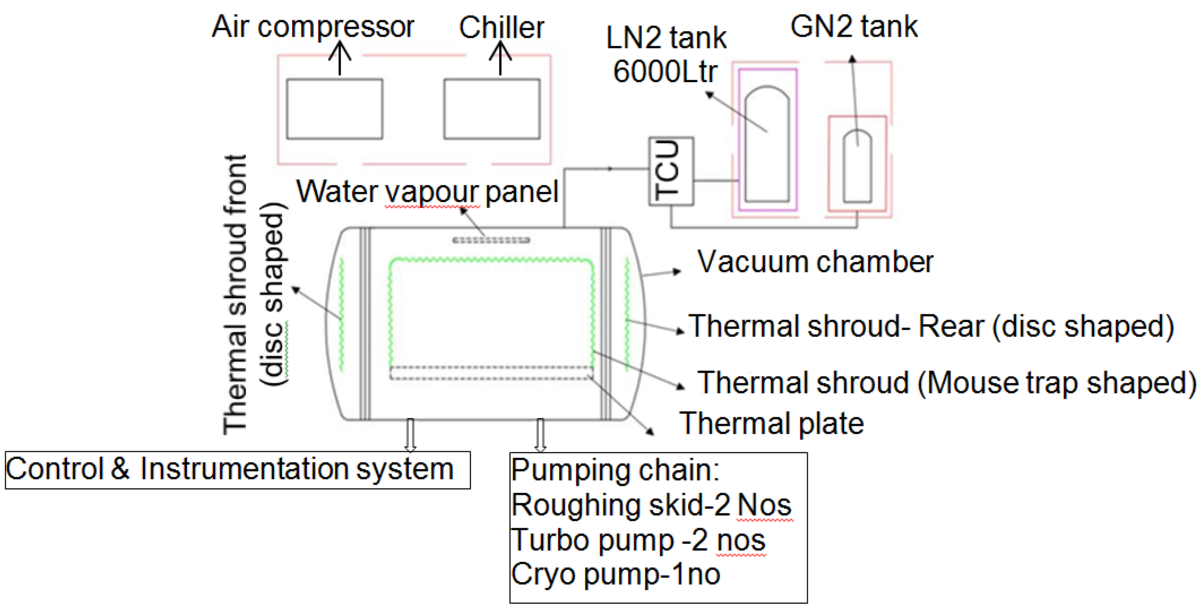
Annexure-1

Thermo Vacuum Chamber Specification

I. Scope of work

Design, realization, installation, commissioning and performance demonstration of a thermo-vacuum chamber at VSSC/ ISRO, Thiruvananthapuram. Scope of supply includes auxiliary subsystems like storage tanks for liquid/ gaseous nitrogen. Supplier shall obtain license from **PESO** for design, realization & installation of LN2 tank. Routing of all lines for the passage of LN2, GN2, and other fluids is in the scope of work. Detailed specifications are given from sections 1 to 9.



(Fig. No.1: Schematic layout for overall system)

I. Detailed description

Proposed thermo-vacuum chamber is for conducting thermal - vacuum tests in the range 153 K to 423 K at 5×10^{-7} mbar. Major subsystems are the vacuum pumping system, thermal system including Thermal Conditioning Unit (TCU) and PLC based SCADA system. Auxiliary systems like liquid nitrogen tanks, gaseous nitrogen tanks, super-insulated vacuum jacketed lines, air compressor and chiller also shall be supplied.

1. Vacuum chamber:

1.1. Specifications of vacuum chamber
1.1.1. Vacuum Chamber design a) The chamber shall be cylindrical with a tori-spherical end dish, horizontally placed. b) It shall be designed for external pressure operation (internal pressure of 5×10^{-7} mbar absolute and external pressure of 1.01325 bar absolute at 35 °C) c) The vacuum chamber and all vacuum chamber subsystems inside the chamber (except

the thermal shroud) shall be constructed using stainless steel (AISI 304L). The vendor shall provide a material test certificate from NABL certified laboratory, stating mechanical and chemical properties with traceability.

d) Flanges of vacuum system shall be CF type with metallic gaskets for all vacuum pumps, vacuum gauges, and instrumentation feedthrough.

e) The internal dimensions of the chamber shall be arrived at considering test space dimensions and clearances required to accommodate thermal shroud fluid lines, water vapour panel and instrumentation cables.

f) The chamber front dish shall be clamped using manual clamps (4 Nos.). There shall be an open/ close status indication in the control console.

g) All joints shall be TIG welded, using certified filler rods and high-purity argon/ helium shield gas.

h) All welded joints shall be leak tested with a Helium Mass Spectrometer Leak Detector to an Individual leak rate of better than1x10^{-9} mbar L/s of Helium.

i) Necessary provisions shall be provided for the handling of the chamber.

j) The chamber door shall be a tori-spherical dished door with flange and the opening stroke shall allow complete access to the thermal plate

k) Rear dish shall be welded to the chamber.

l) The O-ring on the chamber door shall be moulded type and uniform compression of the O-ring shall be ensured.

1.1.2. Test space requirement

a) The thermal shroud shall be mouse trap shaped, with a flat thermal plate of width 600 mm - 620 mm and depth 1000 mm - 1100 mm on which the test article will be placed.

b) The thickness of the thermal plate shall be designed to ensure temperature uniformity across the thermal plate.

1.1.3. Internal surface finish details

a) 3Δ (three triangle) finish for chamber internal surfaces and all hardware exposed to vacuum.

b) The infrared emissivity of the internal surfaces of the chamber shall be within 0.10.

1.1.4. Painting

Surfaces of hardware exposed to outside environment shall be first coated with zinc chromate primer followed by two coats of polyurethane paint.

1.1.5. Vacuum chamber orientation

The chamber shall be oriented horizontally and mounted on a stainless-steel structure meeting all structural requirements.

1.1.6. Vacuum chamber dimension

a) Diameter and depth: Chamber dimensions (1m diameter x 1.2m depth approx..) shall house the mouse trap thermal shroud and test article resting on the thermal plate.
b) The Chamber axis height from ground level shall be 1200 mm.

1.1.7. Vacuum Chamber ports

All ports shall have metallic gaskets and shall be fitted with specified feed-through. Dummy flanges shall be provided for all ports, including feed-through ports. Details of vacuum chamber ports are shown in Table No. 1&*Fig No. 2*

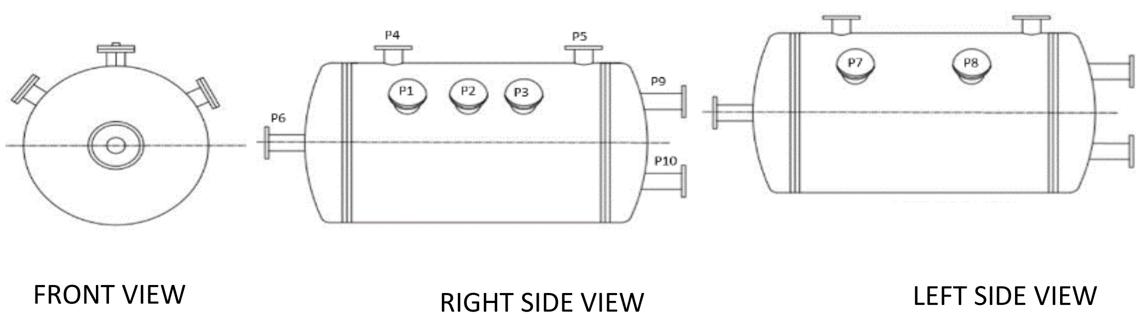
Sl. No.	Port Size	Qty	Location	Purpose	Symbol
1	To be decided by the supplier	Total No.of channels - 50	0°to 90°. quadrant on the chamber belly 100 mm from front dish	T-Type Thermocouple feed through with end connectors for both sides	P1
2	To be decided by the supplier	Total No.of channels - 50	0°to 90° quadrant on the chamber belly 200mm from front dish	K-Type Thermocouple feedthrough with end connectors for both sides	P2
3	To be decided by the supplier	Total No.of channels - 128	0°to 90° Quadrant on chamber belly	Each pin shall have10 A rating electrical feed through, with end connectors for both sides	P3
4	DN 40 CF-F	2	0°on cylindrical chamber body.	Vacuum gauge connecting ports	P4,P5
5	DN 200 CF -F	1	At the centre of the front dish	Viewport	P6
6	DN 40 CF-F	1	315°on cylindrical chamber body.	10mm SS tube with double ferrule type fittings on both ends. (Operating pressure	P7

				700 bar. Both ends shall be fitted with closures welded to CF blank flange with 150mm length on both sides.	
7	DN 60 CF-F	2	315° on chamber belly	Dummy flange with closure	P8
8	DN 200 CF - F(Approx.)	2	On rear dish	Turbo molecular pump Evacuation valve	P9,P10

(Table No. 1: Chamber port details (given are tentative & shall be firmed up during the design review stage)

Note:

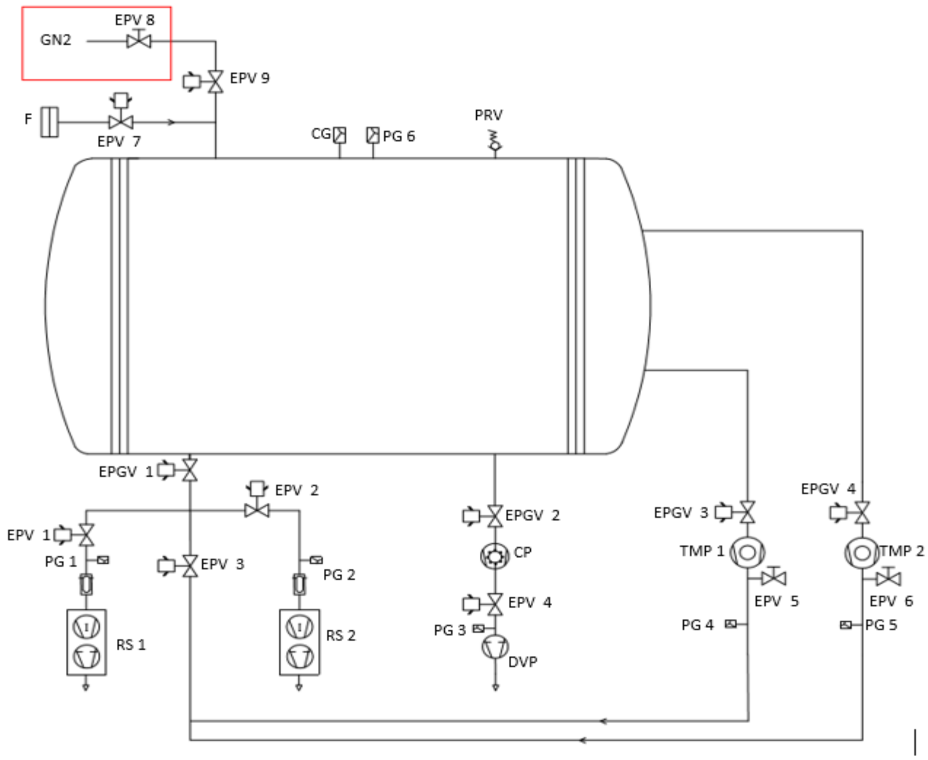
- Angle Convention: 0^0 coincides with 12 O'clock position of front dish while the front dish is being viewed from the front and angular increments from 0^0 to 360^0in the clockwise direction.
- Ports for the vacuum pumping system, LN2 inlet/outlet to the shrouds, water vapour panel, Vacuum measurement, Control thermocouples, and heater power inputs are to be worked out and shall be in addition to the above ports.
- The O-ring grooves & sealing surfaces shall be protected from any scratch mark.
- The opening shall be provided in the thermal shroud corresponding to the viewport as indicated in Table 1.



(Fig No. 2: Tentative scheme for vacuum chamber ports)

2. Vacuum pumping system

The objective of the vacuum system is to pump out vapour and gas present and given out by test articles and chamber elements and to maintain desired vacuum level in the chamber throughout the test. The proposed vacuum system (fig. 3.0) comprises a roughing skid (Rotary and Roots pump connected in series), turbomolecular pumps (TMP), cryo pumps, air admittance system, electro-pneumatic gate valves and angle valves, vacuum monitoring and control system. Roughing skid shall also be used as a backing pump for TMPs and the Cryo pump shall be provided with a dedicated backing pump. A single chain consists of one roughing skid, one TMP and a cryo pumping chain.



(Fig No. 3: Schematic layout- vacuum pumping system)

SI No	Description	Qty	Symbol
1.	Electro pneumatic gate valve	4	EPGV
2.	Electro pneumatic valve	9	EPV
3.	Cryo pump	1	CP
4.	Pirani gauge	6	PG
5.	Cold cathode gauge	2	CG
6.	Dry vacuum pump	1	DVP
7.	Rotary vane pump & Roots pump (Roughing skid)	2	RS
8.	Turbo molecular pump	2	TMP
9.	Air Filter	1	F
10.	Pop-off pressure relief valve	1	PRV

(Table No. 2: vacuum system details)

2.1. Specifications of vacuum system

2.1.1. Vacuum system design:

a) Vacuum pumping system shall be designed to achieve a vacuum of $1x10^{-6}$ mbar from ambient within 90 minutes for double chain and within 180 minutes for single chain respectively, without using water vapour panel.

b) It shall also be able to achieve $1x10^{-6}$mbar within 180 minutes when the thermal shroud temperature is 380 K, without using water vapour panel.

c) Ultimate vacuum shall be demonstrated with vacuum chamber backfilled with GN2 gas.

d) Vacuum pump shall be connected to the vacuum chamber through vacuum isolation gate valves, SS piping of suitable size and flexible bellows.

e) Pumping system shall have adequate pumping capacity and redundancy for continuous operation up to 400 hours at a stretch.

f) The vacuum level in the chamber shall be controlled by PLC. Shall be fully automatic and provided with interlocks for safe operation, including in the manual mode.

2.1.2. Rough Vacuum system configuration (Qty.- 2 Nos.)

a) Roughing skids shall be capable of achieving a vacuum level of $5x10^{-3}$ mbar.

b) Roots pumps shall be integrated with an overflow valve to enable switch on together with the backing pump even at atmospheric pressure.

c) A vacuum gauge shall be provided between roots pump and rotary vane pump.

2.1.3. Turbomolecular Pump (TMP) configuration (Qty.- 2 Nos.)

a) The minimum pumping speed for TMP shall be 1200 Litre/sec

b) The backing line of each TMPs shall be connected to rouging skid with isolation valves as shown in fig 3.

c) TMP shall be capable of achieving a vacuum level of less than $1x10^{-7}$ mbar.

d) TMP body shall be of stainless steel and connected to cylindrical chamber body through CF type flange and shall have an appropriate cooling system.

e) Each TMP shall have a standalone controller mounted in a rack, which shall be provided with a voltage stabilizer and spike arrestor.

2.1.4. Cryo pumping system configuration (Qty.- 1 No.)

a) Cryo pump shall be based on G-M cycle for its two stages along with the Helium compressor. The Cryo pump shall be connected to the chamber through electro pneumatic gate valve.

b) The Cryo pump shall be capable of achieving a vacuum level of less than 1 $x10^{-7}$ mbar.

c) The control system shall control the cryogenic pump at its cooling, heating and regeneration & vacuum pumping stages.

d) The Cryogenic pump shall be regenerated using a dedicated dry vacuum pump with adequate water vapour capacity.

e) Cryo compressor shall have an appropriate cooling mechanism (If water cooling is selected, necessary plumbing lines also shall be in the Supplier's scope).

2.1.5. Vacuum Isolation valve: Based on the system design, the vendor shall provide appropriately sized vacuum valves as per fig.3

a) The vendor has to provide additional gate valves, if necessary.

b) Stainless steel body valves with CF interfaces to be provided for pumps having CF flanges.

2.1.6. Water vapour panel

a) Removable water vapour panel to be located between the thermal shroud and the vacuum chamber.

b) It shall be provided with necessary electro-pneumatic valves, temperature sensors with flexible inlet & outlet tubing and a heating system for removing the condensate after the operation.

2.1.7. Material for vacuum pipeline

SS 304L seamless pipes and flexible bellows of 316 L, suitably sized for the highest conductance

2.1.8. Re-pressurization System

a) For re-pressurizing, the chamber after the test/ process, an air admittance valve EPV7 with 10 µm inlet filters shall be provided. It shall be designed such that the chamber is brought to atmospheric pressure in 10 minutes.

b) Provision for admitting nitrogen gas through EPV 9 to be provided as redundant re-pressurisation system.

3. Thermal system:

When the vacuum chamber is maintained in operational vacuum (5.0×10^{-7} mbar), the thermal shroud & thermal plate shall be heated or cooled by circulating GN2 to achieve set temperature.

Features:

a) The thermal system shall consist of a thermal plate and double-embossed thermal Shroud.

b) A single common thermal conditioning system shall supply GN2 to both the thermal shroud & thermal plate.

c) The test article will be loaded on the thermal plate. The temperature on the thermal shroud and thermal plate shall be automatically controlled to any set temperature through PLC based control system.

d) There shall be provision to use a temperature sensor on the test article as a control sensor (selectable from consoles).

e) The thermal system shall be capable to follow any set linear temperature profile in the range of 153 K to 423 K (with multiple cycles over the entire range) without manual intervention.

f) The thermal system layout is shown in figure 4 and a typical test cycle profile is given figure 5&6.

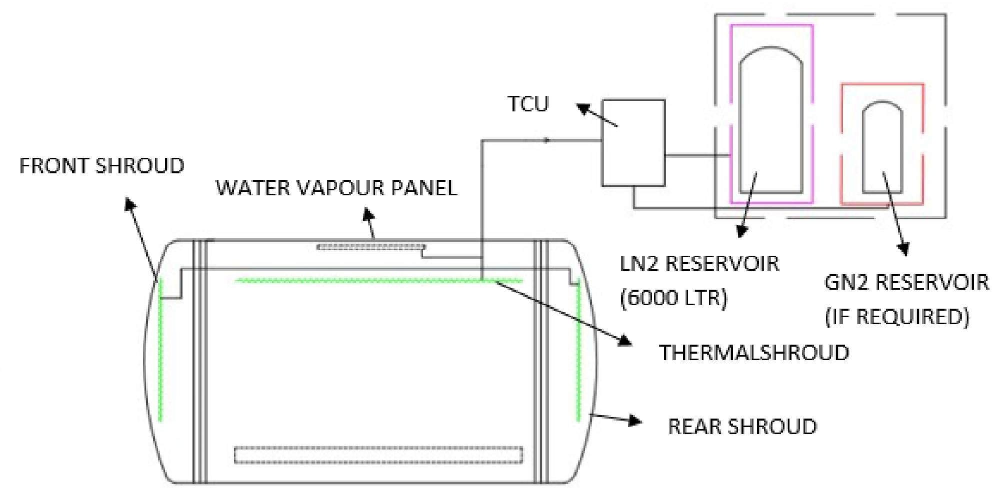
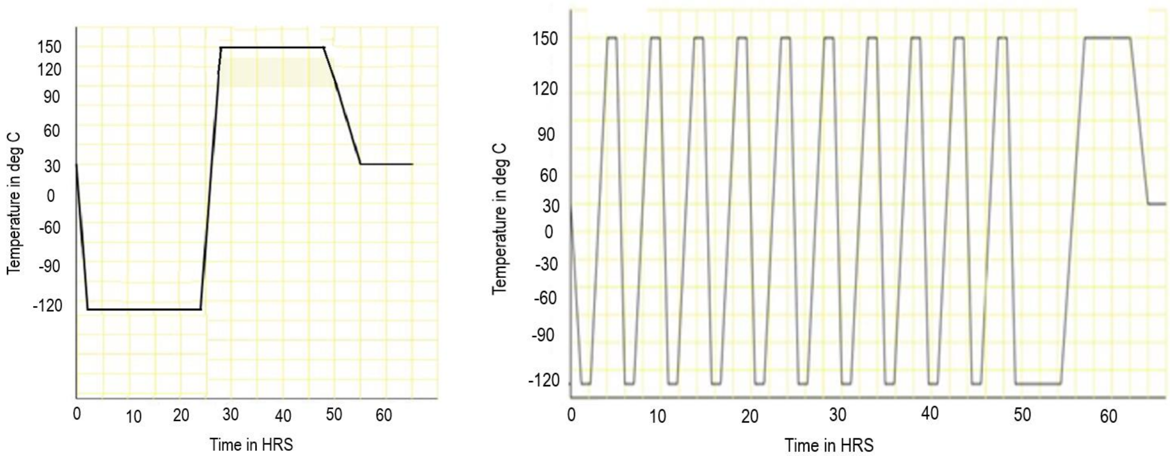


Fig No. 4: Schematic layout for Thermal system)



(Fig . 5& 6 : Typical test profile for Thermo vacuum cycling)

3.1. Specifications of Thermal system

3.1.1. Operating Temperature:153K to 423 K

3.1.2. Cooling/Heating Fluid: Low pressure closed loop GN2 (153 K to 423K).

3.1.3. Heat load expected from test article: total heat load 1 kW (active and passive)

3.1.4. Temperature uniformity on thermal shroud:

a) End closures and on the thermal plate (at steady state): better than ±2 K

b) End closures and on the thermal plate (at transient): ±15 K

c) Control accuracy: ±1 K (difference between set temperature and average of 3 temperatures measured at centre plane of the cylindrical shroud).

d) Measurement sensor: 3 wire film type RTD as per IEC 60751 class B.

3.1.5. Ramp rate (hot & cold): Up to 3 K / minute. Provision for set 1 K/ min, 2 K / minute and 3 K / minute (increment of 1 K / minute).

3.1.6. Mounting of the thermal shroud and thermal plate: Thermal plate and thermal shroud shall be with demountable circulating fluid inlet/outlet feed lines to enable easy removal from the chamber for maintenance & cleaning purposes. Joints to be easily accessible for the operator.

3.1.7. General requirements

a) There shall be an interlock to prevent the operation of thermal system when chamber pressure is higher than $1x10^{-3}$ mbar.

b) Super-insulated vacuum jacketed lines (SIV) to be used in the thermal conditioning unit to maximum possible extent to prevent heat-in-leak. For certain cases where super-insulated vacuum jacketed lines are not feasible inside the unit (to be decided in consultation with the

Purchaser), such lines shall be properly insulated with Aerogel insulation having water vapour barrier.

c) Thermal shroud and thermal plate with parts such as liquid feedthrough shall be designed for thermal cycling in the range of 77 K to 423 K.

d) Necessary bellows / flexible joints shall be provided for preventing thermal stresses during long-duration thermal cycling operations.

3.2. Specification for Thermal shroud

3.2.1. General requirements:

a) Shroud shall be inflated to form annular gap and to be laser welded/ resistance spot welded. TIG welding at the edges of the shroud.

b) Shroud panels shall be designed for thermal cycling from 77 K to 423 K and internal pressure of at least 2 times the pressure of circulating GN2.

c) The thermal plate shall have an internal channel for circulating GN2 for cooling /heating the test article.

d) The thermal plate should be able to carry test article weighing at least 15 kg. It shall have an array (4 rows x 4 columns of 50 mm x 50 mm) of threaded holes (M6 x1x 10 deep) to mount the test article.

3.2.2. Shape and construction: Mouse trap shape, double embossed type, laser welded & inflated/ resistance spot welded & moulded. Each sheet shall be at least 1.5 mm thick.

3.2.3. Size: The shroud shall be able to house a test article with a maximum envelope of 600-620 mm (width) x 1000-1100 mm (depth) x 450 mm (height) on the thermal plate. Tentative schematic of Thermal Shroud with Thermal plate as mentioned in fig.7

3.2.4. End Shrouds: Two separate active shroud panels to be attached the front and rear dish of chamber.

3.2.5. Material of construction: SS316L

3.2.6. Leak tightness:

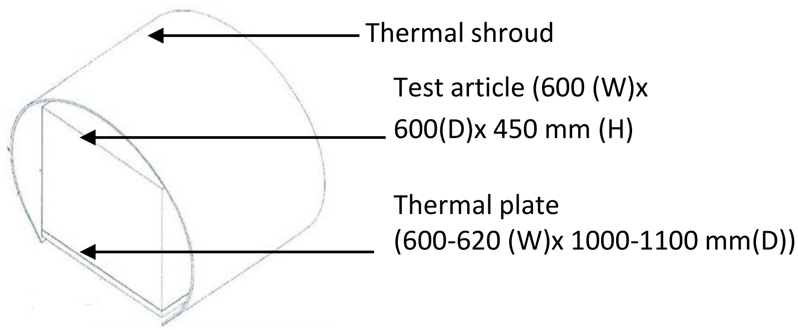
a) Leak tightness of the welded joints in the shroud, thermal plate, and feedthrough shall be better than $5x10^{-9}$ mbar L/s of Helium. It will be demonstrated again after thermal cycling at VSSC site.

3.2.7. Painting:

a) Test space environment including the inner surface of shroud, both active end shrouds, and top surface of thermal plate shall be coated with appropriate paint (such as Aeroglaze Z306) with an infrared emissivity of 0.9 meeting the out-gassing requirements for space environment

(TML:< 1%).

b) Outside the main shroud, active end shrouds and thermal plate shall be electro-polished.



(Figure 7: Tentative schematic of Thermal Shroud with Thermal plate)

4. Auxiliary system details:

The auxiliary system consists of Liquid Nitrogen Storage tank, a gaseous Nitrogen Storage tank (as per the design of TCU), an air compressor, and coolant water circulator. The scope includes obtaining the necessary license from PESO according to prevailing SMPV (U) rules. Super-insulated lines of adequate size shall be used for transferring Liquid Nitrogen from the storage tank to TCU. Adequate pressure sensors shall be provided in the LN2 transfer lines. Safety relief valves shall be provided on the LN2 transfer lines where there is chance for trapping LN2 by the closing of upstream and downstream valves. A tentative layout of the LN2 storage yard is shown in Fig.8 for obtaining PESO License. Space for installing one more LN2 tank of 6 kL capacity shall be provided inside the yard (additional LN2 tank not in the present scope of work). The fencing and foundation/ civil works for the tank is in the scope of VSSC. The design drawings/inputs shall be given by the vendor well in advance for civil works. The specifications for various sub-systems are given below:

4.1. Specification for Liquid Nitrogen Tank

4.1.1. General requirements

a) The liquid nitrogen storage tank shall be vacuum insulated and designed for an evaporation loss rate better than 0.25% of gross volume/day.

b) All valves, devices, valve handles, tags, etc. shall be SS316L/ bronze.

c) Suitable drain points with blow-down valves shall be provided on LN2 / circuits at suitable locations for initial purging to drive out any resident moisture due to the stoppage of the system for a long duration.

d) Outside surfaces of hardware exposed to ambient environment shall be first coated with zinc chromate primer followed by two coats of polyurethane paint.

4.1.2. LN2 tank (Qty: 1 No.)

a) Orientation: Vertical

b) Storage capacity: 6,000 litre (Water capacity)

c) Design Standard tank and piping: ASME SEC. VIII Division I, ASME B31.3 or equivalent

d) The outer diameter of Dewar: 2 meters (max.)

e) Insulation: Multilayer, super insulation with vacuum

f) Net evaporation rate: Less than 0.25 % of gross volume per day.

g) Maximum working pressure: As required for TCU operation (with adequate margin to take care of pressure drop etc.).

h) Design pressure: With standard margin over maximum working pressure as per applicable codes.

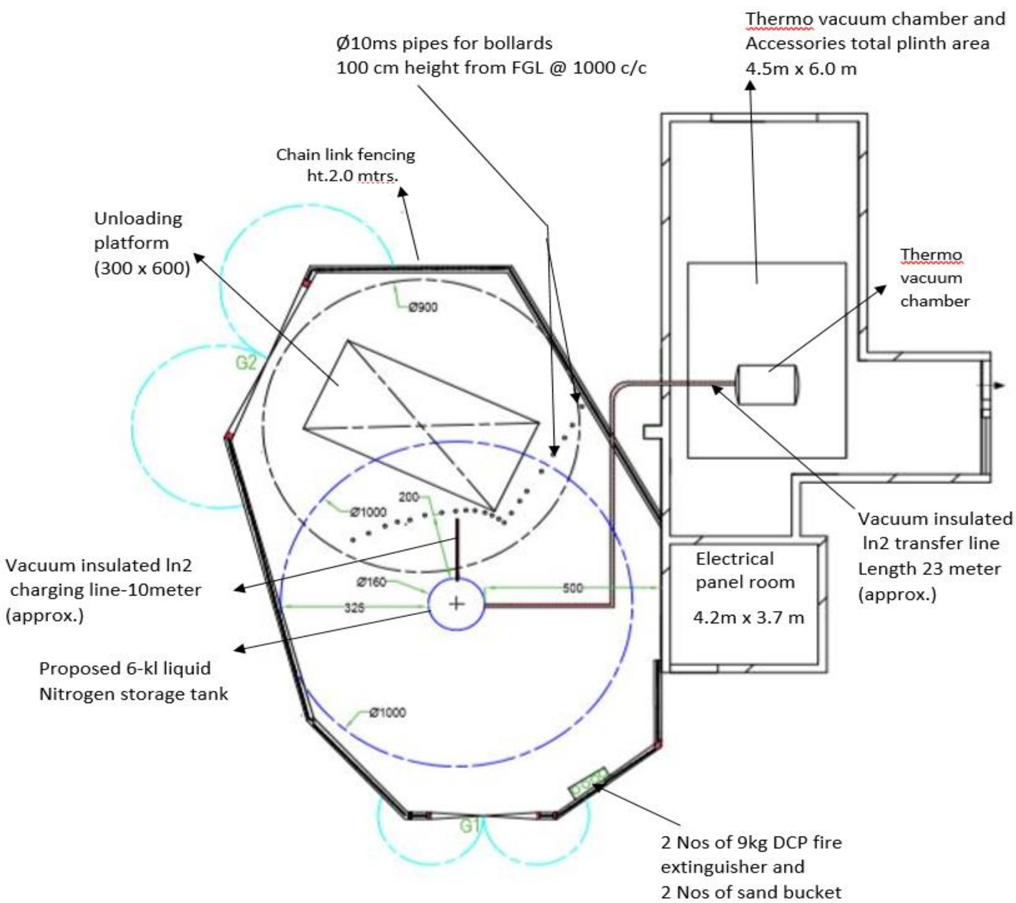
i) Automated operation: Provision for automated operation of LN2 tank from GUI/ SCADA console (Pressurization, Filling, Draining & venting) shall be included. Additional manual isolation valves shall be provided for all these operations.

j) Safety provisions: Two Safety relief valves and two burst discs shall be provided for the inner vessel, and one Safety Device for outer vessel. Safety relief valves shall be provided for the lines in LN2 tank circuit where there is a chance for trapping LN2 during operation (by closing upstream and downstream valves).

k) Filling and drawing lines: Permanently connected to thermal conditioning unit with SIV lines. Additional drain points shall be provided with necessary isolation valve for drawing LN2 for purposes other than the Thermal conditioning system.

l) Pressure, level, and flow indications: Digital readout of level, flow, and pressure gauges with necessary redundancy and facility for automatic logging of data with respect to time shall be provided. This is in addition to mechanical differential pressure gauges and pressure gauges fitted on the tank.

m) Instruments/ control valves positioned outdoors shall have an adequate ingress protection rating.



(Fig No. 8: Layout for LN2 yard (tentative) & SIV lines)

4.2. Air compressor (Qty. 1 No.) (to actuate electro pneumatic valves)

a) A rotary screw air compressor of adequate capacity shall be provided.

b) A compressed air reservoir of adequate capacity and a refrigerated air dryer compatible for the selected air compressor shall be provided.

c) A FRL unit shall be provided at the outlet of the dryer.

d) An automated drain valve with a timer shall be provided for the reservoir and dryer.

e) Compressed air lines shall be of stainless steel. Flexible PU tubes shall be used for short lengths near to actuators & valves.

4.3. Chiller (Qty. 1 No.) (for cryo pump compressor)

a) A closed-circuit water chiller unit of adequate capacity shall be provided.

b) Chiller capacity shall be worked out based on all service requirements in extreme test conditions. Detailed breakup of the cooling requirement shall be submitted.

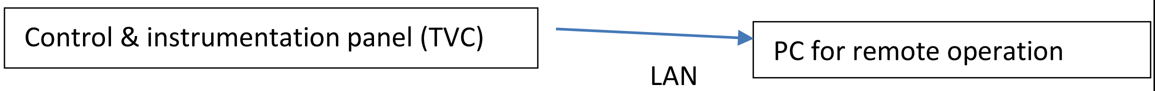
c) There shall be a margin of 50% over the required cooling capacity.

d) The chiller shall operate efficiently in the extreme environment at the VSSC site (40°C& 90% RH).

e) Necessary additives shall be used for preventing corrosion in pump cooling paths/ channels.

5. Control and instrumentation system

The control and instrumentation system of the chamber comprises of the following



a) PLC modules with its execution software
b) Electrical power distribution and switching panel
c) Control and instrumentation panel
d) Data acquisition system
e) Vacuum gauges/sensors and associated instrumentation
f) Temperature sensors and associated instrumentation
g) Temperature controllers / thermal conditioning system
h) Online UPS

5.1. PLC modules with its execution software:

PLC (Programmable Logic Controller) with associated software shall be used for real time monitoring and control of all equipment in the system.

5.2 Electrical Power distribution and switching panel:

Electrical Power distribution and switching panel is in the scope of the supplier. Hence supplier shall install it to facilitate power distribution for all the electrical equipment through appropriately sized starters/relays, switches etc. to ensure proper switching of all equipment and safety of personnel and equipment.

5.2.1 Special earthing:

Special earthing& routing shall be in the scope of the supplier. Earthing pit alone will be in the scope of VSSC.

5.3 Control and instrumentation panel

5.3.1 All the systems like vacuum and temperature shall be controlled from the control and instrumentation panel located close (3 to 5m) to the chamber facilitating the operators to control and monitor the operation of the chamber.

5.3.2 The electrical cabling to and from the panels shall be done professionally as per industry standards and shall be ensured that the routing and clamping doesn't interfere with routine operations and facilitate periodic maintenance and repair works.

5.3.3 Every input and output cable shall be properly identified and tagged. Detailed documentation of the electrical wiring and interconnections shall be provided.

The control and instrumentation panel shall house:

5.3.4 PLC (Programmable Logic Controller) for real time monitoring and control of all equipment in the system.

5.3.5 All instrumentation related to vacuum gauges, temperature sensors, gate valve position indicator, LN2 consumption status monitoring etc shall be positioned in a rack. All instruments shall have provision for automation through an instrument interface like Ethernet/USB etc. The output from all these instruments shall be acquired in a PC through Ethernet/USB interface for monitoring and storage.

5.3.6 There shall be provision for generating different temperature test profiles (Time vs Temperature) using graphical user interface (GUI) in the control PC. There shall be provision for storing a minimum of 20 such test profiles.

5.3.7 PC software: The PC/computer system in the console shall be provided with suitable PLC/ GUI software along with license in the name of ISRO to fulfil the following tasks:

5.3.7.1 Mimic Diagrams displaying functional status of all system components and safety interlocks.

5.3.7.2 Display the state of main process regulation loops such as shroud and thermal plate temperature control.

5.3.7.3 Display and storage of all test facility functional data, alarm condition, messages etc.

5.3.7.4 Display of temperature profiles on shroud and test article with proper scaling of temperature profiles.

5.3.7.5 Customizable program for vacuum and temperature profiles for its generation, storage and execution.

5.4 PC based Data Acquisition System

A PC based Data Acquisition System (DAS) shall monitor and display the temperature data from all the thermocouples/RTDs fixed on the test article and the thermal shroud & thermal plate inside the chamber and also the vacuum parameters of the system. The control and data acquisition PC can be the same. Detailed features are as follows:

5.4.1 The data logging system shall have a fail-safe mechanism not to lose any test data during electrical power failure/system failure condition.

5.4.2 A PC based system with the following configuration is in the scope of supplier.

1. Processer : Intel core i5, 12th gen. or latest
2. RAM : 8 GB or higher
3. Hard disk : 2 TB (SSD)
4. Monitor : LED 26” with wide angle view
5. OS : Windows 11

5.4.3 On screen displays shall include real time plot of vacuum system, thermal system and auxiliary systems data.

5.5 Salient features of the control software

5.5.1 There shall be provision for 3 modes of operations such as Auto mode, Semi auto mode and manual mode.

5.5.2 Auto mode: The temperature and vacuum shall be controlled based on a predefined test profile without any manual intervention.

5.5.3 Semi auto mode: It shall allow the generation of a new test profile, edit (change parameters and set points) an existing one and save in its memory.

5.5.4 Manual mode (Expert mode): Each sub system shall be operated in manual mode (expert mode) and shall be protected with necessary passwords.

5.5.5 There shall be provision for switching over to manual mode from the current mode (Auto /Semi auto mode) without any interference in the process of the test.

5.6 **Salient features of the Data acquisition software**

5.6.1 Real time Data acquisition of temperature, Pressure with respect to Time.

5.6.2 All functions selectable by menus and icons.

5.6.3 Real time graphics and numerical data presentation of selected channels.

5.6.4 Data shall be stored in hard disk periodically for later retrieval.

5.6.5 Data file generation, management and storage.

5.6.6 Report generation (MS Word format). VSSC shall be provide standard report template, all the data to be updated based on this template.

Extra copy of the software: An extra copy of the software(s) developed for this system shall be provided in installable form to take care of any exigency arising due to software corruption/ / malfunction that may occur.

5.7 Vacuum sensors and instrumentation

The pressure / vacuum at various locations including inside the chamber is measured using:

5.7.1 Vacuum gauge (Bayard-Alpert Pirani Capacitance Diaphragm Gauge) for monitoring the chamber pressure.

5.7.2 Suitable monitoring/display units having standard PC interfaces shall be provided along with the vacuum gauges.

5.7.3 Supplier shall provide adequate number of vacuum gauges integrated to the vacuum system for controlling the entire vacuum pumping chain.

5.8 Temperature sensors and Instrumentation:

5.8.1 T-type thermocouples (24AWG), 6 Numbers each to be placed on the shroud and Thermal plate for temperature monitoring. T type thermocouples for shroud temperature monitoring to be located on the shroud surface inside the chamber and connections taken through thermocouple feedthrough with miniature T/C connectors at both ends of the feed through harness. Thermocouple and suitable accessories for installing the thermocouples and other sensor shall be sourced from reputed internationals brands.

5.8.2 T-Type Thermocouple Feed through-3Nos and K-Type Thermocouple feed through 2 numbers, with connectors on both sides are to be provided for test article temperature monitoring.

5.8.3 The connectors and feed through shall be compact and sealed (maximum admissible leak rate per feed through: $1x10^{-9}$ mbar l/s) and shall be thermal vacuum compatible.

5.8.4 All the temperature sensors located on the shroud surface shall be installed in such a way that they can be removed for calibration and can be replaced after calibration without affecting the performance.

5.8.5 The thermal plate/ test article temperature shall be controlled by precise heating or cooling using PLC controller.

6.0 Online UPS system

The system shall have with minimum 30 min. backup. Within this time all systems like PLCs, control system equipment etc shall be switched to safe mode, in case of power failure.

7.0. Electrical feed through:

The chambers need to be provided with electrical feed through of suitable rating for routing signals and power to and from the device under test.120 channels electric feed through for device testing, 10 A rating (for each pin), with mating connectors on both sides shall be provided. Each feedthrough shall be identified by a unique number and tag. Each wire in the harness shall also be tagged. At both the ends the harness of each feed through shall be terminated on to 32 pin ITT D type gold plated connectors.

8. Party shall specify the following in the bid;

8.1 The design methodology and specific details of calculations.

8.2 Schematic of the proposed vacuum pumping system, thermal system, LN2 storage tanks & supply lines. Details shall be given including make of each component / sub systems.

8.3 Materials used and the standards followed in design.

9.0 Sources details: The names of some internationally known suppliers for various equipment have been provided below based on ISRO experience and on availability of aftersales support. Vendor shall have to select the equipment/system from the suppliers given below. Equivalent brands are not permitted without prior approval from VSSC.

9.1 Thermal shrouds: M/s. Tranter USA ,M/s. VG UK, M/s. Bemco inc, USA, M/s. Ziemannsecathen, France, M/s. Magod Laser machining (P) Ltd., Banglore , India ,M/s. FIC spa , Italy & M/s. Angelantoni test technologies , Italy.
9.2 Thermal plate: M/s. Bemco, USA ,M/s. Ziemannsecathen, France ,M/s. FIC spa , Italy, M/s. Telstar, Spain & M/s. Angelantoni test technologies, Italy
9.3 Thermal Conditioning system: .M/s CSL, Leige,Belgium M/s Telstar , Spain ,M/s Intespace , France ,M/s Angelantoni test technologies, Italy & M/s. Dynavac, USA
9.4 Cryo pumps and Turbo molecular pump: M/s. Leybold vacuum Germany ,M/s. HSR , Germany ,M/s. CTI cryogenics, Japan &.M/s. Pfeiffer vacuum GmbH, Germany
9.5 Roughing and roots pump: M/s. Pfeiffer vacuum GmbH, Germany, M/s. Leybold vacuum Germany& M/s. Agilent technologies USA
9.6 Vacuum gate valves: M/s.VAT Vakuumventile AG, Switzerland., M/s. Pfeiffer vacuum GmbH, M/s. Leybold vacuum Germany& M/s.GNB corporation,USA
9.7 Electrical panel / Instruments 1.19" Racks: Rittal 2. Electrical Power panel and switch gear: ABB, L&T, Siemens 3. The PLC/GUI: Siemens, Allen Bradley, Fanuc or L&T.
9.8 Data Acquisition system: Keithley, Siemens, Allen Bradley, ABB, Yokogawa, Schneider, National Instruments
9.9 PLC: Siemens, Allen Bradley, ABB, Schneider
9.10 Vacuum gauges and monitors: M/s. Pfeiffer vacuum GmbH, Germany ,M/s. Leybold vacuum Germany ,M/s.Inficon, USA & M/s.MKS, UK
9.11 Hermetic thermocouples, heater and power feedthrough : M/s.Douglas Electrical components inc,USA ,M/s.PLUGin,France, M/s.MDC Vacuum products,USA& M/s. Pfeiffer

vacuum GmbH, Germany
9.12 Thermocouples, thermocouple connector, RTDs and thermistors: M/s.Omega, USA & M/s.TC,UK, Minco
9.13 cartridge heater: .M/s. Electricfor , M/s.Kamenev & M/s.Thermocoax, Minco
9.14 Temperature controller & power controllers: M/s.EurothermLtd.
9.15 Thermal paint: Make: M/s.Aeroglaze (Z306) & M/s Spefun paintings &coatings
9.16 view port (as an assembly only) : M/s. Pfeiffer vacuum GmbH, M/s. Leybold vacuum M/s. Agilent technologies , , MDC Vacuum
9.17 Sources of supply for compact air compressor: M/s.Atlascopco, M/s Elgi compressor,M/s Chicago Pneumatics, & M/s. Ingersoll Rand,
9.18 water chiller: M/s Eurodifroid, France, M/s Werner Finley, M/s Huber, M/s Julabo
9.19 LN2 Dewar: M/s Inox ,India ,M/s Shell n tube,India ,M/s VRV ,India, M/s Super cryogenics System(P) Limited,India& M/s Cryostartanks and vessel Pvt Ltd India
9.20 Flexibl bellows,clamps,clawclamps,centeringring,O ring: M/s Mawasa, M/s Pfeiffer Vacuum GmBH, M/s Leybold Vacuum, Parker
9.21 Blowers: M/s Fima & M/s Barber-Nichols AS PART OF TCU
9.22 Cryo valves: M/s Herose ,Germany, M/s Burkert ,Germany , UAS M/s Habonium,Israel
9.23 Pressure gauges: M/s Wika& M/s Emerson, M/s Ashcroft
9.24 safety relief valves: M/s Herose ,Germany &Rego , USA
9.25 Differential gauges: M/s Wika, M/S Dwyer, M/s Ashcroft
9.26 level transmitter /Pressure Transmitter: M/s Yokogawa Japan, M/s Hioki,Japan& M/s GE, USA
9.27 process control valve : M/s flowserve,USA& M/s Burkert Germany
9.28 burst disc: M/s BS & B
9.29 Super insulated vacuum jacketed lines: M/s cryodiffusion, France, Cryopal, France, M/s Cryo Fab ,USA ,M/s Inox, India & M/s shell N tube, India
9.30 Switch gears and circuit breakers: M/s Siemens, Germany, M/s Schneider Germany ,M/s ABB & M/s ALLEN Bradley
9.31 online UPS: M/s Schneider,Germany, M/s Reilo, M/s Pillar ,Germany &M/s. APC
9.32 Computer: M/s Hewlett packard HP & M/s Siemens Germany, M/s DELL,M/s IBM
9.33 Actuators: M/s Schubert and salzer ,M/s Festo,Germany& M/s Bosch Rexroth, Germany
9.34 cryo solenoid valves: M/s Weka& M/s Burkert Germany

9.35	**Pneumatic solenoid valves:** M/s Festo ,Germany& M/s Rockwell Automation, USA
9.36	**Pneumatic PU tubes:** M/s Festo ,Germany & M/s Legris ,France
9.37	**Needle valves/Manual valves:** M/s Festo ,Germany ,M/s Legris France &M/s Swagelok
9.38	**Ball Valves/Manual valves :** M/s Festo ,Germany & M/s Legris France
9.39	**air admittance valves**: .M/s VAT,Switzerland, M/s GNB,USA ,M/s Pfeiffer Vacuum GmBH& M/s Leybold Vacuum Germany

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