

HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

ne pharmaplan

User Requirement Specifications

Equipment/System

Bio-waste Inactivation System

Identification #

KIL 01

Document#

URS/ KIL 01

Effective Date

2014-12-01

Revision#

04



User Requirement Specifications Bio-waste Inactivation System

EQUIPMENT TAG	EQUIPMENTS	QUANTITY	Capacity (W.V)
KIL01	COLLECTION TANK- D&P	1 NO	6.5 KL
	COLLECTION TANK- T	1 NO	2.0 KL
	KILL TANK –D&P	1 NO	1.5 KL
	KILL TANK -T	1 NO	1.0 KL

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Identification #	KIL 01	Document#	URS/ KIL 01
Effective Date	2014-12-01	Revision#	04



URS Annexure List

URS Annex No.	Detail
1.	Tentative P&ID for Bio-waste Inactivation System
2.	List of preferred make of components

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HLL Lifecare Pharmaplan	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	

Table of Contents

1.0	APPROVAL SIGNATURES	4
2.0	EQUIPMENT DESCRIPTION.....	5
3.0	PROCESS DESCRIPTION	9
3.1	INPUT & CHARGING METHOD.....	9
3.2	BRIEF PROCESS STEPS	9
3.3	OUTPUT & DISCHARGING METHOD.....	9
4.0	PRODUCTIVITY REQUIREMENT	10
4.1	DESIRED/ SUGGESTED CAPACITY.....	10
4.2	STANDARD BATCH SIZE	10
4.3	CHANGE OVER TIME (IF APPLICABLE)	10
4.4	OTHER PRODUCTIVITY REQUIREMENT	10
5.0	CONTAINMENT	10
6.0	GMP REQUIREMENTS	10
6.1	PROCESS CONTROL.....	10
6.2	FAILURE MODE DETECTION.....	10
6.3	IN – PROCESS CONTROL	11
6.4	LEVEL OF INSTRUMENTATION	11
6.5	BATCH DATA DISPLAY AND RECORD PRINTING.....	12
6.6	GMP REQUIREMENTS (OTHERS)	12
6.7	SPECIFIC REQUIREMENTS	12
7.0	CONSTRAINTS.....	16
7.1	EQUIPMENT LOCATION AND AVAILABLE SPACE	16
7.2	AVAILABLE UTILITY.....	16
8.0	ABBREVIATION	17

HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

nne pharmaplan®	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	

1.0 APPROVAL SIGNATURES

This document is prepared by the Process, Validation and GMP Compliance team of "NNE Pharmaplan India" for the project "Revival of DPT Vaccines manufacturing Facility" (**Project number:-110831**) of Pasteur Institute of India, Coonoor under the authority of their Project Manager. Hence, this document before being effective shall be approved by the QA team of Pasteur Institute of India, and authorized by the appropriate Project Authority.

Prepared by

Name/ Designation	Signature	Date
Mr. Manohar M S Process Engineer- COC Vaccines NNE Pharmaplan India Ltd.		

Checked by

Name/ Designation	Signature	Date
Ms. Shilpa Rao Senior Process Engineer- COC Vaccines NNE Pharmaplan India Ltd.		

Approved by


Name/ Designation	Signature	Date
Mr. Vikas Katial GM-Head COC Vaccines NNE Pharmaplan India Ltd.		
HLL Lifecare Limited		
Pasteur Institute of India		

Authorized by

Name/ Designation	Signature	Date
Project Authority Pasteur Institute of India		

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Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

HLL Lifecare Limited Chennai	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	

2.0 EQUIPMENT DESCRIPTION

Bio-waste inactivation system consists of biowaste drain collection tank, Kill tank with associated pumps, piping and instrumentation. The Biowaste Inactivation system shall be in compliance with Biosafety Level2.

The equipment described by this URS has following:

a) COLLECTION TANK:

- **2 nos. Horizontal Collection tank**
 - 6.5 KL Cylindrical Collection tank – Diphtheria and Pertussis
 - 2.0 KL Cylindrical Collection tank - Tetanus
- 4 nos. transfer pump for the Collection Tank transfer from collection to kill tank (2 working, 2 standby).
- 2 no. 0.22 µm (10 inch) hydrophobic vent filter code 7– one for Diphtheria & Pertussis part and another for Tetanus part.
- The tanks mentioned above should be designed as per ASME BPE cylindrical tank, floor standing on 3 legs, dished bottom, Torispherical welded lid.

b) KILL TANK:

- **2 no. Vertical Cylindrical Kill Tank - one for Diphtheria & Pertussis – 1.5KL (W.V.) and another for Tetanus – 1KL (W.V.)** - with jacket and other utilities.
- 1 no. discharge pump/ recirculation pump (during rinsing/ cleaning), 1 no working. discharge pump/ recirculation pump (during rinsing/ cleaning) – Stand By for Diphtheria & Pertussis.
- 1 no. discharge pump/ recirculation pump (during rinsing/ cleaning), 1 no working. discharge pump/ recirculation pump (during rinsing/ cleaning) – Stand By for Tetanus.
- 2 no. 0.22 µm (10 inch) hydrophobic vent filter code 7– one for Diphtheria & Pertussis kill tank and another for Tetanus Kill tank.
- The tanks mentioned above should be designed as cylindrical tank with double wall, floor standing on 4 legs, dished bottom, Torispherical welded lid.

c) All necessary equipment (hoses, fittings, piping etc.) for execution of the system.

d) Instrumentation and control system.

e) Installation of audio-visual alarm signals. (eg. the system shall activate an alarm when the collection tank, kill tank are full)


- The system to be provided with valves for plant steam supply, compressed air supply and cooling water supply and return. All control valves required for controlling the temperature during inactivation process responding to signal from temperature transmitter on the lower sidewall of the tank based on the temperature set point. The system shall have provision for CIP. The system shall activate an alarm when the collection tank, kill tank are full.
- The system shall be designed to operate automatically through a PLC with HMI. Suitable alarms shall be provided for intimation in case of failure of the services or system. Interlock shall be provided to ensure that the system does not discharge the contents in case inactivation cycle has not been completed.
- In case plant steam is not available, there shall be provision for chemical inactivation a port on the kill tanks is considered.

Design, function and control of the unit have to be GMP compliant.

The equipment should consist of following parts in order to run operation smoothly.

HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

HLL Lifecare Pharmaplan	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	

S. No.	Description	Purpose (COLLECTION TANK)	Purpose (KILL TANK)	Remarks
1.	Shell	To hold the Biowaste Solutions	To inactivate the Biowaste Solutions at 121°C.	
2.	Jacket	Not Applicable	To be used for cooling or heating the solution	
3.	Agitation	Not Applicable	top mounted agitator arrangement	
4.	Insulation	To protect the outer surface	To prevent heat loss during FSIP and process	
5.	Provisions for different nozzle connections	To be used for CIP/ biowaste collection , transfer etc.	To be used for CIP/plant steam/ biowaste etc.	
6.	Any pneumatic valve in harvest line	To transfer the contents	To flush the system completely	
7.	Level sensor	Level sensor with controller	Level sensor with controller	
8.	Pump	Discharge Pump	Discharge Pump	

2.1 General requirements

The general design must be hygienic, with no dead legs and no air pockets. The bio-waste inactivation system must be fully drainable with tank bottom valve at the outlet.

2.2 Purpose of use


Purpose of the inactivation system is to inactivate biowaste solution. The tanks shall be designed, constructed, installed and commissioned to inactivate the biowaste material at 121 - 134°C & send it to ETP for final treatment after cooling @ 35-45°C at least. This also includes appropriate control & monitoring systems.

2.2.1. General tank specifications for (6.5 + 2.0)KL Collection Tank (D&P,T) are as under:

Description	Requirement	Remarks
Working volume	(6.5 + 2.0) KL	
Working temperature range	37°C – 134°C	
Surface Finish	Internally electro- polished up to Ra <0.8 µm	
	Externally Mechanically polished up to Ra<1.2 µm	
	Stainless steel piping interior EP- Ra < 0.8 µm	

HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

HLL Lifecare Pharmaplan	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	

Vessel Quality Certification : ASME VIII

Tank Material – SS AISI 304

Design – Vertical Cylindrical Non-Jacketed tanks at full vacuum with insulation

Top – Torispherical lid

Bottom – Torispherical

2. General tank specifications for 2.5 KL Kill Tank and 1 KL Kill tank are as under:

Description	Requirement	Remarks
Working volume	For Diphtheria & Pertussis - 1.5KL For Tetanus - 1 KL	
Min. mixing volume	Vendor to specify	
Working temperature range	37°C – 134°C	
Rise in temperature per minute (heating capacity)	Vendor to specify (heating from ambient to 121°C)	
Fall in temperature (cooling capacity)	<i>Vendor to specify (before discharging to ETP, inactivated biowaste shall be 35°C to 45°C)</i>	
Process Time	Kill tank cycle considered 4 hours Transfer to kill tank: 30min Heating: 50 min Holding: 30 min Cooling: 95 min Sample to QC Transfer to ETP: 30min Estimated time mentioned above or vendor to specify the cycle time	
Temperature control deviation	±0.5°C	
Surface Finish	Internally Electro polished up to Ra <0.8 µm	
	Externally Mechanically polished up to Ra<1.2µm / 180grit	
	Stainless steel piping interiorEP- Ra < 0.8 µm	

Vessel Quality Certification : ASME BPE

Tank Material – SS AISI 304

Design – Vertical Cylindrical Jacketed tanks at full vacuum with insulation


Top – Torispherical lid

Bottom – Torispherical lid

Refer 6.7 Specific Requirement for further Information on technical specification.


HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

HLL Lifecare Limited PIL	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	


Note:

1.	This Technical Specification is the basis for an inquiry to a vendor and therefore the basis for the vendor's proposal.
2.	The vendor is asked to state in "REMARKS" column with "yes" if the described requirement will be completely fulfilled and with "no" in case the requirement will not or cannot be fulfilled with the proposed equipment. In case of an deviation a comment must be inserted or enclosed as a separate annexure by referring to the respective URS specification number.
3.	The vendor must clearly comment each item of the Technical Specification. The comments must be in English language. If extra cost for necessary options become necessary the item must be clearly stated.
4.	In case that the requirement includes a question or request or an information from the vendor, the answer / information should be stated in the "REMARKS" column.
5.	The final version of this document including the vendor's comments will become basis of a potential purchase order or contract.
6.	The Technical Specification serves to define a summary of all vendors' requirements concerning scope of delivery and services.
7.	The vendor is responsible for technically unobjectionable function of the equipment. This TS is not intended to dictate a technical design to the vendor. If agreed upon with the vendor, the vendor can apply his practically proven design.
8.	Special Instruction a. If no comments against any specification shall be considered as "NO" and b. If there is no reply / comments against the complete URS by the vendor then it shall be treated as unresponsive / technically non-compliant and rejected.
9.	All the instruments and controls mentioned in the URS(s) are expected to be standard supply and part of your standard equipment model. In case of any deviation or redundancy or additional scope of supply is noticed, vendor is required to obtain clarification from HLL before submitting the quotes.
10.	The makes requested are standard international makes. In case of any deviation, vendor to seek clarification from HLL before submitting the offers.
11.	Refer document Installation Requirement Specification and Specific Instructions with URS; NPI_110831_IRS_PII_01
12.	Refer Tender document with URS; NPI/110831/EQP/TD/07

HLL LIFECARE LIMITED, CHENNAI					
Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor					
HLL Lifecare Pharmaplan	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	
Specifications				Remarks	
3.0 PROCESS DESCRIPTION					
3.1 Input & Charging method <i>Note: This section includes the charging method of biowaste and transferring to ETP after inactivation.</i>					
a) Bio-waste from the vaccine facility is transferred to collection tanks under gravity as the system has been placed at tier 1 (which is at the lowest point) so that the liquid waste from all process steps/cleaning units can be drained by gravity to the system respectively. b) Bio-waste is transferred to kill tanks from collection tank using pumps, once the level is achieved. Level transmitter provides the signal to the pump. (Start is activated by the level switches of the collection and Kill tank accordingly)					
3.2 Brief Process Steps					
a) Collection of the biowaste from separate blocks to collection tanks through process drain pipes, which shall be laid with proper slope so that waste is drained by gravity. b) Once the high level is achieved in collection tank, biowaste from collection tank is transfer to kill tank through pump (both kill tanks & collection tanks shall be interlocked for high level, low level, and safe mode of operation) c) Agitation: once proper level is achieved in kill tank, agitation starts mixing the contents. d) Inactivation: All drains which are defined by risk of containing active cells (process waste) from the production (fermentation & microfiltration), CIP and cleaning facilities are led to the collection tank before being transferred to the kill tank, where destruction of live cells happen. After achieving high level in kill tank pump stops and inactivation process starts, plant steam valve opens and get the desired temperature for inactivation. And the biowaste is held for some time at inactivation temperature. e) The temperature to be maintained is 122±1°C and pressure @1.2±0.1 bar f) Cooling: After holding time is completed and it is ensured that, the biowaste is inactivated completely by circulating cooling/soft water. The same shall be checked at regular intervals by sampling. Cooling cycle shall start to obtain the temperature (about 35-45°C) before discharging to ETP. g) Sampling: The kill tank shall be provided with a sampling valve for collection of samples. Diaphragm valve with zero dead leg without steaming provision. h) The Inactivated biowaste is transferred to ETP by using centrifugal pump. i) Cleaning: Recirculation line to be provided and transfer pump between collection tank to kill tank is activated there should be a recirculation in the collection tank prior to feed in to the kill tank.					
3.3 Output & Discharging method					
Transfer of bio-waste from collection tank to Kill tank. After the inactivation cycle is complete the inactivated biomass transferred to ETP.					
File Name	NPI_110831_EQP_URS_KIL 01.doc		Page No.	Page 9 of 18	

HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

HLL Lifecare Pharmaplan	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	

4.0 PRODUCTIVITY REQUIREMENT

4.1 Desired/ suggested capacity

TANK	WORKING VOLUME			
COLLECTION TANK- D&P	1 NO	6.5KL		
COLLECTION TANK- T	1 NO	2.0KL		
KILL TANK –D&P	1 NO	1.5 KL		
KILL TANK -T	1 NO	1.0 KL		

4.2 Standard batch size

Not Applicable	
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4.3 Change Over Time (if applicable)

Not Applicable	
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4.4 Other Productivity Requirement

Not Applicable	
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5.0 CONTAINMENT

Not Applicable	
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6.0 GMP REQUIREMENTS

6.1 Process control

The equipment must operate and control the following process parameters (Kill Tank).

6.1.1	Temperature of biowaste inside the tanks	
6.1.2	Pressure inside the Kill tank during sterilization and cooling	
6.1.3	Adjustable agitation speed during the inactivation process	
6.1.4	Level control for filling up of the tank (LL-for Low level. HL-for High level) (Collection and Kill Tank).	
6.1.5	Exhaust vent filter (to release the excess gases through hydrophobic vent filter, 0.2µm)	


6.2 Failure mode detection

Equipment shall be capable to detect the following failure, notify the operator with alarm and shutdown the process:

6.2.1	Motor overload	
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HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

HLL Lifecare Pharmaplan	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	

6.2.2 Emergency stop activated

6.2.3 Steam pressure higher than the safe limit

6.2.4 Drop in temperature during inactivation hold period

6.2.5 Drop in inactivation control temperature below acceptable temperature band during hold period.

6.2.6 End of cycle

6.3 In – Process control

Heat Inactivation temperature check


6.4 Level of instrumentation

Sufficient and suitable instrumentation for the process, safety and productivity control as indicated in the following table:

Type of control	Purpose	Instrumentation	Failure Mode Detection	Alarm
Collection Tank				
Level measurement	To monitor the volume of the biowaste in collection tank with interlocking	Level sensor	Low or high or Deviating from set value	Yes
Kill Tank				
Temperature	To monitor, indicate and control the vessel temperature	Temperature probe with indicator and controller	Low or high	Yes
Pressure	To monitor, indicate the vessel pressure	Diaphragm Pressure gauge	Low or high	Yes
Pressure	To monitor, indicate the jacket pressure	Pressure gauge	Low or high	Yes
Level measurement	To monitor the volume of the biowaste in kill tank with interlocking	Level sensor	Low or high	Yes
RPM	To control agitation speed	Variable frequency drive with top driven agitator	Deviating from set value	Yes

HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

HLL Lifecare pharmaplan	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	

6.5 Batch data display and record printing

Refer IRS (Installation requirement Specification and Specific Instruction)

6.6 GMP requirements (Others)


6.6.1	In case of inactivation sequence failure (Power, utility failures) the timer should start from zero during inactivation process.	
6.6.2	The filter housings in the tank shall be provided with integrity connectors for in-situ integrity testing of the vent filters .Vent shall be provided with sterilizing grade hydrophobic filter 0.22 µm with suitable arrangement for WIP and FSIP and in place integrity testing.	
6.6.3	Moving parts shall be tightly sealed.	
6.6.4	All nozzles for biowaste contact parts shall be provided with sanitary valve which shall be flushed to the wall on closure and inside surface of the valves can be cleaned during WIP.	
6.6.5	Steam traps shall be provided wherever required.	
6.6.6	Pumps shall be provided to transfer biowaste from collection tank to kill tank.	
6.6.7	Centrifugal pumps will be used to transfer from kill tank to ETP area. These pumps shall be connected to the PLC control. The same pump shall be used for the recirculation of the cleaning fluid during cleaning. The pump shall be of non-sanitary type, leak proof and spill proof. Pump Specification: I. Flow rate: Vendor to specify II. Operating Temperature: 50°C - 60°C III. MOC: SS 304 IV. Flooded type Vendor shall provide the specification of the pump	

6.7 Specific requirements

• COLLECTION TANK (2NO.) SPECIFIC REQUIREMENTS		
6.7.1	In general the equipment has to be designed in a way to get easy and quick access to all necessary maintenance points e. g. Motors etc.	
6.7.2	4 nos. transfer pumps (2W+2S) for the Collection Tank (transfer from collection to kill tank).	
6.7.3	Pumps shall be interlocked between inlet & outlet valves of collection tanks and level sensors of the kill tanks. Pump Specification: I. Flow rate: Vendor to specify II. Operating Temperature: 50°C - 60°C III. MOC: SS 304 Vendor shall provide the specification of the pump	
6.7.4	Base of the tank shall be sloped towards the pump	

HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

HLL Lifecare Pharmaplan	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	

6.7.5 The tank shall be provided with the following on the **Top dish: All ports shall be considered for the tanks.**

- Light/sight glass (preferably metal fused type) – 1 no
- Man hole – 1 no.
- Biowaste inlet port-1no.
- Port for Recirculation Loop – 1no.
- Port with sterile hydrophobic vent filter-1 no (0.22 µm hydrophobic vent filter with code 7 SS 304 filter housing)
- Level sensor port -1no.
- Port for the chemical/liquid addition valve – 1 no.
- Port for Spray ball- 2 nos
- Spare Port – 1no

6.7.6 Spray ball:

- SS 316L Static Spray balls for covering entire internal area of tank i.e. top dish, shell, agitator etc. with 360° spray. (**Spray ball design to be submitted by the vendor**) Systems with WIP shall be designed for 100% coverage of the internal surface areas.
- MOC shall be SS316L
- Spray ball coverage test should be performed during FAT/SAT

• KILL TANK (2NO.s) SPECIFIC REQUIRMENTS


6.7.7 In general the equipment has to be designed to assure a homogeneous temperature distribution during inactivation phase. The design should also in a way be designed to get easy and quick access to all necessary maintenance points e.g. Motors etc.

6.7.8 The tank shall be provided with the following on the top dish: All ports shall be considered for both the tanks separately

- Light/ Sight glass (preferably metal fused type) - 1 no
- Manhole – 1no.
- Transfer port-1no.
- Spray ball port – 2 no.s
- Diaphragm Pressure Gauge -1 no
- Pressure relief valve-1 no
- Exhaust port with sterile hydrophobic vent filter -1 no (0.22 µm hydrophobic vent filter with code 7 SS 304 filter housing)
- Level sensor port – 1 no.


HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

HLL Lifecare Limited Pharmaplan	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	
• Port for the chemical/liquid addition valve – 1 no.					
• Spare port – 1 no.					
<ul style="list-style-type: none">Port for Top mounted agitator:<ul style="list-style-type: none">➤ The agitator shaft to be provided with impellers. (or vendor to specify the design of the impeller)➤ SS 304 bearing frame and direct motor drive arrangement➤ Shaft seal: single mechanical dry running seal for high/ low pressure➤ SS 304 shaft, length shall be decided by the vendor according to the height of the vessel➤ Vendor shall specify the following:<ul style="list-style-type: none">– Shaft diameter– Shaft length– Type of impeller– Maximum- minimum rpm range					
6.7.9 The jacket shall be provided with the following: All ports shall be considered for both the tanks separately					
• Jacket Inlet					
• Jacket Outlet					
• Jacket safety valve with pressure gauge					
• Jacket/ condensate drain					
• Jacket vent valve					
6.7.10 If chemical addition is foreseen, a separate bottle with the chemical shall be used. The transfer of the chemical to the tank shall be through the chemical/liquid addition port.					
6.7.11 The tank shall be provided with the following on the Bottom dish: All ports shall be considered for both the tanks separately					
• Tank bottom to be Torispherically dished with a transfer line					
• Bottom discharge valve provision- 1 no					
• Knuckle port with PT 100 temperature sensor-1 no (side wall)					
• Sampling port with valve- 1 no (side wall)					
6.7.12 Design Parameters (Common for Collection and Kill Tanks): <ul style="list-style-type: none">• Shell working Pressure- Atmospheric pressure• Shell working Temperature- 20-134°C• Shell sterilization Temperature- 121-134°C• Shell design Pressure- Full Vacuum to 3.5 bar(g)• Shell design Temperature- 0-150°C• Jacket working Pressure- 3.5 bar(g) (Kill tanks)					
File Name	NPI_110831_EQP_URS_KIL 01.doc			Page No.	Page 14 of 18


HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

HLL Lifecare Limited Coonoor	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	
<ul style="list-style-type: none">Jacket working Temperature- 150°C (Kill tanks)Jacket design Pressure- Full vacuum to 4.5 bar(g) (Kill tanks)Jacket design Temperature- Vendor to specify (Kill tanks)					
6.7.13 Pump specification: 4 no. discharge pump/ recirculation pump (during rinsing/ cleaning), (2W+2S)for Diphtheria & Pertussis <ul style="list-style-type: none">➤ Flow rate required: Vendor to specify m³/ hr➤ MOC: SS 304➤ Operating temperature range: 50-60°C					
6.7.14 Pump specification: 2 no. discharge pump/ recirculation pump (during rinsing/ cleaning), (1W+1S) for Tetanus. <ul style="list-style-type: none">➤ Flow rate required: Vendor to specify m³/ hr➤ MOC: SS 304➤ Operating temperature range: 50-60°C					
6.7.15 All metallic product contact surfaces should be constructed as per ASME BPE approved SS304 grade stainless steel or better with external surface matt finish.					
6.7.16 All metallic non-product contact surfaces should be constructed of SS304 grade with external surface matte finish.					
6.7.17 All process pipes should be orbital welded with Boroscopy records					
6.7.18 Level sensor shall have the provision to set the level parameter along with high, low and medium concept to perform the auto transfer even at minimal volume.					
6.7.19 Code 7 sterile hydrophobic vent filter and cartridge 0.2 micron hydrophobic of suitable size in SS304 construction					
6.7.20 Spray ball: <ul style="list-style-type: none">SS 316L Static Spray balls for covering entire internal area of tank i.e. top dish, shell, agitator etc. with 360° spray. (Spray ball design to be submitted by the vendor) Systems with WIP shall be designed for 100% coverage of the internal surface areas.MOC shall be SS316LSpray ball coverage test should be performed during FAT/SAT					
6.7.21 Cleaning Requirement: Cleaning shall be done automatically (CIP with soft water and SIP with plant steam). <ul style="list-style-type: none">Collection Tank: the tank cleaned with soft water supply and manually acid-base can be added with transfer pump for cleaning. Recirculation loop is provided for cleaning purposeTransfer pump associated piping: they can be cleaned and steamed manually by supplying plant steam through branch.					
6.7.22 Basic PLC Based Controller with control panel (Displaying synoptic view of running parameters like temperature, level sensor, valve position etc.)					
6.7.23 Vendor shall provide the FRL (Filter, regulator, lubricator), automatic valve assembly and air pressure switch for instrument air. Connections to automatic diaphragm valve shall be in vendor scope.					
File Name	NPI_110831_EQP_URS_KIL 01.doc			Page No.	Page 15 of 18

HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

HLL Lifecare Pharmaplan	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	

7.0 CONSTRAINTS

7.1 Equipment location and available space

This equipment will be installed in the DPT vaccine manufacturing Facility at PII, Coonoor.

Equipment Location:

Block: Biowaste- Inactivation Block

Floor: Ground Floor

Room Size: 7770 mm x 7770 mm

False Ceiling Height : mm

Physical condition of the rooms:

Biowaste Inactivation Room:

1. **Room :**BSL2 hazardous
2. **Class:** General
3. Under Negative Pressure (Supply and Exhaust Air)

The equipment location is indicated in the relevant block of the layout enclosed as **URS Annex-1**

7.2 Available utility

7.2.1 Electricity: Vendor to specify (Report requirement)

7.2.2 Chilled Water@3.5 bar _____ (Report requirement)

7.2.3 Compressed Air/ instrument air@8-10 bar _____ (Report requirement)

7.2.4 Plant Steam @3-3.5 bar _____ (Report requirement)


7.2.5 Soft water@3-5 bar _____ (Report requirement)

Note: *Utility consumption to be specified by the vendor.*

Vendor shall also specify the utility pipe sizes and GA drawing during DQ stage.

HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

nne pharmaplan®	User Requirement Specifications				
	Equipment/System	Bio-waste Inactivation System			
	Identification #	KIL 01	Document#	URS/ KIL 01	
	Effective Date	2014-12-01	Revision#	04	

8.0 ABBREVIATION


Terms	Abbreviation
D&P	Diphtheria & Pertussis
T	Tetanus
HMI	Human Machine Interface
HLL	HLL Lifecare Limited
ISO	International Standards Organization
KIL	Kill Tank
MOC	Material Of Construction
NPI	NNE Pharmaplan India
PIIC	Pasteur Institute of India, Coonoor
PLC	Programmable Logic Controller
RPM	Revolutions Per Minute
SS	Stainless steel
°C	Degree Centigrade

REVISION INDEX

Revision	Date	Reason for Revision
00	2012-09-12	First Draft for Client's Review
01	2013-07-31	Format changed as per HLL requirement
02	2014-10-29	Updated as per HLL's comments on Email dated 23 rd October 2014
03	2014-12-01	Updated as per HLL's comments
04	2015-02-27	Updated as per HLL's comments

HLL LIFECARE LIMITED, CHENNAI

Revival of DPT Vaccine Manufacturing Facility, PII, Coonoor

HLL Lifecare Pharmaplan	User Requirement Specifications				
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	Identification #	KIL 01	Document#	URS/ KIL 01	
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URS Annexure 2: List of preferred make of components

S. No	Description	Make
1.	Ball Valve (Manual and Pneumatic)	President/ Modentic/GEMU
2.	Diaphragm Valve (Manual and Pneumatic)	GEMU/ Burkert/ ITT/SED/Saunders
3.	Steam Trap	Spirax/ Steriflow
4.	NRV	Leader/ alfalaval/Modentic
5.	Temperature sensor, PT 100 (For Vessel)	Negele/Radix/E&H/Rose mount
6.	Temperature Controller	Radix/ wika/ waaree instruments
7.	Flow Switch	Microset/Negele/Davis instruments
8.	FRL (Pressure Regulator)	Janatics/ Festo/ Ingersoll/SMC
9.	Top Driven Agitator	Inoxpa/IKA/PRG
10.	Pressure Gauge	Forbe marshal/ wika/ waaree instruments
11.	Vent Filter Cartridge	Sartorius/ Pall/ Millipore/GE
12.	Electrical Tracing for Vent Filter	PALL
13.	Safety Relief Valve	Teleflo/ Heroes/ Ciprani harrison
14.	Variable Frequency Drive	Siemens/ABB
15.	Centrifugal Pump	Grundfos/Alfalaval
16.	Level Sensor	E&H/WIKA/Rosemount
17.	Level transmitter	E&H/WIKA/Rosemount
18.	PLC and HMI	Allen Bradley/ Siemens
19.	Spray Ball	HAKE/Lechler