SECTION - C

TECHNICAL SPECIFICATIONS OF STORES AND DRAWINGS.

Technical Specifications for Supply, Installation, Integration, Testing and Commissioning of Experimental Helium Cooling System at IPR, Gandhinagar, India

Installation and commissioning site

INSTITUTE FOR PLASMA RESEARCH

GANDHINAGAR, GUJARAT

382428

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List of major abbreviations

IPR	Institute for Plasma Research
EHCL	Experimental Helium Cooling Loop
PICS	Pressure and Inventory Control System
I&C	Instrumentation & Control
P&ID	Process & Instrumentation Diagrams
TSM	Test Section Module
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
ANSI	American National Standard Institute
ISA	International Society of Automation
FCI	Fluid Control Institute
BIS	Bureau of Indian Standards
API	American Petroleum Institute
IS	Bureau of Indian Standards
EJMA	Expansion Joint Manufacturers Association
SCADA	Supervisory Control And Data Acquisition
BOM	Bill Of Material
FAT	Factory Acceptance Test
FRS	Floor Response Spectra
FIM	Free Issue Material

1 General Information

1.1 The scope of the work under this contract will be Supply, Installation, Integration, Testing and Commissioning of Experimental Helium Cooling Loop (EHCL) at IPR, Gandhinagar. The process fluid for the system is helium gas.

1.2 The contractor is specifically requested to visit the site, participate in pre-bid meeting and familiarize himself with the site conditions, working conditions, availability of materials, facilities for storing construction materials, geological and weather conditions and obtain any other information which may influence or affect this tender, before submitting quotation.

1.3 In the lab premises, material handling facility including overhead crane is available, a normal length truck can enter the work site for unloading of required material. Other lifting and handling tools & tackles required like scaffolding, tripod, chain pulley blocks etc. during work inside the laboratory after unloading the material inside. Utilities namely, compressed air, cooling water and electrical power is available at work site. IPR will provide space near the installation site for storage of the items supplied by the contractor for EHCL system.

1.4 EHCL is a high-pressure high-temperature closed loop helium gas system. The loop is designed to operate at 8.0 MPa pressure, 300-400 ºC temperature and 0.2-0.4 kg/s flow rate.

1.5 The EHCL system consists of components (Refer figure-1) such as circulators, heater, recuperator, coolers, vacuum pumps, control and safety valves, associated piping, and necessary instrumentation and control systems. To take care of pressure fluctuation and recovery of helium the loop is equipped with Pressure and Inventory Control System (PICS) that consists of cluster of tanks maintained at different pressures, compressor, safety devices (relief valves and rupture disks) and associated piping and valves (Refer figure-2).

1.6 EHCL being a high-pressure high-temperature system, utmost care has to be taken in all the works of Fabrication, Installation, Integration, Testing, Shipment and Commissioning. All the works shall be free from poor workmanship and during the complete work proper documentation shall be maintained.

1.7 The additional details related to the EHCL system that may be needed during execution of this tender work viz. Operational and control scheme of the loop, process design, I&C design, interlock scheme, electrical design, details of the components etc. will be provided by IPR after the award of the contract.

1.8 Most of the critical loop components including electrical and Instrumentation & Control Systems have been procured by IPR. All these procured items will be provided as free issue material. Components such as helium compressor, tanks, piping, fittings, tubes, filters, insulation materials, support structures, electrical cables and a few valves (ON/OFF, control, drain, vent etc.) etc. shall be procured by the contractor.

1.9 The list of items and salient technical datasheet of various components to be supplied by the contractor is mentioned in Annexure-1. The list of components mentioned in the annexure-1 is not exhaustive, and if required to meet the process, operational, functional and safety requirements of the system the contractor shall supply additional components without any additional cost.

1.10 Preliminary technical details of free issue materials are mentioned in Annexure-3. Additional details, if any, that may be required during execution of work will be furnished to the contractor after the award of the contract.

1.11 Scope of work of this tender includes following:

- Preparation of loop layout, pipe routing & stress analysis, support structure design, barricade sizing calculations, sizing and routing of power cables, sizing and routing of pneumatic tubing and preparation of associated design, drawings & Bill of material.
- Selection of make & model for different components that are to be procured by the contractor in compliance with the technical specifications mentioned in this document.
- Fabrication and Procurement of the items viz. valves, compressor, piping and fittings, support structure materials, filters, helium storage cylinders/tanks, vent and drain valves, power cables, cable trays etc.
- Inspection & testing of raw materials
- Inspection and testing of procured components at Factory and at site (IPR), as applicable.
- Supply of all the necessary documentation, factory test reports and certificates along with components to the assembly site at IPR Gandhinagar.
- Assembly, Installation & Integration of all the loop components (including the free issue materials provided by IPR) at the installation site.
- Electrical / Instrument Cabling, wiring & tubing for all equipment & instruments and integration of the same with control system
- Development of data-acquisition system & implementation of control system logics and interlocks (software based as well as hardware based interlocks) according to loop operational philosophy.
- Development of interface between master control system and control systems of individual components i.e. circulators, electrical heater & helium compressor.
- Development of Graphical User Interface (SCADA) for EHCL.
- Testing & commissioning (leak testing, pressure testing, performance and functional testing of the loop at IPR) of the EHCL system and final acceptance.
- Any other work not mentioned specifically above but is required for efficient execution of work.

1.12 The scope of work of this tender will be executed under the following two phases:

a. Phase-1: Supply of EHCL system at IPR which consists of preparation of loop layout, GA drawings, updating BOM, supply of items etc.
b. Phase-2: Installation & Integration of all the EHCL components and Testing and Commissioning of the EHCL system at IPR.

1.13 The detail scope of work is described in “section 5: scope of work” of the document.

1.14 IPR may appoint a third party for review, witness and inspection of the works associated with the tender and the contractor is requested to consider the same.

1.15 The preliminary P & ID and instrumentation chart is provided in Annexure-2 and Annexure-6 respectively.

1.16 The Test Section Module (TSM) as shown in P & I diagram is for completeness only. Supply, installation & commissioning of TSM are not in the scope of the contractor.

1.17 The process loop including all its components shall conform, in all aspects, to high standards of engineering design and workmanship and be capable of performing continuous trouble free operation in a manner acceptable to the IPR who will interpret the meaning of the specification and shall have the right to reject any material which in his/her judgment are not in full accordance therewith.

1.18 This document provides the Scope of work and related requirements are for the general guidance of the contractor and shall not be considered as exhaustive. The details/specifications not

appearing in the list, but required to complete the work, shall be considered as part of the scope and contractor's offer shall be considered to include the same.

1.19 In the event of any conflict between or within the various sections of this specification or in case of any doubt, the interpretation/decision as given by IPR shall be final.

1.20 Only those contractors who meet the eligibility criteria of the tender shall quote. In particular, the contractor shall have previous experience in mechanical design and detailed engineering of process system; the contractor shall have working experience of ASME/ equivalent EU codes and standards; the contractor shall have experience in executing gaseous system projects. Also, the contractor shall have organizational structure w.r.t. detailed engineering, drafting, planning, procurement, production & quality assurance. For details, refer the eligibility criteria of the tender.

2 Confidentiality Clauses

No party shall disclose any information to any 'Third party' concerning the matters under this contract. In particular, any information identified as" Proprietary" in nature by the disclosing party shall be kept strictly confidential by the receiving party and shall not be disclosed to any third party without the prior written consent of the original disclosing party. This clause shall apply to the sub-contractors, consultants, advisors or the employees engaged by a party with equal force.

3 Brief description of the EHCL

- EHCL is a closed loop helium gas system that will be used as cooling system for testing various fusion blanket components viz. Fusion blanket first wall mock-ups, Pb-Li helium heat exchangers, and divertor mock-ups etc. EHCL is designed to remove 75 kW heat load from test sections/mock-ups.
- The Circuit Diagram of EHCL main loop is shown in Fig.1 (This is only for the purpose of conceptual representation of the system). The components shown here are Circulators, Electrical Heater, Recuperator, Coolers, Filter, TSM (Test Section Module and its heat source) and associated piping, valves and instrumentation systems. The integration of TSM is not in the scope of this tender.
- The helium gas at characteristic pressure, temperature and flow rate enters into the cooling channels of the test section (assembled in TSM) and cools the test section by extracting surface heat flux showered by Electron Gun connected with vacuum chamber. After cooling the test section, the hot helium passes through recuperator (also referred as economizer) where it is cooled down by exchanging heat with cold helium coming from the circulator discharge.
- A recuperator is installed at the crossover point of the loop. In hot leg, TSM and Electrical Heater are assembled. In normal operating condition, the temperature in hot leg is 300-400 ºC. In cold leg, coolers (helium–water heat exchangers), centrifugal circulators, filters and tanks along with associated piping and valves are integrated. In the cold leg, temperature is maintained at 50-200 ºC. After the recuperator, the hot helium passes through cooler (helium-water heat exchanger) where it transfer its heat to water and then enters to circulator. The cooler is designed such that total heat added to the system will be rejected in water along with any system cooling down requirement.
- The centrifugal circulator is designed to overcome the loop pressure drop. The mass flow of the circulator can be influenced by a variable speed drive to provide a slow and precise mass flow regulation.

- Helium from circulator discharge stream passes through the recuperator, where it picks up heat and passes through the electrical heater before entering to the test section. Therefore, the recuperator has a double function: it operates as a pre-heater for the helium flow in the cold leg, and as a cooler for the helium flow in the hot leg.
- After the recuperator, the helium (from circulator discharge) passes through electrical heater, where supplementary heat, if needed, is provided by the heater and thus helium enters at the TSM inlet as the required condition.
- In addition to the normal operation, the electrical heater also plays an important role during initial warming up operations. The Table-1 shows the process parameters of the loop.
- Fig.2 shows the Circuit diagram (This is only for the purpose of conceptual representation of the system) of the PICS of the EHCL.
- PICS consists of components such as compressor, vacuum pump, set of tanks/cylinders maintained at three different pressure conditions, associated piping, and instrumentation & control systems.
- Typically, the pressure in the main loop is maintained at 8 ±0.4 MPa with the help of PICS. A single point connection at the suction of the main circulator (upstream to the inline dust filter) is provided to respond in any fluctuations of the system pressure by addition and withdrawal of the helium inventory as and when required. The complete loop is also equipped with a number of valves (isolation control, drain and vent) and safety devices. The flow rate is maintained as ± 4.0 % of the nominal values and temperature is at ± 5 ºC.
- ASME Boiler and Pressure Vessel codes are chosen as the main reference code for design, fabrication, examination, inspection, and testing of the EHCL. In particular, for pressure equipment, the ASME Section VIII Division-1 and for pressure piping and piping components (valves, fittings, flanges, and bolting), ASME B31.3 is considered.
- SS316L is chosen as structural material for the loop equipment and pipes. Microtherm (helium lines) is considered as insulation material and MS/Carbon steel as support structure material.
- EHCL control system consists of a master PLC based control system (Siemens S7-300) which interfaces with controllers of critical individual equipment (circulator, electrical heater and compressor) for proper control functioning at a centralized level. The master controller of EHCL will communicate over Profibus network with the slave controllers of different components. The Control logic development will be done in STEP7 programming software with WinCC SCADA module and Process variables, valve status from control valves along with alarms will be provided on SCADA.
- The EHCL lab will draw electrical power at low voltage (415 V ± 10%, 50 Hz) from a LT Panel located in the vicinity of the lab. All electrical equipment to be used for EHCL experiment are of Low Voltage Rating (415/230 V AC, 50 Hz).

Table-1: Process parameters of EHCL

Parameters	Operating	Design
Heat load for TSM, kW	75.0	
Temperature at TSM, ºC	300-400	450
Coolant pressure (Helium), MPa	8.0	10.0
Coolant flow rate (Helium), kg/s	0.2-0.4	0.45

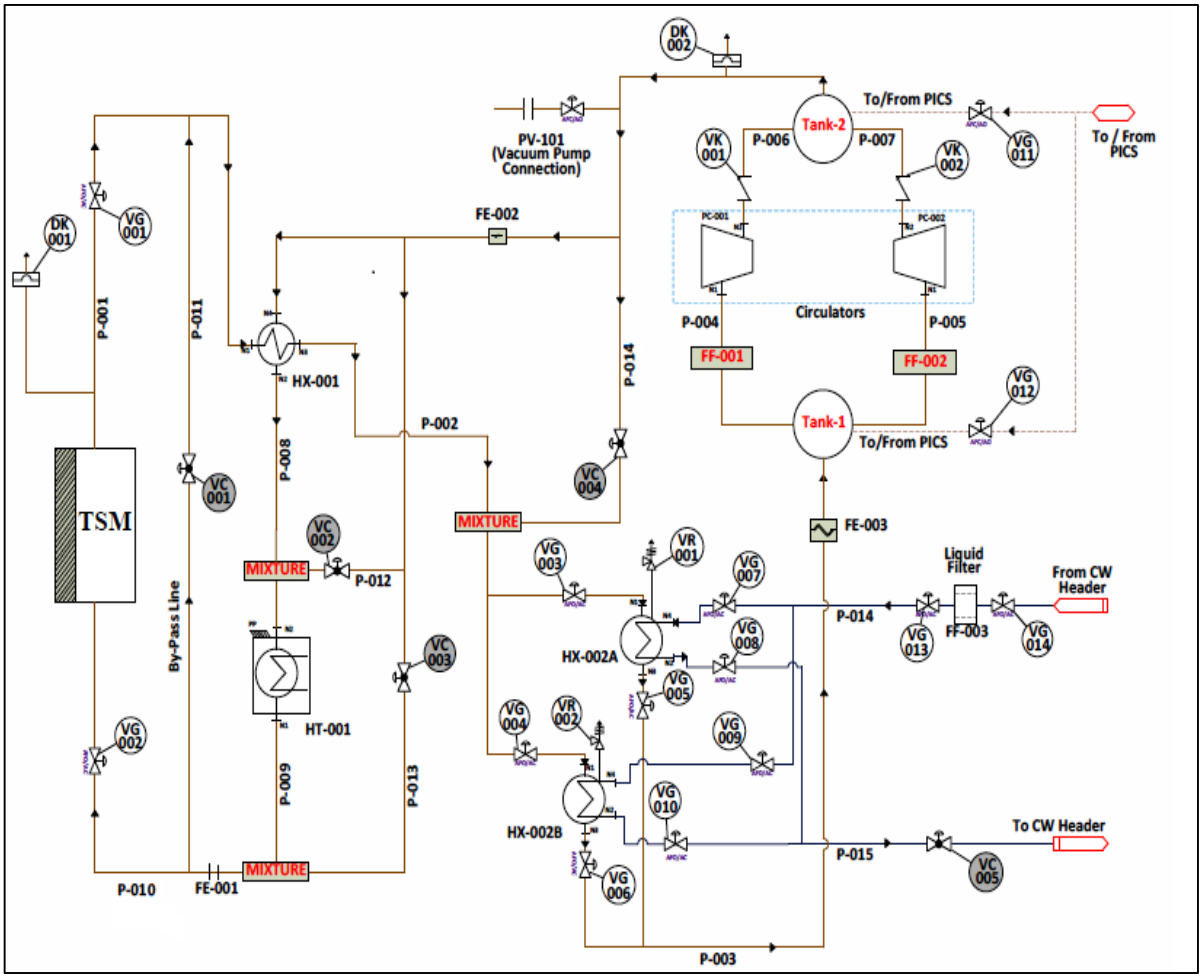

Fig.1: Process flow diagram of EHCL main loop

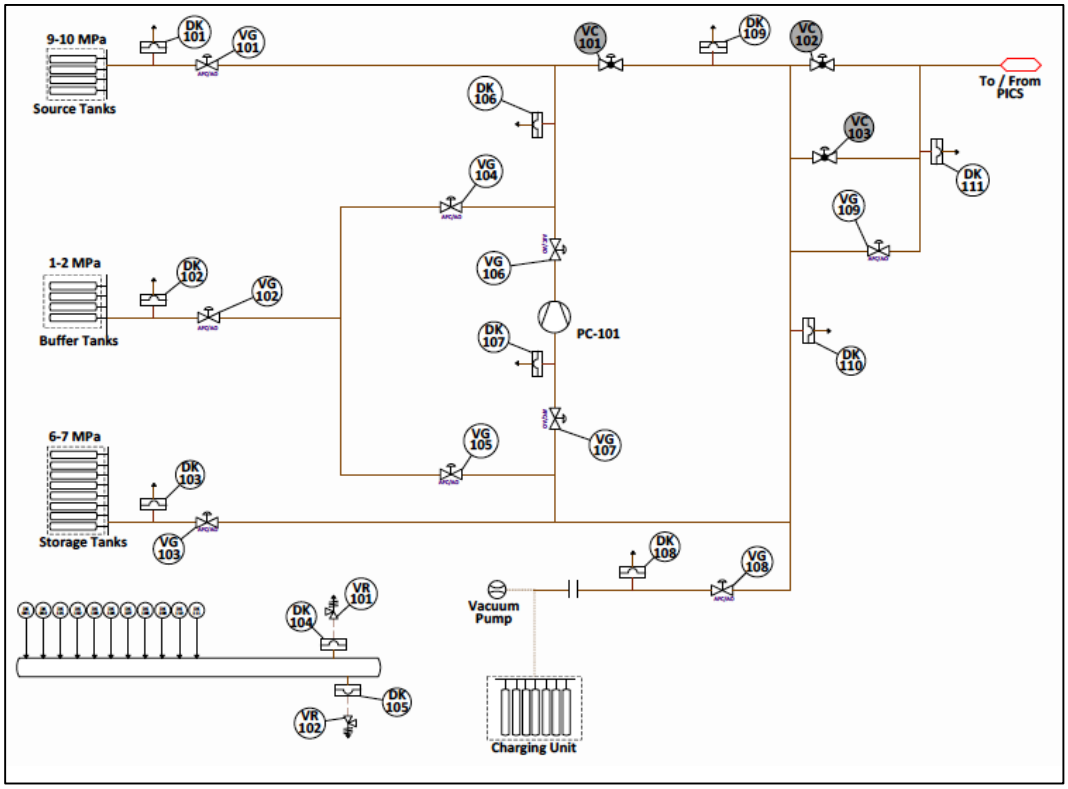

Fig. 2- Process flow diagram of PICS

4 Requirements

This section provides details of applicable codes, standards, guidelines, QA requirements and general safety aspects that are to be followed during design, fabrication, inspection & testing of the EHCL system. In addition, the specific requirements, guidelines and instructions as applicable for particular area of work are mentioned in “Section 5: scope of work” of the document.

The details are mentioned in section 4.1 to 4.3 below:

4.1 Applicable Codes, Standards and Guidelines

4.1.1 The following Standards, Codes and Regulations whichever is applicable in their latest edition including their addenda shall form the basis for design, fabrication, inspection, testing and acceptance of equipment.

4.1.2 In case the contractor refers to any other codes & standards those shall be equivalent to or better than the standards & codes listed below. However, the use of such codes & standards shall be subject to IPR's approval.

4.1.3 Workmanship shall be in accordance with the best practice, adequate to ensure satisfactory operation, service life and ease of maintenance in accordance with the requirement of this specification.

I. American Society of Mechanical Engineers (ASME)

a) ASME Section VIII Div. 1 : Boiler & Pressure Vessel Code
b) ASME B31.3: Process Piping
c) ASME B16.10: Face-to-Face and End-to-End Dimensions of Valves
d) ASME B16.25: Butt Welding Ends
e) ASME B16.34: Valves-Flanged, Threaded, and Welding End
f) ASME B16.6: Steel Pipe Flanges and flanged fittings
g) ASME Section II : Materials and specifications
h) ASME Section V : Non-destructive Examination
a) ASME Section IX: Welding & Brazing qualifications

II. American Society for Testing &Materials (ASTM)

a) ASTM A240 : Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
b) ASTM A312: Standard specifications for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
b) ASTM A182: Forged or Rolled Alloy Steel Pipe Flanges, Forged Fittings and Valves and Parts for High Temperature Service.
c) ASTM A193: Alloy Steel and Stainless Steel Bolting Materials for High temperature Service.
d) ASTM A194: Carbon and Alloy Steel nuts and bolts Materials for High pressure and High temperature Service.
e) ASTM A-450: Specification for general requirements for Carbon, Ferritic alloy and Austenitic alloy steel tubes.
f) ASTM A262: Standard practice for checking IGC on Austenitic S.S
g) ASTM E 94: Standard Guide for Radiographic Examination Using Industrial Radiographic Film
h) ASTM A388: Ultrasonic Examination of Heavy Steel Forgings.
i) ASTM E-15: Standard Practice for Ultrasonic Pulse-Echo Straight-Beam contact testing
j) ASTM E-213: Standard Practice for Ultrasonic Testing of Metal Pipe and Tubing
k) ASTM E-587: Standard Practice for Ultrasonic Angle-Beam Contact Testing
l) ASTM A 380-99: Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
m) ASTM E-165: Liquid Penetrant Test (LPT)

III. American National Standard Institute (ANSI)

a) ANSI B 1.1: Unified Inch Screw Threads
b) ANSI B16.11: Forged Fittings, Socket-Welding and Threaded
c) ANSI B 36.19: Welded and Seamless Austenitic Stainless Steel Pipe
d) ANSI/FCI 70.2: Control valve seat leakage classification

IV. International Society of Automation (ISA)

a) ISA 20.50: Specification forms for process measurement and control instruments, primary elements and control valves
b) ISA S75.01: Flow Equation for sizing control valves
c) ISA S75.02: Control valve capacity test procedures
d) ISA-75.08.05:Face-to-Face Dimensions for Butt-weld-End Globe Control valves

e) ISA S75.11: Inherent flow characteristics and range ability of control valve
f) ISA SP75.17: Control valve aerodynamic control prediction
g) ISA-75.25.01: Test Procedure for Control Valve Response Measurement from Step Inputs
h) ISA 26: Dynamic Response Testing of Process Control Instrumentation

V. Standards of the Expansion Joint Manufacturers Association (EJMA)

a) EJMA: Standards of the Expansion Joint Manufacturers Association

VI. Bureau of Indian Standards (IS)

a) IS 1893 (Part-1): Criteria for earthquake Resistant Design of Structures (seismic Zone-3 to be considered for the design and analysis purpose)
b) IS 4000: 1992, High strength bolts in steel structure- code of practice
c) IS 800-2007, Code of Practice for general construction in steel
d) IS 1239-2 (Part 2): Steel Tubes, Tubulars and Other Steel Fittings
e) IS 7098 Part 1: Standard for XLPE power cables upto 1.1kV
f) IS 325, IS/IEC 60034-1: Rotating Electrical machines
g) IS 3043: Code of Practice for Earthing
h) IS 1255: Code Of Practice For Installation And Maintenance Of Power Cables
i) IS 13947: Low Voltage Switchgear and Control gear
j) IS 4759 and 2629: Hot Dip Galvanization

VII. American Petroleum Institute (API)

a) API 520: Sizing, Selection and Installation of Pressure-Relieving Devices in Refineries
b) API 526: Flanged Steel Pressure Relief Valves
c) API 614 : Lubrication, shaft sealing and control oil systems and auxiliaries for petroleum, chemical and gas industry services
d) API 670: Vibration, Axial Position, and bearing temperature monitoring system

Note: If the contractor has capability to supply the system for a set of standards equivalent to that mentioned above, the same shall be indicated in quotation. The equivalence shall be explained to IPR and subsequent decision shall be taken by IPR for acceptance for use of alternative code and standards.

4.2 Quality Assurance and general QA requirements

The Quality Management System of the contractor and its subcontractor (if any) has to be compliant with the ISO 9001:2008 (or ISO 9001:2015 **)** standard.

It is recalled here, according to the ISO 9001:2008 standard:

4.2.1. Only standard and well recognised software shall be used for calculation and analysis of the system. If any in-house software is used, it has to be qualified and the same shall be approved by IPR.
4.2.2. The documents transmitted to IPR have to be verified and approved by qualified personnel (competent authority) of the company.
4.2.3. The supplied services and equipment will undergo before delivery all necessary verification to be compliant to the present Technical Specification.

General QA requirements:

4.2.4. Contractor (and its subcontractor) to supply Quality assurance plan (QAP). The QAP shall show review, hold point, witness for the specific jobs, witness final and important tests/inspections and issuance of inspection release notes. The same shall be mutually agreed between IPR and the contractor.

4.2.5. Some of the major activities for which review, hold point and witness should be considered are as follows:

Major Activities	Review	Witness	Hold point
Loop layout, Modelling and A	Yes by IPR or its representa	Not Applicable	Yes
FAT and Supply of items	Yes by IPR or its representa	Yes by IPR or its representative(s	Yes
Assembly, Installation Integration of the EHCL syste	Yes by IPR or its representa	Yes by IPR or its representative(s	Yes
Inspection, Testing Commissioning of EHCL at IF	Yes by IPR or its representa	Yes by IPR or its representative(s	Yes

4.2.6. Contractor (and it`s subcontractor) to supply the company Quality Management System.

4.2.7. The contractor shall prepare/maintain documentation including photos & videos for all the phases of work (e.g. Assembly, Installation, Integration, Testing and Commissioning etc.).

4.3 General Safety aspects

4.3.1 The contractor shall take all necessary precautions to ensure safety of labourers deployed for the said work and arrange to provide prompt medical assistance if required. Contractor shall keep the fully equipped first aid box handy at the site.

4.3.2 The Institute is not in any case responsible for any type of accident during the execution of works and it will be the total responsibility of the contractor.

4.3.3 The Contractor has to follow strictly the Government labour Acts, which are and will be in force during the period of execution of work.

4.3.4 All necessary arrangement for labours security, insurance will have to be made by the contractor at his own cost as per rules/ contractor's labour regulations, the contractor shall insure his labours with Insurance Policy.

4.3.5 The contractor has to follow Institute protocol and Safety code. The same is specified in Annexure-5.

5 Scope of work

The contractor shall go through the input documents such as lists of free issue materials, interface details, floor space/lab drawing, P & ID, Instrumentation Chart of EHCL, and preliminary BOM etc. including additional design and analysis documents of EHCL provided by IPR viz. Operational and control scheme of the loop, process design, I & C design, interlock scheme, electrical design, details of the components etc. and perform the following tasks further detailed in 5.1 to 5.7.

5.1 Loop layout, Modelling and Analysis;

5.2 Materials, Fabrication & Procurement;
5.3 Packaging and Shipping;
5.4 Instrumentation and Control system;
5.5 Electrical system;
5.6 Assembly, Installation and Integration of the EHCL system;
5.7 Inspection, Testing and Commissioning of EHCL at IPR;

The complete scope of work of this tender are to be executed in the following two phases:

- **PHASE-1 (Supply of EHCL system at IPR) :**This include preparation of Loop layout, modelling & analysis, preparation of final BOM, updates of P & IDs, sizing and routing details of power, control cables & cable trays, sizing and routing of pneumatic tubing and packing & supply of the items as per the final BOM along with the associated test reports and certificate. This phase includes mainly the scope of work mentioned in section 5.1, 5.2 and 5.3.
- **PHASE-2 (Installation, Integration, Testing and Commissioning of the EHCL system at IPR):** The scope of work of this phase involve Installation and Integration of all the loop components at IPR (including I & C and electrical systems), implementation of Control logic development, and Testing and Commissioning of the complete system as per the details mentioned in the tender document. In includes the scope of work mentioned in section 5.4, 5.5, 5.6 and 5.7.

5.1 Loop layout, Modelling & Analysis

After studying the EHCL input documents, and other details such as codes and standards, IPR requirements, guidelines and instructions as mentioned in the tender document, the contractor has to Prepare the loop layout & pipe routing including components of instrumentation and electrical systems (impulse tubing, power cables, cable trays etc.);Perform the piping stress analysis (preferably using CAESAR software)

Perform support structure design; Thermal and pressure drop calculations for loop layout; tubing layout; Calculations for power and control cables, Cable sizing; voltage drop calculations; and cable tray sizing; Sizing calculations for barricade considering the personal protection etc.; The contractor shall (based on the approved final layout, model and drawings) prepare the final Bill of Material;
Further, the contractor shall perform the following tasks and submit associated documents to IPR for approval:

i. 2D drawings and 3D model for the complete loop (including instrumentation components, impulse & pneumatic tubing and cable trays). The final drawing and models has to be submitted in CATIA format.
ii. Piping flexibility analysis for static and full dynamic conditions (including seismic analysis).
iii. Piping General Arrangement Drawings/Isometric drawings.
iv. Calculation of thermal insulation material for piping and the loop components considering Microtherm/Cerawool as insulation material.
v. Assessments of heat loss and pressure drop for complete loop.
vi. Support structure design for piping, its supports and system installation.
vii. Support structure design for loop components.
viii. Assessment of sizing and thickness calculations for barricade material. The sizing calculations shall be carried out to determine the protection needed to contain the fragment and shock produced during failure of the system.
ix. Design of fixing mechanism (bolts, fasteners etc.) for all the components for assembly, installation and integration in the loop

x. Estimation of tubes, flanges, fittings etc. for instrumentation
xi. Assessment of barricade requirement and estimation of barricade material for the loop
xii. P&ID updating/re-drawing
xiii. Updating operational and control philosophy of EHCL
xiv. Updated signal input/output list
xv. Electrical Load List
xvi. Detailed Single Line Diagram of EHCL system
xvii. Sizing Calculations for power cables and cable trays
xviii. Cable tray layout for Power and Control Cables and Electrical Cable Schedule
xix. Listing of all the Material for Mechanical, Process, Electrical and Instrumentation and Control system of the EHCL and preparation of BOM.
xx. Selection of make & model for different components in compliance with the technical specifications specified in this document and providing general technical details of the selected components.

5.1 (A) Requirements, Guidelines & Instructions:

5.1.1 All the components (provided by the contractor or its subcontractors/suppliers) shall be designed as per ASME Section VIII, Division 1.

5.1.2 The support structure shall be designed as per relevant IS standards: IS 1893 (part-1): 2002, Criteria for Earthquake Resistant Design of Structures; IS 800-2007, Code of Practice for general construction in steel; IS 4000:1992, Code of Practice for High strength bolts in steel structures. The other design works shall be as per best industrial practice.

5.1.3 The seismic design basis for the components and piping shall be in accordance with national standard such as IS-1893. The analysis shall be carried out for based on the Floor Response Spectrum (FRS) of Gandhinagar, provided by IPR.

5.1.4 A typical load cases are given below. However for piping flexibility analysis, detail load cases shall be prepared by the contractor based on ASME B31.3.

Load cases	Scenarios	Design Loading Combinations
Sustained load cases	Testing state	$P_t + D_t$
	Operating state	$P_t + D_w + T_1$
	Maintenance state	$P_2 + D_w + T_2$
Occasional load Cases	Operating state+ SL	$P_1 + D_t + T_1 + SL$
	Maintenance state + SL	$P_2 + D_2 + T_2 + SL$

Pt : Test Pressure , Dt : weight of test fluid at room Temp., Dw : Dead weight , P1, P2: Pressure ranges , T1, T2: Temperature ranges, SL : Seismic level

5.1.5 For the components of process system where design standard has not been specified shall be designed as per best industrial practice available for the same and meet the design & safety requirement for all operating conditions.

5.1.6 The piping and equipment layout of the EHCL shall be optimized based on consideration of ease of operation & maintenance, minimization of system pressure drop, piping flexibility and requirement of piping inventory. The detailed piping and equipment layout drawing shall be submitted after award of the contract and shall be approved by IPR.

5.1.7 For all the procured and fabricated items (e.g. compressors, valves, tanks, filters etc.) data sheet, interface details, make, model no. and general arrangement drawings etc. as applicable, shall be provided by the contractor.

5.1.8 For each valve, the contractor has to provide duly filled up data sheets.

5.1.9 Additionally, for Control valves, characteristic curve and dynamic response details shall be provided.

5.1.10 Apart from Vent & drain points mentioned in the preliminary P&ID, Additional vent & drain points, if required shall be provided by contractor (in consultation with IPR) for smooth commissioning and subsequent operation of the system.

5.1.11 The contractor shall review the loop layout, pipe routing, flexibility analysis; and support structure design by qualified person /competent authority.

5.1.12 The contractor shall submit proper documents associated with the above activities.

5.1.13 All the Design documents shall be submitted and explained to IPR for verification.

5.1.14 For design documentations, the contractor shall carry out minimum three iterations, if required, without any extra cost.

5.1.15 The documents shall be submitted in both PDF and word format.

5.1.16 All software inputs files/excel sheet prepared for EHCL system shall be submitted to IPR.

5.1.17 Contractor shall proceed for procurement and fabrication after approval from IPR.

5.2 Materials, Procurement and Fabrication

The contractor shall go through the following reference documents:

- Annexure-1: List of items to be procured/fabricated by the contractor and their technical specifications
- Annexure-2: Preliminary P & ID
- Annexure-6 : EHCL Instrumentation Chart
- Appendix-3: List of free issue material & interface details
- Updated BOM and other applicable documents

Based on the above references (and other document, as applicable), the contractor shall select the materials and fabricate and (or) procure all the items that are needed for satisfactory completion of the work.

It shall include:

5.2 (A) Materials

5.2.1 The material of construction of various components which comes in contact with fluid shall be Austenitic Stainless Steel 316L with relevant ASTM/ASME/EN grades, unless otherwise specified. However, the contractor may offer equivalent or better materials provided the IPR approves each such material.

5.2.2 All the pipes and tubes shall be of SS316L. Seamless pipes ASTM A312 Grade TP316L, Sch 80/Sch40 (as applicable) as per ANSI 36.19 shall be considered.

5.2.3 Support structure material: Carbon Steel or better with suitable paints. Material required for these support structures should be of good quality conforming to the requirements of ASTM-A-6/A-6M or equivalent.

5.2.4 Insulation material shall be Microtherm or equivalent (the same shall be agreed by IPR). The physical properties of the insulation material are mentioned in the table below.

Properties*	Value/ Ingredients	Range
Density	320 kg/m^3	320-350 kg/m^3
Composition	Amorphous silica	50 to 90%
	Titanium dioxide	10 to 50%
	Glass filaments	0 to 12%
	Silica filaments	0 to 12%
	Aluminium oxide	0 to 25%
Classification Temperature	--	--
Continuous Max. Operating. Temperature	1000°C	--
Specific heat capacity	0.920 kJ/kg.K at 200°C	--
Linear (%) shrinkage after 24 hrs firing	--	--

**While calculating the insulation thickness, the actual thermal properties of the insulation material as provided by the original manufacturer shall be used.*

5.2.5 Pickling and passivation treatment shall be performed and no traces of oil or grease must remain on the surface of metal in the as-delivered conditions.

5.2.6 The supports structure for all components shall be of Carbon Steel or better. Material required for these support structures should be of good quality conforming to the requirements of ASTM-A-6/A-6M or equivalent.

5.2.7 Barricade material shall be of carbon steel or better.

5.2.8 Materials and standard parts which are not specifically described herein and which are necessary for the fulfilment of this specification shall be of good quality and in accordance with the best practice pertinent to the manufacture of pressure parts.

5.2.9 Welding material shall be from reputed manufacturers. All welding material used in the fabrication of equipment/part/components shall conform to the requirements of ASME Section VIII, Division-1. The requirements of ASME Section IX shall be met for applicable qualified welding procedure specification.

5.2 (B) Procurement and fabrication

5.2.10 The contractor has to procure and (or) fabricate the following items/components:

a. ON/ OFF and control valve for water application

b. Pipes and fittings
c. Tubes
d. Compressor
e. Tanks connected to the circulator suction and discharge line
f. Filters (helium and water application)
g. Insulation materials
h. PICS system and external charging units (tanks/cylinders along with pressure gauge and regulators and associated piping and fittings)
i. Pressure reducing valve
j. Drain and vent valves
k. Electrical power cables
l. Control Cables
m. Cable trays for power and control cables
n. Supports for cable tray installation
o. Accessories for cable & cable tray installation (glands, lugs cable ties etc.)
p. Material for surface finish, paints etc.
q. Barricade materials & associated fittings and two doors of similar material as barricade.
r. Support structures for free issue materials (recuperator, coolers etc.) & for all the procured items (e.g. pipes and fittings, valves etc.) as applicable.
s. Support structures for the complete loop assembly (beams, column, fittings, and platform etc.).
t. All other items (e.g. bolts, nuts, levelling plates etc.) required for assembly and installation of components at floor and at support structure.
u. All the process instrumentation required for cooling water loop.
v. Pressure transmitter panel and master controller PLC panel.
w. Instrumentation and control system cables and junction boxes.
x. Pressure transmitter for instrumentation air.
y. Temperature sensor for PICS.
z. Logic solver and associated components for hard-wired interlocks.
aa. Any additional control system components, if identified during design finalization.
bb. The contractor shall carry out supply and installation of electrical fixtures for the process area of the EHCL system inside barricaded enclosure, for e.g. lighting, utility sockets, switchboards etc.
cc. Marking, identification and inspection of all the supplied items as per drawings and the final BOM. Machining/cutting and preparation of parts, if any, shall be performed by the contractor and shall be as per the assembly and fabrication drawings and the final BOM.
dd. Performing associated tests and issuing certificates and test reports for the procured item. The details of the specification for the procured components are

given in the Annexure-1. The documents that are to be submitted during this phase of work are given in section 5.9: Documentation.

5.2 (C) Requirements, Guidelines & Instructions:

a. The fabrication of the various components shall conform to the requirements of ASME Section-VIII, Division-1 and other applicable standards (e.g. ASTM, IS, FCI etc.) as mentioned in the code and standard section of this document.
b. An acceptable level of cleanliness shall be maintained during the manufacturing process. The product used for liquid penetration test and for lubrication must have chloride content less than 200 ppm.
c. If any of the components has different end connection dimension/type or it requires different size for installation than that of Tubing connected to it, the required additional fitting/connector will be in the scope of the contractor.
d. The connection between tube to tube /equipment /valve / other components shall be preferably of Ferrule fitting type which can withstand high pressure & temperature.
e. The Make of Tube, tube fitting and valve shall be compatible & consistent with each other to avoid any leakage during operation of the system.
f. The assembly (and manufacturing) drawings shall identify the inter-stage checks/inspections to be performed at sub assembly levels, if any. The contractor shall also carry out preparation/revision of drawings in order to incorporate any subsequent modifications required in the drawings before and during assembly and manufacturing. Any deviation/revision in the fabrication drawings from the drawings will need the approval from IPR.
g. Materials and standard parts which are not specifically described herein and which are necessary for the fulfilment of this specification shall be of good quality and in accordance with the best practice pertinent to the manufacture of pressure parts.
h. Proper identification and inventory control of all the material shall be maintained throughout the process of procurement and fabrication.
i. All the raw material shall be identified / stamped and inspected by the contractor as per standard practices.
j. Original / Certified Copy of test certificates (mill test certificates) certified by NABL approved laboratory for chemical composition and mechanical properties shall be furnished for all the material.
k. In case of non-availability of test certificates, contractor shall arrange for carrying out of complete testing as called for in the standards. These tests shall be subject to IPR's approval. All cost towards such testing and inspection shall be borne by the Contractor.
l. All the materials designated in accordance with an ASTM specification shall be subjected to tests for chemical, physical, IGCT and other mandatory tests as applicable (e.g. NDT) by the appropriate ASTM specification.

m. Material qualification tests shall be as per ASME section II and performed by the contractor at the NABL approved laboratory. Physical and chemical test certificates for the material of various components shall be furnished for IPR approval. All the testing of materials shall be witnessed by the IPR or its representative.

n. The contractor shall procure all the materials as per relevant applicable specification from reputed manufacturers and not through agents. The source of material procurement shall also be indicated.

o. The contractor shall procure all the items from reputed suppliers and ensure that quality is maintained in all the procured and fabricated items.

p. Wherever make is specified, the contractor should procure the components accordingly.

q. The contractor shall supply the Quality assurance plan (QAP) of the original sub-supplier/fabricator of the items. The QAP shall show review, hold point and witness for the specific jobs; Witness final and important tests/inspections and issuance of inspection release notes; and the company Quality Management System.

r. Test witness, if any, as mentioned in the technical specification (Annexure-1) for the procured/fabricated items shall be carried out by the contractor and (or) representative of IPR.

s. The contractor shall inspect the fabricated items with respect to dimensions, surface finish, fit, alignment etc. Deviations if any, beyond the specified tolerances shall be specifically brought to the notice of the IPR or its representative and written approval is obtained for all such deviations.

t. The contractor shall go ahead with shipping of procured/fabricated items after successful completion of the acceptance tests mentioned in the technical specification/data sheet of the procured items (e.g. hydro-test/pressure test, leak tests, performance tests etc.) and approval of the IPR.

u. For hydro-test the water chloride ion content less be less than 50ppm.

5.3 Packaging and Shipping

It shall include:

5.3.1 Packing of all the items/material for shipment. After successful inspection / testing of items at factory (of contractor or original manufacturer) and approval from IPR all the items that are to be supplied shall be packed properly.

5.3.2 Marking and Nameplate. Part No. / Nameplates shall be mentioned on each part of the loop components. The identification no shall be as per the final BOM.

5.3.3 Shipment of all the items/material to IPR.

5.3.4 Unloading and unpacking of the materials at IPR by the contractor or its representatives.

5.3.5 Inspection & verification of all the shipped items at IPR: For all the supplied material/components, the contractor shall perform inspection & verification at IPR, demonstrating the safe receipt of all the items at IPR site.

5.3.6 The contractor shall prepare associated document and submit it to IPR for review. The documents to be supplied at this stage are mentioned in the documentation section.

5.3 (A) Requirements, Guidelines & Instructions:

a. All the materials supplied by contractor shall be properly packed to avoid any damage during transit. If any damage occurs to any of the components during transport the contractor would have to replace the same at no extra cost.

b. Components of process loop shall be prepared for shipment in accordance with the instructions stated below.
   - The packing of materials and its storage must maintain the material in satisfactory level of cleanliness.
   - All openings shall be adequately sealed to prevent entry of dust or moisture.
   - The parts shall be packed in such a manner as to provide maximum protection against physical damage, corrosion, entry of dust and moisture during transport / transit to the site.
   - The component shall be prepared for a transit period exceeding one month.
   - The construction and lining of the boxes shall provide protection for their contents. The packing shall provide adequate cushioning, blocking and bracing to protect against shocks and prevent internal movement of the parts. Adequate anti-skidding, hoisting and tie down provisions shall be provided to facilitate easy handling and safe movement.
   - Contractor shall supply any material that is missing inside the intact packing cases without any extra cost.
   - Contractor shall be responsible for any damage to the equipment during transit due to improper and inadequate packing.
   - Only package constructed out of sound material and of dimensions proportional to the size and weights of contents shall be used.
   - Bundled materials shall be rigidly steel strapped over the protective covering.
   - Loose materials, e.g. bolts, nuts, etc. shall be packed in gunny bags and sealed in polythene bags with proper tagging.
   - Wherever necessary, proper arrangements for attaching slings for lifting shall be provided.
   - The packing list in duplicate, containing details of components/parts for verification at site shall correspond with the advice note.

c. All the packages shall be clearly, legibly and durably marked on both sides with (as applicable):
   - Destination address as communicated.
   - Purchase Order No. and Date.

- Dimensions, Net and Gross weights.
- Sign showing `Way Up'.
- Sign showing slinging and sling position.
- Any handling and unpacking instructions, if considered necessary.
- All marking shall be made with uniform block letters using water proof paint.
- The contents of the package shall be punched on non-corrosive metal plate and nailed on to the package on a prominently visible place. If the number of items in the package are too many a typed list sealed in transparent water-proof bag shall be kept inside a galvanized steel cover which is nailed on to the outside of package in a prominently visible location.
- Each spare part shall be clearly marked and labelled on the outside of its packing with its description and catalogues/part number.

d. The Contractor shall transport all the fabricated/procured items to the following address at their own cost. The shipping address is as follows:

Store officer

Institute for Plasma Research

Near Indira Bridge, Bhat Village

Gandhinagar, Gujrat- 382428

INDIA

e. The fabricated components shall be transported to site only after they are approved in writing by the IPR's representative for shipping.
f. All the materials transported from the contractors` works shall be temporarily stored at pre-defined locations at the IPR's site.
g. Contractor shall intimate at least fifteen (15) days in advance to IPR, the probable date when the components of process loop are to be ready for dispatch. A packing list also shall be sent along with this.
h. The shifting of the materials from the temporary storage to the site of installation shall be responsibility of the contractor.
i. The contractor will have to arrange the skilled labours as required at their cost.

5.4 Instrumentation and Control system

Instrumentation & control system shall serve various requirements like process parameter monitoring, alarms & Interlocks and feedback controls to satisfy the functional requirements of the process system. Control system should provide a user-interface and control mechanisms for the start-up, operation and safe shut-down of EHCL facility as per operational philosophy provided by IPR. EHCL instrumentation serves to measure pressure, temperature and flow-rate at different locations of the loop. EHCL control system consists of a master PLC based control system which interfaces with controllers of critical individual equipment (circulator, electrical heater and compressor) for proper control functioning at a centralized level. In addition, 02 hardwired interlocks are

incorporated to address the safety of complete system in an accidental scenario (high-temperature and high-pressure at hot-leg of facility) where PLC controllers fails to operate. For EHCL, process parameters to be controlled are pressure, temperature and flow-rate of helium. I&C for EHCL is primarily designed to carry out following important functions:

- To control helium gas flow in the main loop during different experimental campaigns.
- To control helium gas temperature at the bypass line using an electrical heater.
- To control helium gas temperature at the inlet of the circulators by regulating water flow-rate in helium-water heat exchanger(s).
- To control helium gas pressure in the main loop through PICS.
- To control remotely operated control valves, circulators, electrical heater and compressor from control room.
- To annunciate abnormal conditions of process parameters as required.
- To control pressure in Source tank, Buffer tank and Storage tank of PICS.
- To perform data-logging of various process parameters.
- To provide investment protection functions for critical equipment and EHCL loop as whole.
- To provide hardwired interlocks (independent of PLC interlocks) for High-temperature, High-pressure and Emergency Shut-down.

For I&C related activities, IPR will provide the Process & Instrumentation Diagram (P&ID), Instrumentation chart (defining alarm points and interlocks), operational philosophy of EHCL and details of process instrumentation & control components (free issue materials). The provided instrumentation chart is indicative only. Contractor shall consider adequate extra inputs/conditions as required for safe operation of facility.

The following tasks shall be performed by the contractor:

5.4.1 Installation and integration of all the process instrumentation (pressure transmitters, differential pressure transmitters, flow meters, temperature sensors, etc.) with EHCL loop.

5.4.2 Installation of transmitter-rack(s) for pressure transmitters (PTs) and differential pressure transmitters (DPTs) as described in process 3D layout and mounting of transmitters along with manifolds in the rack.

5.4.3 Installation and routing of process impulse tubing (8 mm OD, MOC: SS 316L) for all PTs and DPTs. The estimated total impulse tubing length is approx.1000 metres (considering an average of ~25 metres per instrument).

5.4.4 Fabrication and installation of master controller PLC panel along with internal/external cabling details.

5.4.5 Fabrication and installation of required number of junction boxes, wiring and ferruling the cables etc.

5.4.6 I&C signal cable laying and termination from field process instrumentation and control components (like valves etc.) up to junction boxes. Afterwards, from junction boxes to master controller PLC panel, multi-pair shielded twisted-pair copper cables shall be laid. All I&C signal cables should be shielded and twisted-pair copper

conductors (1.5mm^2) with PVC/PTFE insulation. Cables shall be FRLS jacketed. Estimated total length for I & C signal cable from field I&C to junction boxes is approx. 1500 meters (considering an average of ~ 15 meters per signal as per preliminary instrumentation chart). From junction boxes to master controller PLC panel, estimated cable length of multicore cable is approximately 45-50 meters.

5.4.7 Development of data-acquisition system & implementation of control system logics and interlocks (software based as well as hardware based interlocks) according to loop operational philosophy provided by IPR. The data-acquisition and control system functioning (including SCADA operation, I/O acquisition, alarms and interlocks functionality) will be tested, upto the possible extent, as Factory Acceptance Test through voltage/current signals in source/measurement configurations.

5.4.8 Development of interface between master control system and control systems of individual components i.e. circulators, electrical heater & helium compressor.

5.4.9 Development of Graphical User Interface (SCADA) for EHCL.

5.4.10 Supply, Installation, Integration & commissioning of complete system at IPR lab.

5.4.11 Supply of above works with suitable documents and reports.

5.4.12 The following documents, as applicable shall be updated and submitted to IPR

a. Updated P&ID for EHCL system.
b. Updated Operational and control philosophy of EHCL.
c. Updated signal input/output list.
d. Updated instrumentation chart mentioning all the alarms set-point and detailed interlock definitions.
e. Wiring diagrams, junction box GA drawings

5.4 (A) Requirements, Guidelines & Instructions:

a. IPR will supply process instrumentation, PLC hardware (Siemens S7-300) with STEP 7 and WinCC software required for EHCL, as free issue materials(detailed list provided in annexure-3).Procurement/fabrication of transmitter-rack, cables, cable-trays, fittings, impulse tubing ,controller panel and any remaining I&C components are in the scope of contractor.

b. IPR will provide Siemens SCADA Win CC runtime configurable software with 512 tags. If required, Contractor may need to upgrade the license for more tags, as per EHCL logic development.

c. A few instrumentation components will not be covered under FIM (e.g. cooling water related I&C components, helium mass flow integrator, pressure transmitter for instrumentation air, helium/oxygen monitors, temperature sensor for PICS and logic solver for hardwired interlocks. Preferred make of process instrumentation is Endress+Hauser, Emerson Process Management, Honeywell, Yokogawa, Krohne, Siemens, WIKA. These components, along with any other component as identified during design finalization, will be in the supply scope of contractor.

d. Contractor shall provide at least 1 year standard warranty for all the items, support and services that are provided during phase-1 from the date of acceptance of the items by IPR. However some components shall have 2 years standard warranty and the same are mentioned in the data sheet of the individual component.
e. Contractor shall provide at least 1 year standard warranty for all the items, support and services provided during phase-2 from the date of acceptance of the system by IPR.
f. During the warranty period, the contractor shall also provide technical support to address issues related to control system operation and software, if any.
g. Contractor shall provide developed source code to IPR so that any minor modifications required in future can be carried out by IPR.
h. Contractor shall provide training of the software and associated tools (used in the project) to IPR personnel.

5.5 Electrical Systems

The Scope of Electrical work for EHCL is broadly classified as below:

5.5.1. Sizing, Routing, Supply and Installation of Cable trays for Power and Control Cables.

5.5.2. Sizing, Supply, Laying and Termination of Power and Control cables

5.5.3. Supply and Installation of Electrical Fixtures for EHCL Process Area

5.5.4. Design Documents and Reports for the electrical system

Further details on the above tasks are as mentioned below:

5.5.1. Sizing, Routing, Supply and Installation of Cable trays for Power and Control Cables.

5.5.1.1 Based on the location of electrical and instrumentation equipment of EHCL as per the final approved layout, the contractor shall perform routing of cable trays required for laying of Power and Control cable for EHCL equipment.

5.5.1.2 Separate trays must be installed for Power and Control cables. Wherever both types of cables are to be laid, it should be done in a 2 tier arrangement, wherein, Power cables trays must be laid in the upper tier, while Control cables trays must be laid in the lower tier.

5.5.1.3 The contractor shall carry out sizing of power and control cable trays for all sections of the cable tray layout as per the size and quantity of cables to be installed in each section of the cable tray.

5.5.1.4 Contractor should accommodate supports for cable trays at necessary intervals along the entire layout.

5.5.1.5 The contractor shall submit the entire design for cable tray system (including layout, sizing, support structure design and the BOM for this system) to IPR for approval.

5.5.1.6 After design approval by IPR, the contractor should carry out procurement of cable trays, cable tray accessories and support structures. All the material shall be delivered to IPR.

5.5.1.7 Installation of the cable tray system should be as carried out at IPR as per the final approved cable tray layout.

5.5.1.8 Following specifications and guidelines for cable trays supply and installation to be followed

a. All cable trays are to be installed indoor and overhead
b. Power and Control cable trays shall be of Hot Dip Galvanised Iron (G.I.) material and Perforated Type.
c. Proper cable trays accessories like Bends/Elbows, Tee, Cross, Reducers, Riser, Joint plates should be used wherever required.
d. Cable trays shall be grounded and all cable tray sections shall be electrically bonded.

5.5.2. Sizing, Supply, Laying and Termination of Power and Control cables

5.5.2.1 Contractor shall carry out sizing and selection of power and control cables as per details of Electrical loads and Instrumentation provided by IPR.

5.5.2.2 Power Cables shall be 1.1 kV grade, multi core copper conductor with XLPE insulation. All cables shall be FRLS type.

5.5.2.3 Contractor shall determine quantity of cables required as per the final approved layout of EHCL.

5.5.2.4 The contractor shall generate and submit BOM for Power and Control Cables to IPR for approval.

5.5.2.5 After approval of BOM by IPR, contractor shall carry out procurement of Power and Control Cables as per the BOM. Preferred make of the cable are Polycab, RPG, Havells, KEI. Contractor shall supply the procured cables to IPR and carry out laying of power and control cables in their designated cable trays as per the approved cable tray layout. Proper glanding and termination of all cables on both sides should be performed.

5.5.2.6 Contractor shall provide factory test certificates of the cables to be supplied to IPR.

5.5.2.7 Contractor shall carry out proper tagging of the cables for the purpose of identification.

5.5.2.8 IPR will provide dedicated earth pits for Power earth, Instrument earth and UPS neutral. Contractor shall ensure suitable earthing connections for the installed equipment to their corresponding earth pits.

5.5.3. Supply and Installation of Electrical Fixtures for EHCL Process Area

The contractor shall procure and install the followings items in the EHCL process area inside the barricaded enclosure. All the material and equipment shall be of reputed make.

a) 1 no. of 6 way TPN lighting distribution board with incoming and outgoing circuit breakers
b) Necessary number of lighting fixtures for 300 lux illuminance
c) 10 no. of 15 A plug points
d) 2 nos. of 3 Phase (5 pin, 32 A) Industrial Sockets with MCB on each level
e) Switchboard for light and power socket switches
f) All necessary wiring from the main distribution board to switchboards, lights and power points. The wiring shall be in PVC conduits

5.6 Assembly, Installation and Integration of the EHCL system

It shall include:

5.6.1 Submission of assembly, installation and integration procedure document for the approval of IPR.
5.6.2 Shifting of the material/items from temporary storage place to the installation site.
5.6.3 Components identification and verification.
5.6.4 Supply of all welding consumables, filler wires, Argon cylinders etc. required for assembly & erection of pipelines as per actual site condition, material for Liquid Penetrant testing, Radiography testing etc., as applicable.
5.6.5 Providing all the equipment including grinding machine, tube bending machine, welding generator and other welding equipment, required tools, etc. ,as applicable, to carry out the assembly, installation and integration work.
5.6.6 Arrangement for testing of individual components, as applicable.
5.6.7 Arrangement of all the tackles, scaffoldings, hoisting devices etc. required to carry out the assembly, installation and commissioning activities at IPR site.
5.6.8 Assembly, Installation and Integration of all the loop components including the free issue materials (e.g. electrical heater, recuperator, coolers, etc.) in the EHCL lab at IPR as per the approved P&I diagram, Piping & equipment layout drawings and as per the approved procedure
5.6.9 Installation of all the I&C components (e.g. flow meters, pressure sensors, temperature sensors etc. along with impulse tubing) and Electrical components including activities like routing of Impulse tubing, fabrication & installation of transmitter racks and mounting of transmitters on the same, fabrication & Installation of cable tray, fabrication & installation of required numbers of Junction boxes in the field, Wiring, ferruling etc. fabrication & Installation of panel for housing the master controller (PLC), lamp for common alarm
5.6.10 Integration of control system of individual components with the master control system.
5.6.11 Laying of Power and Control cables in respective cable trays, Tagging, Glanding and Termination of Power and Control cables at both ends
5.6.12 Assembly and installation of the support structures.

5.6.13 Erection of supports structures including fixing on wall with the help of proper supporting. Stainless steel shims have to be provided between all MS supports and SS tubing to avoid direct contact.

5.6.14 Installation of barricade material.

5.6.15 Repair and replacement of parts damaged during erection

5.6.16 Integration/ connection of the pipes with the loop components and post weld heat treatment, if any, for the joints.

5.6.17 Assembly of suitable insulation materials on the piping and components of the loop that are operated at high temperature (>50 °C).

5.6.18 Procurement, installation and integration of any item/service, which may not have been specifically mentioned herein but are needed for satisfactory completion of the work, shall also be treated as included and the same shall also form part of scope, unless otherwise specifically excluded.

5.6.19 Performing welding and connections works associated with the above activities and post treatments as applicable.

5.6 (A) Requirements, Guidelines & Instructions:

a. Assembly, installation and Integration shall be carried out as per the approved procedure only.

b. Electrical power supply available at IPR's site (at a single point close to site) are 3 Phase 415 V AC and Single phase 230 V AC. Frequency of power supply is 50 Hz. The contractor shall make his own arrangements for distribution of power to all his work from the point of supply provided by IPR. If any of the component(s) require power supply other than as specified above the necessary arrangement to derive that power supply shall be in the scope of the Contractor. It shall be the responsibility of the contractor to provide and maintain the complete installation on load side of supply with due regard to safety requirement at site. All cabling and installation shall be carried out by licensed electrical contractors only with appropriate statutory requirement given in a) Indian Electricity Act. 1910 (as amended), b) Electricity Supply Act. 1948 (as amended) and c) Indian Electricity Rules, 1956 (as amended). All the wiring shall be done along routes approved by IPR representative.

c. IPR will not be liable for any loss or damage to the contractor's equipment as a result of variation in voltage or frequency or interruptions/stoppage of power supply. On interruptions/stoppage of power supply for a continuous period not exceeding 24 hours, the contractor shall have no claim whatsoever against IPR. For any power failure/stoppage resulting in interruptions for a continuous prolonged period more than 24 hours, the contractor will be eligible only for reasonable extension of time and not for any compensation on this account.

d. IPR will not be liable for any loss to the contractor arising from failure or interruption due to stoppage of works, any attendant delay consequent upon

such failure, interruption or stoppage of power supply or due to variations in voltage or frequency.

e. Compressed air supply at 4-7 kg/cm^2 (g) pressure with a combined nominal flow rate of 25 CFM is available at IPR's site for actuating different valves and for commissioning.
f. Water for the work will be made available to the contractor at free of cost at the site.
g. Chiller unit and water supply for heat exchangers shall be made available by IPR.
h. Shifting of free issue material to the installation site is in the scope of IPR.
i. Shifting of electrical heater, recuperator, coolers, circulators and other free issue materials from the existing location to the installation site is in the scope of IPR.
j. The decision of IPR , as to whether the contractors have occasioned any loss, deterioration or destruction of the free issue materials, while in their possession, custody or control from whatever cause arising as also the decision regarding quantum of the damage suffered by IPR shall be final and binding on the contractor.
k. The installation and integration activities shall be supervised by the competent person of the company and all the workers shall be well trained.
l. Competent Supervisor (s) who shall be regularly at site and shall give his whole time to the superintendence of the erection of the works and whose duties shall include the supervision of all the activities viz. welding, assembly and installation, integration, testing, commissioning, repair and replacement of any damaged components and find alterations required to correct errors, in detailing of fabrication.
m. Insulation materials shall be installed after successful completion of leak tests of the loop.
n. Aluminium foil/sheet is to be provided over the insulation surface (Microtherm) for mechanical protection.
o. After installation identification tag is required to put for all components including equipment, valves, tube etc.
p. All the support structure requires for installation of the system including tubing, equipment, valve etc. is in scope of contractor.
q. All the support structure like column, beams, purlins, tie members etc. shall be of standard make (e.g. TATA, JINDAL etc.) and painted with two coat primer and epoxy (white color).
r. Barricade shall be painted along with all the other exposed surfaces with two coat primer and epoxy (white color)
s. Welding and integration works shall be performed in supervision of the qualified person of the company and the same shall be verified and inspected by its inspector authorised for these type of inspection. In the absence of the in house

inspector a third party inspector can be appointed by the contractor in consultation/agreement with IPR.

t. The employment of sufficient number of competent manpower to the Supervisor to complete the work within the time period specified to be arranged by the contractor.

u. The employment of competent Inspection, Authority and supporting staff familiar with the welding quality requirements as stated in this document shall be arranged by the contractor.

v. Suitable area near the site of work will be provided to the contractor free of cost for carrying out the work. The contractor shall be solely responsible for proper storage and safe custody of his materials/equipment and materials issued to him.

w. The contractor shall make his own hoisting & scaffolding arrangement required for the execution of the job. In work areas where the facility of hoisting equipment and scaffolding is available, the contractor shall be permitted to utilize them free of charge, for the execution of his work. At the assembly site overhead crane is available. However, the event of the IPR`s permanent hoisting equipment or scaffoldings not being available to the contractor for his work, or being out of order shall never be the cause for claims of extra payments or an excuse for delays in executing the contractual scope of work.

x. All components of loop shall be neatly finished in a workmanship like manner. All exposed metal surfaces shall be smooth and free from burrs. Finished surface shall be protected against corrosion and mechanical damage.

y. The contractor shall provide the list of works and supervisors and provide necessary clearance and supporting documents required by IPR.

z. Before closure of openings of any component with the end caps, it shall be carefully checked to ensure that all extraneous matter such as rags, tools, rubbish, foreign matter, loose scale and dirt weld rod stubs etc. have been removed. After the interior is cleaned and dried, all openings shall be closed with blank flanges, caps, etc. to prevent entry of water, dirt or any other foreign material. Small openings shall also be plugged with caps/plugs. Sufficient number of desiccants bags shall be placed inside the components at appropriate places for adequate protection against humidity and moisture.

aa. The dimensional tolerances shall be within the limits indicated in the fabrication drawings made by suppler and as per the ASME code.

bb. At demountable joints to prevent leakage, the contractor shall use suitable seals. The sealing materials should be compatible to the pressure and temperature conditions of the location.

cc. All SS surfaces are to be suitably subjected for pickling and passivation as per ASTM A380 or its latest version.

dd. All MS surfaces to be painted shall be thoroughly cleaned by approved methods. The application procedure shall be in accordance with the paint manufacturer's recommendations.

ee. The paint shall be from reputed manufacturers. The IPR shall approve the surface preparation and the application procedures before painting.

ff. The SS (clad) surface need not be painted but it has to be treated either chemically or buffed to give a good glazed surface finish.

gg. The painting shall not be carried out on any surface without obtaining prior clearance from the IPR or his authorized representative.

hh. The painting wherever applicable shall be carried out only after the final finish with three coats of the polyamide base epoxy paint over two coats of epoxy resin based zinc chromate primer.

5.6 (B) Welding works: Requirements, Inspection & Acceptance

a. All welding shall be performed only by qualified welders and under ASME Section IX, using qualified procedures under section IX and modified if necessary to conform to any further requirements stated herein.

b. Only reputed brand electrodes like Advani / ESAB / D&H/ equivalent should be used for carrying out welding.

c. All weld joint preparation, welding process, welding procedure qualification and weld inspection shall be as per ASME Section VIII Division-1.

d. Welding consumables shall be in accordance with ASME Section II, Part C for ASME based material and require IPR's prior approval before their use.

e. All pressure bearing welds, shall be full penetration welds preferably by manual GTAW process.

f. Dye penetrant inspection shall be carried out at root and final pass of welding.

~~g.~~ All type of weld joints shall be 100 % examined by ultrasonic and /or radiography testing.

h. For welds which will be ultrasonically examined, the finished surfaces inside and outside shall be ground smooth to the extent possible that are completely free of ridge, undulations and any marks that could prejudice the examination. Particular care shall be exercised at the root and at the weld edges so that weld blends smoothly into parent metal.

i. Liquid penetrant examination shall be used to verify that the defect has been completely removed prior to weld repair. Repaired welds shall be re-inspected in accordance with the original weld inspection procedure. All weld preparation on material shall be cleaned and free of moisture, grease and other contaminants.

j. All the weld joints shall be inspected in the following stages:

1. <u>Pre welding examination</u>

Ensure the drawings and related documents are available; Identified raw material is used and recorded; standard welding machines are used and equipment/tools are in good condition.

2. <u>During welding examination</u>
   Tack welding shall be done at equal interval before final welding. Surface cracks shall not be permissible; welding parameters shall be monitored and recorded.

k. In case of repair, re-welding shall be carried out as per the standard welding procedure and as per approved WPS. The repair weld shall pass through normal inspection procedure. Details of weld repairs shall be lodged for future reference.

5.7 Inspection, Testing and commissioning EHCL at IPR

The inspection, testing and commissioning activities has to be taken up in the following sequence:

5.7.1 Pre-commissioning
5.7.2 Helium leak testing (individual joints/connection)
5.7.3 Helium leak testing (integrated system)
5.7.4 Pressure testing the integrated loop:
5.7.5 Commissioning of the EHCL

For operating the loop at its nominal condition, initially the loop is charged at 6.0- 7.0 MPa and then circulator is switched on and water flow is established across the coolers. The helium gas is heated slowly by electrical heater till the helium temperature reaches to 300 ºC in the hot leg. During the heating process, the loop pressure also increases to ~ 8.0 MPa. In case, loop pressure is higher or lower than the nominal value, PICS is used to maintain the same by withdrawing or adding required inventory. The details of the different Inspection, Testing and commissioning activities of EHCL System at IPR are as follows:

5.7.1 Pre-commissioning activities

a. Components identification, verification and dimensional checks as per the loop layout, model, drawings and final BOM.
b. Checking the consistency of installed system as per approved P&I diagram and piping & equipment layout drawings
c. Mechanical check like size & gaskets of required size & ratings, tightness of all bolted joints, supporting of all piping and equipment, ferruling check etc.
d. Checking of all the interfaces and connections, utilities, and health of individual systems etc.
e. Electrical checks like the terminal tightness at equipment end and breaker end, measurement of the supply voltage at breaker end shall be carried out. Ensure that all protective devices are wired and configured properly and are functional

Check the Insulation Resistance of relevant components, check direction of rotation of circulator etc.

f. Pre-commissioning Control & Instrumentation checks like venting of all instruments tubing, calibration of instruments, checking of standalone trips/interlocks, testing of SCADA working etc.
g. Checks for reediness of individual components such as circulator, electrical heater, compressor, operation of different valves with actuator, verification of instrumentation and electrical systems etc.
h. Preparation of testing procedure and checklist document for Pre-commissioning activities of the loop and performing the cleaning/flushing of the complete loop using inert gas/helium followed by loop evacuation.

5.7.2 Leak testing (individual joints/connection)

a. Preparation of leak testing procedure document for checking individual joints and connections.
b. DP test in compliance of ASME section V.
c. Leak testing of all the individual weld joints/ connection (including instrumentation process connections). The contractor shall perform helium leak testing in compliance of ASME section V.
d. Leak testing shall be performed by sniffer probe method
e. The leak rate from the joints shall not be greater than 10^{-6} Pa-m^3/s.

5.7.3 Helium leak testing (integrated system)

a. Preparation of leak testing procedure document for integrated leak testing.
b. Readiness of the systems, leak detector, instruments and reference documents etc.
c. Performing integrated leak testing in cold condition (at Room Temp.) at different set pressures as defined below:
d. Maintain the loop pressure slightly above the atmospheric pressure and hold for sufficient time to allow the piping to equalize strains (ten minutes minimum) and the potential leak sites (joints: threaded, socket welded, butt welded, ferrule connections and flanged) of the part are scanned using a Sniffer Probe connected to the inlet of the leak detector.
e. Gradually, increasing the loop pressure in steps up to 7.0 MPa and measure/record the drop in loop pressure, if any, after holding for sufficient time (~ 30 minutes) at different set pressures (e. g. 1.0, 2.0, 3.0, 4.0, 5.0, 6.0 and 7.0 MPa) and observe for pressure drop in loop, if any. The steps mentioned here for gradually increasing the loop pressure and leak testing is indicative. These tests will be carried out as per the mutually agreed test procedure document
f. Increase the loop pressure to the nominal operating pressure (8.0 MPa), and perform the pressure decay test. For the pressure decay test, the loop shall be

charged at 8.0 MPa and held for 5 hours. The maximum allowable change in pressure is ≤0.1 MPa (1 bar) over a period of 5 hour.

g. Perform the helium leak test at nominal operating pressure and temperature conditions (Pr. ~ 8.0 MPa, Temp. 300 ºC) by pressure decay test. The maximum allowable change in pressure is ≤1.0 bar over a period of 5 hour.
h. The integrated leak test with 8.0 MPa pressure as defined in the point no. (f) and (g) above shall be carried out after pressure testing (point no 5.7.4) of the loop.

5.7.4 Pressure testing of the integrated loop:

a. Preparation of pressure testing procedure document for integrated system.
b. Readiness of the systems, safety measures and reference documents.
c. The pneumatic test pressure shall be carried out for 1.1 times the design pressure of the system. The details procedure shall be follows as per ASME sec VIII div.1. (Pressure vessels) and ASME B31.3 (process piping).
d. The pressure test shall be performed using inert gas helium/nitrogen.

Note: Prior to integrated leak testing and pressure testing of the system a test procedure document complying with applicable codes and standards, safety guidelines and standard industrial practices, has to be prepared and mutually agreed and accordingly these tests will be performed.

5.7.5 Commissioning activities

a. Preparation of operational and instruction manual for the loop operation and preparation of commissioning test procedure document (for cold tests and hot tests).
b. The report/document shall be prepared prior to initiating the commissioning activities.
c. The contractor shall complete all the interface connections w.r.t. electrical, I & C and utilities etc.
d. Completion of data-acquisition system & implementation of control system logics and interlocks (software based as well as hardware based interlocks) according to loop operational philosophy.
e. Completion of interface between master control system and control systems of individual components i.e. circulators, electrical heater & helium compressor.
f. Completion of Graphical User Interface (SCADA) for EHCL.
g. The contractor shall demonstrate the integrated loop operation from the control room (remote operation).
h. As part of commissioning tests, the following tests shall be carried out:
   i. **<u>Cold tests</u>:** Operating the loop at different pressure conditions (e.g. 5.0, 6.0 and at 8.0 MPa) and at Room Temp., and operating flow conditions (0.2- 0.4 kg/s) for about 2-3 hours for each operating pressure conditions and

checking the system integrity, functionality of components, performance and operation & control of the complete loop.

ii. **Hot tests**: This shall be performed in the following steps:

- Operating the loop at lower pressure and temperature conditions (~ 6.0 MPa and ~ 200 ºC) and operating flow conditions (0.2- 0.4 kg/s) and checking the system integrity, functionality of components, performance and operation & control of the complete loop.
- Operating the loop at nominal pressure at ~8.0 MPa and at different temperatures (e.g. 200 ºC, 250 ºC) and operating flow conditions (0.2- 0.4 kg/s) for about 1-2 hours for each of the operating temperature condition and checking the system integrity, functionality of components, performance and operation & control of the complete loop.
- Operating the loop at nominal pressure (at ~ 8.0 MPa) and temperature condition (300 ºC to 400 ºC) and operating flow conditions (0.2- 0.4 kg/s) for ~5 hours. The temperature shall be gradually increase to the maximum operating temperature.

iii. **Functional tests for I & C systems**

- Functional tests for all the I&C systems such as Display, Alarms, interlock functions and control loops.

Note: Prior commissioning tests an Operational/Test procedure document complying with applicable codes and standards, safety guidelines and standard industrial practices, has to be prepared and mutually agreed.

5.7 (A) Requirements, Guidelines & Instructions:

a. The required manpower for the execution of the all the work (assembly, installation, integration, testing and commissioning) shall be arranged by the contractor.
b. Prior to performing specified activities, the associated documents shall be prepared and submitted to IPR for approval.
c. All the test parameters shall be recorded and documented.
d. For above testing and commissioning activities, the utilities viz. helium gas, water, electrical power and necessary instruments (leak detector, vacuum pump etc.), shall be provided by IPR.
e. Any other equipment/machine/other utilities required for carrying out installation and commissioning at IPR site shall be in the scope of the Contractor.
f. During the commissioning phase, the EHCL system shall be reviewed by the expert team (appointed by IPR) for providing clearance and approval of the routine loop operation. The recommendation/suggestion, if any provided by the expert team shall be implemented by the contractor without any extra cost.
g. After successful completion of the above tests all the waste materials shall be cleared by the contractor.

6 Acceptance

The complete scope of work is executed in two phases and thus phase-wise acceptance is provided. Once all the activities of phase-1 is successfully completed, the acceptance is provided for first phase. Similarly after successful completion of all the activities of phase-2 the acceptance for second phase is provided. The details of the acceptance criteria for the two phases are as follows:

Acceptance for phase-1:

S.no	Activities	Acceptance criteria
1.	Loop layout, Modelling and Analysis	Successful completion of all the activities as mentioned under scope of work (section 5.1) related to the section, submission of the associated documentations and acceptance / approval of the same by IPR.
2.	Materials, Fabrication & Procurement	Successful completion of all the activities as mentioned under scope of work (section 5.2 and 5.3) related to these sections, submission of the associated documentations, and safe delivery of all the items at IPR along with Factory acceptance test reports & certificates, and acceptance / approval of the same by IPR. The acceptance criteria for the individual items are mentioned in annexure-I.
3.	Packaging and Shipping	

Acceptance for phase-2

S.no.	Activities	Acceptance criteria
1.	Instrumentation and Control system	Successful completion of all the activities as mentioned under scope of work (section 5.4) related to the section, submission of the associated documentations and acceptance / approval of the same by IPR.
2.	Electrical system	Successful completion of all the activities as mentioned under scope of work (section 5.5) related to the section, submission of the associated documentations and acceptance / approval of the same by IPR.
3.	Assembly, Installation and Integration of the EHCL system	Successful completion of all the activities as mentioned under scope of work (section 5.6) related to the section, submission of

		the associated documentations and acceptance / approval of the same by IPR.
4.	Inspection, Testing and Commissioning of EHCL at IPR;	
	Pre-commissioning activities	Successful completion of all the activities as mentioned under scope of work (section 5.7.1) related to the section, submission of the associated documentations and acceptance / approval of the same by IPR.
	Leak testing (individual joints/connection)	a. Successful completion of all the activities as mentioned under scope of work (section 5.7.2) related to the section, submission of the associated documentations and acceptance / approval of the same by IPR. b. The leak rate (joints) ≤ 10^{-6} Pa-m^3/s.
	Helium leak testing (integrated system)	a. Successful completion of all the activities as mentioned under scope of work (section 5.7.3) related to the section, submission of the associated documentations and acceptance / approval of the same by IPR. b. Successful completion of pressure decay test (System Pr. ~8.0 MPa, RT, and holding time 5 hours), maximum allowable change in pressure ≤0.1 MPa. c. Successful completion of pressure decay test at nominal operating condition of the EHCL system (Pr. ~ 8.0 MPa bar, Temp. ~300 ºC, and holding time 5 hours), maximum allowable change in pressure ≤ 0.1 MPa.
	Pressure testing of the integrated loop;	a. Successful completion of all the activities as mentioned under scope of work (section 5.7.4) related to the section, submission of the associated documentations and acceptance approval of the same by IPR.

		b. Successful completion of pneumatic test. The pneumatic test pressure 1.1 times the design pressure (10.0 MPa) of the system.
	Commissioning activities	Successful completion of all the activities as mentioned under scope of work (section 5.7.5) related to the section, submission of the associated documentations and acceptance approval of the same by IPR.
	Cold tests	Successful completion of cold test: Operating EHCL system at operating pressure (80 bar) in cold condition (RT). Temp., and operating flow conditions (0.2-0.4 kg/s) & checking the system integrity, functionality of components, performance and operation & control of the complete loop.
	Hot tests	Successful completion of hot test: Operating EHCL system at operating nominal pressure (~ 8.0 MPa), temp. (300 to 400 ºC) and flow conditions (0.2- 0.4 kg/s) & checking the system integrity, functionality of components, performance and operation & control of the complete loop.
	Functional tests for I & C systems	Successful completion of functional tests for all the I & C systems such as Display, Alarms, interlock functions and control loops.

7 Documentations

Quotation complete in every respect should be forwarded along with detailed catalogues, specifications, data sheets etc. Quotations not giving complete information, as asked below, will be liable for rejection. IPR has right to demand any additional technical documents, if required for proper evaluation of the offer, for information or for checking/ensuring the quality of product.

7.1 Documents / Information to be submitted with bid

i. Supporting documents required for complying the IPR Eligibility Criteria.
ii. Technical offer clearly indicating the different components included and Scope of work.
iii. Filled in Annexure-IV the salient technical specification of different components offered and Company's detail respectively.
iv. Make, Model no., technical datasheet and relevant catalogues for all the components being offered for the EHCL system
v. Cv value of different categories & size of Valves, as applicable
vi. Split up of Time (delivery) schedule phase wise
vii. Complete list of deviations from this specification, if any.
viii. Cost split up for different items and activities as per price-bid template of the tender document
ix. Contractor (and it`s subcontractor) to supply Quality assurance plan (QAP) and the company Quality Management System. The QAP shall show review, hold point, witness for the specific jobs, witness final and important tests/inspections and issuance of inspection release notes.
x. Details of subcontractor, if any
xi. Any other documents mentioned in the tender document

7.2 Documents to be submitted after placement of the purchase order

Following stage wise documents/information may be provided during the execution of the order

A. Loop layout, Modelling & Analysis (including I & C and Electrical system design activities)

i. 2D drawings and 3D model (in CATIA) for the complete loop (including instrumentation components, impulse tubing and cable trays)
ii. "Network Schedule"/" LINKED BAR CHART" mentioning the schedule of various activities till the completion of work.
iii. Updated P&ID.
iv. Piping flexibility analysis results for static and dynamic conditions (including seismic analysis).
v. Piping General Arrangement Drawings/Isometric drawings.
vi. Calculation of thermal insulation material for piping and the loop components considering Microtherm as insulation material.
vii. Thermal and pressure drop calculations for the complete loop.
viii. Support structure design documentations for piping and components of EHCL
ix. Estimation of tubes, flanges, fittings etc. for instrumentation.

x. Sizing and thickness calculation results for the barricade in view of the protection needed to contain the fragment and shock produced considering the anticipated accidental / failure cases.
xi. Updated operational and control philosophy of EHCL.
xii. Updated signal input/output list.
xiii. Electrical Load List
xiv. Detailed Single Line Diagram of EHCL system
xv. Detailed I&C wiring Diagram
xvi. Sizing Calculations for power cables and cable trays
xvii. Cable tray layout for Power and Control Cables
xviii. Electrical Cable Schedule
xix. Technical details of different components being offered along with the relevant catalogue
xx. Design document of the procured & fabricated components
xxi. Sectional / GA drawing mentioning the material of constructions of different parts for different main components like Valves with actuators, Filter & Strainers, compressor, Junction boxes, Master controller PLC panel etc.
xxii. Detailed Quality Assurance Plans (QAP) indicating stage wise inspection & testing plan to be followed for procured & fabricated components
xxiii. BOM document including all the mechanical, electrical and I&C components
xxiv. Any specific design and test reports, as mentioned in the technical specification of the specific components shall be provided by the contractor.
xxv. Any other relevant documents asked by IPR.

B. Material, Procurement, Fabrication and Testing at Factory

i. Material test certificates for all the procured materials.
ii. Inter Granular Corrosion Test (IGCT) certificates
iii. QAP for the fabricated components.
iv. Hydro/pneumatic test reports/certificates for the procured components
v. Leak Test reports/certificates for the procured components
vi. Certificates / reports for design and performance for the bought out components.
vii. Datasheet, general arrangement drawings, analysis reports etc. for the procured items.
viii. Factory test certificate/ report for the acceptance of the component for the procured items.
ix. Supporting documents for design and performance of the supplied component.
x. Calibration test certificates and functional test reports shall be provided for all procured instrumentation components.
xi. Control panel block drawing and circuit diagram

xii. Any specific design and test reports, as mentioned in the technical specification of specific component.
xiii. Any other relevant documents asked by IPR

C. Packaging and Shipping of items at IPR

i. List of the supplied items
ii. Packing & Shipping details
iii. Guarantee certificates for the procured and fabricated components
iv. Operating and maintenance manual for all the procured items
v. Procedure for Installation and commissioning at IPR site
vi. System Start up procedure, as applicable
vii. Inspection / verification report for the received material
viii. Any other relevant documents asked by IPR

Note: The documentations mentioned in this section A, B and C are part of phase-1 activities. The documentations related to design and analysis activities (mentioned in section A) shall be submitted in advance (within 12 weeks) for IPR approval.

D. Assembly, Installation & Integration activities at IPR

i. Installation and integration sequence/plan for all the EHCL loop components
ii. Inspection/Test procedure document for Liquid penetrant examination, Ultrasonic test, Radiographic test, Eddy current test etc.
iii. Material test certificates for welding materials to be used at the factory
iv. Welding Procedure Specification (WPS)
v. Welder Qualification certificate
vi. Procedure Qualification Report (PQR) prepared by qualified welder
vii. Heat treatment procedure, as applicable.
viii. Detail P&I drawings, as required during installation and integration phase.
ix. Drawings and models for Piping & equipment layout
x. As built drawings of procured and fabricated components.

E. Inspection, Testing and Commissioning activities at IPR

i. Testing procedure document for Pre-commissioning.
ii. Helium Leak testing procedure document for performing leak test of individual joints and integrated leak test.
iii. Testing procedure document for Pressure test (pneumatic) of the integrated system.
iv. Testing procedure document for performing commissioning tests (cold and hot test of the system.
v. Operational and Instruction manual for the loop operation.
vi. Control loop code
vii. license of all the software used for implementation

F. Completion stage (after installation and commissioning activities at IPR's site)

i. As built drawings of P&I and Piping & equipment layout.
ii. As built drawings of different components.
iii. Inspection & testing report of integrated system.
iv. Integrated performance test Report.
v. Instruction, Maintenance, operation & safety manual for Process loop including its different components & instruments
vi. As built Electrical and Instrumentation wiring diagrams
vii. Any other relevant documents

Note: The documentations mentioned in this section D, E and F are part of phase-2 activities and these documents shall be submitted before completion of phase-2.

7.3 Spares and accessories:

Contractor shall provide the list of spares considering 3 years of operation of EHCL. The spare list shall be provided separately. Based on the IPR inputs/ comments, the spare list will be finalized.

8 SUB-CONTRACT

The contractor may sub-contract part of the work with the written consent from the IPR. However, the contractor shall be responsible to the IPR for all works under this contract including the works of sub-contractors, as allowed by the IPR. Sub-contracting shall not affect the delivery schedule under any circumstances. Sub-contracting of entire job is not permitted.

9 RIGHTS & PRIVILEGES

9.1 IPR reserves the right to inspect any machinery or material or equipment furnished or used by Contractor under the contract and to reject any, which is found defective in workmanship, or otherwise unsuitable for the use and purpose intended, or which is not in accordance with the intent of the contract.
9.2 Should IPR waive the right to inspect any equipment, such waiver shall not relieve contractor in any way of his obligations under the contract.
9.3 IPR or IPR's representatives shall be permitted free access to Contractor's or his sub- contractor's shop at all working hours for the purpose of evaluating technical capability or inspecting work at all stages of progress.
9.4 IPR's representative shall be provided full assistance in the form of necessary tools, instruments, equipment and qualified operators to facilitate inspection.
9.5 IPR reserves the right to call for certificates of origin, and test certificates for all raw material and equipment at any stage of manufacture.
9.6 Contractor shall keep a set of latest prints of the approved drawings available, on the shop floor for reference of IPR's representative during the inspection.

10 Warranty:

Phase-1

10.1 The contractor shall warrant that all the components thereof furnished during the phase-1 are new and of high quality and that the goods will be free of defects in materials, fabrication and workmanship as per the requirements of this technical specification for a minimum period of twelve (12) months from the date of the acceptance of the same by IPR. However for some components, the warranty period is twenty four (24) months and the same are specified in the data sheet of the individual component.

Phase-2

10.2 The contractor shall warrant that the process loop & all the components (components and services provided by the contractor) thereof furnished during the phase-2 are new and of high quality and that the goods will be free of defects in materials, fabrication and workmanship as per the requirements of this technical specification for a minimum period of twelve (12) months from the date of the acceptance of the integrated system at IPR.

Notes:

a. *If within the above stipulated guarantee period, the subject goods or any parts thereof are found defective because of poor design, workmanship or materials, the contractor at his own expense, repair or furnish and install replacement parts of workmanship and material approved by the IPR. The guarantee period for replaced parts or repair work shall be same as above.*
b. *The warranty period shall be extended by the length of time required to make any adjustments, changes or repairs necessary to fulfill the guarantee.*
c. *The contractor shall obtain similar guarantees from each one of his sub-contractors. However, the overall responsibility shall lie with the contractor.*

11 Training:

After the completion of Phase-2 activities, comprehensive hands-on training (for at least three days) at the IPR's site shall be provided at the cost of the contractor. This training must include operation, trouble shooting and maintenance of the complete system and its components.

12 Delivery Period

The delivery of the complete scope of work of the contract is carried out under the following two phases:

Sl. No.	Tasks	Time period
1	PHASE-1: Supply of EHCL system at IPR	30 weeks

		(from the date of PO placement)
2	PHASE-2: Installation & Integration of all the EHCL components and Testing & Commissioning of the EHCL system at IPR.	32 weeks (from the date of intimation by IPR to start the phase-2 activities)

Notes:

1. *Contractor stands committed for completion of all the activities of both the phases. The scope for phase-1 shall be completed and settled first, as per the tender conditions. Following the completion of phase-1, IPR shall intimate the contractor for the commencement of work of Phase 2.*
2. *After completion of the phase-1 activities, IPR may intimate to the contract to start the activities of Phase-2 within 9 months (maximum).*
3. *Contractor should adhere to the delivery terms mentioned above, failing which their offer/quotation shall not be considered for further evaluation.*

13 Clearance of Site on Completion

On completion of the works, the contractor shall clear away and remove from the site, all surplus materials, rubbish and temporary works of every kind and leave the whole site, furniture, walls and works clean and in good condition to the satisfaction of the Institute at his own cost. If the contractor fails to clear the site within 7 days after virtual completion/submission of final bill whichever is earlier, the Institute may get the site cleared at contractor's cost.

Annexure-1

Material to be fabricated/procured by the contractor and their technical details

Sl. No.	Description of items	Identifications /tag no
1.	Supply, installation, Integration, testing and commissioning of ON / OFF valve for cooling water	VG-007, VG-008 VG-009, VG-010, VG-013
2.	Supply, installation, Integration, testing and commissioning of Control valve for cooling water	VC-005
3.	Supply, installation, Integration, testing and commissioning of Helium compressor unit	PC-101
4.	Supply, installation, Integration, testing and commissioning of Filters for helium gas line	FF-001 and FF-002
5.	Supply, installation, Integration, testing and commissioning of Filters for water line	FF-003
6.	Supply, installation, Integration, testing and commissioning of circulation suction and discharge tanks across circulators	Tank-1 & Tank-2
7.	Supply, installation, Integration, testing and commissioning of Pressure reducing valve	PRV-101
8.	Supply, installation, Integration, testing and commissioning of water line instrumentations (flow meter, pressure transmitter and thermocouples with thermowells)	FE-005, MP-010, MTE-018, MTE-019,
9.	Supply, installation, Integration, testing and commissioning of thermocouple with thermowell in PICS line.	MTE-101
10.	Supply, installation, Integration, testing and commissioning of pipe-surface mount thermocouple with transmitter located at electrical heater outlet.	MTE-011
11.	Supply, installation, Integration, and commissioning of pressure transmitter panel and associated accessories.	2 No.
12.	Supply, installation, Integration, testing and commissioning of I&C cables along with cable	As per the layout

	trays, cable ferrules, cable tray supports, junction box, glands, etc.	
13.	Supply, installation, Integration, testing and commissioning of master controller PLC panel.	1 No.
14.	Supply, installation, Integration, testing and commissioning of pressure transmitter for monitoring instrument air pressure in the system.	PT for Instrument air (MP-IA)
15.	Supply, installation, Integration, and testing of 8mm instrument tubing and fittings along with necessary supports.	As per the layout
16.	Supply and installation, of electrical cables and cable trays along with supports and accessories for laying, tagging, glanding and termination	As per the layout
17.	Supply, installation, Integration, testing and commissioning of Drain and Vent valves.	10 Nos.
18.	Supply, installation, Integration, testing and commissioning of PSVs (helium gas).	VR-001
19.	Supply, installation, Integration, testing and commissioning of PSVs (water).	VR-002, VR-003
20.	Supply, installation, Integration, testing and commissioning of Rupture discs.	5.0 Nos.
21.	Supply, installation, Integration, testing and commissioning of non-return valves	5.0 Nos.
22.	Manual ball valves PV-002 and PV-101	2.0 Nos.
23.	Supply, installation, Integration, testing and commissioning of PICS unit, charging unit along with associated fittings and connections.	PICS set-up (1 no.)
24.	Supply of Barricade material for enclosing the process area	Indicative Process area ~ 10m x 10m x 5m (H) & 4m x 4m x 4m (H)]
25.	Supply, installation, Integration, and testing of seamless pipes of different sizes	As actual
a.	Pipe Size - DN40, Sch. 40 S	Water system
b.	Pipe Size - DN100, Sch. 40S	Helium system

c.	Pipe Size - DN50, Sch. 80S	Helium system
d.	Pipe Size - DN25, Sch. 40S	Helium system
26.	Supply, installation, Integration, and testing of insulation materials for hot pipes and components	As actual
a.	Pipe Size - DN50, Sch. 80S	Microtherm
b.	Pipe Size - DN40, Sch. 40 S	Microtherm
c.	Insulation on Recuperator, Coolers, Electrical heater, tanks, filter, valve body etc.	Microtherm
27.	Supply, installation, Integration, and testing of pneumatic tubing	As actual
28.	License upgradation for Siemens WinCC SCADA for additional tags for EHCL logic development, if any.	--
29.	Supply, installation, integration and testing of Electronics/Logic-solver for all hardwired interlocks as per required functionality mentioned in EHCL Instrumentation charts.	Hardwired interlocks as per Instrumentation chart
30.	Spares items, if any	--

Note: If required, the details of the above items can be updated based on the design and analysis of the system. For Identifications /tag no of the items, please refer EHCL P & ID (annexure-2)

List of Approved manufacturer/make:

Sl. No.	**Details of equipment**	**Suggested manufacturer / make (or equivalent)**
1.	Control valve for water line	VELAN/Flowserve
2.	ON/OFF valve for water line	VELAN/Flowserve
3.	Helium Compressor	Sundyne / HOFER
4.	Dust filters	Delta filters
5.	Water strainers	Trishul/Triveni/Sant/Emerald/Leader/Advance/ Flowtech/Crescent valves/Flairs/Emerald
6.	Pressure reducing valve	Parker/Bombay fluid/Emerson

7.	Process instruments	WIKA, Endress+Hauser, Emerson Process management,Siemens, Krohne, Honeywell, ABB, Yokogawa
8.	I&C cables and Power cables	Polycab. Havells, KEI and Finolex.
9.	Master Controller PLC Panel	President, Rittal, Valrack, Selrack.
10.	Instrument tubing and fittings	Swagelok/Parker
11.	Pressure safety valves	LESER/Nirmal Industries/FIKE/PARKER
12.	Rupture discs	BS&B/FIKE/Donadon
13.	Seamless pipes	Ratnamani / Suraj Ltd./MTS pipes
14.	Insulation material	Microtherm or other reputed make

Note: For any system components if make is not specified, only reputed make must be used with prior approval from IPR.

SL. NO. 1 & 2: (Technical specifications of Control and ON/OFF valves for water system)

1.0 Introduction

This specification is for the supply of two types of valves for the water line in main loop:

1.1. Control valves: These valves are required to control flow/temperature as per the experimental requirements in EHCL.

1.2. ON/OFF Valves: These valves are required for flow isolation as per the experimental requirements in EHCL.

Data sheet for Control valve (water line)

General requirement	
Tag No.	**VC-005**
Material of construction	Stainless steel 316L with relevant ASTM grade
Fluid medium	Cooling water (DM water)
Applicable code	ASME B16.34/ISA/FCI-70.2/MSS SP-117/EJMA
Type	Globe Control valve
Process conditions	
Mass flow rate (range)	30-120 LPM
Operating temperature and pressure	25 ºC and 0.3 MPa
Design temperature and pressure	100 ºC and 0.5 MPa
Pipe size	$1^{1/2}$ " 40 Sch
C_v range	2-12
Air fail action	Open
Performance	
Leak rate across body (welded connection)	$<10^{-6}$ Pam^3/s
Leak rate across seat	As per Class IV leakage as FCI 70.2
Rangeability	> 30:1
Dead band	Less than 0.5% of input span
Hysteresis	Less than 0.7% of output span
Inaccuracy of the positioning	Less than 1% of input span
Body	
Size	40 mm
Type	Single seated
Material	ASTM-A 351 Grade CF8M
End connections	Butt welded, CL 300
Bonnet	
Bonnet material	ASTM-A 351 Grade CF8M
Type	Bolted
Bonnet gasket material	ASTM-A 351 Grade CF8M
Stem packing material	PTFE

Trim	
Type	Unbalanced
Plug and stem material	ASTM-A 351 Grade CF8M
Seat material	ASTM-A 351 Grade CF8M
Actuator	
Type	Diaphragm type pneumatic actuator
Air pressure	4-7 bar
Air tubing connection	½" NPT (M)
Threaded fasteners	
Bolts and Studs	ASTM A193 Gr. 8MA
Nuts	ASTM A194 Gr. 8MA
Control valve accessories to be provided by the contractor	
All the control valve accessories mentioned below shall be from reputed manufacturers: a. Smart positioner b. Current to pressure converter (I to P Converter) c. Position transmitter (2-wire with a transmission facility of 4 to 20 mA) d. Air filter-regulator e. Limit switches f. Interconnecting Tubing	
Inspection and Testing: The contractor has to perform the following tests at factory and submit associated tests results/ test certificates. The tests results shall satisfy the technical details mentioned in the specification above. IPR or its representative (s) may witness some of the tests at the factory. a. Liquid penetration examination of body, bonnet, plug, stem, fasteners b. Radiographic examination of castings as per ASME Sec. V c. Intergranular corrosion test for body, bonnet, plug, stem d. Hydrostatic test to be performed as per ASME Sec. VIII Div.1 e. Seat leak test to be performed as per FCI 70.2 f. Helium leak test to be performed as per ISO 15484-1 with helium gas (Sniffer method) g. Functional test includes opening/closing of valve and proper operation of positioner h. Static performance test: Checking of T_{63}/T_{86}/Dead band/Overshoot parameters i. Cv and flow characteristics tests to be performed as per ISA 75.02	

Data sheet for ON/OFF valve (water line)

General requirement	
Tag No.	**VG-007/VG-008/VG-009/VG-010/VG-013**
Material of construction	Stainless steel 316L with relevant ASTM grade
Fluid medium	Cooling water (DM water)
Applicable code	ASME B16.34/ISA/FCI-70.2/MSS SP-117/EJMA
Type	Globe valve

Process conditions	
Mass flow rate (range)	30-120 LPM
Operating temperature and pressure	25 ºC and 0.3 MPa
Design temperature and pressure	50 ºC and 0.5 MPa
Pipe size	$1^{1/2}$ " 40 Sch
Air fail action	Open
Performance	
Leak rate across body (welded connection)	$<10^{-6}$ Pam^3/s
Leak rate across seat	Class IV leakage as FCI 70.2
Rangeability	> 30:1
Dead band	Less than 0.5% of input span
Hysteresis	Less than 0.7% of output span
Inaccuracy of the positioning	Less than 1% of input span
Body	
Size	40 mm
Type	Single seated
Material	ASTM-A 351 Grade CF8M
End connections	Butt welded, CL 300
Bonnet	
Bonnet material	ASTM-A 351 Grade CF8M
Type	Bolted
Bonnet gasket material	ASTM-A 351 Grade CF8M
Stem packing material	PTFE
Trim	
Type	Unbalanced
Plug and stem material	ASTM-A 351 Grade CF8M
Seat material	ASTM-A 351 Grade CF8M
Actuator	
Type	Diaphragm type pneumatic actuator
Air pressure	4-7 bar
Air tubing connection	½" NPT (M)
Threaded fasteners	
Bolts and Studs	ASTM A193 Gr. 8MA
Nuts	ASTM A194 Gr. 8MA
ON/OFF valve accessories	
All the ON/OFF valve accessories mentioned below shall be from reputed manufacturers: • Solenoid valve • Air filter-regulator • Limit switches • Interconnecting Tubing	

Inspection and Testing: The contractor has to perform the following tests at factory and submit associated tests results/ test certificates. The tests results shall satisfy the technical details mentioned in the specification above. IPR or its representative (s) may witness some of the tests at the factory.

- Liquid penetration examination of body, bonnet, plug, stem, fasteners
- Radiographic examination of castings as per ASME Sec. V
- Intergranular corrosion test for body, bonnet, plug, stem
- Hydrostatic test to be performed as per ASME Sec. VIII Div.1
- Seat leak test to be performed as per FCI 70.2
- Helium leak test to be performed as per ISO 15484-1 with helium gas (Sniffer method)
- Functional test includes opening/closing of valve and proper operation of positioner
- Cv and flow characteristics tests to be performed as per ISA 75.02

Sl. No 3: Technical specifications of Helium Compressor (PC-101)

Sr. no.	Parameters	Value
A. Functional requirements:		
1.	Process Fluid	Helium gas
2.	Suction pressure (Absolute) (MPa)	~0.1
3.	Maximum (safety valve set) Pressure (gauge) (MPa)	19
4.	Working Pressure (gauge) (MPa)	15
5.	Maximum Helium flow rate (Nm^3/hr)	15-20
6.	Static leak rate (mbar.l/s)	10^{-3} or better
7.	Type of Compressor	Diaphragm
8.	Residual oil content, (mg/m^3)	0.01-0.05 or better
9.	Ambient temperature range (ºC)	10-45
10.	Discharge Temperature range (ºC)	<15 C above ambient/intake
11.	Noise level (ISO 3744)	< 85 dB
B. Standard scope of supply:		
12.	In-built purification system, to minimize contamination of the process fluid, if any	
13.	Gas intake connection complete with gas connection; female thread, particle filter, intake buffer vessel intake pressure gauge, intake pressure monitoring by pressure sensor and shut-off solenoid valve. (as applicable)	
14.	Pressure relief valve after every stage.	
15.	Safety valve sealed at each stage with a return line back into the buffer vessel.	
16.	Oil pumping system: Forced feed lubrication type. Oil pump with oil filter shall be provided. (as applicable)	
17.	Inlet buffer vessel with connection via flexible hose to inlet of compressor shall be provided. The buffer vessel to have a safety valve.	
18.	Motor	SIEMENS, ABB, GE, CG or equivalent make continuous duty 3-phase induction motor of suitable rating as per compressor requirement.
C. PLC based Control Panel:		
19.	Mains Supply	3-Phase 415V ± 10%, 50Hz
20.	Emergency stop	To be provided
21.	Ingress Protection	IP55 or better
22.	User Interface	HMI display with push buttons or keypads

Sr. no.	Parameters	Value
23.	Display Parameters	• Discharge/ Final pressure (bar) • Hours meter • Gas temperature (C) before cooler • Compressor On/OFF • Maintenance survey • Error indications /error logbook (minimum 10 entry; FIFO basis)
24.	Errors and Alarm Indications	• Emergency stop • Motor overload • Low and high gas suction pressure • Low oil lubricating pressure • Final gas Temperature high • Final gas Pressure high
25.	Required signals from compressor Control Panel to IPR master controller	• Local operation mode • Remote operation mode • Fault signals • Profibus with IPR master controller
26.	Command signals from IPR master controller to Compressor control panel	• Start/Stop command signal
D. Spares:		
27.	Commissioning Spares	The contractor should arrange for spares required during installation and commissioning. (if any)
28.	Operational Spares	The contractor should provide operational spares for minimum 1000 running hours (to be quoted separately).
E. Test Reports/certificates to be provided by the contractor		
29.	Hydro/pneumatic test reports/certificates	As per ASME Sec. VIII Div. 1
30.	Static Leak Test reports/certificates	10^{-3} (mbar.l/s) or better Shall be carried out as per ASME Sec. V or equivalent standards
31.	Test reports/certificates for Residual content	0.01-0.05 (mg/m^3) or better. To be carried out as per QAP
32.	Test reports/certificates for Noise level	< 85 dB
33.	Material test certificate	As per QAP
F. Performance tests (at factory)		

Sr. no.	Parameters	Value
34.	Measurement of suction and discharge pressure	Shall comply with the values / functions mentioned in this data sheet.
35.	Functioning of motor and its connection	
36.	Leak rate measurement	
37.	Performance of overall control system	
G. Inspection and Testing: The contractor has to perform the tests mentioned in section E and F in this specification at factory and submit associated tests results/ test certificates. The tests results shall satisfy the technical details mentioned in the specification above. IPR or its representative (s) may witness some of the tests at the factory.		
H. Warranty:		
38.	The Contractor should offer a warranty for minimum of 2 years from the date of acceptance of the item.	
I. Training:		
39.	Comprehensive hands-on training (for at least two days) at the factory site shall be provided at the cost of the Contractor. This training must include operation, trouble shooting and maintenance of the compressor and all its subsystems.	

Sl. No 4: Technical specifications of filters (helium gas line)

Tag No.	**FF-001 and FF-002**
Type	Sintered Powder Filter Cartridge
Material of housing and cartridge	Stainless steel 316L with relevant ASTM grade
Fluid to be handled	Helium gas
Quantity	2 nos.
Filter rating	3 micron
Maximum allowable pressure drop	≤ 50 mbar
Outlet gas quality (min.)	99.99%
Applicable Code	ASME Section VIII Division 1
No. and size of nozzles for process piping	1 no. of inlet nozzle (2”) 1 no. of outlet nozzle (2”)
Design temperature and pressure	100 ºC & 10.0 MPa
Mounting	Vertical with leg support
Additional information:	Differential pressure gauge to be provided for pressure drop measurement. Contractor to submit GA drawings and operational manual/brochure.
Test reports/ Certificates to be provided	Hydro test, NDT report, pressure drop certificates, material certificates (Tests to be performed as per the applicable ASME codes). The tests results shall satisfy the technical details mentioned in the specification above. IPR or its representative (s) may witness some of the tests at the factory.
Preferred make	Delta Filters

Sl. No 5: Technical specifications of filters (water line)

Tag No.	**FF-003**
Media	DM water
Type	Casted body Y-strainer
Pressure rating	CL 150
Operating temperature, ºC	0-80
Design temperature, ºC	100
Operating pressure, MPa	0.3
Design pressure, MPa	0.5
Max. rated flow, LPM	120
Material of construction	SS 304 or better
Screen mesh size	100 micron (wire mesh to be supported by perforated SS sheet)
Thickness of SS perforated sheet	Minimum 24 gauge thick
Maximum pressure drop, bar	0.3 at rated flow

Sealing	PTFE or equivalent
End connection	As per ASME B16.5, class 150 SORF flanges
Testing standard	As per API 598
Test reports/ Certificates to be provided	Hydro test, NDT report, pressure drop certificates, material certificates, GA drawings and operational manual (Tests to be performed as per the applicable ASME codes). The tests results shall satisfy the technical details mentioned in the specification above. IPR or its representative (s) may witness some of the tests at the factory.
Preferred make	Trishul/Triveni/Sant/Emerald/Leader/Advance/ Flowtech/Crescent valves/Flairs/Emerald

Sl. No 6: Data Sheet/ Technical spec. of Circulator suction and discharge tanks

Tag no.	Tank-1 and Tank-2
Material of construction of wetted part	Stainless steel 316L with relevant ASTM grade
Approximate capacity	35 liters
Fluid to be handled	Helium gas
Quantity	2 nos.
Applicable Code	ASME Section VIII Division 1
Dimensions	300 mm (D) x 500 mm (H) and t ~10mm
No. and size of nozzles for process piping on each tank	1 no. of inlet nozzle (2”) 2 nos. of outlet nozzle (2”)
Design temperature and pressure	100 ºC & 10.0 MPa
Mounting	Vertical with leg support
Additional information:	All the nozzles shall be spaced at 90° to each other as per the supplied GA drawing
Test reports/ Certificates to be provided	• Hydro test, leak test, material certificates, NDT report (Tests to be performed as per the applicable ASME codes). • The tests results shall satisfy the technical details mentioned in the specification above. IPR or its representative (s) may witness some of the tests at the factory.
Other Details/requirements	As per technical specification of the tender document

Sl. No 7: Data Sheet/ Technical specifications of Pressure reducing valve

Tag No.	**PRV-101** (at recovery compressor suction line)
Type	Diaphragm sensing pressure regulator
Process fluid	Helium gas
Body material	SS 316L
Seat material	SS 316L
Flow pattern	Straight
Actuator operation	Automatic
Maximum inlet pressure, MPa	15.0
Maximum outlet pressure, MPa	$\leq$ 0.1
Design pressure, MPa	20.0
Operating temperature, ºC	10-45
Design temperature, ºC	50
Max. flow rate, Nm^3/hr	15-60
End connection	Butt welded
Max. leak rate, Pa/m^3-sec	10^{-6}
Port configuration	Left to right with pressure gauge ports (At inlet and outlet).
Test reports/ Certificates to be provided	Hydro test, NDT report, material certificates, GA drawings and operational manual (Tests to be performed as per the applicable ASME codes). The tests results shall satisfy the technical details mentioned in the specification above. IPR or its representative (s) may witness some of the tests at the factory.
Other Details/requirements	As per technical specification of the tender document. To satisfy the above pressure reduction, contractor is suggested to select appropriately the no. of stages (e.g. single / multiple).
Preferred make	Parker/Bombay fluid/Emerson or equivalent

Sl. No 8, 9, 10, 11, 12, 13 and 14: Data Sheet/Technical spec. Instrumentations

Temperature Sensors with Transmitters	
Tag No.	**MTE-101, MTE-011, MTE-018, , MTE-019**
Type	K-Type Ungrounded thermocouples with 2-wire loop powered temperature transmitters
To be installed on	• 1-inch piping for helium temperature measurements (MTE-101) in PICS. • DN40 pipe for water temperature measurements (MTE-018 and MTE-019) in water line of main loop. • SS-pipe surface for surface temperature measurement (MTE-011) at heater outlet line. Necessary installation provision is to be made as deemed necessary in consultation with Engineer-in-charge.
Mounting	• Through weld-in type thermowells (MTE-101, MTE-018 and MTE-019). • Through surface spot-welding (MTE-011).
Calibrated Span	• 0-500ºC corresponding to 4-20 mA DC output signal for MTE-011. • 0-100ºC corresponding to 4-20 mA DC output signal for MTE-101, MTE-018 and MTE-019.
Maximum Operating Temperature	• 400ºC for MTE-011. • 100 ºC for MTE-101. • 50ºC for MTE-018 and MTE-019.
Design Pressure	• 200 bar (g) for MTE-101. • Ambient pressure for MTE-011. • 5 bar (g) for MTE-018 and MTE-019.
Accuracy	As per IEC-60584, Class-1
Test reports/ Certificates to be provided	• Calibration tests to be performed at 3 equally spaced points within the calibrated span of each temperature element. The accuracy shall be confirmed to as per IEC-60584, Class-1. • Hydrotest shall be performed for all the thermowell units with test pressure as 1.5 times the design pressure. • The tests results shall satisfy the technical details mentioned in the specification above. IPR or its representative (s) may witness some of the tests at the factory.

Preferred make	WIKA, Endress+Hauser, Emerson Process management, Siemens, Krohne, Honeywell, ABB, Yokogawa.
Pressure Transmitters	
Tag No.	**MP-010,** **MP-IA** (Sl. No. 14 of annexure-1)
Type	2-wire loop powered type gauge pressure transmitters
To be installed on	• Instrument air common header supply line (MP-IA). • Cooling water inlet supply line (MP-010).
Mounting	Through 2-way valve manifolds
Maximum Operating Temperature	50 ºC
Design Pressure	• 10 bar (g) for MP-IA. • 5 bar (g) for MP-010.
Calibrated Span	• 0- 10 bar (g) for MP-IA corresponding to 4-20 mA DC output signal. 0-5 bar (g) for MP-010 corresponding to 4-20 mA DC output signal.
Accuracy	±0.5% of calibrated span or better
Test certificates	• Calibration tests to be performed at 3 equally spaced points within the calibrated span of each pressure transmitter. The accuracy shall be confirmed to be within ±0.5% of calibrated span. • Hydrotest shall be performed for each pressure transmitter unit with test pressure as 1.5 times the design pressure.
Preferred make	Endress+Hauser, Emerson Process management, Siemens, Krohne, Honeywell, ABB, Yokogawa.
Flow Sensor with Transmitter	
Tag No.	**FE-005**
Type	Vortex flowmeter with 2-wire loop powered flow transmitter
To be installed on	Cooling water outlet line (FE-005).
Line Size	DN 40, Schedule 40
Maximum Operating Temperature	50 ºC
Design Pressure	5 bar (g)
Calibrated Span	0-100 LPM corresponding to 4-20 mA DC output signal
Accuracy	±1% of reading or better

Test reports/ Certificates to be provided	• Calibration test to be performed at 3 equally spaced points within the calibrated span of flow transmitter. The accuracy shall be confirmed to be within ±1% of reading. • Hydrotest shall be performed for flow sensor unit with test pressure as 1.5 times the design pressure. • The tests results shall satisfy the technical details mentioned in the specification above. IPR or its representative (s) may witness some of the tests at the factory.
Preferred make	Endress+Hauser, Emerson Process management, Siemens, Krohne, Honeywell, ABB, Yokogawa.
Pressure Transmitter Panel (Sl. No. 11 of annexure-1)	
Quantity	2 units
Size	1500 mm X 500 mm footprint for each panel
Material	Suitable size transmitter panel; MS/GI pipe with 2” outer diameter universal mounting; powder coated.
Junction Boxes (Sl. No. 12 of annexure-1)	
Supply and installation of MS/CS Junction boxes with suitable size including supply of all supports and fixing materials for installation of box, complete with rail-mounted terminal blocks and PVC dual side slotted duct-cable managers. Junction boxes shall be made from 2 mm thick metal-sheet with necessary cable glands. Powder coating should be done on the junction boxes. Junction box shall contain appropriate number of DIN rail mounted screw terminal blocks with terminal size of upto 1.5 mm^2.	
I&C Cables	
Conductor Material	Copper
Conductor type	Stranded
Cable Type	• Shielded twisted pair copper cables (1.5 mm^2) from all field transmitters and other I&C components upto the local junction box(es). • Multi-pair shielded twisted-pair copper cables (each pair of 1.5 mm^2) from local junction box(es) upto master controller PLC panel.
Insulation Material	PVC/PTFE
Overall Jacket	FRLS jacketed
Preferred Make	Polycab. Havells, KEI and Finolex.

Approximate length required	• 1500 mtrs from field transmitters and I&C to junction box(es). • 50 mtrs from junction box(es) to master controller PLC panel. (Cable lengths may vary depending on final loop layout. Above values are approximate estimations).
All field wiring should be routed via suitable cable trays and ducts	
Master controller PLC Panel (Sl. No. 13 of annexure-1)	
Quantity	1 unit (for mounting of master controller PLC and associated accessories).
Rack-type	Floor standing 36U/42U 19" instrument/server rack with toughened transparent glass front door, appropriate ventilation fans, caster wheels with foot brakes, front and rear lights. The panel shall contain top and bottom cable entry provision, PVC dual-side slotted duct cable manager (vertical and horizontal) with removable covers, necessary power distribution units (for internal AC supply distribution), MCBs, fuses, relays, earthing bar etc.
Preferred make	PRESIDENT, RITTAL, VALRACK, SELRACK.

Sl. No 15: Data Sheet/ Technical spec. of Instrument tubing and fittings

Supply of 8mm instrument tubing, fittings, fittings along with clamps, trays etc., all required within the battery limit of experimental requirements in EHCL.	
Length	1000 meters
Material	SS 316 L
Preferred make	Swagelok , Parker or equivalent
Test reports/ Certificates to be provided	• Material test reports, hydro test, NDT (Tests to be performed as per the applicable ASME codes). • The tests results shall satisfy the technical details mentioned in the specification. IPR or its representative (s) may witness some of the tests at the factory.
Other requirements	As mentioned in the tender document

Sl. No 16: Data Sheet/ Technical spec. of Electrical power cables and Cable Trays

Electrical Power Cables	
Conductor Material	Copper
Conductor Type	Stranded
Insulation Material	XLPE
Sheath Material	PVC
Cable Type	Multi-core, unarmored/flexible, FRLS
Voltage Grade	1100 V
Applicable Standard	IS 7098 Part 1
Preferred Make	Polycab, Havells, KEI, Finolex
Approximate Length required	
3.5 core 300 sq.mm 3.5 core 120 sq.mm 3.5 core 70 sq.mm 3.5 core 35 sq.mm 3.5 core 25 sq.mm 3.5 core 16 sq.mm 4 core 4 sq.mm 3 core 2.5 sq.mm	70 m 75 m 120 m 70 m 80 m 285 m 120 m 60 m (Cable lengths may vary depending on equipment layout. Above values are approximate estimations)
Power and Control Cable Trays	
Type of Cable Tray	Perforated Type
Material	Hot Dip Galvanized Iron (G.I.)
Cable Tray Thickness	2 mm
Installation	Indoor, overhead
Length of Cable Tray to be supplied and installed	As per final approved cable tray layout generated by contractor

Sl. No 17 Data Sheet/ Technical specifications of Drain and Vent valves

Item	Drain and vent valves
Material	SS 316L
Size	DN15
Quantity	10 nos.
Type	Manual bellow sealed valves
Test reports/ Certificates to be provided	• Hydro test, NDT report, material certificates (Tests to be performed as per the applicable ASME codes). • Other required documents: GA drawings and operational manual. • The tests results shall satisfy the technical details mentioned in the specification. IPR or its representative (s) may witness some of the tests at the factory.
Other Details/requirements	As per technical specification of the tender document

Sl. No 18 and 19: Data Sheet/ Technical specifications of PSVs

Tag No.	**VR-001** (Relief valve at Circulator discharge)
Material of construction	SS 316L (except bellow material: Inconel 625)
Applicable code	API 520/API 526/API 527/ASME Sec. VIII Div. 1
Leakage class	Class IV or better
Type	Full bore type (bellow sealed)
Make	LESER/Nirmal Industries/FIKE/PARKER
Fluid to be handled	Helium gas
Quantity	1 no.
Operating temperature, C	80
Operating pressure, MPa	8.3
Design temperature, C	100
Design pressure, MPa	10.0
Set pressure, MPa	9.4
Minimum relieving capacity, kg/hr	1440
Additional information:	Contractor shall size, select and procure the valve based on the capacity requirements and appropriate codes. The connection between the system and pressure relief device shall have a minimum inside diameter equal to or greater

	than the nominal inside diameter of the pressure relief device inlet.
Tag No.	**VR-002/VR-003** (Relief valve at Cooler outlet – Water line)
Material of construction	SS 316L
Applicable code	API 520/API 526/API 527/ASME Sec. VIII Div. 1
Leakage class	Class IV or better
Type	Full bore type (bellow sealed)
Make	LESER/Nirmal Industries/FIKE/PARKER
Fluid to be handled	Water
Quantity	2 nos.
Operating temperature, C	40
Operating pressure, MPa	0.3
Design temperature, C	100
Design pressure, MPa	0.5
Set pressure, MPa	0.4
Minimum relieving capacity, LPM	90
Additional information:	Contractor shall size, select and procure the valve based on the capacity requirements and appropriate codes. The connection between the system and pressure relief device shall have a minimum inside diameter equal to or greater than the nominal inside diameter of the pressure relief device inlet.
Test reports/ Certificates to be provided	▪ Hydro test, leak test, material certificates, set pressure and back pressure test, NDT report (Tests to be performed as per the applicable ASME codes). ▪ Other documents: GA drawings and operational manual. ▪ The tests results shall satisfy the technical details mentioned in the specification. IPR or its representative (s) may witness some of the tests at the factory.
Other Details/requirements	As per technical specification of the tender document

Sl. No 20: Data Sheet/ Technical specifications of Rupture discs

Tag No.	**DK-001** (TSM outlet)
Preferred Make	BS&B/FIKE/Donadon
Type	Forward acting scored type (tension loaded non-fragmenting)
Disk MOC	SS 316L
Disk size	1”
Disk thickness, mm	0.5
Disk holder MOC	SS 316
Relieving gas	Helium
Min. Relieving capacity, kg/hr	1440
Relieving temperature, C	400
Design temperature, C	450
Operating pressure, MPa	8.0
Operating ratio, %	85
Specified burst pressure, MPa	9.4
Manufacturing range, %	0
Burst pressure tolerance, %	$\pm$5
Marked burst pressure, MPa	9.4
Design pressure, MPa	10.0
Min. net flow area, sq. inches	0.86
Backpressure	Atmosphere
Max. leak rate, mbar-l/sec	$1x10^{-6}$
Other Details/requirements	As per technical specification of the tender document
Test reports/ Certificates to be provided	▪ Leak test, material certificates, burst pressure test, NDT report ▪ Other documents: GA drawings and operational manual. ▪ The tests results shall satisfy the technical details mentioned in the specification. IPR or its representative (s) may witness some of the tests at the factory.

Tag No.	**DK-002** (**Circulator outlet**)
Preferred Make	BS&B/FIKE/Donadon
Type	Forward acting scored type (tension loaded non-fragmenting)
Disk MOC	SS 316L
Disk size	1”
Disk thickness, mm	0.5
Disk holder MOC	SS 316
Relieving gas	Helium
Min. Relieving capacity, kg/hr	1440
Relieving temperature, C	400

Design temperature, C	450
Operating pressure, MPa	8.0
Operating ratio, %	85
Specified burst pressure, MPa	9.4
Manufacturing range, %	0
Burst pressure tolerance, %	±5
Marked burst pressure, MPa	9.4
Design pressure, MPa	10.0
Min. net flow area, sq. inches	0.86
Backpressure	Atmosphere
Max. leak rate, mbar-l/sec	$1x10^{-6}$
Other Details/requirements	As per technical specification of the tender document
Test reports/ Certificates to be provided	▪ Leak test, material certificates, burst pressure test, NDT report (Tests to be performed as per the applicable ASME codes). ▪ Other documents: GA drawings and operational manual. ▪ The tests results shall satisfy the technical details mentioned in the specification. IPR or its representative (s) may witness some of the tests at the factory.

Rupture disks In PICS at different locations	
Quantity	3 nos.
Preferred Make	BS&B/FIKE/Donadon
Type	Forward acting scored type (tension loaded non-fragmenting)
Disk MOC	SS 316L
Disk size	1”
Disk thickness, mm	0.8
Disk holder MOC	SS 316
Relieving gas	Helium
Min. Relieving capacity, m^3/hr	20
Relieving temperature, C	10-45
Design temperature, C	50
Operating pressure, MPa	15.0
Operating ratio, %	85
Specified burst pressure, MPa	19.0
Manufacturing range, %	0
Burst pressure tolerance, %	±5
Marked burst pressure, MPa	19.0
Design pressure, MPa	20.0
Min. net flow area, sq. inches	0.86
Backpressure	Atmosphere
Max. leak rate, mbar-l/sec	$1x10^{-6}$
Other Details/requirements	As per technical specification of the tender document

Test reports/ Certificates to be provided	▪ Leak test, material certificates, burst pressure test, NDT report (Tests to be performed as per the applicable ASME codes). ▪ Other documents: GA drawings and operational manual. ▪ The tests results shall satisfy the technical details mentioned in the specification. IPR or its representative (s) may witness some of the tests at the factory.

Sl. No 21 and 22: Data Sheet/ Technical spec. of Non-return and manual valves

Tag no.	**VK-001, VK-002, VK-101, VK-102 and VK-103**
Type	Non-return valves
Material	SS 316L
Size and quantity	1" (40 Sch) and 3 nos. VK-101, VK-102 and VK-103 2 " (80 Sch) and 2 nos. VK-001, VK-002,
Other Details/requirements	▪ Wafer type suitable to sandwich between ASME B16.5, class 150 SORF flanges ▪ The valves shall be of flapper / Single plate swing / dual plate spring type as per in SOQ. ▪ Operating temperature: 15 – 50 ºC ▪ Seat leakage: Bubble tight shut-off (Class VI), Design standard: API 6D ▪ Other requirements as per technical specification of the tender document
Test reports/ Certificates to be provided	▪ Hydro test, leak test, NDT report, material certificates (Tests to be performed as per the applicable ASME codes). ▪ Other Documents: GA drawings and operational manual. ▪ The tests results shall satisfy the technical details mentioned in the specification. IPR or its representative (s) may witness some of the tests at the factory.
Tag no.	**PV-101, PV-002 and PV-003**
Type	Manual Ball valves
Material	SS 316L
Size and quantity	1" (40 Sch) and 3 nos.
Other Details/requirements	▪ End connections shall be as per ANSI/ ASME B16.5, 150 # R.F (SORF). ▪ MOC of handle should be MS with plastic cover. ▪ Other requirements as per technical specification of the tender document
Test reports/ Certificates to be provided	▪ Hydro test, leak test, NDT report, material certificates, GA drawings and operational manual.

	▪ The tests results shall satisfy the technical details mentioned in the specification. IPR or its representative (s) may witness some of the tests at the factory.

Sl. No 23: PICS along with charging unit

Requirements of PICS cylinder assembly:

1. PICS of the EHCL system consists of 16 nos. of volume ~ 46.7 liters water capacity. These cylinders are arranged in the following 3 clusters as follows:
    - 1st cluster = 4 cylinders (source tank)
    - 2nd cluster = 4 cylinders (storage tank)
    - 3rd cluster = 8 cylinder (buffer tank)
2. The cylinders in the cluster are interconnected to one another making a single volume, for example, the source tank volume is created by connecting 4 cylinders and similarly storage tank and buffer tank are by connecting 4 and 8 cylinders respectively.
3. In normal operation, the source tank are maintained at ~ 9.0 MPa, storage tank at ~ 6.0 MPa and the buffer tank at ~1.0 MPa pressures. The pressure in the different tanks are maintained using the helium compressor of the PICS.
4. These 16 cylinders are part of PICS system and are connected to the main loop as shown in the P & ID of the EHCL and are part of the PICS loop. These PICS cylinders are filled time to time by external source (charging unit).
5. The charging unit has 8 cylinders bank and these cylinders are provided by IPR. However, header and associated piping, gauges, valves for connection and distribution from charging unit to PICS are in the scope of the contractor.
6. Additionally, each cylinders in PICS cluster shall be connected to a common header with the provision of individual cylinder isolation valve, flexible hose for connection each cylinder, pressure gauge and main isolation valve.
7. All the PICS cylinders shall be mounted in MS power coated Frames system.
8. During operation, helium is required to be transferred from one cluster to another as well as between main loop and the PICS cylinders, therefore provision of back filling is must and provision of the same shall be ensured.
9. For the external charging unit the contractor shall make provision for common header, flexible hose for connection each cylinder and main isolation valve and a MS power coated Frames for housing these 8 nos. of cylinders. The filled cylinders for charging unit will be provided by IPR.
10. For the external charging unit of 8 cylinder a MS power coated Frames system to be provided along with flexible hose for connection each cylinder, pressure gauge and main isolation valve.
11. Any other components /instrument that are required for proper functioning of the PICS shall be provided by the contractor.
12. In addition to the above, details of the cylinder arrangements are as follows:

Sl. No.	Description	UOM	Qty
1.	Supply of 7 m^3 gas capacity empty cylinders fitted with suitable valve for helium gas service. Cylinder water capacity : 46.7 liters Documentations: manufacturer test certificate and CCOE filling provision.	Nos.	16
2.	Fabrication and supply of Brass and copper manifold set for each cluster line. 1st cluster = 4 cylinders 2nd cluster = 4 cylinders 3rd cluster = 8 cylinder Connection tapping point for each cylinder with pressure gauge and vent provision. Flange end connection: 1" x 1500#	set	01
3.	Fabrication and supply of MS power coated Frames system with three rows for accommodating 8 cylinders each and provision for mounting manifold system	set	01
4.	Fabrication and supply of MS power coated Frames system with one row for accommodating 8 cylinders and provision for mounting manifold system (Charging unit)	set	01
5.	Fabrication and supply of supply of 8 cylinder Brass and Copper back-up manifold system consisting of individual cylinder isolation valve, flexible hose for connecting each cylinder, pressure gauge and main isolation valve etc.		
6.	Other requirements		
7.	Installation, testing and commissioning at IPR Gandhinagar		
8.	Warranty	At least 1 year	
9.	Documents, Test reports/ Certificates to be provided	▪ Hydro test, Leak test, material certificates of cylinders/instruments (Tests to be performed as	

		per the applicable ASME codes). ▪ Other documents: GA drawings and operational manual. ▪ The tests results shall satisfy the technical details mentioned in the specification. IPR or its representative (s) may witness some of the tests at the factory.

Note: The items mentioned here is not exhaustive and the contractor shall consider providing all the items required for proper functioning of PICS.

Sl. No 24: Barricade material surrounding the process area

Item	Barricade material surrounding the process area and fittings and connections for personal protection
P&ID tag nos.	-
Process area*	10 m * 10 m * 5 m and 4 m * 4 m * 4 m
Material	Carbon steel
Size and quantity*	3-4 mm thick, ~6 ton
Other Details/requirements	As per technical specification of the tender document (material certificates /reports). IPR or its representative (s) may witness some of the tests at the factory.

*These details will be finalised based on the design calculations

Sl. No 25: Data Sheet/ Technical spec. of seamless pipes of different sizes

Seamless pipe, along with necessary piping, fittings, clamps, etc., all required within the battery limit of experimental requirements in EHCL. All piping & associated works shall be carried out at working site of EHCL as actual and as per system requirement.	
Material	SS 316L with relevant ASTM standard
Applicable code	ASME B31.3/B16.5
Type	Seamless
Pipe Size - DN50, Sch. 80S	80 meters (main loop)
Pipe Size - DN25, Sch. 40S	40 meters (PICS)
Pipe Size - DN100, Sch. 40S	20 meters (common vent line)
Pipe Size - DN40, Sch. 40S	40 meters (water line)
Design temperature and pressure	a) Main loop: 450 ºC and 10.0 MPa b) PICS: 50 C and 20.0 MPa c) Water line: 100 ºC,10 bar
Preferred make	Ratnamani/Suraj Ltd./MTS pipes or equivalent
Test reports/ Certificates to be provided	• Material test reports, hydro test, NDT reports (Tests to be performed as per the applicable ASME codes). • The tests results shall satisfy the technical details mentioned in the specification. IPR or its representative (s) may witness some of the tests at the factory.

Other requirements	As mentioned in the tender document
Support structure and type	As per the layout and pipe flexibility requirements

Sl. No 26: Data Sheet/ Technical spec. of insulation material

Insulation material for hot helium pipes, components and on water line along with necessary fittings, clamps, etc., all required within the battery limit of experimental requirements in EHCL. All insulation & associated works shall be carried out at working site of EHCL as actual and as per system requirement.	
Material	• Microtherm or equivalent (on helium gas based process pipe lines and process loop components) • Cerawool (on cooling water based process pipe lines and process loop components)
Maximum allowable insulation outer surface temperature, C	• 60 ºC (for helium gas) • 50 ºC (for cooling water)
Pipe Size - DN50, Sch. 80S	80 meters (main loop) - Microtherm
Pipe Size - DN40, Sch. 40S	40 meters (water line) – Microtherm
Process components (e.g. Recuperator, electrical heater, coolers, filters, valve body etc.	Microtherm
Other requirements	As mentioned in the tender document
Documents/test reports	Material test reports, thermal properties

Indicative value of insulation thickness for the loop components and piping are as follows:

Component	**Design temp., C**	**Insulation material**	**Insulation thickness (mm)**
Recuperator	400	Microtherm	50.0
Cooler	200		25.0
Circulator	100		15.0
Electrical heater	400		50.0
Dust filter	100		15.0
Hot leg piping (He)	400		50.0
Cold leg piping (He)	200		25.0
Water line	100	Cerawool	15.0

Sl. No. 27 Data Sheet/ Technical specifications of pneumatic tubing

The pneumatic tubing is required for actuation of process valves (cooling water and helium gas). Contractor shall perform routing, fabrication, laying and connection of pneumatic tubing with their manifolds/headers as per the loop layout and within the battery limit of experimental requirements in EHCL to all the process valves. All tubing & associated works shall be carried out at working site of EHCL as actual and as per system requirement.

Material	SS 316L
Size	As per loop layout and sizing calculations
Length	~100 m
Max. flow available	25 CFM
Max. working air pressure available	10 bar (g)
Other Details/requirements	As per technical specification of the tender document

Sl. No 28: License upgradation of Siemens SCADA Win CC additional tags for EHCL logic development, if any

IPR will provide Siemens SCADA Win CC runtime configurable software with 512 tags. Complete details of software components will be shared with the contractor. If required, contractor may need to upgrade the license for more tags, as per EHCL logic development.

Sl. No 29: Electronic / Logic Solver for all hardwired interlocks as per required functionally mentioned in EHCL

Development of hard-wired interlocks for high-temperature and high-pressure accidental conditions, will be in scope of contractor. Contractor to provide necessary electronics/logic solver and complete the installation, integration, testing and commissioning according to instrumentation chart and loop operational philosophy provided by IPR.

Sl. No 30: Spares items, if any

The contractor shall suggest list of spares for 3 years of the operation of the loop. The final spare list will be prepared after IPR approval.

Annexure-2

P & ID and Instrumentation chart of EHCL

(These details are provided separately)

Annexure-3

List of free issue material and their preliminary details

Preliminary List of free issue material and interface details (Dimensions, weight, nozzle details etc.) provided by IPR

Sr. no.	Free issue Material	List of components (Quantity)
1.	Mechanical components	Circulator (02), chiller for circulator (01), electrical heater (01), recuperator (01), coolers (02), Vacuum pump (01), Safety valve (02), Rupture disc (13), Mass flow integrator (01) and oxygen sensor (02), Bellow sealed ON/OFF and control valve for helium application (24), Helium sensor (02), Strainer for helium line (02)
2.	Process Instrumentation	▪ Coriolis mass flow meter for helium flow-rate (01), ▪ Conditioning Orifice type mass flow meter assembly for helium flow-rate (01), ▪ Pressure Transmitters with 2-way manifolds for helium pressure(17), ▪ Differential Pressure Transmitters with 3-way manifolds for helium differential pressure (11), ▪ Thermocouples with Weld-in type Thermowell assembly for bulk helium temperature (16)
3.	Control system components (Hardware and Software)	▪ SIEMENS PLC S7-300 (CPU 315-2 PN/DP) (01), ▪ SM 321 DI Modules (04), ▪ SM 322 DO Modules (03), ▪ SM 331 AI Modules (11), ▪ SM 332 AO Modules (04), ▪ Interface Modules (02), ▪ Power Supply (01), ▪ Accessories and Adaptors/Connectors, ▪ SIEMENS STEP7 Professional programming software (01), ▪ SIEMENS WinCC SCADA software – 512 TAG RC runtime configurable (01)
4.	Electrical components	LT Circuit Breaker Panel, Distribution Board, Control Panels for Electrical Heater and He Turbo Circulators, UPS system

<u>Note:-</u> IPR will provide above stated Free Issue Material at the time of installation and commissioning (Phase-2) of the EHCL system at IPR.

Interface/sizing details of the mechanical components

Sr. no.	Mechanical component	Qty.	Typical envelope dimensions of single unit, mm	Typical weight of single unit, kg	Typical nozzles/ Interface details
1.	Circulator *(Circulator is used to overcome the pressure drop in the loop components. The cold helium (< 60 C) is compressed in the circulator and the required pressure head is discharged by centrifugal action of the machine. The suction temperature to the circulator inlet is restricted to ≤ 60 C).*	2	800 (L)*300 (D)	150	1.5” 80S
2.	Chiller for circulator *(This component is needed for providing chilled water supply ~ 10 ºC for cooling the circulators.)*	1	-------	-------	-------
3.	Electrical heater *(The electric heater acts as a supplementary heat source in EHCL. Before entering the TSM, the hot helium (after picking up heat from recuperator) passes through electrical heater, where supplementary heat, if required, is provided by the heater and at desired temperature the hot helium enters into the TSM. Moreover, the electrical is also required during warming up, loop*	1	4000(L)* 250(D)	1500	4” 80S

	conditioning, hot standby (maintain the loop at hot condition prior to the operation) condition etc.)				
4.	Recuperator *(It is a printed circuit plate type heat exchanger. This is installed at the crossover point of the loop. The function of the recuperator is to exchange heat between the hot helium (coming from TSM outlet) and the cold helium (coming from circulator discharge)*	1	1300(L)*900(W)*700(H)	1200	2” 80S
5.	Coolers *(Helium-Water Heat Exchanger or cooler acts as heat sink in the loop. It is the interface equipment between the process fluid (helium gas) and water cooling system. The upstream hot helium is cooled to ≤ 60 C before entering the circulator suction. The cold water (at ~25 C) enters into the cooler and gets heated up (~ 40 C) by exchanging heat from helium (coming from recuperator).*	2	700(L)*600 (W)*300(H)	100	2” 80S
6.	Vacuum pump	1	1500(L)*1000(W)*1500(H)	250	1” 40S
7.	Safety valves	4	-------	-------	As per the P& ID
8.	Rupture disc	13	-------	-------	As per the P& ID
9.	Bellow sealed ON-OFF and control valve	24	-------	-------	As per the P& ID

Details of Process Instrumentation

Sr. no.	I&C component	Qty.	Dimensions (envelope)	Weight	Nozzles details /Process connections
1.	Coriolis mass flowmeter	01	Face to Face length = 567 mm	-	2" WNRF Flanges, Class 900/1500 (ASME B16.5)
2.	Conditioning Orifice type mass flowmeter assembly	01	-	-	2" WNRF Flanges, Class 1500 (ASME B16.5)
3.	Pressure Transmitters with 2-way manifolds	17	-	-	½" NPT (F)
4.	Differential Pressure Transmitters with 3-way manifolds	11	-	-	12 mm OD tubing
5.	Thermocouples with Weld-in type Thermowells assembly	16	-	-	Welding diameter = ¾" (26.7 mm)

Details of Control System hardware components

Sr. no.	Control System components	Qty.	No of channels per Module	Total no of channels
1.	SIEMENS PLC S7-300 (CPU 315-2 PN/DP) Model: 6ES7315-2EH14-0AB0	01	-	-
2.	SM 321 DI Modules Model: 6ES7321-1BL00-0AA0	04	32	128
3.	SM 322 DO Modules Model: 6ES7322-1BL00-0AA0	03	32	96
4.	SM 331 AI Modules Model: 6ES7331-7KF02-0AB0	11	8	88
5.	SM 332 AO Modules Model: 6ES7332-5HF00-0AB0	04	8	32
6.	Siemens make Interface Modules Model: 6ES7153-2BA02-0XB0	02	-	-
7.	Siemens make Power Supply Model: 6ES7307-1KA02-0AA0	01	-	-
8.	Accessories & Adaptors/Connectors	-	-	-

	(detailed model numbers can be provided separately)			

Details of Control System software components

Sr. no	Control System softwares	Floating Licenses
1.	SIEMENS STEP7 Professional programming Software Model: 6ES7810-5CC11-0YA5	STEP 7 Professional 2010/V12 Combo
2.	SIEMENS WinCC SCADA software – 512 TAG RC runtime configurable	SIMATIC WinCC V7.0 SP3 Runtime & Configuration,512 Power tags (RC 512)

Sr. no.	Electrical component	Qty	Dimensions (L X D X H)	Weight
1.	LT Circuit Breaker Panel (800A)	1	2.5m X 1.0m X 1.98m	---
2.	LV Distribution Board (250A)	1	1.2m X 0.45m X 1.93m	---
3.	Electrical Heater control panel	1	0.8m X 0.5m X 2m	---
4.	Circulator control panels	2	1.7m X 0.6 m X 2.1 m	---

Annexure-4

Technical Compliance sheet

(Technical information to be furnished to be furnished by contractor along with technical bid)

Sl. No 1 and 2: Control valves and ON/OFF valves for water system

Make	
Model no.	
Material of construction	
Fluid medium	
Applicable code	
Type	
VC-005 (water line)	
Process conditions	
Mass flow rate (range	
Pressure differential (range)	
Operating temperature and pressure	
Design temperature and pressure	
Pipe size	
Air fail action	
Cv	
Characteristics	
Performance	
Leak rate across body	
Leak rate across seat	
Rangeability	
Dead band	
Hysteresis	
Inaccuracy of the positioning	
Body	
Size	
Type	
Material	
End connections	
Bonnet	
Bonnet material	
Type	
Bonnet gasket material	
Stem packing material	
Trim	

Type	
Plug and stem material	
Seat material	
Actuator	
Type	
Air pressure	
Air tubing connection	
Threaded fasteners	
Bolts and Studs	
Nuts	

Control valve accessories

All the control valve accessories mentioned below shall be from reputed manufacturers

- Actuator: **YES/NO, (Make/model no.):**
- Valve positioner (Smart type): **YES/NO, (Make/model no.):**
- Current to pressure converter (I to P Converter): **YES/NO, (Make/model no.):**
- Position transmitter preferably 2-wire with a transmission facility of 4 to 20 mA: **YES/NO, (Make/model no.):**
- Air filter-regulator: **YES/NO, (Make/model no.):**
- Interconnecting Tubing: **YES/NO**

Inspection & Testing

- Cv and flow characteristics test: **YES/NO**
- Static test: **YES/NO**
- Material test: **YES/NO**
- Liquid penetration examination of body, bonnet, plug, stem, fasteners: **YES/NO**
- Ultrasonic examination of stem: **YES/NO**
- Intergranular corrosion test for body, bonnet, plug, stem: **YES/NO**
- Hydrostatic test: **YES/NO**
- Seat leak test: **YES/NO**
- Helium leak test: **YES/NO**
- Functional test: **YES/NO**

General requirement	
Make	
Model no.	
Material of construction	
Fluid medium	
Applicable code	
Type	

VG-007/VG-008/VG-009/VG-010/VG-013 (Water line)

Process conditions	
Mass flow rate (range	
Operating temperature and pressure	
Design temperature and pressure	
Pipe size	
Air fail action	
Performance	
Leak rate across body	
Leak rate across seat	
Rangeability	
Dead band	
Hysteresis	
Inaccuracy of the positioning	
Body	
Size	
Type	
Material	
End connections	
Bonnet	
Bonnet material	
Type	
Bonnet gasket material	
Stem packing material	
Trim	
Type	
Plug and stem material	
Seat material	
Actuator	
Type	
Air pressure	
Air tubing connection	
Threaded fasteners	
Bolts and Studs	
Nuts	

ON/OFF valve accessories

All the ON/OFF valve accessories mentioned below shall be from reputed manufacturers:

- Actuator: **YES/NO, (Make/model no.):**
- Solenoid valve**: YES/NO, (Make/model no.):**
- Air filter regulator**: YES/NO, (Make/model no.):**
- Limit switches**: YES/NO, (Make/model no.):**
- Interconnecting Tubing **: YES/NO**

Inspection & Testing
• Static performance test**: YES/NO** • Material test**: YES/NO** • Liquid penetration examination of body, bonnet, plug, stem, fasteners s**: YES/NO** • Intergranular corrosion test for body, bonnet, plug, stem**: YES/NO** • Hydrostatic test**: YES/NO** • Seat leak test**: YES/NO** • Helium leak test**: YES/NO** • Functional test**: YES/NO**

Sl. No 3: Technical specifications of Helium Compressor

Sr. no.	Parameters	Value
	J. Functional requirements:	
40.	Process Fluid	
41.	Suction pressure (Absolute) (MPa)	
42.	Maximum (safety valve set) Pressure (gauge) (MPa)	
43.	Working Pressure (gauge) (MPa)	
44.	Maximum Helium flow rate (m^3/hr)	
45.	Static leak rate (mbar.l/s)	
46.	Type of Compressor	
47.	Residual oil content, (mg/m^3)	
48.	Ambient temperature range (C)	
49.	Discharge Temperature range (C)	
50.	Noise level (ISO 3744)	
	K. Standard scope of supply:	
51.	In-built purification system, to minimize contamination of the process fluid, if any	
52.	Gas intake connection complete with gas connection; female thread, particle filter, intake buffer vessel intake pressure gauge, intake pressure monitoring by pressure sensor and shut-off solenoid valve. (as applicable) **YES/NO**	
53.	Pressure relief valve after every stage. **YES/NO**	
54.	Safety valve sealed at each stage with a return line back into the buffer vessel. **YES/NO**	
55.	Oil pumping system: Forced feed lubrication type. Oil pump with oil filter shall be provided. (as applicable) **YES/NO**	
56.	Inlet buffer vessel with connection via flexible hose to inlet of compressor shall be provided. The buffer vessel to have a safety valve. **YES/NO**	
57.	Motor	
	L. PLC based Control Panel:	
58.	Mains Supply	
59.	Emergency stop	
60.	Ingress Protection	
61.	User Interface	
62.	Display Parameters	
63.	Errors and Alarm Indications	
64.	Required signals from compressor Control Panel to IPR master controller	

Sr. no.	Parameters	Value
65.	Command signals from IPR master controller to Compressor control panel	
	M. Spares:	
66.	Commissioning Spares	
67.	Operational Spares	
	N. Test Reports/certificates to be provided by suppliers	
68.	Hydro/pneumatic test reports/certificates	**YES/NO**
69.	Static Leak Test reports/certificates	**YES/NO**
70.	Test reports/certificates for Residual oil conten	**YES/NO**
71.	Test reports/certificates for Noise level	**YES/NO**
72.	Material test certificate	**YES/NO**
	O. Performance tests (at IPR)	
73.	Measurement of suction and discharge pressure	
74.	Functioning of motor and its connection	
75.	Leak rate measurement	
76.	Performance of overall control system	
	P. Warranty:	
77.	The Contractor should offer a warranty for minimum of two year from the date of acceptance of the system by IPR**.** During the warranty period, the Contractor should rectify all problems including replacement and repair of faulty components and items at the earliest. If this requires a site visit by the Contractor's specialist engineer then that should be facilitated by the Contractor at no extra cost. The Contractor should submit the terms and conditions of the warranty in his proposal offer. **YES/NO**	
	Q. Training:	
78.	Comprehensive hands-on training (for at least two days) at the factory site shall be provided at the cost of the Contractor. This training must include operation, trouble shooting and maintenance of the compressor and all its subsystems. **YES/NO**	

Sl. No 4 and 5: Data Sheet/ Technical specifications of filters and Strainers

Tag No.	**FF-001 and FF-002**
Make	
Type	
Material of housing and cartridge	
Fluid to be handled	
Quantity	
Filter rating	
Maximum allowable pressure drop	
Outlet gas quality (min.)	
Applicable Code	
No. and size of nozzles for process piping	
Design temperature and pressure	
Mounting	
Additional information:	Differential pressure gauge to be provided for pressure drop measurement. **YES/NO**

Tag No.	**FF-003**
Make	
Media	
Type	
Pressure rating	
Operating temperature, C	
Design temperature, C	
Operating pressure, MPa	
Design pressure, MPa	
Max. rated flow, LPM	
Material of construction	
Screen mesh size	
Thickness of SS perforated sheet	
Maximum pressure drop, bar	
Sealing	
End connection	
Testing standard	
Additional information	Contractor has to provide material test certificates, drawings etc. with all the details with the strainer. **YES/NO**

Sl. No 6: Data Sheet/ Technical spec. of Circulator suction and discharge tanks

Circulator suction and discharge tanks

Material of construction of wetted part	
Approximate capacity	
Fluid to be handled	
Quantity	
Applicable Code	
Dimensions	
No. and size of nozzles for process piping on each tank	
Design temperature and pressure	
Mounting	
Additional information:	
Test reports	
Other Details/requirements	As per technical specification of the tender document **YES/NO**

Sl. No 7: Data Sheet/ Technical specifications of Pressure reducing valve

PRV-101 (At recovery compressor suction line)	
Type	
Process fluid	
Body material	
Seat material	
Flow pattern	
Actuator operation	
Maximum inlet pressure, MPa	
Maximum outlet pressure, MPa	
Design pressure, MPa	
Operating temperature, C	
Design temperature, C	
Max. flow rate, m^3/hr	
End connection	
Max. leak rate, Pa/m^3-sec	
Port configuration	
Test reports	
Other Details/requirements	As per technical specification of the tender document **YES/NO**

Sl. No 8, 9, 10, 11, 12, 13 and 14: Data Sheet/Technical spec. Instrumentations

Temperature Sensors with Transmitters	
Tag No.	**MTE-101, MTE-011, MTE-018, , MTE-019**
Type	
To be installed on	
Mounting	
Calibrated Span	
Maximum Operating Temperature	
Design Pressure	
Accuracy	
Test certificates	
Make	
Pressure Transmitters	
Tag No.	**MP-010, MP-IA**
Type	
To be installed on	
Mounting	
Maximum Operating Temperature	
Design Pressure	
Calibrated Span	
Accuracy	
Test certificates	
Make	
Flow Sensor with Transmitter	
Tag No.	**FE-005**
Type	
To be installed on	
Line Size	
Maximum Operating Temperature	

Design Pressure	
Calibrated Span	
Accuracy	
Test certificates	
Make	
Pressure Transmitter Panel	
Quantity	
Size	
Material	
Junction Boxes	
Supply and installation of MS/CS Junction boxes with suitable size including supply of all supports and fixing materials for installation of box, complete with rail-mounted terminal blocks and PVC dual side slotted duct-cable managers. Junction boxes shall be made from 2 mm thick metal-sheet with necessary cable glands. Powder coating should be done on the junction boxes. Junction box shall contain appropriate number of DIN rail mounted screw terminal blocks with terminal size of upto 1.5 mm^2. **YES/NO**	
I&C Cables	
Conductor material	
Conductor type	
Cable type	
Insulation material	
Overall jacket	
Approximate length required: • 1500 metres from field transmitters and I&C to junction box(es). • 50 metres from junction box(es) to master controller PLC panel.	
Make	
All field wiring should be routed via suitable cable trays and ducts	
Master controller PLC Panel	
Quantity	

Rack-type	
Make	
Test reports for instrumentation	
Other Details/requirements	As per technical specification of the tender document: **YES/NO**

Sl. No 15: Data Sheet/ Technical spec. of Instrument tubing and fittings

Length	
Material	
Make	
Documents/test reports	
Other requirements	As mentioned in the tender document: **YES/NO**

Sl. No 16: Data Sheet/ Technical spec. of Electrical power cables and Cable Trays

Electrical Power Cables	
Conductor Material	
Conductor Type	
Insulation Material	
Sheath Material	
Cable Type	
Voltage Grade	
Applicable Standard	
Make	
Approximate Length required	
3.5 core 300 sq.mm 3.5 core 120 sq.mm 3.5 core 70 sq.mm 3.5 core 35 sq.mm 3.5 core 25 sq.mm 3.5 core 16 sq.mm 4 core 4 sq.mm 3 core 2.5 sq.mm	
Power and Control Cable Trays	

Type of Cable Tray	
Material	
Cable Tray Thickness	
Installation	
Length of Cable Tray to be supplied and installed	As per final approved cable tray layout generated by contractor **YES/NO**

Sl. No 17: Data Sheet/ Technical specifications of Drain and Vent valves

Make	
Model no.	
Item	
Material	
Size	
Quantity	
Type	
Documents/test reports	
Other Details/requirements	As per technical specification of the tender document **YES/NO**

Sl. No 17 Data Sheet/ Technical specifications of pneumatic tubing

Material	
Size	
Length	
Max. flow available	
Max. working air pressure available	
Other Details/requirements	As per technical specification of the tender document **YES/NO**

Sl. No 18 and 19: Data Sheet/ Technical specifications of PSVs

Item	**VR-001 (Relief valve at Circulator discharge)**
Make	
Model no.	
Material of construction	
Applicable code	
Leakage class	

Type	
Make	
Fluid to be handled	
Quantity	
Operating temperature, C	
Operating pressure, MPa	
Design temperature, C	
Design pressure, MPa	
Set pressure, MPa	
Minimum relieving capacity, kg/hr	
Additional information:	Contractor shall size, select and procure the valve based on the capacity requirements and appropriate codes. The connection between the system and pressure relief device shall have a minimum inside diameter equal to or greater than the nominal inside diameter of the pressure relief device inlet. **YES/NO**
VR-002/VR-003 (Relief valve at Cooler outlet – Water line)	
Make	
Model no.	
Material of construction	
Applicable code	
Leakage class	
Type	
Make	
Fluid to be handled	
Quantity	
Operating temperature, C	
Operating pressure, MPa	
Design temperature, C	
Design pressure, MPa	
Set pressure, MPa	
Minimum relieving capacity, LPM	
Additional information:	Contractor shall size, select and procure the valve based on the capacity requirements and appropriate codes. The connection between the system and pressure relief device shall have a minimum inside diameter equal to or greater than the nominal inside diameter of the pressure relief device inlet. **YES/NO**
Documents/test reports	
Other Details/requirements	As per technical specification of the tender document **YES/NO**

Sl. No 20: Data Sheet/ Technical specifications of Rupture discs

DK-001 (TSM outlet)	
Make	
Model no.	
Type	
Disk MOC	
Disk size	
Disk thickness, mm	
Disk holder MOC	
Relieving gas	
Min. Relieving capacity, kg/hr	
Relieving temperature, C	
Design temperature, C	
Operating pressure, MPa	
Operating ratio, %	
Specified burst pressure, MPa	
Manufacturing range, %	
Burst pressure tolerance, %	
Marked burst pressure, MPa	
Design pressure, MPa	
Min. net flow area, sq. inches	
Backpressure	
Max. leak rate, mbar-l/sec	
Other Details/requirements	As per technical specification of the tender document **YES/NO**

DK-002 (Circulator outlet)	
Preferred Make	
Model no.	
Type	
Disk MOC	
Disk size	
Disk thickness, mm	
Disk holder MOC	
Relieving gas	
Min. Relieving capacity, kg/hr	
Relieving temperature, C	
Design temperature, C	
Operating pressure, MPa	
Operating ratio, %	

Specified burst pressure, MPa	
Manufacturing range, %	
Burst pressure tolerance, %	
Marked burst pressure, MPa	
Design pressure, MPa	
Min. net flow area, sq. inches	
Backpressure	
Max. leak rate, mbar-l/sec	
Other Details/requirements	As per technical specification of the tender document **YES/NO**

In PICS	
Quantity	
Make	
Model no.	
Type	
Disk MOC	
Disk size	
Disk thickness, mm	
Disk holder MOC	
Relieving gas	
Min. Relieving capacity, m^3/hr	
Relieving temperature, C	
Design temperature, C	
Operating pressure, MPa	
Operating ratio, %	
Specified burst pressure, MPa	
Manufacturing range, %	
Burst pressure tolerance, %	
Marked burst pressure, MPa	
Design pressure, MPa	
Min. net flow area, sq. inches	
Backpressure	
Max. leak rate, mbar-l/sec	
Other Details/requirements	As per technical specification of the tender document **YES/NO**

Sl. No 21 and 22: Data Sheet/ Technical spec. of Non-return and manual valves

Make	
Model no.	
Type	

P&ID tag nos.	
Material	
Size and quantity	
Other Details/requirements	As per technical specification of the tender document **YES/NO**

Make	
Model no.	
Type	
P&ID tag nos.	
Material	
Size and quantity	
Other Details/requirements	As per technical specification of the tender document **YES/NO**

Sl. No 23: PICS along with charging unit

Sl. No.	Description	UOM	Remarks
1.	Supply of 7 m^3 gas capacity empty cylinders fitted with suitable valve for helium gas service. Cylinder water capacity : 46.7 liters Reference code: IS7285-part2-2004 Documentations: manufacturer test certificate and CCOE filling provision.	Nos.	
2.	Fabrication and supply of Brass and copper manifold set for each cluster line. 1st cluster = 4 cylinders 2nd cluster = 4 cylinders 3rd cluster = 8 cylinder Connection tapping point for each cylinder with pressure gauge and vent provision.	set	

	Flange end connection: 1" x 1500#		
3.	Fabrication and supply of MS power coated Frames system with three rows for accommodating 8 cylinders each and provision for mounting manifold system	set	
4.	Fabrication and supply of MS power coated Frames system with one row for accommodating 8 cylinders and provision for mounting manifold system (Charging unit)	set	
5.	Fabrication and supply of supply of 8 cylinder Brass and Copper back-up manifold system. Consists of individual cylinder isolation valve, flexible hose for connection each cylinder, pressure gauge and main isolation valve.	**YES/NO**	
6.	Other requirements		
7.	Installation, testing and commissioning at IPR Gandhinagar	**YES/NO**	
8.	Warranty for the components		

Sl. No 24: Barricade material surrounding the process area

Item	
tag nos.	
Process area	
Material	
Size and quantity	
Other Details/requirements	As per technical specification of the tender document **YES/NO**

Sl. No 25: Data Sheet/ Technical spec. of seamless pipes of different sizes

Material	
Applicable code	
Type	

Pipe Size - DN50, Sch. 80S	
Pipe Size - DN25, Sch. 40S	
Pipe Size - DN100, Sch. 40S	
Pipe Size - DN40, Sch. 40S	
Design temperature and pressure	
make	
Documents/test reports	
Other requirements	As mentioned in the tender document **YES/NO**
Support structure and type	As per the layout and pipe flexibility requirements **YES/NO**

Sl. No 26: Data Sheet/ Technical spec. of insulation material

Material	• Microtherm (on helium gas based process pipe lines and process loop components) **YES/NO** • Cerawool (on cooling water based process pipe lines and process loop components) **YES/NO**
Maximum allowable insulation outer surface temperature, C	•
Pipe Size - DN50, Sch. 80S	
Pipe Size - DN40, Sch. 40S	
Process components (e.g. Recuperator, electrical heater, coolers, filters, valve body etc.	Microtherm **YES/NO**
Other requirements	As mentioned in the tender document **YES/NO**
Documents/test reports	

Indicative value of insulation thickness for the loop components and piping are as follows:

Component	**Design temp., C**	**Insulation material**	**Insulation thickness (mm)**
Recuperator	400		
Cooler	200		
Circulator	100		
Electrical heater	400		
Dust filter	100		
Hot leg piping (He)	400		
Cold leg piping (He)	200		
Water line	100		

Sl. No 27: License upgradation of Siemens SCADA Win CC additional tags for EHCL logic development, if any

IPR will provide Siemens SCADA Win CC runtime configurable software with 512 tags. Complete details of software components will be shared with the contractor. If required, contractor may need to upgrade the license for more tags, as per EHCL logic development.	Contractor`s comments Agreed/not agreed

Sl. No 28: Electronic / Logic Solver for all hardwired interlocks as per required functionally mentioned in EHCL

Development of hard-wired interlocks for high-temperature and high-pressure accidental conditions, will be in scope of contractor. Contractor to provide necessary electronics/logic solver and complete the installation, integration, testing and commissioning according to instrumentation chart and loop operational philosophy provided by IPR.	Contractor`s comments Agreed/not agreed

Sl. No 29: Spares items, if any

Contractor to suggest list of spares for 3 year of operation of the loop. The list of spares will be finalised after IPR approval	Contractor`s comments Agreed/not agreed

Authorised Signatory

Official Seal

Date :-

Annexure-5

IPR Safety Code

1. PURPOSE

The purpose of this protocol is to establish, implement and execute a safe and effective program for the prevention of incidents that may cause injury to persons or damage to the property. The specified responsibilities remain with the contractor for compliance.

2. SCOPE

2.1 This protocol shall be considered minimum requirements necessary for all works performed inside the Institute for Plasma Research (IPR) and associated centres/units/departments.

2.2 All the contractor while at IPR and associated centres/units/departments work site are required to ensure that themselves, their workers and employees, sub-contractors, suppliers, contractors and visitors, must comply with the provisions of this protocol.

2.3 The contractor shall review and educate their workers and employees about the stipulations of this protocol.

2.4 This protocol is in addition to the responsibility of the contractor towards safety, health and environmental compliance envisaged under law, code or statutory requirements.

3. PROTOCOL

3.1 The contractor has to provide appropriate Personal Protective Equipments (PPE) like safety shoes, safety helmets, goggles, hand gloves, full body safety harnesses, etc. as required for safety of themselves, their workers and employees, sub-contractors, suppliers, contractors and visitors at site. All PPE must conform to relevant Indian and/or International Standards. These should be maintained in recommended condition by suitable storage, maintenance and inspection. IPR shall have right to examine the PPE and determine their suitability, reliability, acceptability and adaptability.

3.2 The contractor shall provide and maintain proper illumination, fencing, guards, stairs, ladders, scaffolding, warning signs, caution boards, etc. as required to ensure safe working conditions at site.

3.3 The contractor shall ensure that all floor and wall openings are fixed and properly guarded/barricaded during the course of work and at the end of each day's work with appropriate caution board.

3.4 The contractor must adhere to the requirements of Safety, Health and Environment (SHE) Policy of IPR, salient features of which are:

a. Continual improvement in its Safety, Health & Environment Performance,
b. Conservation of natural resources,
c. Waste minimization,
d. Compliance with applicable statutory and regulatory requirements,
e. Creating safety & environmental awareness to its employees and associates.

3.5 The contractor has to ensure to employ only persons who are medically fit and having sufficient skills for execution of work. The contractor must ensure efficient job supervision through educated, qualified, experienced and responsible supervisors to ensure safety at site.

3.6 All staff persons including workers must undergo Safety Induction Training prior to depute them at IPR and associated centres/units/departments for any kind of work. Training module may include video film, clippings, photographs etc. related to work execution. In addition to this, Job specific training must be imparted to the concerned workers periodically.

3.7 The contractor has to ensure that Daily Tool Box Talk shall be conducted at least for new workers by responsible work in-charge/supervisor for each activity and its record to be maintained.

3.8 The contractors themselves, their workers and employees, sub-contractors, if any, shall comply with the instructions given by the Safety Officer or his authorized nominee or IPR's representative regarding safety precautions, protective measures, housekeeping requirements, etc. IPR shall have the right at its sole discretion to stop the work, if the work is being carried out in such a way that it may cause accidents or harm to the workers or damage to the equipment. Contractor shall get the unsafe condition removed and report to IPR.

3.9 The contractor shall have no right to claim any damages/compensations for stoppage of work due to safety reasons as provided in para 3.8 .The period of such stoppage of work will not be taken as an extension of time for completion of work or exemption from liquidated damages/compensation delay.

3.10 The contractor should ensure that water, fuel and energy are used judiciously. The water & power points must be closed / put off when not in use.

3.11 Good housekeeping practices must be followed strictly.

3.12 All equipment used for maintenance, fabrication and assembly work, etc. by the contractor must meet Indian/International standards. In case such standards do not exist, the contractor must ensure these to be absolutely safe. All equipment shall be strictly operated and maintained in accordance with manufacturers' operation manual and safety instructions.

3.13 The contractor must not interfere or disturb electric, fuses, cables and other electrical equipment belonging to IPR or another agency under any circumstances whatsoever unless expressly permitted in writing by IPR.

3.14 Contractor shall arrange adequate facilities for first aid, medical aid and treatment for his staff and workers engaged at the work site.

3.15 The contractor has to fully be responsible for the behaviour and conduct of themselves, their workers and employees and sub-contractors. Any cost of loss or damage to client's property caused by contractor's employees or workers will be recovered from the contractor.

3.16 In case of any accident that occurs during the maintenance/ fabrication/erection or associated activities undertaken by the contractor thereby causing any minor or major or fatal injury to themselves, their workers and employees, sub-contractors due to any reason, it shall be the responsibility of the contractor to promptly inform IPR's Work in-charge and Safety Officer in prescribed form of IPR. This should also be informed to statutory authority, if required, under the applicable laws. The contractor shall maintain a register of accidents.

3.17 In case the contractor fails to fulfil statutory requirements, IPR shall have the right to withhold contractors payments till the requirement are fulfilled.

3.18 The contractor shall plan his activities so as to avoid interference with the assignments of other departments and contractors at the site. In case of any interference, necessary coordination must be sought by the contractor from IPR for safe and smooth working.

3.19 All necessary precautions shall be taken to prevent outbreak of fires at the site. Adequate provisions or as recommended by Safety Officer of IPR must be made by the contractor to extinguish fires.

3.20 The contractor shall follow the stipulated procedure regarding work in the radiation area and other works related with radiography. The contractor shall be fully responsible for the safe storage and handling of his and his sub-contractor's radio-active sources in accordance with AERB rules and other applicable provisions.

3.21 The contractor shall issue photo identity card for themselves, their workers and employees, sub-contractors to be deployed at site. They are required to be displayed prominently during the period of their stay within IPR and associated centres/units/departments.

3.22 The contractor shall obtain gate pass from IPR and associated centres/units/departments for entries and exists of all materials and equipment.

3.23 Smoking and eating/chewing of tobacco is strictly prohibited at site.

3.24 Any person under the influence of any intoxicating beverage, even to the slightest degree shall not be permitted at work site.

3.25 Person below the age of 18 years must not be employed for any work at site

3.26 IPR may from time to time, add or amend to these protocols and issue directions.

3.27 The contractor shall comply with safety instructions as laid down in as per Appendix-1.

Appendix-1

SAFETY INSTRUCTIONS
FOR CONTRACTORS OF MECHANICAL/MAINTENANCE/FABRICATION/ ERECTION AND OTHER RELATED ACTIVITIES

CONTENTS

1. GENERAL INFORMATION

1.1 The purpose of safety instruction document is to establish, implement and execute a practical and effective method for preventing accidents, injuries and property damage.

1.2 This document will help contractors and their associates to recognize, evaluate and control hazardous activities within their areas of responsibility.

1.3 This document defines the procedure with which safety practice will be administered, identifies responsibilities and ensures control of work area safety.

1.4 Contract agreement signed with contractors and the provisions of this document are intended to complement each other to ensure safe working conditions.

1.5 The provisions of this document apply to IPR and associated centres/units/departments.

1.6 Throughout this document, reference to a contractor means the contractor's company and the associated subcontractors, consultants, contractors and suppliers. Reference to contractor's management means personnel responsible for managing, supervising or directing contract activities and employees.

1.7 Non-compliance of this document is treated as non-compliance of contract agreement that may result in warning/penalty. Willful or repeated non-compliance may result in contractor dismissal and contract termination.

1.8 This document for contractors is a supplementary document to statutory rules, codes and regulations having jurisdiction, and does not negate, abrogate or minimise any provisions of these rules, codes and regulations. It is intended to supplement and enforce the individual program of the contractor and to coordinate the overall safety effort. Contractors are responsible for the safety and health of their employees, subcontractors, consultants, contractors, suppliers, and visitors while in IPR and associated centres/units/departments.

1.9 Contractor's managers and supervisors are responsible for preventing incidents or conditions that could lead to incidents, injuries, illness or fatalities. The ultimate success of the safety program depends on the cooperation of everyone. The contractor's management must ensure that safety provisions are enforced and that effective training and education programs are employed.

2. ROLE OF THE CONTRACTOR

2.1 Top Management of the Contractor

The commitment of top management of the contractor towards safety is very important. Top management needs to ensure the following:

2.1.1 To implement safe methods and practices, deploy appropriate machineries, tools & tackles, experienced supervision and skilled workforce, etc. required for execution.

2.1.2 To ensure that employees and workers deployed are physically and mentally fit. They should possess requisite skill, qualification, experience etc.

2.1.3 To deploy qualified and trained safety supervisor, safety officers and/or safety manager reporting to site In-charge for supervision, co-ordination and liaison for the implementation of safety.

2.1.4 To ensure that the employees and workers have appropriate health and safety training. The certification of such training should be produced for verification, on demand.

2.1.5 To obtain all necessary and applicable licences, permits, and insurance policy of his employees and workers before executing any work. A copy of the same must be submitted to the relevant authority at IPR.

2.1.6 To ensure that all incidents (minor/major injuries, fatality, fire, property damage etc.) including near misses shall be reported to the relevant authority at IPR immediately verbally as well as in written format of IPR. Also, keep record for the same.

2.1.7 The liability for any compensation on account of injury sustained by an employee of the contractor will be exclusively that of the contractor.

2.1.8 To provide personal protective equipments required for the safety and first-aid kits at worksite.

2.1.9 To maintain appropriate records of all employees and workers deployed to carry out the work at site.

2.1.10 Contractor shall not employ any labour below 18 years of age.

2.1.11 A photo gate pass duly approved by IPR administration shall be issued by the contractor to their personnel, employees, subcontractors, etc.

2.1.12 To co-operate with all the security arrangements of IPR.

2.1.13 Contractor may ask for clarifications required in safety related issues, whenever a need arises.

2.1.14 To follow and implement all the safety rules and regulations of the local bodies, state, national and international. Contractor shall also comply with all the statutory requirements and notifications, as applicable, in relation to employment of his employees issued time to time by the concerned authorities.

2.2 Contractor Safety Officer, Safety Supervisor and/or Job Supervisor

The duties and responsibilities of the contractor safety officer, safety supervisor and/or job supervisor shall include the following:

2.2.1 To assess the hazards associated with work at site in consultation with all concerned and establish safe working procedure.

2.2.2 To establish a written records of factors that can cause injuries,illness or other safety related problems.

2.2.3 To undertake routine/surprise inspections of all work sites to ensure compliance with safety standards, codes, rules, regulations and orders applicable to the work concerned.

2.2.4 To check whether the proposed working arrangements/procedures are safe and satisfactory, particularly at the interface between contractors planned work and IPR facilities.

2.2.5 To ensure that required guards and protective equipment are provided, used and properly maintained.

2.2.6 To ensure that the workers understand the working procedures for carrying out the work safety and the hazards that may be encountered.

2.2.7 To take immediate actions to correct any violation of safety rules observed or reported.

2.2.8 To ensure that appropriate warning signboards and tags are displayed.

2.2.9 To report each incident and/or injury in accordance with established procedures and assists during investigation.

2.2.10 To arrange tool box meeting daily and shall continue this process to make workmen safety conscious. To keep a constant liaison with the relevant authority at IPR on safety issues.

2.3 Contractor Employees

The duties & responsibilities of the contractor employees should include the following:

2.3.1 The contractors' employees must be trained for safety standards, procedure to carry out high risk job (if involved), use of Personal Protective Equipment (PPEs) in general and specific for a particular job, emergency preparedness and fire extinguisher and medical first-aid.

2.3.2 To perform work safely as per the job requirements/instructions and wear appropriate PPEs.

2.3.3 To inform promptly to their management regarding all work related incidents resulting in personal injury, illness and/or property damage, etc.

2.3.4 To take all necessary and appropriate safety precautions to protect themselves, other personnel and the environment.

3. PENALTY FOR NON-COMPLIANCE

The following penalties shall be imposed on the contractor by the IPR and shall be deducted from his running/final bill.

Sr. No.	Non-Compliance/Violation of Safety Protocols/Rules/Norms	Penalty
1.	Non-use of PPE like Safety Helmet / Safety Shoes etc.	Rs. 100 per day/person
2.	Over speeding (> 30Km/Hr) / rash driving or improper parking	Rs. 100 per occasion
3.	Non-use ELCB/MCB, Use of non-standard socket, poor cable joint, laying wire/cables on floor, non-use of socket, electrical jobs by incompetent person	Rs. 200 per day/case
4.	Working at height without full body safety harness, using non-standard scaffolding and not arranging fall protection arrangement	Rs. 500 per day/case
5.	Handling of compressed gas cylinders without trolley and double gauge regulator, Improper keeping/storage of gas cylinder	Rs. 200 per day/case
6.	Use of domestic LPG for cutting purpose.	Rs. 200 per day/case
7.	No fencing/barricading of excavated/open areas.	Rs. 200 per day/case
8.	No provision of firefighting equipment during hot works. Use of firewater for purpose other than firefighting.	Rs. 200 per day/case
9.	No reporting of Nearmiss/First-aid/Injury/Property damage/Minor fire etc. incidents	Rs. 500 per case
10.	Poor Housekeeping	Rs. 200 per day/case
11.	No deployment of safety officer/safety supervisor responsible for safety at work site as mentioned in Chapter No. 5	Rs. 500 per day

Safety Officer or any other officer authorized by IPR will report safety violation to the concerned Engineer In-charge for imposing necessary penalty. Engineer-in-charge shall ensure that the penalty amount has been deducted from the running bill of contractor. Imposing any penalty for violation of safety norms does not absolve the contractors from their contractual obligation/ responsibility. Contractor shall be fully responsible for any accident and/or injury to their employees or property due to

violation of safety norms.

4. PROVISION FOR SAFETY SUPERVISOR /SAFETY OFFICER OF CONTRACTOR

The contractor shall depute at least one Safety Supervisor / Safety Officer for critical activities as follows,

i. Work at height (working beyond 2.5 mtr. above ground)
ii. Materials and Material Handling which includes movement of heavy material by crane, movement of tractor trolley on slopes, Manual lifting of heavy material to height, erection of heavy machinery, equipment, etc.
iii. Loading and unloading of equipment, structural materials, machineries, etc., Fabrication and erection work
iv. Working near high voltage lines, electrical installations, etc., charging of electrical system, transformers, switch yard, switch gears, etc.
v. Work on pressure vessels/lines
vi. Work in confined space
vii. Radiography work
viii. Work related to welding, gas cutting, grinding, etc.
ix. Work with pneumatic tools/compressed air
x. Leak detection testing / Hydraulic testing

In addition to above list, IPR may also recommend for some specific tasks, which are not covered, to depute Safety Officer/Safety Supervisor.
Safety supervisor shall be qualified of minimum Diploma in Engineering/ Graduate in Science with approved course in the field of safety and/or fire. He shall able to read and understand English and speak regional/national language. He shall have experience as safety supervisor for a period of minimum one year.

Safety Officer shall be qualified of minimum Bachelor in Engineering/ Post Graduate in Science with approved course in the field of Safety and/or Fire. Safety Officer shall have good communication and written skill to liaison with the client. He shall have good command in English and regional/national language. He shall have experience for a period of minimum three years of supervisory level.

5. GENERAL SAFETY PROVISIONS

5.1 Personal Protective Equipment

The contractor is responsible to provide all necessary standard make (ISI marked) personal protective equipment (PPE) suitable to give sufficient protection against hazards involved in their work / job to their employees, as per the job requirement and insist/enforce their staff to put on the same while at works and ensure

that the PPEs are properly used and maintained in a condition suitable for immediate use. The contractor shall have sufficient stock of various PPEs to avoid any shortage of supply and shall take adequate steps to ensure proper use of equipment by those concerned. The ongoing work is liable to be stopped at any time if the contractor's staff is found working without PPEs.

5.1.1 All persons employed at site shall use safety helmets. For other types of works, persons working in that area shall also use safety helmets, if advised by Safety Engineer/Engineer-In-Charge.

5.1.2 Persons engaged in welding and gas-cutting works shall use suitable welding face shields. The persons who assist the welders shall use suitable goggles. Protective goggles shall be worn while chipping and grinding.

5.1.3 All persons working at heights more than 2.5 m above ground or floor and exposed to risk of falling down shall use full body safety harness, unless otherwise protected by cages, guard railings, etc. In places where the use of safety harness is impractical, suitable net of adequate strength fastened to substantial supports shall be employed.

5.1.4 When workers are employed in sewers and inside manholes, which are in use, the Contractor shall ensure that the manholes are opened and are adequately ventilated at least for an hour. After it has been well ventilated, the atmosphere inside the space shall be checked for the presence of any toxic gas or oxygen deficiency and recorded in the register before the workers are allowed to get into the manholes. The manholes opened shall be cordoned off with suitable railing and provided with warning signals or caution boards to prevent accidents. There shall be proper illumination in the night.

5.1.5 The following is the list of various PPEs to be used for various works/worksites.

List of Safety Equipment

Sr. No.	PPE	Purpose
01	Industrial Safety Helmet	For protection of head against falling objects or during fall of person from height.
02	Safety Goggles (Grinding, Welding, etc).	For protection of eyes against flying particles / dust, chemical splash, spark, arc, flashover etc.
03	Face shield	For protection of face against flying particles / dust, chemical splash, spark, arc, flashover etc.
04	Ear plug / Ear muffs	For ear / hearing system protection while working in high noise level area.
05	Apron (PVC /cryo/Cotton)	For body protection against chemicals, oils, cryogenics, sharp edged objects, heat, hot objects etc.
06	Gloves (Nitrile/Leather, cryo, Electrical shock proof)	For protection of hands against chemicals, oils, cryogenics, sharp edged objects, heat, hot metals/objects, electricity etc.
07	Safety Shoes	For protection of leg/feet against falling objects, sharp edged objects, heat, hot metals/objects,, electricity etc.
08	Full body safety harness/ I Rope /Life line/ Fall	For fall prevention while working at heights or in depth, working in vessel or in confined space.
09	Dust Respirator	Protection of respiratory system against dust.
10	Self-contained breathing apparatus (SCBA) set	Working in oxygen deficient areas.

5.2 Electricity

The following are provided for general guidance of the Contractor and shall be read as specific requirement, in addition to complying with Indian Electricity Act, Indian Electricity Rules and IS Specifications.

5.2.1 Only qualified electricians familiar with code requirements are allowed to perform electrical work.

5.2.2 Employees are not permitted to work near an unprotected electrical power circuit unless they are protected against electrical shock by de-energizing the circuit and grounding it, or are protected by effective insulation or other means, and are wearing .required personal protective equipment.

5.2.3 The electric power supply will be generally made available at one point in the works site of the contractor by IPR.

5.2.4 All light fixtures and portable equipment shall be effectively earthed to main earthing.

5.2.5 All earth terminals shall be visible. No gas pipes and water pipes shall be used for earth connection. Neutral conductor shall not be treated as earth wire.

5.2.6 The contractor shall not connect any additional load without prior permission of IPR.

5.2.7 Joints in earthing conductors shall be avoided. Loop earthing of equipment shall not be allowed. However tappings from an earth bus may be done.

5.2.8 Electrical equipment and installations shall be installed and maintained as to prevent danger from contact with live conductors and to prevent fires originating from electrical causes like short circuits, overheating etc. Installation shall not cause any hindrance to movement of men and materials.

5.2.9 Materials for all electrical equipment shall be selected with regard to working voltage, load and working environment. Such equipment shall conform to the relevant standards.

5.2.10 Electric fuses and/or circuit breakers installed in equipment circuits for short circuit protection shall be of proper rating.. For load of 5 KW or more earth leakage circuit breaker of proper rating shall be provided in the circuits.

5.2.11 Wires and cables shall be properly supported and approved method of fixing shall be adopted. Cables shall not be left on floor/ground. Loose hanging of wires & cables shall be avoided. Lightning and power circuits shall be kept distinct and separate.

5.2.12 Reinforcement rods or any metallic part of structure shall not be used for supporting wires and cables, fixtures, equipment, earthing etc.

5.2.13 All cables and wires shall be adequately protected mechanically against damages.

5.2.14 Multi-stranded conductor cables shall be connected by using cable lugs/ sockets. Cable lugs shall preferably be crimped. They shall be of proper size and shall correspond to the current rating and size of the cable. Twisted connections will not be allowed.

5.2.15 All the Distribution Boards, shall have MS enclosures and shall be dust, vermin and waterproof. The Distribution Boards, switches etc. shall be so fixed that they shall be easily accessible.

5.2.16 The Contractor shall provide proper enclosures/covers of approved size and shape for protection of all switch boards, equipment etc. against rain.

5.2.17 Isolating switches shall be provided close to equipment for easy disconnection of electrical equipment or conductors from the source of supply, when repair or maintenance work has to be done.

5.2.18 All connections to lighting fixtures, starters or other power supplies shall be provided with PVC insulated, PVC sheathed twin/three/four core wires to have better mechanical protection for preventing possible damage to equipment or injury to personnel. Taped joints shall not be allowed and the connections may be made in looping system. Electric starter of motors, Switches shall not be mounted on .wooden boards. Only sheet steel mounting or iron framework shall be used.

5.2.19 Only PVC insulated and PVC sheathed wires or armored PVC insulated and sheathed cables shall be used for external power supply connections of temporary nature. Weatherproof rubber wires shall not be used for any temporary power supply connections. Taped joints in the wires shall not be used.

5.2.20 All portable appliances shall be provided with three-core cable and three-pin plug. The third pin of the plug shall invariably be earthed. It shall be ensured that the metal part of the equipment shall be effectively earthed.

5.3 House Keeping

5.3.1 The Contractor shall at all times keep his work spot, site office and surroundings clean and tidy from rubbish, scrap, surplus materials and unwanted tools and equipment so as not to create unsafe condition or fire hazard.

5.3.2 Welding and other electrical cables shall be properly routed.

5.3.3 No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public.

5.3.4 Cleaning of the work area at the end of the day and upon completion of work is a part of the job.

5.3.5 The Engineer-in-charge has the right to stop work if the Contractor fails to improve upon the housekeeping after having been notified.

5.4 Fire Safety

5.4.1 All necessary precautions shall be taken to prevent outbreak of fires at the site. Adequate provisions shall be made to extinguish fires, if it still breaks out.

5.4.2 Quantities of combustible materials like timber, bamboos, coal, paints, etc., shall be kept minimum in order to avoid unnecessary accumulation of combustibles at site.

5.4.3 Containers of paints, thinners and allied materials shall be stored in a separate room which shall be well ventilated and free from excessive heat, sparks, flame or direct rays of the sun. The containers of paint shall be kept covered or properly fitted with lid and shall not be kept open except

while using.

5.4.4 Fire extinguishers shall be located at the site at appropriate places.

5.4.5 Adequate number of workmen shall be given education and training in firefighting and extinguishing methods.

5.5 Scaffolding

Accidents are also caused by the ladders falling or the climber losing his balance or failure of scaffolds. As such, utmost care should be taken as ladder and scaffolding are extensively used for maintenance and construction purpose. Some of the safe practices as listed below are to be observed before commencement of work.

5.5.1 Adequate and safe means of access and exit shall be provided for all work places, at all elevations. Using of scaffolding members (avoiding a ladder) for approach to high elevations shall not be permitted.

5.5.2 Suitable scaffolds shall be provided for workmen for all works that cannot safely be done from the ground, or from solid construction except such short duration work as can be done safely from ladders. Ladder shall be of rigid construction having sufficient strength for the intended loads and made either of good quality wood or metal and all ladders shall be maintained well for safe working condition.

5.5.3 Short ladder must not be tied together to give greater lengths. All ladders of 6 m or above should be tied to the structure on which they are resting to prevent from. An extra worker shall be engaged for holding the ladder if ladder is not securely fixed. If the ladder is used for carrying materials, suitable foot holds and handholds shall be provided on the ladder. The ladder shall be given an inclination not steeper than 1 in 4(1 horizontal and 4 vertical). Ladders shall not be used for climbing carrying materials in hands. While climbing both the hands shall not be free.

5.5.4 The free length must extend by 1.5 meters above the point of landing but should not be more than 1/4th of the ladder length. No portable single ladder shall be over 9 meter in length. Metal ladders may not be used for electrical work.

5.5.5 Scaffolding or staging more than 3.5 m above the ground or floor, swung or suspended from an overhead support or erected with stationary support shall have a standard guard rail properly attached, bolted, braced or otherwise secured at least 1.0 m high above the floor or platform of such scaffolding or staging. The guard rail shall extend along the entire exposed length of the scaffolding with only such opening as may be necessary for the delivery of materials. Standard railing shall have posts not more than 2 m apart and an intermediate rail halfway between the floor or platform of the scaffolding and the top rail. Such scaffolding or staging shall be so fastened as to

prevent it from swaying from the building or structure. Scaffolding and ladder shall conform to relevant IS specification (IS: 3696). Timber/Bamboo scaffolding shall not be used.

5.5.6 Working platforms of scaffolds shall have toe boards at least 15 cm in height to prevent materials from falling down.

5.5.7 Every part of scaffolding must be of sound construction. Steel planks used in scaffolds should be carefully inspected and should be tied on both sides with suitable fixing arrangements to the pipes. Scaffolding must not be overloaded.

5.5.8 The Steel pipe & clamp to be used must be of good quality. The spacing between the vertical & horizontal members of the scaffolding should not be more than 1.5m and 1 meter respectively. The scaffolding should be further strengthened with cross bracing and stays.

5.5.9 The scaffolds should be provided with short climbs ladders for safe ascending/ descending of workmen in the job. Only those workmen who are well trained/ experienced in erecting scaffolding should be engaged for scaffolding work. The men working in the actual erection/dismantling of the scaffolding and all persons using the scaffolding must use appropriate PPEs.

5.5.10 A sketch of the scaffolding proposed to be used shall be prepared and approved by the Engineer-in charge, prior to start of erection of scaffolding. All scaffolds shall be examined by Engineer-In-Charge before use.

5.5.11 Working platform, gangways and stairways shall be so constructed that they shall not sag unduly or unequally and if the height of the platform or gangway or stairway is more than 3.5 m above ground level or floor level, they shall be closely boarded, shall have adequate width for easy movement of persons and materials and shall be suitably guarded.

5.5.12 The planks used for working platform shall not project beyond the end supports to a distance exceeding four times the thickness of the planks used. The planks shall be rigidly tied at both ends to prevent sliding and slippage. The thickness of the planks shall be adequate to take load of men and materials and shall not collapse.

5.5.13 Each opening in the floor of a building or at a working platform shall be provided with suitable means to prevent fall of persons or materials by providing suitable fencing or railing.

5.5.14 Safe means of access shall be provided to all working platforms and other elevated working places. Every ladder shall be securely fixed. No single portable ladder shall be over 9 m in length. For ladders up to 3m in length the width between side rails in the ladder shall in no case be less than 300 mm. For longer ladders this width shall be increased by at least 20 mm for each additional meter of length. Step spacing shall be uniform and shall not exceed 300 mm.

5.5.15 Adequate precautions shall be taken to prevent danger from electrical lines and equipment. No scaffolding, ladder, working platform, gangway runs, etc.

shall exist within 3 meters of any uninsulated electric wire. Whenever electric power and lighting cables are required to run through (pass on) the scaffolding or electrical equipments are used, such scaffolding structures shall have minimum two earth connections with earth continuity conforming to IS Code of Practice.

5.6 Lifting/Hoisting Equipment and Erection

Accidents do happen while working overhead or due to failure or unsafe use of hoisting equipment. As such, adequate care must be taken to prevent it. The following are some of the precautions to ensure safety of the workmen engaged by the contractor:

5.6.1 Contractors involved in handling of any material overhead must install necessary barricades, warning signs or take any other steps necessary to prevent others from walking/standing beneath the load.

5.6.2 Hoisting machines, tackles including their attachments, anchorage and supports must conform to the good mechanical construction, sound materials and adequate strength and free from patent defect and shall be preserved in good condition.

5.6.3 All equipment like crane, chain blocks, sling, and rope including all other material handling equipment must have valid load test certificates.

5.6.4 Thorough inspection and load testing of lifting machines and tackles shall be done by a competent person at least once every 12 months and records of such inspection and testing shall be maintained.

5.6.5 Every crane driver or hoisting appliances operator shall be properly qualified and no person below the age 21 years should be in charge of any hoisting machine.

5.6.6 Every hoisting machine and all gears shall be plainly marked with the safe working load. No part of any machine or gear shall be loaded beyond the safe working load (SWL).

5.6.7 In case of IPR's machines, the safe working load shall be notified by Engineer-in-charge. For contractor's machines, the contractor shall notify the safe working load to Engineer-in-charge.

5.6.8 Motors, gearing transmission, electric wiring and other dangerous parts of hoisting appliances should be provided with safe guards.

5.6.9 No cranes shall be left unattended with hanging load and on completion of work, the boom/jib of the crane may be brought down and kept in horizontal condition.

5.6.10 No crane including hydra crane shall be allowed to move on road with suspended load.

5.7 Welding and Gas Cutting

5.7.1 Welding and gas cutting operations shall be done only by qualified and authorized

persons and as per IS specifications and Code of Practice.

5.7.2 Welding and gas cutting shall not be carried out in places where flammable or combustible materials are kept and where there is danger of explosion due to presence of gaseous mixtures.

5.7.3 Welding and gas cutting equipment including hoses and cables shall be maintained in good condition.

5.7.4 Barriers shall be erected to protect other persons from harmful rays from the work. When welding or gas cutting is in elevated positions, precautions shall be taken to prevent sparks or hot metal falling on persons or flammable materials. Adequate ventilation shall be provided while welding in confined space.

5.7.5 Suitable type of protective clothing consisting of fire resistant gauntlet gloves, leggings, boots and aprons shall be provided to workers as protection from heat and hot metal splashes. Welding shields with filter glasses of appropriate shade shall be worn as face protection.

5.7.6 Welding and gas cutting shall not be done on drums, barrels, tanks or other containers unless they have been emptied, cleaned thoroughly and it is made certain that no flammable material is present.

5.7.7 Fire extinguisher shall be available near the location of welding operations. Prior permission shall be obtained from safety section for working at vulnerable areas and operating areas before flame cutting/welding is taken up.

5.7.8 Tarpaulin, if used should be of fire retardant.

5.7.9 For electric (Arc) welding the following additional safety precautions shall be taken:

- When electrical welding is undertaken near pipe lines carrying flammables, such pipe lines shall not be used as part of earth conductor but a separate earth conductor shall be connected to the machine directly from the job.
- Personnel contact with the electrode or other live parts of electric welding equipment shall be avoided.
- Extreme caution shall be exercised to prevent accidental contact of electrodes with ground.

5.7.10 The cylinders containing poisonous/toxic or inflammable / explosive gas like Oxygen, Acetylene, Hydrogen, Ammonia, Chlorine, CO_2 etc. shall be handled safely taking due cares. To handle / shift such cylinders a special trolley / cage meant for it must be used but in no case it should be rolled.

5.7.11 No domestic LPG cylinder is allowed for Hot Work such as Gas Welding / Gas Cutting.

5.7.12 A person must remain in the area for a minimum period of 30 minutes after hot work is completed to ensure the site is safe. Welding machine shall be switched off after the completion of work.

5.8 Grinding

5.8.1 All portable grinders shall be used only with their wheel guards in position to reduce the danger from flying fragments should the wheel break during the use.

5.8.2 Grinding wheels of specified diameter only shall be used on a grinder- portable or pedestal - in order not to exceed the prescribed peripheral speed.

5.8.3 Goggles shall be used during grinding operation.

5.9 Painting

5.9.1 The Contractor shall not employ women on the work of painting with products containing lead in any form. Only men above the age of 18 years shall be employed on the work with lead paint.

5.9.2 Smoking, open flames or sources of ignition shall not be allowed in places where paints and other flammable substances are stored, mixed or used. A caution board, with the instructions written in national/regional language, "SMOKING - STRICTLY PROHIBITED" shall be displayed in the vicinity where painting is in progress or where paints are stored.

5.9.3 When painting work is done in a closed room or in a confined space, adequate ventilation shall be provided. If adequate ventilation cannot be provided, workers shall wear suitable respirators.

5.9.4 Epoxy resins and their formulations used for painting shall not be allowed to come in contact with the skin. The workers shall use plastic gloves and/or suitable barrier creams.

5.9.5 Workers shall thoroughly wash hands and feet before leaving the work. Work clothes shall be changed and laundered frequently.

5.10 Radiography

5.10.1 Only properly trained, qualified personnel shall be allowed to use radiation producing equipment or handle radioactive source.

5.10.2 Radiography works may be carried out preferably after office hours or on holidays.

5.10.3 The following are some basic rules to be followed:

- The ionization radiation source shall not be left unattended.
- Radiation film and dose meter shall be used.
- The exposed area shall be clearly identified, barricaded by rope or other effective means and internationally recognized symbol for radiation shall be placed around the perimeter of any area which may be affected by radiation.
- Contractor shall coordinate with safety officer to ensure that the

dose rate at barricade does not exceed 0.75 milirems per hour.

5.11 Maintenance of Equipment

5.11.1 Disconnect the electrical power before starting the mechanical maintenance of the equipment/machine.

5.11.2 During the maintenance of equipment/machine, it should be doubly ensured that the machine does not move unexpectedly causing injury to the person involved.

5.11.3 Full proof lockout system or power lock off system should be followed. Power lock off system shall include the electrical power, energy stored in springs, suspended parts or any other potential power sources.

5.11.4 A highly legible information plate should be kept near the equipment/ machine under maintenance giving the details of work being carried-out, warning instructions etc., to enable the workers, supervisors or any visitors to keep away.

5.11.5 Removal of such plates immediately after the maintenance, repair etc., shall be -insured.

5.11.6 Instructions from the machine manufacturers' service/installation book should be followed during maintenance of the equipment.

5.11.7 Only trained personnel should be employed for carrying out maintenance, repair, adjustment etc.

5.11.8 Identified tools should be used to carry out such works.

5.11.9 Guards should be replaced immediately after the maintenance work.

5.11.10 Eli Chips and debris must be swept up and properly disposed.

6. REPORTING FORM

6.1 Near Miss Reporting Form

(This form may be filled and submitted to the Safety Section within 48 hours from the incident time)

1. Name of Person Affected/Observed Near miss:	2. Group/Division/Section:
3. Designation:	4. Location of Near Miss:
5. Date & Time of Near Miss:	6. Contact no:/Ext. No.:
7. Near Miss Description: (*Describe fully, the protocol / procedure been followed including all substances, equipment and machinery being used which was related to the near miss.)*	

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8. Possible Damage that might have happened:

(i)

(ii)

9. Corrective Actions Proposed to prevent reoccurrence of such near miss incident(s):

SUBMITTED BY:

Signature:

Name:

Date:

6.2 Incident Reporting Form

This form is to be filled and submitted for all incidents except near miss to safety section within 72 hours from the incident time)

A. PERSONNEL INFORMATION

Name of Injured:		PR No.:
Group:		Contact No./ Ext. No.:

Incident Site:	**Employee Category:** ( ) Permanent Employee ( ) Project Employee ( ) Contract ( ) AMC ( ) TPIA ( ) Service Provider/Contractor ( ) Other Category

B. CATEGORY OF INCIDENT

First aid case	
Medical case	
Asset/Equipment/Property damage	
Vehicle incident	
Fire	
Fatal Accident	

C. INCIDENT INFORMATION

Date / Time of Incident	Date/Time Reported To Group Leader
Person Reporting Incident	
Incident Description:	
Injury / Illness Description:	

D. TREATMENT INFORMATION

Treatment Description

Treatment Administered By	Date Of Treatment	Time Of Treatment
Phone No of clinic / hospital	Name of Clinic/Hospital:	
Pl. attach medical officer's prescription for medical treatment: -	Released from Hospital Date / Time: -	

E. INITIAL CORRECTIVE ACTION INFORMATION

Immediate Causes of incident:
Initial Corrective actions taken 1. 2. 3.

Prepared By:

Sign:
Name:
Designation:
Date:

Reviewed By:

Sign:
Name:
Designation:
Date:

Annexure-6

EHCL Instrumentation Chart

(These details are provided separately)

Annexure-7

Data acquisition and Control System schematic

(These details are provided separately)

Annexure-8

Additional details to be provided by IPR after placement of the purchase order

a) EHCL lab layout and Drawings
b) Additional details of FIMs as required
c) Preliminary Loop layout (for reference)
d) Operational and control philosophy of EHCL system
e) Process flow details of EHCL system
f) Input/output lists of the EHCL system.
g) Floor Response Spectra (FRS) details
h) Any other details, drawings etc. that may require during the work.