawings for execution of the work.

1.4. INSPECTION AND TESTING OF MATERIALS

1.4.1. Contractor shall be required, if requested, to produce manufacturers test certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Bureau of Indian Standards.

1.4.2. For examination and testing of materials and works at the site Contractor shall provide all testing and gauging equipment necessary but not limited to the following:

a. Steel tapes

b. Weighing machine

c. Plumb bobs, sprit levels, hammer

d. Micrometers

1.4.3. Hydraulic machine

1.4.4. All such equipment shall be tested for calibration at any approved laboratory, if required by the Engineer-In-Charge. All testing equipment shall be preferably located in special room meant for the purpose.

1.4.5. Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Engineer-In-Charge.

1.5. METRIC CONVERSION

1.5.1. All dimensions and sizes of materials and equipment given in the tender document are

commercial metric sizes.

1.5.2. Any weights, or sizes given in the tender having changed due to metric conversion, the nearest equivalent sizes accepted by Indian Standards shall be acceptable without any additional cost.

1.6. COMPLETION DRAWINGS

1.6.1. On completion of work, Contractor shall submit one complete set of original tracings and six prints of "as built" drawings. These drawings shall have the following information.

1.7. Run of all piping, diameters on all floors, vertical stacks and location of external services.

1.8. Ground and invert levels of all drainage pipes together with location of all manholes and connections up to outfall.

1.9. Run of all water supply lines with diameters, locations of control valves, access panels.

1.10. Layout showing location of all mechanical equipment and piping connections.

1.11. All shop drawings shall be updated from time to time for the purpose of making completion drawings.

1.12. No completion certificate shall be issued unless the above drawings are submitted.

1.13. Contractor shall provide four sets of catalogues, service/operation & maintenance manuals, manufacturer's drawings, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.

1.14. All "warranty cards" given by the manufacturers shall be handed over to the Engineer-In-Charge.

1.15. TESTING

1.15.1. Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.

1.15.2. Tests shall be performed in presence of the Engineer-In-Charge and test records for the tests shall be duly signed by Contractor and the Engineer-In-Charge.

1.15.3. All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.

1.15.4. Contractor shall perform all such tests as may be necessary and required by the local authorities to meet municipal or other bye-laws in force.

1.15.5. Contractor shall provide all labour, equipment and materials for the performance of the tests.

1.16. SITE CLEARANCE AND CLEANUP

1.16.1. The Contractor shall, from time to time, clear away all debris and excess materials accumulated at the site.

1.16.2. After the fixtures, equipment and appliances have been installed and commissioned, Contractor shall clean-up the same and remove all plaster, paints, stains, stickers and other foreign matter or discolouration leaving the same in a ready to use condition.

1.16.3. On completion of all works, Contractor shall demolish all stores, remove all surplus materials and leave the site in a broom clean condition, failing which the same shall be done by the Engineer-In-Charge at the Contractor's risk and cost. Cost of the cleanup shall be deducted from the contractor's bills on pro-rata basis in proportion to his

contract value.

1.17. LICENCE PERMITS AND AUTHORITIES

1.17.1. Contractor must hold a valid plumbing or any other as required license by the municipal authority or other competent authority under whose jurisdiction the work falls.

1.17.2. Contractor must keep constant liaison with the local development, municipal /statutory authority and obtain approval of all drainage, water supply, fire suppression and other works carried out by him.

1.17.3. Contractor shall obtain, from the municipal and other authorities 'C' & 'D' & other forms as required for approval of drainage and water supply works during execution and the completion certificate with respect to his work as required for occupation of the building. Contractor shall obtain permanent water supply and drainage connections from authorities concerned. CLIENT shall reimburse the fees paid to the authorities towards the connection charges on production of receipts for money paid.

1.17.4. Contractor shall get any materials tested from the appropriate authority if so required with no cost to the CLIENT/CLIENT.

1.18. CUTTING OF WATER PROOFING MEMBRANE:

1.18.1. No walls terraces shall be cut for making and opening after water proofing has been done without written approval of Engineer-In-Charge. Cutting of water proofing membrane shall be done very carefully so as other portion of water proofing is not damaged. On completion of work at such place the water proofing membrane shall be made good and ensured that the opening/cutting is made fully water proof as per specifications and details of water proofing approved by Engineer-In-Charges.

1.19. MATERIALS

1.19.1. Unless otherwise specified and expressly approved in writing by the Engineer-In-Charge, only materials of makes and specification as mentioned in the list of approved makes attached with the specifications shall be used.

1.19.2. If required, the Contractor shall submit samples of materials proposed to be used in the works. Approved samples shall be kept in the office of the Engineer-In-Charge.

2. DESIGN BASIS:-

The central RO Capacity shall be of miminum 5000 LPH capacity for Hospital. Building. In all other areas portable RO Water System with SS water cooler shall be installed as per DBR & meeting functional requirements.

2.1.TREATED WATER QUALITY

Physical Quality

Normally the RO water turbidity shall be less than 1 NTU.

The colour of the filtered water shall be restricted to 2 Hazen units on platinum cobalt

There shall be nothing objectionable as regards taste and odor

Chemical Quality

The pH value of filtered water shall be within 6.5 – 7.0

Other chemical quality parameters such as total dissolved solids should be less than 50 ppm

Biological Quality

Throughout the year, 100% of samples shall not contain any coliform organism in 100 ml.

Coliform organisms shall not be detectable in 100 ml of any two consecutive samples. No sample shall contain E – Coli in 100 ml.

EXPECTED TREATED WATER CHARACTERISTICS AFTER RO (REVERSE OSMOSIS PLANT)

Expected Treated Water Characteristics after RO (Reverse Osmosis Plant)	
Parameters	**Characteristics**
PH	6. 0 – 7.0
Total Dissolved Solids	<50 ppm
Suspended solids	Nil
Turbidity	Nil
Iron as Fe	Nil
Total Hardness	Less than 5 ppm

The Output of RO Water should comply with the BIS 10500 for Drinking Water.

The RO membranes are embedded within the pressure vessel. One side of the membrane is enclosed within the brine seal to avoid the mixing of filtered water and inlet water. Each membrane is connected to the other by means of interconnect or, and has a common permeate end. The filtered water is collected from the permeate end is sent to drinking and cafeteria usage.

3. Components & specification of Centralized RO Plant are mentioned hereunder:-

3.1. **RO High Pressure Feed Pumps (HPP)** of Vertical multistage centrifugal type and suitable head to generate permeate flow. The pump casing construction shall be of SS-316 & impeller shall be also SS 316. The motor shall be TEFC with IE-3 efficiency suitable for a supply of 415V / 3 Phase at 50 Hz. Supply. The pump shall be supplied complete with base channel, coupling foundation bolts, pressure gauge, valves at inlet and outlet of each pump. (1 working + 1 Standby). RO high pressure pump is water feeding from treated water tank to RO module at high pressure flow.

3.2. R**O Raw Water Pumps (RWP)** of Vertical multistage centrifugal type and suitable head to generate permeate flow as Required. The pump casing construction shall be of SS-316 & impeller shall be also SS 316. The motor shall be TEFC with IE -3 efficiency suitable for a supply of 415 V / 3 Phase / 50 Hz. Supply. The pump shall be supplied complete with base channel, coupling foundation bolts, pressure gauge, valves at inlet and outlet of each pump. (Contractor to confirm duty for suitability). (1 working + 1 Standby).

3.3. **Package type RO module** capable of giving a net treated water output as required. The Reverse osmosis module shall be made out of Sprial Wound Thin Film Composite suitable BSPT/NPT connections shall be used for connecting feed and reject ends. The modules shall be supplied complete with all necessary instrumentation, valves for sampling, drain, reject and permeate.

3.4. **Special Antiscalant dosing system** consisting of one HDPE tank of capacity as Required with a positive displacement diaphragm dosing pump having variable flow rate.The motor shall be suitable for operation at 240 V / single phase / 50 Hz supply. The pump shall be supplied

complete with necessary polypropylene piping, valves, strainers and injection fittings.

3.5. **Micron cartridge filter** (shall be made of FDA compliant high quality poly propylene material) suitable for a flow rate as Required to achieve particle filtration of less than 5 microns. The unit shall be supplied complete with inlet and outlet branches, removal caps for replacement of elements, inlet and outlet pressure indicator, valves etc. complete in all respect.

3.6. **CIP system (Cleaning in Place)** consisting of HDPE tank with agitator complete with inlet/outlet, drain overflow etc. along with SS pump of capacity as required and cartridge filter of 10 micron. The cartridge filter shall be made of FDA compliant high quality poly propylene material to achieve particle filtration of less than 10 microns.

3.7. **PH correction dosing system** consisting of one HDPE tank with a positive displacement diaphragm dosing pump having variable flow rate as required. The motor shall be suitable for operation at 240 V / single phase / 50 Hz supply. The pump shall be supplied complete with necessary polypropylene piping, valves, strainers and injection fittings.

3.8. **Centralized control panel** made out of CRCA sheet min. 2mm thick having main contactors for all pumps (listed above) including SPP, 3 phase thermal overload relay. The control panel for monitoring and control of RO system shall include all required signal lamps, HRC fuses, and Annunciation box with hooter. All control and power cabling along with double earthing between the panel shall be included in the scope of the contractor. An emergency stop push button shall be provided in the panel.

3.9. **High pressure side piping** from the RO high pressure pumps to the rejects stream control valves shall be of SS 316 using all SS fittings ball valves of suitable pressure rating shall be used till 50 MM size, above 50 MM, flanged globe / water butterfly valves in SS construction shall be used. Rejects pressure control valves shall be globe valve and feed flow control valve shall be of SS 316.

3.10. **SS 316 RO Water storage** tank (Capacity as Required) of minimum 3mm thickness. Tank shall be provided with water flow meter at inlet & outlet, inlet / outlet valves, overflow / drain connection with MH cover (550 mm I.D.) Tank shall be mounted on 450 mm high steel structural supports with access ladder painted with 2 coats of red oxide paint.

3.11. ELECTRICAL AND INSTRUMENTATIONS

Control Panel : Fixed cubical type with weather proof DOL/Star Delta Starters (as per requirements) consisting of incoming feeder with outgoing feeder feeders, Voltmeters, Ammeter, push button with indicator lamp, overload relays, Contactors, Bus bar of required size, control cablings etc.

Type of panel:

Compartment for individual feeder

MOC:

MS (1.6mm thick sheet) fabricated with powder coating.

Earthing Consist of Copper flats/copper wire of required size for earthing motors ,MCC Etc. Required compression glands ,ferrules, ties, aluminum etc.

Instrumentation

Like level controllers, pressure switches, pressure gauges as required.

3.12 Instruments List including but not limited to (Provision to be considered in the Centralized R.O Plant)

Sr. No.	INSTRUMENT
1	Flow Indicator
2	Pressure Gauge
3	Pressure Switch (Low & High)
4	Conductivity Indicator
5	PH Meter etc.

4. PORTABLE RO WITH SS BODY WATER COOLER

Design, Supply, installation, testing & commissioning of Portable RO with water coolerof 80 LIT (approx.) storage capacity & water flow rate 50 LPH through faucets including RO membrane, pumps, motors, cartridge filters, interconnecting pipes, valves, cable etc. along with water cooler facility. It shall be provided with adjustibel cold water thermostat, seam welded food grade stainless steel tank, pre coated outer body, mechanically expanded condenser, overload compressor protection, sturdy compressor & trouble free operation, insitu power saving PUF insulation, no. of faucets (min. 2), 7 stages of filteration(approx.) with speedy drainage facility. The refrigerant shall be ecofriendly & the unit shall be silent operation type.The oprating temperature shall be between 15 to 45 degree C.
It shall be provided with auto flush feature.

MATERIALS: The Portable Water Purifier shall have PP meltdown sediment filter, activated carbon block, thin film composite spiral wound type reverse osmosis membrane, ultra violet membranes, diaphragm type pump, suitable for maximum 500 ppm hardness, 10 NTU turbidity, TDS of max 2000 ppm inlet water quality& a reduction upto 75% in TDS & Hardness parameters. The system shall be suitable for a supply of 100-240 V AC / 50 Hz. The Purifier shall be supplied with all equipment membranes, filters and pumps, motors, interconnecting pipes, adaptor and cable of minimum 1.8m length & complete in all respect.

Testing , Commissioning & Opeartion: After satisfactory installation of the centralized R.O system, entire system shall be tested, commissioned & operated for continuous 15 days as directed by E-I-C.

CHAPTER- Q

TECHNICAL SPECIFICATIONS - BIO MEDICAL WASTE MANAGEMENT SYSTEM

Integrated Sterilizer & Shredder (ISS):

1. Source of the Autoclave:

The system shall use Non-burn Technology. It shall adopt steam sterilization method integrated with a shredder. Process should be in one continuous automated cycle with no use of conveyor belts for transporting waste to a separate shredder. The unit shall not use any chemicals.

2. Capacity:

Chamber Volume shall be 140 to 200 Litres minimum and shall have a capacity to treat minimum 40 kg/hr.

3. Power: 3- phase, 400 V - 440 V, 50 Hz.

4. Loading: Loading shall be from the top. The waste should be able to be loaded in the chamber by a single person without help. The level of loading the waste should not be more than 5 feet from ground level. No stairs or lift should be used for using the machine at any time. It should have a mechanism where the chamber shifts from stationary in any direction for ease of loading and unloading

5. Unloading:

Waste shall be removed from the vessel automatically. There shall be auto switch off for protection. There shall be a safety system, which should prevent the cycle to start if the door of the machine is open.

6. Chamber:

The treatment vessel shall be vertical (to optimize space occupied) and built of sturdy material like SS 316L or better. There should only be one opening in the chamber.

7. Installation:

Installation area should be less than 160 sq ft.

8. Shredder: Shredder blades shall be of SS/carbon steel material. Shredder mechanism shall be at the bottom of the vessel to optimize full chamber volume.

9. Cycle Duration:

Cycle time should be less than 35 minutes. After treatment, the system should ensure substantial volume reduction in the range of 70 – 90%. Shredding time should be for minimum 7 minutes for better efficiency. It should be able to shred & sterilize waste simultaneously. It should have separate cycle with no shredding option so the machine can also be used as only an autoclave for heavy metals.

10. Temperature range required:

Temperature range shall be minimum 136 degree Celsius and pressure range shall be 2.4 – 5.0 bar with provision for vacuum to ensure proper sterilization. The system should be able to separate liquid and the solid in the chamber itself before unloading the treated waste. A system with an option to cool down the treated material below 60 Celsius degree in less than 3 mins shall be

provided. A system shall be able to take out the air (in order to have proper and efficient sterilization) before sterilization starts through a bio filter in order to avoid any hazardous air exhaust. The final treated waste should be non-reusable. There shall be audio alarm system for printing, door unlock, temperature error, pressure error etc.

11. PROCESS:

The system shall be able to treat a mixture and treat different types of waste in one cycle. The system shall be able to treat glass, Scalpels, Blades and Needles. There shall be an automatic washing cycle system. The system shall have one test cycle to detect leakages under pressure.

12. OPERATION AND CONTROL:

Cycle should be fully automated and controlled by a microprocessor. Automatic computerized reports of essential sterilizing parameters (selected cycle, start time, cycle stages, temperature/ pressure, end time, cycle status i.e. pass/fail) should be possible. Operator LCD Touch Screen should be present with all indicators (selected cycle, start time, cycle stages in graphs as well, temperature/ pressure, end time, cycle status i.e. pass/fail). A system should be able to collect the cycle data on a memory chip/card through an integrated slot. For optimal accuracy of sterilization parameters, the system should be equipped with at least 2 temperature sensors and two pressure transducers. There shall be a protective housing with a safety door with a safety switch.

13. ACCESSORIES REQUIRED:

There shall be an In-built steam generator. Steam generator shall be automatically controlled by electronic system. It shall have its own R.O. system for water treatment. The system should have a cart or equivalent to collect treated waste. The OEM should provide the same. An integrated printer for data collection and printing shall be provided. An air compressor which has metal sound proof system shall be provided.

14. CERTIFICATION AND STANDARD:

- Central / State Pollution Control Board guidelines, latest as amended.
- European CE/ US FDA. ISO 9001:2008 – Quality Management systems requirements.
- ISO 9001, ISO 13485, ISO 14001 & ISO 18001 certifications.

All test certificates as applicable shall be submitted by the EPC Contractor to Engineer-In-Charge.

15. Other Conditions:

Any accessories, if required for successful installation, testing & commissioning of the system shall be provided without extra cost.

16. **Testing , Commissioning & Opeartion:** After satisfactory installation of the system, entire system shall be tested, commissioned & operated for continuous 15 days as directed by E-I-C.

CHAPTER- R

Technical Specifications - Organic Waste Converter

All the Equipment comprising of Composting machine, double curing system & shredder shall be designed to operate 10-12 hrs a day. Accordingly suitable capacity & no. of OWC shall be provided to process approx. 5000 kg biodegradable waste generate per day.

I. Composting Machine

- Capacity : As Per requirement
- Power Connection : As Per requirement
- Brim Capacity : As Per requirement
- Waste Batch size : As Per requirement
- Batch Duration : As Per requirement
- MOC : All contact parts of SS-304.
- Trolley MoC : MS Powder Coated / S.S 304

II. Double Curing System

- HDPE crates of adequate size, laminated with aerating net.
- Four shelf folding storage rack of adequate size.
- Collection tray of G.I. of adequate size.
- Double Fogger, Disc Filter, Ball Valve, Pump, Time Control unit for spray and frequency control, pressure gauge, and other accessories like piping, valves etc.

III. Portable Shredder

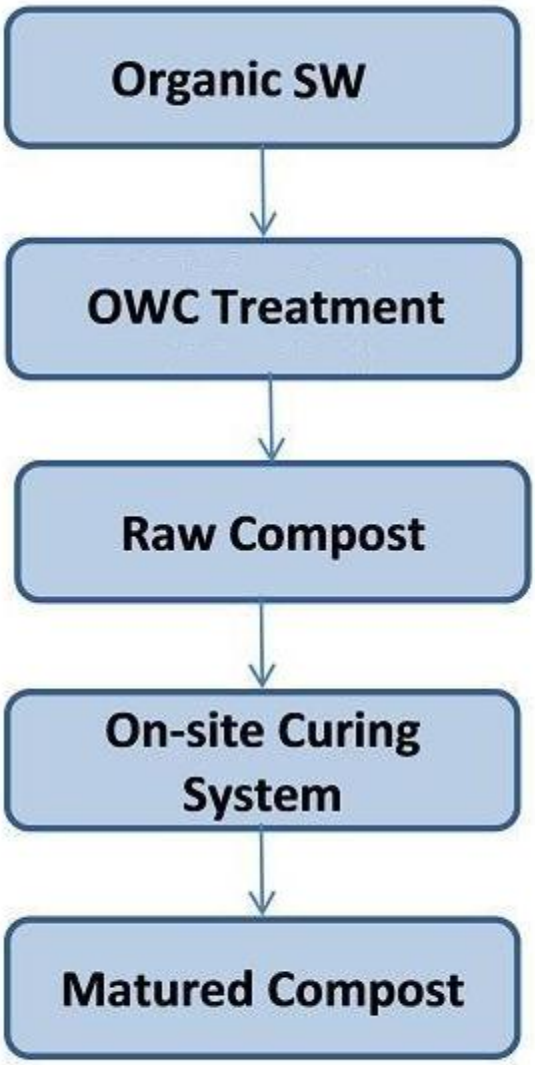
- Capacity : As Per requirement
- Motor : As Per requirement
- Phase : Single Phase.
- Weight : As Per requirement
- Dimension : As Per requirement

Other requirements:

- Space requirement: It should include segregation, Treatment & storage area.
- 3 Phase Power supply with suitable electrical panel
- 4 Pole MCB – No. as required.
- Single Phase – 5 Amp –3 Pin Switch Socket - No. as required.
- Single Phase connection – No. as required.
- 1/2" Dia. Tap for water connection.

Testing , Commissioning & Opeartion: After satisfactory installation of Organic Waste Converter, entire system shall be tested, commissioned & operated for continuous 15 days as directed by E-I-C.

FLOWCHART OF ORGANIC WASTE CONVERTER



CHAPTER- S

List of Approved Makes of Materials- Services & Related Works

S.No.	Details of equipment/ material	Make/Manufacturer
DRINKING WATER PUMPING SYSTEMS /WATER TREATMENT PLANT / REVERSE OSMOSIS ETC.		
1.	Anti-Vibration Mounting & Flexible Connections	Dunlop/Flexionics/Kanwal/Industrial Corporation/Resistoflex
2.	Butterfly Valve	Zoloto/Audco/Kirloskar/AIP/Advance
3.	Cartridge Filter	Milton Roy/Grundfos/Big Blue
4.	Centralized RO Plant	Ion Exchange/ Thermax/ Pentair/PAMM/AWMS
5.	Chain Pulley Block	Indef/ Ardee/ J.K. Morris
6.	Check Valve – Dual Plate	Advance/Honeywell/Audco/Zoloto
7.	Check Valve – Wafer Type	Advance/Danfoss/Zoloto/Honeywell
8.	Conductivity Meter	Fox/Rosemount/Aster/Digital
9.	Couplings	Lovejoy/Dunlop/Burgmann
10.	Dosing Pumps	LMI/Pulser Feeder/Toschon/Grundfos
11.	Dosing Pumps	LMI/Pulser Feeder/Toschon/Grundfos
12.	Electronic Flow Meter	Krohne (Forbes Marshall)/Rockwin Cirrus Engineering
13.	Fastener	Fisher/Hilti/Canon
14.	Filter	Ion Exchange/ Thermax/Pentair
15.	Flow Meter	Energy/Honeywell/Cirrus Engineering
16.	GI / MS Pipes	Tata Steel/Jindal/SAIL
17.	GI pipes fittings	Unik/ Jain Sons/Zoloto /DRP
18.	GM / Forged Brass Ball Valves	Zoloto/Honeywell/RB
19.	HDPE Tanks	Sintex/Amitex/Sheetal
20.	High Pressure Pumps	DP/Grundfos/ITT/Willo-Mather Platt
21.	Hydro-pneumatic System	HBDGM/ Grundfoss / Salmson / Nocchi / Kirloskar/ DP Holland / Wilo
22.	Level Controller & Indicator (Water)	Auto Pump/Cirrus Engineering/Technika Techtrol
23.	Mechanical Seal	Burgmann/Sealol/Dunlop
24.	Non return valve	Zoloto/Honeywell/RB
25.	ORP Meter	Fox/Rosemount/ Rapid Control/ Maharaja / Waltronics
26.	Paints	Asian/Berger/ICI/Shalimar Paints
27.	pH Meter	Fox/Rosemount/Aster/Digital
28.	Pipe clamp & supports	Chilly/Euroclamp/Kanwal
29.	Pipe clamp & supports	Chilly/Euroclamp/Kanwal
30.	Portable RO Plant	Bluestar/Usha/Eureka Forbes/ Kent/ Prestige/ Voltas/ AO Smith

S.No.	Details of equipment/ material	Make/Manufacturer
31.	Pressure Gauge	Fiebig/ Emerald/H. Guru/Baumer
32.	Pressure Switch	Switzer/Honeywell/Indfoss
33.	Raw Water Pump Set/ Treated Water pump set/ Drainage Pump Set or any other type of pump sets.	DP/Grundfos/ITT/Willo-Mather Platt/KSB
34.	Resin	Ion Exchange/Thermax/3M/Pentair
35.	RO Membrane with Housing	Dow/Hydranautics/Tricep/G.E/Mitsubishi
36.	Sluice Valves	IVC/Kirloskar/ Zoloto
37.	Sodium Hypochlorite Dosing System	Asia LMI/ Grundfos/ Seiko/ E - Dose
38.	Softener Vessel	Ion Exchange/Thermax/Pentair
39.	SS 316 Pipes	Jindal/ Viega/Sumito
40.	SS 316 Strainer	Normax/Swadeshi/Worth valve
41.	SS 316 Valves	Audco/ Zoloto /Leader/Walson
42.	Storm Water Drainage & Sewage Sump Pumps (Submersible)	DP/Grundfos/Xylem-ITT/Willo-Mather Platt
43.	Transfer Pumps	DP/Grundfos/Xylem -ITT/Willo-Mather Platt
44.	Water Meter (Mechanical Type)	As per Plumbing & Sanitary make list
45.	Welding Rods	ADORR/Esab/ Advani/ Victor
46.	Y Strainer	Emerald/Zoloto /Sant
HOT WATER GENERATOR SYSTEM		
1.	Air release valve/ Insulation/ Thermometer/ Pressure Gauge	As per Approved makes for HVAC Works.
2.	Ball valve /Check valve/"Y" – strainer/ GI/MS pipes	As per Approved makes for Fire Fighting Works.
3.	Hot Water Generators	Enmax/ Sunmax/ Goodsun / TATA Power Solar / Thermax/ Rapid Control
4.	Recirculating pumps	Grundfos/ DP /Mather Platt – Wilo/KSB
SOLAR PV/ HOT WATER SYSTEM		
1.	Solar PV System	Tata Power Solar / Havells Solar Edge/ Schneider/ Socomec/ Emmvee
2.	Solar Hot Water System	HoneyWell / Solahart / Sol. Power/ TATA Power Solar/Bosch/Solimpeks
3.	Butterfly Valve	Audco/Danfoss/Honeywell/Zoloto
4.	Check Valve – Dual Plate	Advance/Honeywell/Audco/Zoloto
5.	Check Valve – Wafer Type	Advance/Danfoss/Zoloto/Honeywell
6.	CPVC pipes	Supreme/Ashirwad/Astral
7.	GI Pipes	Tata Steel/Jindal (Hissar)/ SAIL
8.	GM / Forged Brass Ball Valves	Danfoss/Honeywell/Zoloto
9.	Heat Exchanger	GEA Eco flex/Alfa Level or equivalent
10.	Hot Water Re circulation OR other Pumps	DP – Holland/Grundfos /Xylem -ITT/ Wilo – Mather Platt

S.No.	Details of equipment/ material	Make/Manufacturer
11.	Insulation for Hot Water Pipes	Armacell – Armaflex/Eurobatex – Union Foam K-Flex/ Thermaflex
12.	Level Controller & Indicator (Water)	Auto Pump/Cirrus Engineering/Technika / Techtrol
13.	Pipe clamp & supports	Chilly/ Euroclamp/ Kanwal
14.	Sluice Valves	IVC/ Kirloskar/ Advance
15.	Solenoid Valve	Danfoss/ Avcon/ Honey well
16.	Water Meter	As per Plumbing & Sanitary make list
17.	Y Strainer	Leader/ Zoloto/ Audco/ Castle/ Emerald/ Rapid cool/ Advance
18.	Heat Pump	Daikin/Emerson/Cristopia/Bluebox, Climaveneta/Certikin
ELECTRICAL WORKS		
1.	11 KV HT Panel with 11kV Vacuum Circuit Breaker (VCB)	L&T/ ABB / Schneider/ Siemens or their authorized Channel Partner
2.	33/66 kV HT Panel with 33/66 kV SF6 Breaker	L&T/ ABB / Schneider/ Siemens or their authorized Channel Partner
3.	33/66 kV HT Panel with 33/66 kV Vacuum Circuit Breaker (VCB)	L&T/ ABB / Schneider/ Siemens or their authorized Channel Partner
4.	ACB (TP,4P) with variable microprocessor	L&T (U-Power Omega)/ Siemens (3 WL)/ Schneider (MVS) / ABB (Emax)/Legrand (DMX3)
5.	Automatic Transfer Switch (ATS)	L&T/ ABB/ Siemens/ Schneider / Socomec
6.	Auto Changeover & Current Limiter (ACCL)	Indo Asian/ Havells/ Salzer/ Elmeasure/ L&T/ ABB / Siemens/ Schneider/ Legrand
7.	Auxiliary relays compatible with PLC etc.	Siemens/ L&T/ ABB/ Areva/ Schnieder
8.	Batteries	Hitachi/Panasonic/ Yuasa/ SF/ Exide/ Amco/ Amaraja
9.	Battery Charger	Amaraja/ Sabnife/ Statcon/ Voltstat/ HBL
10.	Battery Charger-cum-DCDB	Amaraja/ Volstat/Caldyne/ Expo-Fyn/ BCH/ HBL
11.	Boom Barrier	FAAC/ Godrej Vigiguard/ Somfy/Gunnebo
12.	Brass compression Gland (Heavy duty)	Commex/ Gripwell/ Dowell
13.	Bus bar	Jindal/ Hindalco/ Indal
14.	Bus Duct - Sandwich	L&T/ Schneider/ C&S/ Godrej/ Legrand/ EAE/ Advance
15.	Bus trunking , rising mains, end feed unit, top-off box (plug-in type)	L&T/ Schneider/ C&S/ Godrej/ Legrand/ EAE/ Advance
16.	Cable Jointing Kit / HT termination Kit	Reychem/ Xicon/ 3M
17.	Cable Lugs & Glands	Dowel/ Johnson/ Gripwell/ Comex/ Hex/ Comet
18.	Cable Tray/ Race ways / Floor trunking / wall channels	MEM/ BEC/ OBO Bettermann/ Indiana/ Legrand/ RMCON
19.	Capacitors with harmonic filters	L&T/ Siemens / Schneider/ ABB/ Ducati

S.No.	Details of equipment/ material	Make/Manufacturer
20.	Ceiling /Exhaust/Wall fans	Crompton/ Usha/ Orient/ Bajaj/ Havells
21.	Chemical Earthing	JMV LPS Ltd./ Pragati Electrocom
22.	Coaxial Wires	Finolex/ Delton/ Skytone/ L&T/ KEI/ Finolex/ Gloster
23.	Colour Monitor	Samsung/ LG/ Sony/ Philips
24.	Compression Gland and Lugs / thimbles	Dowel/ Comet/ Gripwell
25.	Contactors	ABB/ L&T/ Schneider/ Siemens
26.	Control fuse base with HRC fuse / HRC Fuse	L&T/ Siemens/ ABB/ Alstom/ Schnieder
27.	Crimping Lugs/ Thimbles	Dowells/ Hex/ Commet
28.	CT/ PT's	L&T/ Kappa/ C&S/ CGL/ AE / Meco
29.	Cubicle Type Fuse Unit/ RMU	Siemens/ L&T/ ABB/ Schneider
30.	Data/Telephone/TV Outlets	Systemax/ Belden/ Simone/ MK/ Legrand/ Havells/ Anchor
31.	DB's	Hager/ Havells/ Legrand/ L&T/ Schneider/ ABB/ Siemens
32.	DG Set - Assembler	Jakson & Company / Jakson Ltd/ Sterling Generators / Sudhir Gensets/ Powerica/ Kirloskar (KOEL authorized OEM) / TIPL (Gainwell)
33.	DG Set - Alternator	Stamford/ Leroy Somer/ Toyo Denki/ AVK-SEG/ Kirloskar (KOEL Green)
34.	DG Set - Engine	Cummins/ Mitsubishi/ Perkins/ Volvo/ Caterpiller/ Kirloskar (KOEL Green)
35.	DG Synchronizing Controller	Woodword/ Dief/ Deep sea
36.	Digital Lighting Control System	Wipro/ Siemens/ Philips/ Schneider/ ABB/ L&T
37.	Digital Numerical Relays	L&T/ ABB / Siemens/ Schneider/ Areva
38.	DWC HDPE Pipe	DURA-LINE / REX / CARLON/ EMTELLE
39.	Digital Energy Meters including Dual Source Energy Meters	L&T/ Rishabh/ Schneider/ HPL/ Siemens/ ABB/ Socomec/ Neptune
40.	Electrical Motors	L&T/ ABB/ Siemens/ Kirloskar
41.	Optical Fiber Cable	Sterlite Technologies/ Finolex/ Belden/ Delton/ Skytone
42.	Fire Extinguisher	Ceasefire/ Exflame/ Minimax/ Life Guard/ Safex
43.	Fire Survival Cables	KEI/ Polycab/ Havells/ Fusion Polymers
44.	PVC insulated FRLS - Aluminum / Copper 1.1 KV grade flexible wires	L&T/ Gloster/ Havells/ Polycab / Finolex/ RR Kable/ KEI/ Batra henlay
45.	G.I./Cu. Strip & earthing material	Bharati/ Indiana/ Slotco
46.	Hand Gloves & Rubber Mat	Premier Polyfim Ltd/ Polyelectrosafe/ Challenger/ Electromat/ Safe Hold
47.	HRC Fuse	Siemens/ L&T/ ABB/ Schneider
48.	HT & LT Cables (Power & Control Cables,	Gloster/ Havells/ Nicco/ Finolex/ KEI/Polycab

S.No.	Details of equipment/ material	Make/Manufacturer
	Solar Cables)	
49.	Indicating Lamps	AE/ Kaycee/ Vaishnav/ L&T/ Siemens/ Schnieder/ Teknik/ ABB
50.	Industrial Socket Outlets	ABB/ L&T/ Legrand/ Siemens/ Hager
51.	Insulated Rubber Mat	Premier Polyfilm Ltd/ Polyelectrosafe/ Challenger/ Electro Mat/ Safe Hold
52.	Insulators	Jaya Shree/ Modern/ IEC/ WSI
53.	Inverter	Microtek / Luminous / Su-Kam/ Eaton
54.	Isolators	Siemens/ L&T/ ABB/Socomec/ Schnieder
55.	Isolation Panels for Modular OT	Pieco/ Schnieder/ L&T/ ABB/ Siemens/ Hakel
56.	Jointing Kit	Reychem/ Xicon/ Birla-3M
57.	LED Light Fixtures and Lamps	Philips/ Wipro/ Trilux/ Syska/ Lighting Technologies / Havells
58.	Lighting for Facade	Philips/ Wipro/ Trilux /Allurays/RZB/BEGA
59.	Lightening Protection	L&P ELECTRO/ LPI/ Indelec/ OBO Bettermann/ APS
60.	LT Panels / Synchronizing Panels/ Capacitor Panels	L&T/ ABB / Schneider/ Siemens/ Legrand or their Authorized Channel Partners
61.	MCBs / RCCB/Isolaters / RCBO / Change over switch	Hager/ Havells/ Legrand/ L&T/ Schneider/ ABB/ Siemens/ Indoasian (Optipro)
62.	MCCB with Variable Microprocessor based (O/C, S/C, E/F) / Thermo magnetic releases	L&T (D-sine)/ Schneider (CVS)/ ABB (Tmax)/Siemens (3VA)/ Legrand (DPX3)
63.	Measuring Instruments (Analog Meter)	L&T/ AE/ MECO/ Rishabh/ Schnieder
64.	Measuring Instruments (Digital Type)/ MFM/KWH meter	L&T/ Ducati/ Conzerv/ Secure/ Siemens/ Schnieder/ ABB
65.	Modular Switches/ Socket outlets and wiring accessories with moulded cover plate	MK (Elements) / Siemens (Delta)/ Legrand (Arteor)/ L&T (Entice)/ Havells (Crabtree-Murano)/ Schnieder (Opale)/ Wipro (North West-Platia)/ ABB (Ivie) / IndoAsian (Elvira)
66.	MPCB	L&T/ Siemens/ ABB/ Schnieder
67.	MS Conduit	BEC/ AKG/ Steel Kraft/ RMCON
68.	MS Conduit accessories	BEC/ AKG/ Steel Kraft/ RMCON
69.	Multi-function Meter	L&T/ ABB / Siemens/ Schneider
70.	Nurse Call System	Schrack Seconet/ Honeywell/ Rauland-Borg
71.	Occupancy Sensors/ Lighting Control System	Phillips/ Schneider/ Legrand/ Wipro/ L&T/ Havells
72.	Overload relay & Single phase preventer	ABB/ L&T/ Siemens/ Schnieder
73.	Package/ Unitised Substation	ABB/ Siemens/ Schnieder/ C&S
74.	Panel Accessories	L&T/ Teknic/ Rishabh/ Siemens/ Schnieder
75.	Power Capacitor	L&T/ Meher/ EPCOS/ Siemens/ Schneider
76.	Programmable timer (self-powered electronic digital) /Astronomer	L&T/ Siemens/ Hager/ Havells/ Legrand/ Schnieder

S.No.	Details of equipment/ material	Make/Manufacturer
77.	Protective relays (Microprocessor based compatible with PC & PLC)	Siemens/ L&T/ ABB/ Areva/ Schnieder
78.	Push Buttons	Siemens/ L&T/ ABB/ Schneider/ C&S/ Teknik
79.	PVC Conduit & Accessories	Clipsal/ Polypack/ BEC/ AKG
80.	Relay / Contractors/ Timers / Starters and Control Panel	Siemens/ L&T/ Schneider/ ABB
81.	Selector Switch	Siemens/ L&T/ Teknic/ Salzer/ Schnieder/ ABB
82.	Street Light Poles & Light Fixtures – Solar & Conventional	Philips/ Wipro/ Havells/ Bajaj/ Keselac Schreder
83.	Surge Diverter	Tercel/ ABB/ Siemens/ Emerson/ Hager/ Phoenix/ Legrand
84.	SCADA & BMS System	Schneider/ L&T/ Honeywell / Siemens/ABB
85.	Tap-off/ Splitter box	Zinwell/ Novatron/ Catvision
86.	Telephone Tag Block/Jack Panel/ Face Plate	Krone/ Phoenix/ Wago/ Beldon/ Panduit/ Huwaei
87.	Terminal Strip	Connect well/ Phoenix/ WAGO
88.	Termination Kits	Raychem/ Birla/ 3M
89.	Transformer (Oil Type/ Dry Type)	ABB/ Siemens/ Kirloskar/ Voltamp/ Areva/ Schneider
90.	Trivector - Meter (Digital type) only for SEB supply	L&T/ Secure meter/ Enercon/ Siemens/ Socomec/ Schnieder
91.	UPS	Emerson (Vertiv)/ Schnieder (APC)/ Eaton/ Socomec
92.	Variable Frequency Drive	L&T/ Siemens/Danfoss/ABB/ Schneider
FIRE FIGHTING WORKS		
1.	Air Release Valve/Air Cushion Tank	Zoloto/Advance/Leader/Audco/Castle
2.	Alarm Valve & Hydraulic (Alarm motor with coupling)	HD fire protect/TYCO/VIKING/Newage
3.	Alternator	Stamford/ Lorey Somer/ Kirloskar/ Toyo Denki/ AVK
4.	Ammeter/ Voltmeter/ PF/ kW/ Hz/ meter /Energy Meter/ Multimeter	As per respective electrical make list
5.	Anchor Fastener	Fischer / Hilti /Wurth
6.	Ball Valves	L&T/ Audco /Zoloto/ Advance/Emerald/ KSB
7.	Battery	Exide/ AMCO /Amararaja/ Panasonic
8.	Butt welded fitting (UL Listed) & accessories	V.S. Forge/True Forge / DRP-M
9.	Butterfly valves	L&T/ Audco/ Zoloto / Advance/ KSB
10.	Cable lugs and glands	As per electrical make list
11.	Cables	As per electrical make list
12.	Check Valve/Foot Valve/Sluice Valve/	L&T/Audco / Zoloto Advance/KSB

S.No.	Details of equipment/ material	Make/Manufacturer
	NRV	
13.	Control / Potential / Current Transformer	As per respective electrical make list
14.	Deluge valve/ Solenoid valve/ Spray nozzle	HD / Tyco/Viking
15.	Diesel engine driven pump	Ashok Leyland/ Cummins/ Perkins/ WILO-Mather & Platt/ Kirloskar/Armstrong Fluid Technology
16.	ELCB	As per electrical make list
17.	Epoxy Paint	As per Civil Works make list
18.	Fire Buckets	Safex / Minimax/Cease Fire/Peter Autokit
19.	Fire Extinguisher	Minimax / Newage/ Eversafe/ Tyco –Johnsons Control
20.	Fire Hydrant Valves/ Fire RRL Hose Pipes / Fire Hose Reels/ Fire Man's Axe/ Gun metal short branch pipe/ 2/ 3/4 FB inlet/ draw Out connection/Hose Box/ Hose reel drum /Nozzle/ blank Caps & Chains / Coupling	Ceasefire / Newage /Minimax/HD/Tyco
21.	Fire Pumps	Mather&Platt(WILO)/Grundfos/Kirloskar/Xylem –ITT/ Armstrong Fluid Technology
22.	Electrical Motors	ABB/ Siemens/Kirloskar/C&G/BALDOR
23.	Flow Meter	Scientific Equipments(p) Ltd./System Sensor or equivalent
24.	Flow switch	Potter / Rapid flow/Danfoss/Viking/Belimo/Honeywell
25.	Foot Valve (Cast iron/ Gunmetal)	Kirloskar / Zoloto/Advance/L&T
26.	Forged steel fitting & accessories	V.S.Forge/True Forge / DRP-M
27.	GI clamps	Chilly/Hilti or equivalent
28.	GI / MS Pipes	Tata / Jindal- Hissar/ SAIL
29.	Gunmetal Valves (Globe Valves)	Audco / Zoloto Advance/L&T
30.	Over Load Relays	As per electrical make list
31.	Pipe coat material (pipe protection)	Pypcoat / Makphalt / Safex
32.	Pipe Hangers/ Clamps/Supports	Chilly/ GMGR /CAMRY/Hilti
33.	Power/auxiliary Contactors	As per electrical make list
34.	Pressure Gauge	Fiebig/ H.GURU/HD/BRC
35.	Pressure Switch	Indfoss/ Switzer/ Danfoss/Honeywell
36.	Push Buttons/ Indicating lamps LED	As per respective electrical make list
37.	Single Phase Preventer	As per electrical make list
38.	Solenoid valve/ Spray nozzle	HD / Tyco/Danfoss/ Honeywell
39.	Sprinkler Heads (Sidewall/ Upright/ Pendant)	Grinnel- Tyco / Viking / HD
40.	Steel flexible extension	Eversafe /Newage/Tyco/Viking
41.	Vibration Eliminator	Resistoflex / D'wren / Kanwal

S.No.	Details of equipment/ material	Make/Manufacturer
42.	Weld Electrodes	Advani/ ESAB/ L&T/Victor
43.	Pot strainer	Emerald/ VTM/ Rapid Cool
44.	Y- Strainer	Zoloto/Audco /Emerald/Advance
45.	Rubber Bellows	Resistoflex/Easyflex/Kanwal
46.	Fire Suppression System/ Gas Flooding Sytem	Tyco/Newage/Minimax/Viking
47.	Linear Pnuematic Heat Detection Tube System	Firetrex/ UTC/ Tracefire/ Jactone/ Rotarex
48.	Clean Agent Fire Extinguisher	Kanex/Tyco/Newage/SVS Buildwell/Minimax/Lifeguard/Ceasefire
FIRE ALARM SYSTEM		
Note: All fire alarm components/ Panels shall be UL listed & confirm to NFPA standards.		
1.	Control Cable	RR Cable/ Bonton/ Havells/ Polycab/ Finolex/ KEI
2.	Intelligent Addressable Fire Alarm Panel/Detectors/ Hooters/ Manual Call Point UL Listed/ Talkback/ Control Module/ Monitor Module/ Control relay Module/ Short Ckt. Isolator/	Honeywell/ Bosch/ Edwards/ Tyco-Simplex / Siemens
3.	Intelligent Addressable Fire Alarm System	Honeywell/ Bosch/ Edwards/ Tyco-Simplex / Siemens
4.	Response Indicator	Honeywell/ Bosch/ Edwards/ Tyco-Simplex / Siemens
5.	Fire Survival Cable	Bonton/Skytone/ Fusion Polymers/ KEI/ Havells/ Polycab
6.	Fire Annunciation Panel	Minilec/ Honeywell-Notifier/ Siemens/ Tyco - Simplex
7.	Panic Button	Eureka Forbes/ Fire Pro / Tyco
8.	Photo Chromatic Switch	Bajaj/ Wipro/Phillips/L&T
9.	Splitter Box	Shyam Antenna/ CAT vision or equivalent
10.	Termination Control Cable	Dowell's/ Elemex/ Wago/ Phoenix
LIFTS		
1.	Lifts	OTIS/ Kone / Mitsubishi/ Schindler/ Johnson
2.	Dumb Waiter Lifts	OTIS/ Kone/ Schindler/Sigma/East India
LV System/ PA System/ CCTV System/ Access Control System/ Door Interlocking System		
1.	Door Controller, Card Reader, Biometric Reader, Access Control server Software, Smart card	Honeywell/Bosch/HID/Spectra/ Morpho
2.	E Magnetic lock	Honeywell/Bosch/HID/Spectra/ Morph
3.	Amplifier	Bosch/ Honeywell/ Bose
4.	CAT 6/6a Wire/Accessories - Jack Panel / Face Plate	Belden/ Simone/ Panduit/ Commscope/ Cisco/ Legrand/TADIRAN

S.No.	Details of equipment/ material	Make/Manufacturer
5.	CCTV Camera/ NVR/Central Monitoring Software / Other Items	Honeywell / Pelco /Cisco /Bosch/ Axis/ Sony/ Impulse
6.	CD / DVD Player	Bosch/ Honeywell/Bose
7.	Door Interlocking System	NRH/Eltech/Avon
8.	PA Speaker, Voice controller, paging station, Microphone	Bosch/ Honeywell/Bose
9.	RG 6, RG 11/Wire/ Coaxial Cables	Belden/ Skytone/ Bonton/ Finolex/ KEI/ Polycab/ Legrand
10.	Speaker Wire	Bonton/Delton/Polycab/KEI/ Legrand
HVAC SYSTEM		
1.	2-Way Pressure Independent Balancing & Control Valve	Siemens/ Danfoss/Oventrop /Belimo
2.	Adhesives for Insulation	Pidilite/Superlon / Armacell
3.	Adjustable Frequency Drive/ Automatic AFD Bypass/ Pump Controller/ Differential Pressure Sensor/ Transmitter	Xylem-ITT/Grundfos/Armstrong or as per OEMs
4.	Air cooled package units	Voltas/ Bluestar/HITACHI or equivalent
5.	Air & Dirt Separator/Dirt Separator	Spirotech/ Calefi/ Optivent /Spirotherm/Flamco/Armstrong
6.	Air Distribution (Ducting) -GI/GSS Sheets	SAIL / TATA Steel/ Jindal-Hissar
7.	Air Handling Units with Coils etc.	Zeco/ Edgetech/VTS/ Waves/Flaktwood
8.	Air washer	Zeco/ Waves/ Edgetech/ VTS/Humidin
9.	Aluminium Sheet for Ducts	Jindal/ Hindalco/ Indal
10.	Automatic Air Vent	Anergy / Rapid Cool/Emerald/CIM
11.	Axial Flow Fans	Kruger / Systemair /Greenheck/ Wolter/Nicotra
12.	Balancing Valves (Water Duty)	Advance / Audco/L&T/Honeywwell/Danfoss/Belimo
13.	Ball valves (With & W/O Strainers)	Audco /KSB/Advance/ L&T /Zoloto
14.	Butterfly Valves (Water Duty)	Advance / Audco/ L&T/Zoloto/KSB
15.	Cable Lugs/Thimbles/Glands	As per Approved Makes of Electrical Works
16.	Cable Tray	As per Approved Makes of Electrical Works
17.	CAV Box/VAV Box	Trox/ System Air / Ruskin Titus /Honeywell /Johnson's Control/Belimo
18.	Centrifugal Fans/Fan section/Plug Fans	Kruger / Greenheck /Comefri/ Wolter/ Nicotra/Systemair
19.	Check Valve/Foot Valve/Sluice	Advance / Audco/ L&T/Zoloto/KSB

S.No.	Details of equipment/ material	Make/Manufacturer
	Valve/NRV	
20.	Chilled Water Pump (Primary/Secondary)/ Condenser/Hot Water Pumps etc.	Armstrong /Grundfoss/Xylem -ITT
21.	Control Cables	As per Electrical Makes
22.	Cooling Tower	Bell / Paharpur/Flowtech/Nihon Spindle
23.	CPRX Compound/Tar felt	Shalimar tar product / Asian / Pidilite
24.	DRY Scrubber	Rydair/ Trion/ Honeywell
25.	Duct Dampers/ Grills/ Diffuser/ VCD/ Collar Damper etc.	Caryaire / Systemair/ Conaire/ Dynacraft /Airflow (Mapro)
26.	Electric Motor	ABB/ Siemens/ Crompton Greaves /BALDOR
27.	Electric motor (Fire Rated)	Marathon/ Havells-Lafert/ Baldor /ROTOMOTIVE
28.	Expansion Tank	Xylem-ITT/ Armstrong/ Grundfos /Flamco
29.	Factory Fabricated Duct & Flanges	Rolastar / Zeco / Ductofab / Technofab/GPS Spiro
30.	Fan Coil Units with Fans	VTS/Flaktwood/Daikin/Carrier/Johnson Control
31.	Fasteners-Dash	HILTI / Fischer / Cannon / Wurth
32.	FCU Copper Connection Set/ FCU Link	ATS/ Oventrop/ CSI
33.	Filters -Pre/ Fine/ Hepa & BIBO	Thermadyne / Spectrum/ Camfil/ American Air Filter
34.	Fire Damper Actuator	Belimo/Siemens/Danfoss/Honeywell
35.	Fire Dampers / Smoke Dampers	Trox/ Greenheck/Ruskin Titus/Systemair
36.	Flexible Duct Connection	Airflow/Pyroguard / Rolastar/ UP Twiga
37.	Flexible Pipe Connection	Resistoflex/ Easyflex/ Diamond/ Dunlop
38.	FRP lining for condenser piping	Owen-corning/UP Twiga/Binani
39.	GI/ MS Piping (chilled/condenser/drain/hot)	Jindal-Hissar/TATA/SAIL
40.	Globe/Gate Valve	Audco / Advance / Danfoss/L&T/KSB/Zoloto
41.	Heat Recovery Exchanger/ Ventilator/ Wheel	Ostberg/DRI / Flaktwoods/ Heatex/ BryAir
42.	Hot Water Generators	KEPL / Rapid cool/ Emerald/Enmax
43.	Humidifier	KEPL / Rapid cool/ Emerald /Enmax
44.	Inline Fans	Kruger / Nicotra/ Greenheck/ Ostberg
45.	**Insulation Material**	
46.	a) Fiber Glass – Aluminium faced Insulation	UP Twiga / Owens Corning/ Kimmco
47.	b) Polyurethane Foam (PUF) Insulation	Styrene Packaging & Insulations/Lloyd Insulations/Supreme
48.	c)Nitrile Rubber /EPDM Insulation with antimicrobial	K-Flex/Superlon/Armacell/Supreme
49.	d) XLPE Insulation	Supreme/ Vidoflex/ Trocellene

S.No.	Details of equipment/ material	Make/Manufacturer
50.	e) Expanded Polystyrene Insulation	Styrene Packing/Mettur Beardsell/ Toshiba/Trocellin/ Thermobreak
51.	Laminar Flow HEPA tent	Systemair/TROX/American Air Filter/ Conaire/ Thermadyne/ Airtech
52.	Magnehelic Gauges	Mitbraus Instruments/ Dwyer / Omicron
53.	Paints	As per Civil Works Makes
54.	Pre insulated Ducts	Pal/Zeco/ ALP/ Kingspan/ Spiro / UP Twiga
55.	Pipe Supports	EASYFLEX/Resistoflex/Diamond
56.	Pipe Supports-PUF	Llyod insulation/ Melanpur/ Beardsell
57.	Power Cables	As per Electrical Makes
58.	Pressure /Temperature Gauges	H.Guru / Feibig / Warree/H.D/BRC
59.	Propeller Fans	Crompton/ Khaitan/ Alstom/ Bajaj/GE
60.	Thermostat /Humidistat	Honeywell / Johnson / Siemens /Schneider
61.	Purge Valve/ Drain Valve	Audco/Advance / Anergy/Zoloto
62.	PVC /uPVC pipe	Polypack/ Supreme/Astral/Finolex
63.	Red Oxide/ Zinc Chromate Primer	As per Civil Works Makes
64.	Refrigerant Copper Pipes	MANDEV Tubes/Rajco Metal/Mehta Tubes (Max Flow)/Kwality Tubes (Raj State)
65.	Room Thermostat	Honeywell/ Johnson/ Siemens/ Schneider
66.	RP Tissue	UP Twiga/ Styrene Packing or equivalent
67.	Split AC Units /Precision AC	Toshiba/Daikin/ Hitachi/ Carrier
68.	Starters/ change over switch/ push buttons/ Indication Lamps/ Rotary switches/ 1-phase preventor/ Soft starter/ MCB/ MCCB/ ACB/ Contactor etc.	As per respective Electrical Makes
69.	Strip Heater	Das Pass/ Escorts/KEPL or equivalent
70.	UV & Weather protective Coating	Pidilite/ Foster/ Amicon
71.	UVGI System (Ultra Violet Germicidal-Irradiation System)	Ruks/ Trimed/Sterile Air
72.	V Belt	Dunlop/ Fenner/ Hilton
73.	Vacuum Degasser	Spirotech/ Optivent/ Calefi/ Comfort/ Spirotherm/ Flamco
74.	Variable Frequency Drive	Siemens/Danfoss/ABB/ Schneider/ L&T
75.	VRV/ VRF Outdoor/ Indoor Units/ Refnet Joints/Remote Controllers	Mitsubishi Electric/ Daikin/ Toshiba/ Panasonic/ Carrier
76.	Chillers	Daikin-Mcquay/ Carrier / Trane / York/ Dunhambush
77.	Water Flow Switch	Honeywell/ Danfoss/ Belimo/ Emerald/ Rapid Cool
78.	Vibration Isolators	Easyflex/kanwal/ResistoFlex
79.	Air Ionizers/ Air Purification System	Plama Air/ Aerisa/ Bentaxna/RGF/Aquaair

S.No.	Details of equipment/ material	Make/Manufacturer
80.	Pot Strainer	Emerald/ VTM/ Rapid Cool
81.	Y- Strainer	Zoloto/Audco /Emerald/ Rapid cool/ Advance
82.	Chilled Water Cassette Unit	Carrier/TRANE/Daikin/Johnson Control
83.	Motorized Butterfly Valve	Honeywell/Belimo/Danfoss/Siemens
IBMS SYSTEM		
1.	Operator Workstation	Dell/Lenovo/HP/IBM
2.	Printer	Canon/Xerox/HP/Epson
3.	Network Switch	Cisco/D-Link/HP/Allied Telesis
4.	Capacitive Touch Panel	Siemens/Honeywell/Schneider/ALC
5.	BMS Software	Siemens/ Schneider/L&T/Honeywell
6.	System Integration Units	Siemens/ Schneider/Johnson Controls/Delta Electronics
7.	Direct Digital Controller	Honeywell/Siemens/Schneider/L&T
8.	Immersion Temperature Sensor RTD	Greystone / Honeywell / Siemens / Schneider / Danfoss/L&T
9.	Outside Air Temperature+ Humidity Sensors	Greystone / Honeywell / Siemens / Schneider /L&T
10.	Ultrasonic Waterflow meter	Kampstrup/Landis+Gyr/Shenitech/Siemens/ Honeywell
11.	Differential Pressure Switches for Air/ Water	Greystone / Honeywell / Siemens / Schneider / L&T/Kele/ALC
12.	Water Flow Switch	Greystone / Honeywell / Siemens / Schneider / L&T/Weksler/Danfoss
13.	DP Sensor for Water	Honeywell / Siemens / Schneider / L&T
14.	pH Analyser	Hach/Omicron/Forbes Marshall
15.	TDS Analyser	Hach/Omicron/Forbes Marshall
16.	DP Switch for Filter Status	Honeywell / Siemens / Schneider / L&T
17.	Air/ Water Sensors / Switches / Pressure transmitters/Differential Pressure Switch Air/ Water /Differential Pressure Transmitter	Greystone / Honeywell / Siemens / Schneider / Danfoss/L&T
18.	Colour Monitor	LG/Samsung/Sony/Phillips
19.	Communication Cables / Signal Cable	Delton/Fusion Polymer/Skytone/Finolex
20.	Copper Conductor Control Cable	Same as per Electrical make list
21.	Current Relay	Same as per Electrical make list
22.	Duct Mounted Temperature + RH sensor/ Duct Temperature Sensor	Greystone / Honeywell / Siemens / Schneider / Danfoss/L&T
23.	Level Switch / Level Transmitter	Honeywell / Dwyer/ Radix/ Weksler
24.	Flow & BTU Meter	Schenitech / Honeywell / Kampstrup
25.	GI Conduits	Same as per Electrical make list
26.	LAN cables for BMS Network	Same as per Electrical/LV make list
27.	MS Conduits	Same as per Electrical make list

S.No.	Details of equipment/ material	Make/Manufacturer
28.	Sensor- CO2/ CO / PH / TDS	Honeywell / Hach / Greisinger
29.	PVC Conduits	Same as per Electrical make list
30.	Voltage / Current / Power Factor Transducer	L&T / Siemens / Schneider
SEWAGE/ EFFLUENT TREATMENT PLANT		
1.	Air Blowers	Beta/ Everest/ Kulkarni / TMVT
2.	Air Diffussion System	Airfin/Usha Ruba/Rehau
3.	Air Vent Valve	Oven trop (Germany) / CIM / Rapid Control
4.	Anti Corrosive Tape for Pipe protection	Pypcoat / Marphalt / Cotek/STP
5.	Ball Valve	Zoloto/Honeywell/RB
6.	Bar Screen	KSP/AWMS/PAMM
7.	Blowers	Kay / airvac /Everest
8.	Butterfly valves	Zoloto/Audco/Kirloskar/AIP/Advance
9.	Centrifuge	Apollo/United/B.A Engineering
10.	Check Valve – Dual Plate	Advance/Honeywell/Audco/Zoloto
11.	Check Valve – Wafer Type	Advance/Danfoss/Zoloto/Honeywell
12.	Chemical Cleaning Pump	WILO / DP/Grundfos/Xylem
13.	Chemical Cleaning tank	Polycon / Sintex/Vectus
14.	Chemical Dosing system	Asia LMI/ Seiko/ E – Dose/ Grundfos
15.	Dosing Pump	Grundfos / Asia LMI / E-dose / Prominent
16.	Electrical Panel	As per electrical MAKE LIST
17.	Epoxy Paint & Paint	Berger / J&N / Asian
18.	F.R.P Vessel	Pentair / Aventura /Thermax
19.	Flow Meter (Digital)	Aster (Totalized) / VATS /Scientific
20.	Flow Rota Meter for Suction Pump	UKL / Aster /Scientific
21.	Foot Valve	Kirloskar/ Kalpana /Leader/BDK
22.	G.I. fittings (malleable cast iron)	Unik/ Jain Sons/Zoloto /DRP
23.	G.I. Pipes/M.S. Pipe	Tata Steel / Jindal / SAIL
24.	High pressure feed pump.	WILO / DP/Grundfos/Xylem
25.	Level Controller	Aster/Cirrus Engineering/Rockwell Automation
26.	Level Indicator	Aster/Cirrus Engineering/Rockwell Automation
27.	Level Switch	Aster/Cirrus Engineering/Rockwell Automation
28.	MBR Module	G.E/Siemens/Mitsubishi
29.	MBR Permeate Suction Pump	WILO / DP/Grundfos/Xylem
30.	Media	Cooldeck/Usha Ruba/MM Aqua/Pharmatech
31.	Motor	Siemens/Crompton & Greaves/ ABB
32.	MSEP Vessel	As per Manufacturer's standard
33.	Multiport Valve	Pharer (U.S.A)/ ORG/Astar
34.	Non return valve	Zoloto/Honeywell/RB

S.No.	Details of equipment/ material	Make/Manufacturer
35.	PH Meter	VATS / Hanna/Aster/digital
36.	Pipe clamp & supports	Chilly/Euroclamp/Kanwal
37.	PLC / HMI	Schneider / Allen bradley /Mitsubishi
38.	Pressure Gauges	Waree / H Guru /Fiebeg
39.	Pressure Switch	Danfoss / Indfoss / Switzer
40.	Pump Sets i/c Water transfer and sludge disposal/transfer pump	WILO / DP/Grundfos/Xylem
41.	Resin	Thermax / Ion Exchange/Auchtel
42.	Semi Auto Fine Screen	Toro/KSP / AWMS/PAMM
43.	Sewage & Drainage Submersible Pumps	WILO / DP/Grundfos/Xylem
44.	Sewage Feed pump	WILO / DP/Grundfos/Xylem
45.	Strainers	Emerald / Zoloto / Maharaja Casting
46.	Transfer Pumps	WILO / DP/Grundfos/Xylem
47.	UV Systems	Alpha UV/ Creative UV/ Pentair/Eureka Forbes
48.	VFD	Danfoss/Allen Bredly/Siemens/ABB
49.	Vibration Eliminator / Anti vibration Mounting	Resistoflex / Kanwal /Banco/Dunlop
50.	Water Meter	As per Plumbing & Sanitary make list
51.	Y Strainer	Leader/ Zoloto/ Audco/ Castle/Emerald/ Rapid cool
IPABX & TELEPHONE SYSTEMS		
1.	Data/ Telephone cable (2/4 /10 / 20/ 50/ 100 PAIR CABLES)	Delton/ Finolex/ Polycab/ Bonton/ Legrand
2.	Digital/ANALOG PHONES/ Handsets/IP phones	Beetel /Panasonic /Siemens / Alcatel/Cisco /Tadiran
3.	IPABX Server and Gateways	Alcatel/ Avaya/ Cisco/ Siemens/ Nortel/ Tadiran
4.	MDF/IDF	Krone/ TVS/ Finolex
5.	Telephone tag block/Jack Panel/ Face Plate	Krone/ Phoenix/ Wago/ Beldon/ Panduit/ Huwaei/ Legrand/Amp
6.	VOICE BOX – RJII	Krone/ TVS/ Finolex
DATA NETWORKING & WIFI SYSTEM		
1.	Active Components – Core and Edge switch	CISCO/ Juniper/ HP/ Dell
2.	Enclosures – Distribution rack and server rack	APW/ Netrack / Rittal / Legrand/MTS
3.	Ethernet Switch / Indoor & Outdoor WIFI device/ Transreceivers	CISCO/ JUNIPER/HP
4.	Routers	ALCATEL/ AVAYA/ CISCO/HP/JUNIPER
5.	Server	IBM / Dell/ HP/CISCO
6.	Firewall	CISCO/ Juniper/HP/Fortinet/Palo Alto
7.	Passive Components – Cat 6/Cat 6A/	Belden/ Simone/ Panduit/ Commscope/ Cisco/

S.No.	Details of equipment/ material	Make/Manufacturer
	Patch panel/ Patch Cord/ Information outlets/ Optical fiber Cable/ Fiber patch cord/ pigtails/ LIU/ Adapters/ Connectors	Legrand/TADIRAN
Audio Visual System & Stage Lighting System for Auditorium & Conference Rooms		
1.	Symmetrical Line Array Speakers, Flying Subwoofers, Loudspeakers, Power Amplifier, Digital Sound Processor, Digital Mixing Console, Microphone, Loudspeaker Cables	L-Acoustics/ Bose/ Martin-Audio/ Labgruppen/ Powersoft
2.	DVD cum USB Player	Sony/ Philips/ Samsung/ Bose
3.	Equipment Rack	Rittal/ Netrack/ Cisco/MTS/APW
4.	PVC Conduits & Raceways	AKG/BEC/ Hensal/ Clipsal/ Polypack/ Precision
5.	LED Dimmable Lights	Philips/ Wipro/ Havells/ Lutron/Trilux
6.	LED Signage Board	Wipro/ Philips/ Bajaj/Instapower/Decon
7.	Video Projector	Christie/ Sony/ Panasonic/Philips
8.	Projection Screen	Draper/ Da-Lite/ Grandview/ Harkness
9.	LED Display Monitors	LG/ Sony/ Panasonic/ Philips/Samsung
10.	Video Conferencing Unit	Sony/ Polycom/ Palco/ Cisco
11.	HD PTZ Camera, Joystick	Sony/ Panasonic/ Palco/Cisco/Bosch
12.	Optical Fibre Cable	Extron/ Crestron/ Kramer/Amp/Belden
13.	HDMI / VGA Cable	Kramer/ Beldon/ Klotz
14.	Stage Lighting – Spot Light, Par Light, Flood Light, Dimmer pack, Lighting Console, Splitter, Lamp prism with moving head,	Canara Lighting/ Effectron/ Stage Technologies
15.	Junction Box	ABB/L&T/Havells/Schneider/Legrand
16.	Curtain Control Panels, Remote Control	Canara Lighting/ Effectron/ Stage Technologies
17.	RGY Laser	CT Lasers/ Canara Lighting/ Laser World
18.	Fog Machine, Metal gobos	Antari/ Canara Lighting/ Robe
19.	Fire Retardant Curtain, Plastic cyclorama screen	Omplie/ Raymond/ Mayur
20.	Lamps	Osram/ Philips/ GE/ Wipro
21.	DMX Signal Cable for DMX Network	Falcon/ Beldon/ Polycab/ Finolex
Solid Waste Management System		
1.	Integerated Sterilizer with Shredder	Celitron / Ecodas / Cisa
2.	Organic Waste Converter	ENVIcare Soln. Pvt. Ltd/ Excel Industries Ltd/ Greenvironindia

Note:	
1.	The contractor will use one of the approved makes as approved by the Engineer -in-charge.
2.	In case of different quality / pattern of same make, the pattern/ quality shall be approved Engineer – in – charge.

3.	For materials/equipment/ to be used in items of work for which approved makes are not given herein, the makes of such materials /equipment shall be as decided by Engineer –in-charge.
4.	If any major equipment is using a small component of make other than that given as a standard component with the equipment, the same shall be accepted subject to approval of Engineer –in-charge.

CHAPTER- T

Technical Specifications- Medical Gas Pipeline System(MGPS)

	Technical Specification of MGPS
1	**Oxygen Supply System**
1.1	**Fully Automatic Oxygen Control Panel**
	Automatic control panel should be constructed in accordance with the requirement of international standards. The fully automatic oxygen control panel should comply with HTM 02-01/NFPA 99C/ DIN / EN / ISO-7396-1 standards. It should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed.
	The manifold assembly should provide two stages of pressure regulation. A single stage primary regulator, one for each cylinder bank should be used to initially reduce cylinder pressure and two single stage pressure regulators should be provided in the control cabinet for final delivery pressure regulation. One delivery pressure regulator in service and one should be ready for service in a standby mode.The Manifold control panel should be with digitaldisplay, fully automatic type and switches from "Bank in Use" to "Reserve bank " without fluctuation in delivery supply line pressure. Changeover should be performed by electrically/pneumatically operated valves contained in the control cabinet. In the event of an electrical power failure (incase of electronically operated) the valves should automatically open to provide an uninterrupted gas flow. It should be 100% automatic and should not require manual adjustment.
	Indication for changing the cylinders should be clearly identified on the front of the control panel.
	All functional components should be enclosed in corrosion resistant robust material.
	All components inside the Control Panel like Pressure Regulators, piping and control switching equipment should be cleaned for Oxygen Service and installed inside the cabinet to minimize tampering with the regulators or switch settings.
	The Control Panel shall include two pressure relief valves, one high pressure approx. 200/350psi and one low pressure approx.75 psi.
	The heavy duty control panel should be provided with a flow capacity of **1500 or more LPM** at 50 to 60 psi.
	The Automatic Control Panel should be installed in such a way to meet the peak flow requirement of the Hospital/Institute (If the requirement is more than flow capacity requirement automatic control panel the bidders has to supply 02 numbers of Automatic Control Panel and design the system in such a way to meet the flow requirement of respective institute)
	Control panel should have Alarm reset switch/Mute /acknowledgement switch to control and monitor the alarm indications by the operator.
1.2	**Oxygen Manifold Supply System**
	The size of Manifolds should be **2 X 16** and it shall be compatible with Class-D type bulk cylinders.

	Manifold shall consist of two high pressure header bar assemblies to facilitate connection of primary and secondary cylinder supplies. Each header bar shall be provided with respective numbers of cylinder pigtail connections to suit cylinder valves as per IS.3224/ BS/ ASME incorporating a check valve at the header connection.
	Each header bar assembly shall be provided with a high pressure shut off valve. Oxygen Manifold should consist of respective numbers of class D-type bulk oxygen cylinders. The manifold should be hydraulically tested to atleast **3000 psig**. The manifold should be so designed that it shall suit easy cylinder changing and positioning. The system should have non – return valves for easy changing of cylinders without closing the bank. The cylinder should be placed with the help of cylinder brackets and fixing chains which should be galvanized.
1.3	**Emergency Oxygen Manifold**
	The size of Manifolds should be **2 X 5** and it shall be compatible with Class-D type bulk cylinders.
	Manifold shall consist of high pressure header bar assemblies to facilitate connection of respective numbers of cylinder supplies. Header bar shall be provided with respective numbers of cylinder pigtail connections to suit cylinder valves as per IS.3224/ BS/ ASME incorporating a check valve at the header connection. Header bar assembly shall be provided with a high pressure shut off valve.
	Oxygen Manifold should consist of 2/1 rows of respective numbers of class D-type bulk oxygen cylinders. The manifold should be hydraulically tested to **atleast 3000 psig**. The manifold should be so designed that it shall suit easy cylinder changing and positioning. The system should have non – return valves for easy changing of cylinders without closing the bank. The cylinder should be placed with the help of cylinder brackets and fixing chains which should be galvanized.
1.4	**Oxygen Flow meter with Humidifier Bottle**
	Back Pressure Compensated flow meter for accurate gas flow measurement with following features:
a	Control within a range of 0-15 LPM.
b	It should meet strict precision and durability standard.
c	The flow meter body should be made of brass chrome plated materials.
d	The flow tube and shroud components should be made of clear, impact resistant polycarbonate.
e	Flow tube should have large and expanded 0-15 LPM range for improved readability at low flows.
f	Inlet filter of stainless steel wire mesh to prevent entry of foreign particles
g	The humidifier bottle is made of unbreakable & reusable polycarbonate /polysulfone material autoclavable at 121 degree centigrade .
h	Humidifier Bottle should be covered under warranty.
i	Should be BIS/European CE certified with 4 digit notified body no/ UL Listed/US FDA/ETL listed
2	**NITROUS OXIDE SYSTEM**
2.1	**Fully Automatic Nitrous Oxide Control Panel**

	The fully automatic N2O control panel should comply with HTM 02-01/ NFPA 99 C/ EN /DIN /ISO 7396-1 STANDARD. It should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed.
	The manifold assembly should provide two stages of pressure regulation. A single stage primary regulator, one for each cylinder bank should be used to initially reduce cylinder pressure and two single stage pressure regulators should be provided in the control cabinet for final delivery pressure regulation. One delivery pressure regulator in service and one should be ready for service in a Standby mode. The Manifold control panel should be digital fully automatic type and switches from "Bank in Use" to "Reserve bank " without fluctuation in delivery supply line Pressure. Changeover should be performed by electrically/ pneumatically operated valves contained in the control cabinet. In the event of an electrical power failure (incase of electrically operated) the valves should automatically open to provide an uninterrupted gas flow. The manifold should not require any manual resetting or adjustments after the replacements of the depleted cylinders.
	The Control Panel shall include two pressure relief valves, one high pressure approx.200psi and one low pressure approx.75 psi.
	The control panel should also have heaters to prevent ice formation on the regulators at high flow rates.
	The Control Panel should be made to provide Heavy Duty and have a flow capacity of **500 LPM or more** at 50 to 60 psi.
	The Automatic Control Panel should be installed in such a way to meet the peak flow requirement of the Hospital/Institute (If the requirement is more than flow capacity requirement automatic control panel the EPC Contractor has to supply 02 numbers of Automatic Control Panel and design the system in such a way to meet the flow requirement of respective institute)
	Control panel should have Alarm reset switch/Mute / acknowledgement switch to control and monitor the alarm indications by the operator.
2.2	**Nitrous Oxide Manifold**
	The size of Manifolds should be 2 X 5 and it shall be compatible with Class-D type bulk cylinders.
	Manifold shall consist of two high-pressure header bar assemblies to facilitate connection of primary and secondary cylinder supplies. Each header bar shall be provided with respective number of cylinder pigtail connections to suit cylinder valves as perIS.3224/ BS/ ASME incorporating a check valve at the header connection. Each header bar assembly shall be provided with a high pressure shut off valve. The manifold should be hydraulically tested to **atleast 3000 psig.** The manifold should be so designed that it shall suit easy cylinder changing and positioning. The cylinder should be locked with the help of cylinder brackets and fixing chains which should be galvanized.
2.3	**Emergency N2O Manifold**
	The size of Manifolds should be 2 X 2 and it shall be compatible with Class-D type bulk cylinders.

	Manifold shall consist of high-pressure header bar assemblies to facilitate connection of cylinder supplies. Header bar shall be provided with respective numbers of cylinder pigtail connections to suit cylinder valves as per IS 3224/ BS/ ASME incorporating a check valve at the header connection. Header bar assembly shall be provided with a high pressure shut off valve. Nitrous oxide manifold should consist of respective numbers of cylinders
	The manifold should be hydraulically tested to **atleast 3000 psig**. The manifold should be so designed that it shall suit easy cylinder changing and positioning. The system should have non – return valves for easy changing of cylinders without closing the bank. The cylinder should be placed with the help of cylinder brackets and fixing chains which should be galvanized.
3	**Medical and Surgical Air System (Package Unit) - Tolerance of +/-5% is acceptable on plant flow capacity**
	air cooled Oil free Screw Compressors /Scroll Compressors for continuous duty application with highest output of compressed air, low power consumption and very low vibration resulting in low noise level.
	The medical air plant shall fully comply with the requirements of the HTM 02-01/ NFPA 99 C/EN/DIN/ISO 7396-1. It should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed
3.1	**Air Compressor Modules**
	It should be **Screw Compressors /Scroll Compressors** to produce the plant output of minimum 2500 LPM as primary and 1250 LPM as standby or Total minimum capacity plant caapacity of 3750 LPM.
	Medical quality air shall be delivered at a nominal pressure of 400 kPa (4 bar) and 700kPa(7 bar) gauge for supply of the hospital medical air and surgical air.
	Compressor plant should be designed in such a way that compressors will switch on in a sequential manner as per flow demand.
	The compressors should be standalone ones with independent power supply.Each Compressor should be suitable for both continuous and frequent start/stop operation at a nominal plant pressure of 10bar or more.
	The duty compressors shall be automatically rotated by the plant control system to ensure even wear. Compressors shall be supplied and installed. Desiccant dryer shall be provided with a dew point sensing switch that shall provide an alarm on the plant control panel and central hospital alarm system when the water concentration in the delivered air rises above the limit. Duplex desiccant dryer and filtration modules shall be provided with three or more individual stages of filtration as follows:
	Stage 1: Coalescing filter upstream of the desiccant dryer for removing liquid water particles down to 1micron.
	Stage 2: Particulate filter after the desiccant dryer for dust protection and removing particles down to 1 micron.
	Stage 3: Bacteria filter for removing particles down to 0.01 micron.
	Purity should be tested as per the American Pharmacopeia / European Pharmacopeia standard.

	The plant control and power management system shall monitor the safe operation of the plant, providing signal into the alarm system as per the requirements of the standard.
	Pressure Reducing Station: for 4 bar and 7 bar should fully comply and meet with the requirements of the standard. Simplex pressure reducing station shall comprise as in-line pressure regulator, with downstream pressure gauge. Isolation valves and pressure release valves should be provided as per the standard. Duplex pressure reducing station to have two branches, connected to the MGPS in parallel in order to allow maintenance on the components of one branch, while the gas flow is maintained in the other branch.Ball Valves - Full bore which operate from fully open to fully closed position with a quarter turn of the handle.Complete pressure reducing station with base plate mounted for ease of installation.
	Padlocks **(if applicable to standards)** available to allow locking of the valves in both open and closed positions and must have easy to read pressure gauges. Base plate mounted and supplied with copper stub pipes for ease of installation using inert jointing procedures.
	The compressor system should have-
a	**Intake filter Delivery pipe**
b	Mounting on air tank along with all standard fittings viz. safety valve, pressure gauge, delivery valve, drain valve etc.
c	Bidder shall provide all electric control panels, starters etc required for proper functioning of motor.
d	Desiccant Air Dryer – 2 nos.(Duplex)
e	2-Stage or more Breathing Air Filters – 2 sets(Duplex)
f	Outlet pressures for drills/equipment and ventilators should be a minimum of 7 bar and 4 bar respectively.
g	Duplex pressure reducing station
	The compressor should be heavy duty, reliable with long MTBF. Each compressor cylinder is to be protected by a temperature switch, which will stop the drive motor and provide an alarm signal in the event of abnormal discharge air temperature. Each compressor module should include an inline filter with particle retention of 10 microns, inlet isolation valve, discharge isolation valve, and pressure relief valve. The capacity should be capable to take care of total load of all the outlets.
3.2	**Vertical Air Receiver**
	Total air receiver capacity shall be at least 50% (+/- 5%) of the primary plant capacity (capacity as mentioned in the tender) in 1 minute in terms of free air delivered at normal working pressure. Each air receiver shall be protected by a pressure relief valve, a fusible plug and include a pressure gauge with isolating valve and a drain cock.
	The corrosion resistant coated receiver is to be equipped with tested safety pressure relief valve, sight glass pressure gauge, automatic drain, three-valve by-pass and source isolation valve. Should be fabricated as per ISO/ASME/BS
3.3	**Air Treatment Module**

	The air treatment module should include dual dryers, dual filtration system and a dewpoint transmitter with local audible and visual signals and dry contacts for remote monitoring. The components should be mounted on a common base with interconnecting copper/brass piping and upstream and downstream isolation valves. The isolation valves must allow either set of components to be serviced without shutting down the system.
	Dryers should be of heatless desiccant design and sized to provide for the peak calculated demand. The desiccant dryers should be equipped with dew point dependent switching feature tominimize the need for purge air.
	The dual filtration system should remove liquid and particulate matter, consisting of 0.5micron coalescing filters with differential pressure indicators and automatic drain, airline pressure regulators with gauges, final pressure relief valve, and sampling valve.
	Each bank should consist of three stage treatment. Digital dew point monitor is to be supplied with alarm contacts as per requirement of the standard.
3.4	**System Controls**
	The "Continuous on Demand" feature will stop the operation of the motors during periods of low or no demand. The control include individual self-protected combination motor controls with short circuit protection, single phase and thermal overload protection, individual control circuit with transformers primary and secondary protection,pressure sensors, temperature switches with reset buttons, and an electronic controller to automatically change the operating sequence of the compressors. The cabinet shall have status display to include system pressure, dew point pump operation, accumulated time, maintenance interval, fault conditions, and silence button, lighted Hand-Off-Automatic selector switches and safety disconnect operating handles. All required local alarm functions shall be integrated in to the packaged system.
	The system should be designed to function even if the programmable controller fails.
3.5	**Accessories**
	Accessories including for job site installation such as inlet and discharge flexible connectors, vibration mounting pads, and source isolation valve should be supplied.
	All the filters should be covered under warranty period.
4	**VACUUM SYSTEMS (Package unit) - Tolerence of +/-5% is acceptable in plant flow capacity**
	It should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed-)and should comply with HTM 0201/ NFPA 99 C / EN /DIN/ISO 7396-1
4.1	**Vacuum Pump Module**
	It should be Rotary Vane Type to produces the plant output of minimum 2000 LPM as primary and 2000 LPM as standby.
	Designed flow capacity should be minimumof LPM capacity as mentioned. The vacuum plant shall comprise air-cooled, **oil lubricated** rotary vane vacuum pumps suitable for both continuous and frequent start/stop operation at inlet vacuum levels between 500mmHg and 660 mmHg.

	The control system should normally employ automatic rotation of the lead pump to maximize pump life and ensure even wear.Vacuum pump inlets shall include a wire mesh filter and integral non-return valve to prevent oil suck back and pressure increases in the vacuum system.
	Each vacuum pump shall be fitted with anti-vibration pads between the pump foot and mounting frame. The plant shall be fitted with duplex bacteria filter system.
4.2	**Vacuum Receiver**
	The vacuum receiver shall be made of rust free corrosion resistant steel and fabricated as per ASME/BS/ISO for a vacuum pressure of 760mmHg. It should include bypass valves, manual drain valves, vacuum gauge. Vacuum reservoir shall have total volume of at least 100 % of **primary plant output (+/- 5%) (capacity as mentioned in the tender)** in one minute in terms of free air aspired at normal working pressure.
4.3	**System Controls**
	The control include individual self-protected combination motor controls with short circuit, single phase and thermal overload protection, individual control circuit transformers with primary and secondary protection, pressure sensors, temperature switches with reset buttons, and an electronic controller to automatically change the operating sequence of the compressors. The system should have a status display to show the system pressure, elapsed time, maintenance interval, fault conditions, and silence button, lighted Hand-Off-Automatic selector switches and safety disconnect operating handles.
	All required local alarm functions should be integrated into the packaged system. The circuitry should be designed so that the audible signal can be silenced and the visual indicator will remain until the fault has been cleared and the reset button resets. Local alarm functions should be annunciated for reserve pump in use
4.4	**Bacterial Filters**
	The filters should be designed for removal of solid, liquid and bacterial contamination from the suction side of vacuum pump systems, preventing damage to the pump and the potential biological infection of the surrounding environment. The dryer should be particulate filter dryer with ability to remove particles as small as 1micron.
	Each individual filter shall have the capacity to deliver full design flow such that one set is designated duty and the other will be standby. Bacteria filters shall have efficiency at least 99.999% when tested by the sodium flame method in accordance with BS 3928:1969/as per required standard utilising particles in the 0.02 to 2 micron size range. The pressure drop across each clean filter at 50% of the system design flow should not exceed 25 mm Hg (3 kPa) at a vacuum of 475mm of Hg (63 kPa). Bacteria filters shall be marked with the legend 'Bio-Hazard'.
	Each bacteria filter shall be provided with a transparent sterilizable collection jar to collect condensate. The total water capacity of the pressure vessels shall be at least 100% of the design flow rate of the plant in 1 minute in terms of free air aspired.
4.5	**Accessories**
	Accessories included for job site installation are inlet and discharge flexible connectors, vibration mounting pads, and source isolation valve, inlet check valve, thermal malfunction switch and vacuum control switch. Flexible connectors on inlet and exhaust of each pump, exhaust tee with union as well as copper tubing with Shutoff- cock for **gauge/bypass valve** and vacuum switch etc.

	All the filters should be covered under warranty period.
5	**Ward Vacuum Units**
	It must consists of the following:-
a	1no of Suction Regulator and 1no of 1000 ml polysulfone /polycarbonate collection jar.
b	Suction Regulator**(Digital/Analogue)**: Suction regulator should be supplied with a safety jar, including and antibacterial filter and an anti-overflow safety device. Should have wide membrane continuous suction controller. **In case of digital suction regulator, battery should be replaced by the bidder during warranty period**
c	Should have vacuum levels: **0-750 mm Hg or more**
d	Should have vacuum gauge fitted with a protective bumper device.
e	Should have on/off knob allowing for the quick restoration of a readjusted vacuum level.
f	Must have central adjustment knob with a color coded for **0 to 750 mm Hg or more.** Should have Polysulfone/ polycarbonate 100cc safety jar, autoclavable at 121° C at 5mins,unbreakable, fitted with an anti-overflow safety device and equipped with antibacterial filter. It should be totally transparent, to ensure perfect sucked liquid visibility.
5A	Low flow ward vacuum unit - Should have vacuum levels: **0-150 mm of Hg +/- 10%**
6	**Theatre Vacuum unit for OT**
	It must consist of the following: -
a	Suction Regulator **(Digital/Analogue)** and 2nos. 1500ml or more polysulfone/ polycarbonate collection jar and both to be mounted on a trolley. **In case of digital suction regulator, battery should be replaced by the bidder during warranty period**
b	Suction Regulator: Suction regulator should be supplied with a safety jar, including an anti-bacterial filter and an anti-overflow safety device. Should have wide membrane continuous suction controller
a	Should have vacuum levels : **0-750 mm of Hg or more**
b	Should have vacuum gauge fitted with a protective bumper device.
a	Should have on/off knob allowing for the quick restoration of a readjusted vacuum level.
b	Must have central adjustment knob with a color coded for **0-750 mm Hg or more.** Should have polysulfone/ polycarbonate safety jar, autoclavable at 121° C, unbreakable, fitted with an anti-overflow safety device and equipped with antibacterial filter.
a	Collection jar should be totally transparent, to ensure perfect sucked liquid visibility.
7	**AGSS (Anesthetic Gas Scavenging System) Plant -**
	Anesthetic Gas Scavenging System (AGSS) of **minimum LPM as Primary & LPM as Standby(LPM as mentioned in DBR),**It should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed and should comply with HTM 02-01/ NFPA 99 C/EN/ISO 7396-1.

	The package should consist of **duplex rotary vane/claw/Blower type vacuum pumps**, a control panel **with automatic changeover**, and mounted on a common base frame.
	AGSS pump: Each pump should be completely cooled and have absolutely no water requirements. The suitable wiring from OTs to AGSS plant for remote control/suitable reservoir (as aplicable) is the responsibility of the bidder.
	System in-line non-return values should allow individual pump servicing. Active anesthetic gas scavenging systems should be designed to safely remove exhaled anesthetic agents from the operating environment and dispose of them to atmosphere from the highest point of the hospital building, thus preventing contamination of the operating department and providing a safe and healthy workspace for the personal. AGSS design should be dependent upon flow rate and pressure drop characteristics of the individual components of systems. It is essential that terminal units, remote controls (If required) and pump units work in synchronized manner after connection of workstation to the AGSS System.
	Installation should be on roof top/suitable location. Piping, Non-Return-Valves (NRVs), and inlet nozzle should be suitably placed. Connecting hose suitable to fit with anesthesia workstation should be provided.
8	**DISTRIBUTION PIPING**
8.1	**Piping specifications**
	Copper pipe should be as per standard BS: EN 13348:2008/ ASTM B819 standards, Solid drawn, seamless, deoxidized, non-arsenical, half hard (hard can be accepted only for sizes 54mm or more), tempered and degreased copper pipe conforming to the standard. All copper pipes should be degreased & delivered capped at both ends. The pipes should be accompanied with manufacturers test certificate for the physical properties & chemical composition.
	Copper pipe must have reputed third party inspection certificate (Eg. Lloyd's or TUV or SGS).
	Fittings should be made of copper and suitable for a working Pressure of up to 17bar and especially made for brazed socket type connections. All valves shall be pneumatically tested for twice the working pressure and factory degreased for medical gas service.
	Copper fittings should comply with EN 1254:1 factory degreased and brazing filler metals should comply with EN 1044. Fitting should be degreased, individually packed for medical use.
	The minimum thickness of copper pipes of 35mm and above outer diameter, should be 1.2mm and the thickness of copper pipes less than 28mm outer diameter, should be 1mm as mentioned in DBR.
8.2	**Installation & testing**
	Installation of piping shall be carried out with utmost cleanliness. Only pipes, fittings and valves that have been degreased and fittings shall be used at site. Pipe fixing clamps shall be of nonferrous or non-deteriorating plastic suitable for the diameter of the pipe.

	Inert gas welding technique should be used by passing oxygen Free Nitrogen Gas inside the copper pipes during silver brazing, in order to avoid carbon deposition inside the copper pipes. Only copper-to-copper joints are permitted on site except threaded or flanged joints may be made where pipelines are connected to items such as valves and control equipment. No flux shall be used for joining Copper to Copper joints and on for joints made on site. Copper to copper joints shall be brazed using a 5% silver-copper phosphorous brazing alloy CP104. A total of 5 joints shall be cut out for examination to establish the quality of the joints being made on site. The insides shall be clean and free from oxides and particulate matter and the minimum penetration of the brazing alloy at any point shall be three times the wall thickness of the tube. If the joints examined do not conform to these requirements, then adjacent joints shall be cut out and examined until the extent of faulty workmanship has been made good. Copper-to-brass or gunmetal joints shall only be made under controlled conditions off site. The joints are ordinarily used to join short copper pipe tails to brass, gunmetal or bronze fittings to permit their connection into the pipeline. The sub-assemblies shall be degreased and individually sealed in bags or boxes before delivery to site.
	Adequate supports should be provided while laying pipelines to ensure that the pipes do not sag. Suitable sleeves shall be provided wherever pipes cross through walls / slabs. All pipe clamps shall be non-reactive to copper.
	After erection, the pipes are to be flushed with dry nitrogen gas and then pressure tested with dry nitrogen at a pressure equal to twice the working pressure or 150 psig, whichever is higher for a period of not less than 24 hours.
	Length and quantity of individual items (Copper pipes, AVSUs, Alarm panels, Isolation valves, Outlets, pendants etc.) are mentioned. However quantity will be calculated and paid at actuals. Bidder should quote unit price for all the items as detailed
	Maximum interval between supports (Horizontal and Vertical)
	(12mm Pipe - 1.5m, 15mm pipe - 1.5m, 22mm pipe – 2m, 28mm pipe-2m, 35mm pipe-2.5m, 42mm pipe -2.5m, 54mm pipe - 2.5m, 76mm pipe – 3meter)
8.3	**Painting**
	All the pipes from manifold/plant upto the outlets should be painted with two coats of synthetic enamel paint and colour codification should be as per standards followed and with consultation with competent authorities of the Institute.
9	**GAS OUTLETS**
	Terminal Units (Gas Outlets) with probes/Adaptors for O2, N2O, Compressed Air 4, Air 7, AGSS, Vacuum & CO2 (CO2 can be optional depending on the requirement)
	The Medical gas outlets shall confirm to HTM 02-01/ NFPA 99 C/EN/DIN/ ISO 7396-1. Front Loading Type Terminal Outlets should be designed to dispense medical gases (or an inlet for medical vacuum) to the secondary equipment (flow meters, Suction regulators, etc.) at the point of use and is gas specific so that secondary devices cannot be “attached” to the wrong gas. When not in use the gas in a non-flowing state within the Outlet (Terminal unit) sealed by “O” ring. The adapter when inserted pushes the poppet inside and the gas starts flowing and sealing is ensured by the “O” ring or a seat. The Outlets are Quick Connect Type and gas specificity is accomplished by "Pin indexing." The outlets should have following features:
	• Push to insert and press-to-release mechanism for probes.

	• Allows plugging of probes from front.
	• Self-sealing valve on disengaging the probe (Quick disconnect)
	• Smooth quite action.
	• Non return valve for on line servicing/ repairing
	• Indexed to eliminate inter-changeability of gas services
	• Color-coded gas specific front plate
	• Totally leak proof, safe & easy to operate
	• Configurations possible: surface, flush & Bead-head.
	•Outlets should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed
	•All outlets should have respective labels (i.e.O2 / N2O / CO2 / Air4 / Air7/Vacuum/AGSS/etc.) displayed accordingly.
10	**AREA VALVE SERVICE UNIT**
	Area valve service units should fully comply and meet with HTM 02-01/NFPA 99C/EN/DIN/ISO7396-1. It should provide a zone isolation facility for use either in an emergency or for maintenance purpose The Area Valve Service Unit should incorporate **prefitted ball valve** in a box with emergency access. It should be reliable and easy to operate, easy purge, sample & pressure testing and emergency supply system. **Quantity of valves is considered under DBR heading line isolation vales.**
	Medical gas/vacuum services should be fixed copper, piped to and from their respective area valve service units. A color coded service identity label should be fitted behind the valve handle. The unit should provide a zone isolation facility. Gas Flow direction should be indicated.
	The box shall be made from extruded aluminium/**MS powder coated** to prevent corrosion. All wetted parts (except seals and gaskets) should be brass or copper. Each unit assembly should be factory tested for gas tightness. Rubber pipe grommets should be provided to ensure any leaking gas does not escape from the unit into a wall cavity. All visible aluminum surfaces should be powder coated.
11	**ALARM SYSTEM**
11.1	**Master Alarm**
	Should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed.
	Complies with HTM 02-01 / NFPA 99C/EN/DIN/ ISO 7396-1 Standards.
	Each Master Alarm should be modular in design and be fitted with required number of master alarm modules. The master alarms should be capable to monitor minimum 40 Point.
	Each point represents an alarm condition that the source equipment might have. When an alarm condition exists, a red light flashes and the audible alarm sounds. If several alarm conditions occur simultaneously, the most recent alarm light should flash, while the other alarm lights should remain lit. When an alarm condition is created, an audible alarm should be actuated. A dry contact module should be available to interface with a building management system.
	The box material should be of gauge steel of requisite thickness and equipped with mounting brackets. The emissions from alarms should conform with EMC standards.

	Master alarm management system should be designed to display alarm conditions from the source supply units indicating the broad status of the source equipment and manifolds as well as the master distribution status from the source supplies. Depending on the alarm priority, a visual and audible alarm should be initiated to indicate an alarm condition.
	Each panel shall display and/or input up to forty point alarms. Panel should be ready to use with BMS system.
	The master alarm must be able to monitor the following source alarm conditions.
	· Oxygen Source Empty/Fault
	· Oxygen Cylinder Bank Empty/Fault
	· Oxygen Emergency Bank Empty/Fault
	· Air Compressor Faulty/Operation
	· Vacuum Pump Faulty/Operational
	· Vacuum Deficiency Vacuum Reservoir
	· And Other MGPS Signals & Alarms
	Bidder shall be responsible for all cabling from local alarm panels(OTS & ICUs) to master alarm panel. **Bidder should quote unit rate per meter interconnection cost and 1000m will be considered for ranking purpose. Payment will be made at actuals**
	Master alarm should be integrated with BMS/HIS
11.2	**Medical Gas Area Alarm**
	The medical gas central alarms should be capable of monitoring up to 5 medical gas services by means of pressure sensors which detect deviations from the normal operating limits of either pressure or medical vacuum. The area alarm should have a digital/Analogue display of pressures. The medical gas area alarm should fully satisfy the HTM 02-01/ NFPA 99 C/EN/DIN/ISO 7396-1 requirements and should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed.
	An audible warning should sound simultaneously with any failure indication and a mute facility should be provided. "
	Note: The bidder may offer combined unit of AVSU & alarm, bidder has to match the quantiy of AVSU/Alarm whichever is higher
12	**Line Isolation Valves**
	The Lockable line valves must degreesed and complete valve with **stuffed pipe & fittings, factory tested** and complies with HTM 02-01/ NFPA 99 C/EN/DIN/ISO 7396-1 standard.
13	**Supply of O2 Cylinders – Class D Type**
	Should be as per BIS/IS/ASME Standard
14	**Supply of O2 Cylinders – Class D Type**
	Should be as per BIS/IS/ASME Standard
15	**Horizontal/ Vertical Bed Head Panel**

	It shall confirm to HTM 02-01/ NFPA 99 C/EN/DIN/ISO 7396-1. The design should be approved by the respective institute before installation and it is responsibility of the bidder after getting order they have to discuss with respective institute and finalized the Bed Head Panel (Vertical/Horizontal) as per site condition. Vertical BHP should be upto False Ceiling Lavel and all outlets and sockets should be located at reachble hieght. Horizontal BHP should be of maximum 1000mm for 2 Gas outlet configuration, 1200mm for upto 4 outlets configuration and 1500mm for 6/8 Outlet configurations.
	It should conforms to ISO 11197 standards
	It should have following features:-
	Efficient, Safe & Robust design in extruded aluminium section.
	Smooth curved surfaces, and choice of base colour and fascia plates.
	Unit should have integrated rail system to mount accessories
	The headwall system should be constructed of aluminium extrusions joined together to form a carcass to suit the particular application. Unit should be factory assembled for electrical and mechanical components.
	Segregation of services i.e. Low voltage supplies, High Voltage supply and Medical gases should be maintained.
	Front fascia plate should be removable individually to access for respective service.
	It should have one rail for mounting Accessories.
	Each bed-head unit shall be supplied with electrical and electrical outlets pre-fitted, wired and certified.
	Note: Gas Outlets quantities are already taken in consideration of quantities of respective outlets in DBR.
	Holder for vacuum collection jar –1
	Nurse call switch – 1 (not in the scope of MGPS Vendor only space for same has to provide)
	5 /15A combined Electrical socket with switch – minimum 4 Nos. with 2 outlet combination, 6 Nos. with 4 outlet combination and 8 Nos. with 6/8 outlet combination
	RJ-45 socket/ Ethernet -01
	Two spare spaces
16	**High pressure tubes for O2, N2O, Compressed Air,& Vacuum**
	It should be colour coded for individual services i.e. white for Oxygen, Blue for N2O and Yellow for Vacuum, Black for air. Antistatic rubber tube should be as per ISO standards. It should be CE marked/UL Listed. The 200m Hose- Gas wise requirement should be taken from Client/HLL.
17	**Electrical Wiring with Electrical Panels –**
	All wiring inside the Manifold Room and Plant room required for MGPS equipment and General electrification. Institute will provide one point supply only. Other are under the scope of bidder. All the work should be as per BIS/CE standard and material used should be reputed make only.
18.	**CARBON DIOXIDE SYSTEM**

	The system should consist of medical CO2 Manifold **2 + 2 Primary & 1+1 Standby** with Class-D type Cylinders and control panel . Control panel of CO2 should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed.
	The Modular Manifold supply system shall provide carbon dioxide piped distribution system.
	The Modular Manifold system should be in such a way that it increases flexibility and allows easy enlargement of the manifold capacity in case of future expansion. Should be complies with HTM 02-01/ NFPA 99 C/EN/DIN/ ISO 7396-1 standard.
	Fully Automatic Control panel for CO2 System
	The Manifold Control System should supply any type of medical gas from both left and right hand manifold banks. Operation and performance criteria should fully satisfy the requirements of HTM 02-01/ NFPA 99 C/EN/DIN/ ISO 7396-1 standard. The fully automatic CO2 control panel should comply with the standard. It should be US FDA / European CE Certified with 4 digit notified body number or American ETL/ American UL listed.
	The Manifold Control System shall supply on uninterrupted flow of 500 L/min. to a 400 k Pa (4 bar) distribution system. Either the left or right hand manifold bank may be designated "Duty" and should automatically changeover to supply the distribution system from the "Standby" bank when pressure in the "Duty" bank falls to a predetermined level.
19	**Interconnection to LMO Tank (Optional Price should be quoted)**
	Price should be quoted per meter basis for inclusive of all installation, material (Copper Pipes, fittings, etc), trenches and labour etc. charges as per site condition. The payment will be made on actual meter consumption for interconnection from LMO tank to Gas Manifold room.
20	**Site Modification –**
	i. EPC Contractor should be responsible for antistatic rubber flooring in the manifold room and thickness of flooring not less than 1inch.
	ii. EPC Contractor should provide a raised Loading/Unloading Platform of suitable sized adjacent to manifold room, so that cylinder can be loaded & unloaded easily form the lorry/vehicle.
	iii. EPC Contractor should be responsible for foundation of Plant Room (If required) for Medical Air Plant, Vacuum Pant & AGSS Plant.
	v. EPC Contractor should be responsible for all civil modifications and repair for successful completion of MGPS Plant, Manifold, and Pipeline installation and commissioning throughout the proposed blocks/buildings
	vi. EPC Contractor should be responsible for internal walls/partitions & doors for creating separation between MGPS Plant and Manifold room, etc as per their requirement.
20	**Testing ,Commissioning and Validation**
	All works of MGPS must strictly carried out as per specification laiddown in HTM 02-01/NFPA 99c/ISO 7396.

	Test after completetion of of installationshould be carried out and documented by the manufacturer. The equipment required for testing should be provided by the supplier.
	Test and Procedures after complete installation and before use of the system. a) Test and Check for lekage,correct zoning and identification of zone isolation valves-check for identification of terminal units b)Test for cross connection,flow pessure drop,and system performance c) Test of pressure-relief valves and safety valves d) Functional test of all sources of supply e)Test of warning systems f)Test for Cleanliness g) Test for gas identities.
	Testing and Validaton of entire system should be carried out by **third party** as per standard (HTM 02-01/NFPA 99c/ISO 7396).The cost of testing/Validation should be borne by the supplier.The complete test report should be submitted to Consignee and Consultants.

MGPS System		
List of Approved Make		
1	LMO Tank (20KL Primary Supply and 10KL Backup Supply)	Linde / Prax Air / Inox
2	Secondary Oxygen Manifold and Emergency oxygen manifold with automatic control panels	Atlas Copco / Amico / Ohio Medical / pneumatic berlin /Drager/G.Samaras
3	Oxygen Flow meter with Humidifier Bottle	Atlas Copco / Amico / Ohio Medical / pneumatic berlin /Drager /G.Samaras
4	Nitrous Oxide Manifold and Emergency NO2 Manifold with automatic control panel	Atlas Copco / Amico / Ohio Medical / pneumatic berlin /Drager/G.Samaras
5	Co2 Manifold and Emergency Co2 Manifold with automatic control panel	Atlas Copco / Amico / Ohio Medical / pneumatic berlin /Drager/G.Samaras
6	Medical Air Supply System (4 Bar & 7 Bar) complete.	Powerex/ Atlas Copco / Amico / Ohio Medical /pneumatic berlin/Drager/G.Samaras
7	Medical Vacuum (suction) Supply System Complete.	Powerex/ Atlas Copco / Amico / Ohio Medical /pneumatic berlin/Drager/G.Samaras
8	Vacuum Units (Ward/Theaters/Lowflow)	Atlas Copco / Amico / Ohio Medical / pneumatic berlin /Drager/G.Samaras
9	AGSS system Complete	Powerex/ Atlas Copco / Amico / Ohio Medical /pneumatic berlin/Drager/G.Samaras
10	Distribution Piping Complete with Accessories.	Copper Pipe : Mehta Tube(Maxflow) / Rajco / Metal Alloys (Metalco) Fittings : Conex Banninger
11	Gas Outlets with Probes	Atlas Copco / Amico / Ohio Medical / pneumatic berlin /Drager
12	Area Valve Service System & Line Isolation Valve	Atlas Copco / Amico / Ohio Medical / pneumatic berlin /G.Samaras
13	Alarm Systems (Master & Area)	Atlas Copco / Amico / Ohio Medical / pneumatic berlin /Drager /G.Samaras

14	Bed Head Panels (Vertical & Horizontal)	MPS/ PES/ Prenit/ MDD/ Active/ Eubiq / Medirail Systems/Drager
15	High pressure tubes for O2, N2O, CO2, AGSS, Compressed Air & Vacuum, Etc.	Atlas Copco / Amico / Ohio Medical / pneumatic berlin /Drager
16	Gas Cylinders	Everest Kanto / Rama Cylinders / BPCL (BIS Approved Only)

Note:

1.	The contractor will use one of the approved makes as approved by the Engineer -in-charge.
2.	In case of different quality / pattern of same make, the pattern/ quality shall be approved Engineer – in – charge.
3.	For materials/equipment/ to be used in items of work for which approved makes are not given herein, the makes of such materials /equipment shall be as decided by Engineer –in-charge.
4.	If any major equipment is using a small component of make other than that given as a standard component with the equipment, the same shall be accepted subject to approval of Engineer –in-charge.

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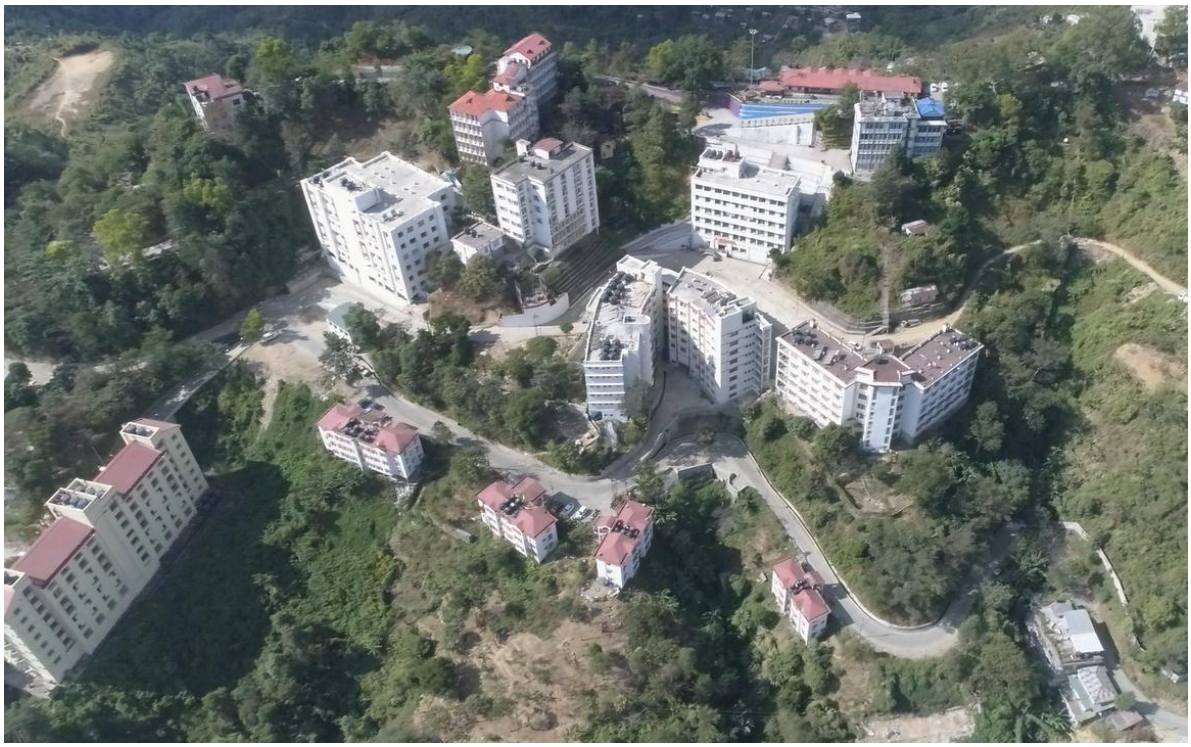
END OF VOLUME – 5

Vol. -6: Tender Drawings

UP-GRADATION AND DEVELOPMENT OF REGIONAL INSTITUTE OF PARAMEDICAL & NURSING SCIENCES,AIZAWL, MIZORAM



CLIENT
Regional Institute Of Paramedical & Nursing Sciences, Aizawl, Mizoram
(Ministry Of Health and Family Welfare, Govt. of India)

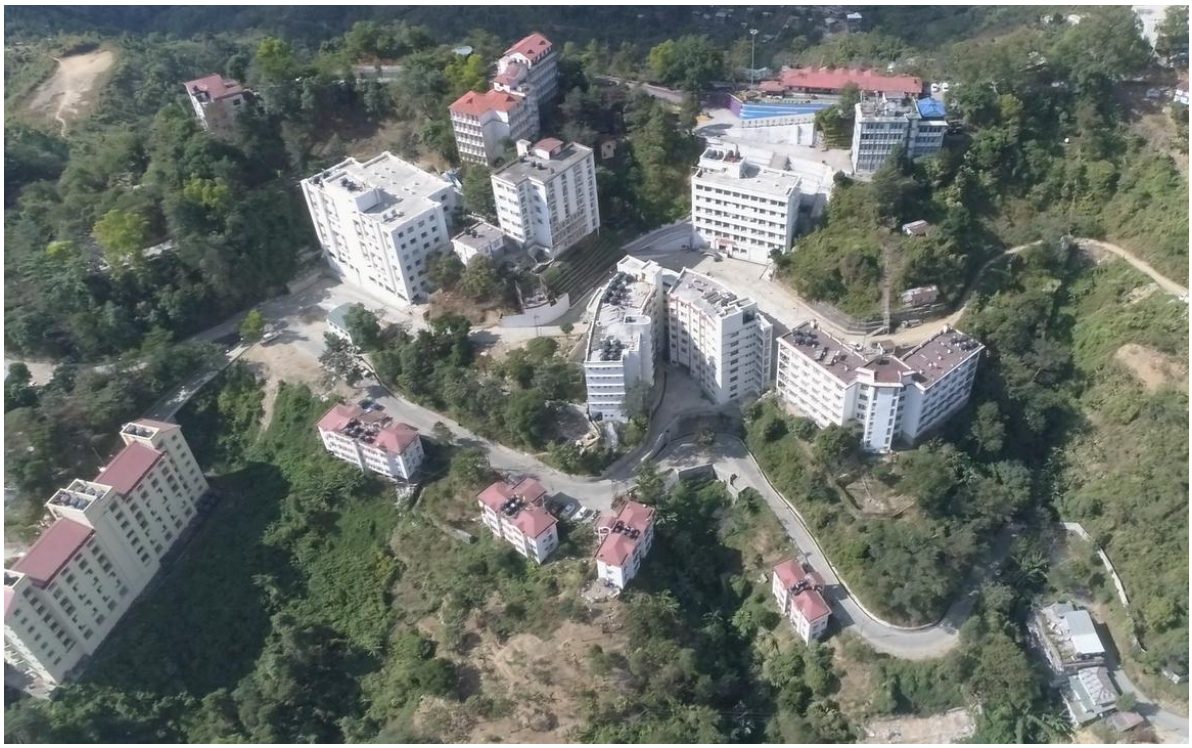
PROJECT CONSULTANT
HLL Lifecare Limited
(A Government of India Enterprise)

Vol. 6: Tender Drawings

Refer e-tender portal
https://etenders.gov.in/eprocure/app

Vol.-7: FINANCIAL BID

UP-GRADATION AND DEVELOPMENT OF REGIONAL INSTITUTE OF PARAMEDICAL & NURSING SCIENCES,AIZAWL, MIZORAM



Client

Regional Institute Of Paramedical & Nursing Sciences, Aizawl, Mizoram (Ministry Of Health and Family Welfare, Govt. of India)

Project consultant

HLL Lifecare Limited
(A Government of India Enterprise)

Vol. 7: Financial Bid

(To be submitted online only)

Refer e-Procurement System at NIC's (CPP Portal)
https://etenders.gov.in/eprocure/app