

भारत सरकार
अंतरिक्ष विभाग
सतीश धवन अंतरिक्ष केंद्र शार
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निविदा सूचना सं. TENDER NOTICE NO. SDSC SHAR/Sr.HPS/PT/RO-LSSF/51/2025-2026

भारत के राष्ट्रपति की ओर से वरि. प्रधान क्रय एवं भंडार, सतीश धवन अंतरिक्ष केंद्र श्रीहरिकोटा निम्नलिखित वस्तुओं के लिए ऑनलाइन निविदाएं आमंत्रित करते हैं:- On behalf of President of India, Sr. Head Purchase and Stores, SDSC SHAR, SRIHARIKOTA invites on line quotations for the following.

क्र.सं. Sl No	संदर्भ सं. Ref. No.	विवरण Description	मात्रा Qty.
01.	SDSC SHAR /TLP PURCHASE /TLP/ 2025001463 [Public Tender - Two Part]	Realization & Commissioning of 50 MTPD Cryogenic Air Separation Plant including Operation & Maintenance at SDSC SHAR.	02 Lots

निविदा दस्तावेजों को डाउनलोड करने की अंतिम तिथि Last Date for downloading of tender documents : 06.01.2026 at 14:00 hrs.
ऑनलाइन निविदा जमा करने की अंतिम तिथि Due Date for submission of bids online : 06.01.2026 at 14:00 hrs.
बोली पूर्व बैठक Pre-bid Meeting : 16.12.2025 from 10.00 Hrs
निविदाएं खोलने की नियत तिथि Due Date for opening of tenders : 06.01.2026 at 14:05 hrs.

निविदाकार के लिए निर्देश Instructions to Tenderers:

निविदाएं ईजीपीएस के माध्यम से ही भेजी जाएं तथा कोई निविदा शुल्क लागू नहीं होगा।
Bids shall be submitted on line through EGPS only and No tender fee shall be applicable.

- कार्य के सम्पूर्ण विवरण/जानकारी तथा नियम व शर्तों इत्यादि के लिए संलग्न अनुलग्नक को देखें। / For full details/scope of work and terms and conditions etc., please see the enclosed annexures.
- इच्छुक निविदाकार इसरो की ई-खरीद वेबसाइट इसरो न्यू ई-प्रोकुरमेंट www.eproc.isro.gov.in से ई-निविदा डाउनलोड और अपनी निविदा ई-खरीद पोर्टल पर ऑनलाइन जमा कर सकते हैं। डाक / वाहक / स्वयं द्वारा प्राप्त निविदाओं पर विचार नहीं किया जाएगा। / Interested tenderers can download the e-tender from ISRO NEW E-PROCUREMENT website www.eproc.isro.gov.in and submit the offer online in the e-procurement portal. Offers sent physically by post/courier/in person will not be considered.
- निविदा दस्तावेज इसरो की वेबसाइट www.isro.gov.in इसरो न्यू ई-प्रोकुरमेंट वेबसाइट www.eproc.isro.gov.in तथा सतीश धवन अंतरिक्ष केंद्र शार की वेबसाइट www.shar.gov.in पर भी उपलब्ध हैं। इन्हें केवल ई-खरीद पोर्टल से डाउनलोड और निविदा ऑनलाइन जमा कर सकते हैं। / Tender documents are also available on ISRO website www.isro.gov.in, ISRO New e-procurement website www.eproc.isro.gov.in and SDSC SHAR, Sriharikota website www.shar.gov.in. The same can be downloaded and offer can be submitted online in the new e-procurement portal only.
- निर्धारित तिथि/समय के पश्चात प्राप्त बोलियों पर विचार नहीं किया जाएगा। / Quotations received after the due date/time will not be considered.
- वरि. प्रधान क्रय एवं भंडार, सतीश धवन अंतरिक्ष केंद्र श्रीहरिकोटा के पास किसी भी या सभी निविदाओं को स्वीकार / अस्वीकार करने का अधिकार है। / Sr. Head, Purchase and Stores, SDSC-SHAR, Sriharikota reserves the right to accept or reject any/or all the quotations.
- GeM GARPTS Report ID: GEM/GARPTS /18112025/A298S3GXY1PT

दिनांक DT: 05.12.2025

वरि. प्रधान क्रय एवं भंडार
Sr. HEAD PURCHASE AND STORES



सत्यमेव जयते

GOVERNMENT OF INDIA
DEPARTMENT OF SPACE

REQUEST FOR PROPOSAL
FOR
50 MTPD CRYOGENIC AIR SEPARATION PLANT

This Request For Proposal (RFP) is primarily aimed to award the contract for Establishment of a Cryogenic Air Separation Plant with 50 MTPD capacity, at SDSC SHAR.

SATISH DHAWAN SPACE CENTRE SHAR
INDIAN SPACE RESEARCH ORGANISATION
SRIHARIKOTA - 524121

DEFINITION OF TERMS AND INTERPRETATION

“Request For Proposal”	Request For Proposal (RFP) is this document specifying requirements of systems to be realized, scope of work involved, eligibility criteria / conditions for short listing of Bidders and award of Contract.
“Department or Purchaser”	Satish Dhawan Space Centre (SDSC) SHAR, Sriharikota represented by Sr. Head, Purchase & Stores acting on behalf of the President of India.
“Bid”	Shall mean the proposal / document that the Bidder submits in the requested and specified form in the specification in response to this RFP.
“Bidder or Supplier or System Integrator”	Shall mean the Sole Bidder who shall submit or who have submitted the Bid.
“Contract”	The formal agreement signed by Department and Contractor for execution of work.
“Contractor”	The successful Bidder chosen by the Department, responsible & accountable to the Department for executing the works under the Contract and include legal personal representative(s) /successor(s) / assign(s) of the Contractor’s firm or company or the person(s) comprising the Contractor’s firm or company.
“Site”	The facility at Sriharikota on which work is to be executed under the Contract which shall be allotted by the Department for the purpose of carrying out the work.
“Approval”	Shall mean and include the written approval by the purchaser of a documents, drawing or other particulars in relation to this Contract.
“Commissioning”	Shall mean the putting into operation of plant by Contractor with the assistance from Purchaser’s Personnel.

**REQUEST FOR PROPOSAL FOR ESTABLISHMENT OF
CRYOGENIC AIR SEPERATION PLANT WITH 50 MTPD CAPACITY
AT SATISH DHAWAN SPACE CENTRE SHAR**

Satish Dhawan Space Centre SHAR (SDSC SHAR) of Indian Space Research Organisation (ISRO) under Department of Space, Government of India is the lead Centre for Integration, Servicing and launching of Launch Vehicles. It is located at Sriharikota in Tirupati District of Andhra Pradesh, India, near to Chennai about 100 Kms.

This Request For Proposal (RFP) is primarily aimed to award the contract on potential Bidders who can setup or establish Cryogenic Air Separation Plant at SDSC SHAR. BIDDERS who are eligible and having experience in “Design, Engineering, Manufacturing, Inspection, supply, Erection, Civil Construction works, Testing & commissioning of a Cryogenic Air Separation Plants”, shall respond for the tender.

This Request For Proposal (RFP) specifies the requirements of Design, Engineering, Manufacturing, factory testing before dispatch, Material supply, Inspection & Testing, Transportation to Site, Unloading, Storage, Site Erection, Structural sheds, support structures, etc; associated Civil, Electrical & Air conditioning works; Testing and Commissioning of a 50 MTPD Capacity Cryogenic Air Separation Plant at SDSC SHAR.

The plant shall be supplied with a warranty period of 12 months from the date of commissioning.

Technical and Non-technical services related to Operation & Maintenance (O & M) and Transportation of LOX & LN2 to Storage Facilities at SDSC SHAR, are also part of the Tender and shall be in the scope of Supplier after successful realisation & commissioning of the plant, as per RFP terms. The O & M of the plant shall be carried out by the contractor, for a period of 3 years after successful commissioning. Cost towards Plant realisation and O & M works shall be quoted as per the price formats enclosed in the RFP. Purchase Order shall be placed initially for plant realisation & commissioning along with O & M during the warranty period of 12 months, on the successful BIDDER. A separate purchase order will be placed on the successful BIDDER subsequently during Warranty period, for balance 2 Years Operations & Maintenance Support. During the O&M period Supplier shall be responsible for procuring production consumables like chemicals, oils, lubricants, Operational spares, OEM spares and consumables etc. towards 24x7 Plant Operations.

This RFP document is organized in parts, as follows:

PART 1	Technical Specifications for Design, Engineering, Manufacturing, Inspection, Supply, Erection, Testing & Commissioning of 50 MTPD Cryogenic Air Separation Plant
PART 2	Operation and Maintenance of Air Separation Plant after Realization
PART 3	Commercial Terms and Conditions
PART 4	Bidder Qualification Criteria & Evaluation
PART 5	Formats to be filled by Bidder
PART 6	Checklists
PART 7	Annexures

Though the technical content of this document gives functional requirements, plant description / configuration along with other requirements, it is necessary that the BIDDER carefully note the content of the document, for arriving at the most optimum Air Separation Plant with the state-of-the-art technology, having best energy efficiency so as to reduce the power consumption to a minimum.

It is required that the BIDDER shall study the complete RFP and understand the requirements prior to the submission of the techno commercial bid in order to avoid any lack of understanding subsequently on the technical and commercial aspects.

BIDDERS shall submit the bids in Two parts viz (i) Techno-commercial (non-priced) bid and (ii) Price bid on ISRO E-procurement portal. Prospective BIDDERS shall fill details in formats mentioned in PART 4 provided in the RFP and submit along with credentials / documentary proof. The “Minimum Qualification criteria” mentioned for Financial turn over, Technical eligibility and Past experience of similar class of works completed, will be first scrutinized by DEPARTMENT. The DEPARTMENT will initially evaluate the techno-commercial bids and shortlist the suitable BIDDERS whose techno-commercial bids are compliant with the RFP specification. The DEPARTMENT will open the price bids of the techno-commercially qualified BIDDERS only, arrange post-price bid discussion, if necessary, and award the Purchase Order based on the technically suitable Lowest-priced bid.

Air Separation Plant realisation & commissioning shall be completed in 24 months, the BIDDERS are advised to take utmost care in studying the quantum & nature of work

towards realisation and plan adequate & suitable resources for executing the contract complying with the specifications and requirements with in the stipulated realisation period.

Important Dates:

Last date for submission of bids to RFP	
Opening date of Technical Bid	
Opening date of Price Bid	

Pre-Bid Clarification meeting will be arranged at SDSC in order to have a better understanding of the activities involved, clarify doubts, if any and visit to site. The interested BIDDER is hereby requested to take part in the Pre-Bid meeting scheduled as below:

Date :	As per the Tender document
Time :	As per the Tender document
Venue :	Satish Dhawan Space Centre SHAR, Sriharikota Tirupati District, Andhra Pradesh – 524124, India Focal point: Sr. Purchase & Stores Officer, RO&LSSF Contact Number 08623 225127 / 226331 Email: sselvan@shar.gov.in / psolssf@shar.gov.in

Interested BIDDERS shall provide the details of the representative(s) taking part in the interaction meeting well in advance to the Focal Point in order to arrange for Security clearance. Representatives shall carry an “Authorization Letter” issued by Company / Firm / Organisation for attending the Pre-Bid meeting. The Pre-Bid shall be conducted in both Offline and Online modes as per the Date & Time mentioned in the Tender document.

Any request for advancing / postponement of Pre-Bid meeting will not be entertained under any circumstance. Attendance for Pre-Bid meeting is not mandatory.

ABBREVIATIONS

AMC	- Annual Maintenance Checks
ASU	- Air Separation Unit
BOQ	- Bill of Quantity
BL	- Battery Limit
CED	- Civil Engineering Division
CPWD	- Central Public Work Department
DCS	- Distributed Control System
DG	- Diesel Generator
EOT	- Electrical Overhead Track
FFL	- Finish Floor Level
FDA	- Fire Detection Alarm
GLR	- Ground Level Reservoir
HT	- High Tension
HAZOP	- Hazard and Operability Studies
ICS	- Instrumentation and Control System
ITP	- Inspection and Test Plan
IO	- Input/ Output
iMCC	- Intelligent Motor Control Centre
LT	- Low Tension
KL	- Kilo Liters
kWhr	- Kilowatt Hour
kV	- Kilo Volt
LIN	- Liquid Nitrogen
LOX	- Liquid Oxygen
MAC	- Main Air Compressor
MSIHC	- Manufacture, Storage and Import of Hazardous Chemical
NBC	- National Building Code of India
O&M	- Operation and Maintenance
OEM	- Original Equipment Manufacturer
PBU	- Pressure Building Unit
PH	- Public Health
PCC	- Plain Cement Concrete
PFD	- Process Flow Diagram
P&ID	- Process & Instrumentation Diagram
PESO	- Petroleum Explosives and Safety Organization
PLC	- Programmable Logic Controller
PO	- Purchase Order
QAP	- Quality Assurance Plan
RFP	- Request for Proposal
RCC	- Reinforced Cement Concrete
SS	- Stainless Steel
SACAD	- Supervisory Control and Data Acquisition
TPD	- Tonnes per Day
TSA	- Temperature Swing Adsorber
TPI	- Third Party Inspection
WTP	- Water Treatment Plant

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PART 1

1.0 TECHNICAL SPECIFICATION OF
CRYOGENIC AIR SEPARATION PLANT

1.1 MAJOR SYSTEMS OF CRYOGENIC AIR SEPARATION PLANT

The Cryogenic Air Separation Plant is required to be planned for realisation in an approximate area of land with dimensions of 200 (m) x 200 (m), as per good engineering practice.

The following major systems are envisaged, under the proposed Contract, toward meeting the satisfactory production of both LOX and LIN along with product transportation:

- a. Production Plant:
 1. Air Compressor units, along with associated subsystems – filtration units, water cooling systems, oil circulation systems, etc.
 2. Purification unit, waste gas management system, & Regenerative cooling system, etc.
 3. Cryogenic Cold box – Low-pressure and high-pressure distillation columns, Heat Exchangers, Expander, Reboiler, etc.
 4. Makeup Water System.
- b. Storage tanks and product delivery / Dispensing System:
 1. 2 nos. of 250 KL cryogenic storage tanks and Loading Pumps.
 2. 2 nos. of Road Transportation tankers (40KL) along with Haulers and Unloading pumps.
- c. Electrical Substation & Power Distribution System.
- d. Instrumentation & Control System, including Gas Analyzers.
- e. Safety & Fire Protection Systems.
- f. Water softening plant.
- g. Effluent Treatment Plant / ZLD, if any, to meet statutory requirements.
- h. Civil Works & Air Conditioning Systems.

- Electrical power switch room or substation with multi-stage voltage level, Analytical lab room
- DCS room
- Fire pump house
- SPTA room
- Display monitoring room
- Documentation room
- Security room, Dispatch terminal, etc.
- Associated buildings, BT Roads, and sub-systems
- Structural shed for Compressor station, etc

The detailed scope of the Air Separation Plant is covered in the following sections of the document

1.2 TECHNICAL DETAILS & SPECIFICATIONS OF THE AIR SEPARATION UNIT

1.2.1 TECHNICAL DETAILS OF THE AIR SEPARATION UNIT

Design of ASU shall be based on a cryogenic process cycle consisting of a main air compressor, precooling, purification, booster air compressor (if required), Turbo Expander, and Rectification columns. The process cycle adopted must minimize capital cost, minimize energy usage, maximize product recovery, and allow maximum operating flexibility.

The Air separation process shall include the following major steps as envisaged: -

- Air Filtration
- Compression
- Pre cooling
- Purification
- Cooling to liquid air temperature
- Separation into components by low-temperature distillation

S. No	Group	Description
1	Suction Filter	Captures dust and other airborne particles from the incoming air.
2	Main Air Compressor -MAC	The MAC draws atmospheric air and compresses it to high pressure. Interstage coolers remove the heat generated during air compression.
3	Air Precooling Unit	Cools and removes the moisture from the compressed air stream before it is sent to the purification unit.

S. No	Group	Description
4	Pre-Purification Unit (Temperature Swing Adsorption)	Removes contaminants that could freeze and clog equipment at cryogenic temperatures. A Temperature Swing Absorber system shall be adopted, containing materials like desiccant and molecular sieves to adsorb water vapor, carbon dioxide, and hydrocarbons.
5	Cold Box	Thermally insulated box that contains the cryogenic heat exchangers, distillation columns, valves, & piping to maintain the extremely low temperatures needed for the process.
6	Turbo Expander	Provides the necessary refrigeration to produce liquids in the distillation columns. which works by expanding the high-pressure gas, causing its temperature to drop significantly.
7	Main Heat Exchanger	Used to cool the compressed air before it enters the distillation columns. Incoming air shall be cooled using the outgoing waste gases and product gases. A regenerative process shall be adopted for cooling or heating towards cost-effectiveness.
8	Double Distillation Column	The liquid air is fed into one or more columns. The temperature gradient in the columns causes components to separate. Structured packing is preferable. Re-boiler for heat integration of the low-pressure & high-pressure distillation columns
9	Storage & Delivery Systems	250 KL Cylindrical cryogenic tanks with self self-pressure building unit (PBU), Road

S. No	Group	Description
		Transportation Tankers (each 1 nos for LOX & LIN respectively).
10	Evaporators & Accumulators	Towards LIN to GN2 conversion for the supply of Instrument Air for Startup & Plant shutdown.
11	Instrumentation	Process Instruments, Remote Valves, Flow meter & Online Analyzers and associated Instrumentation.
12	Control System	PLC system, in which, controller, communication bus, power supply, and Communication card are redundant types. PLC is used to achieve data collection, process control, logic calculation, sequence control, and quick interlock.
13	Electrical Systems	All equipment and systems to provide a continuous, safe, and reliable power supply to all critical ASU process equipment and utility loads under both normal and emergency conditions, incorporating redundancy, dual incomers, and automatic source transfer features in accordance with applicable IS/IEC and CEA standards

Note: The above-listed equipment groups are not exhaustive, and other items/ systems required for the efficient and satisfactory functioning of the ASU and meeting the desired end product requirements are also to be included in the techno-commercial offer and to be supplied.

1.2.2 TECHNICAL SPECIFICATIONS OF THE AIR SEPARATION UNIT

S. No.	Parameter	Description	
1	Plant design capacity	50 MTPD of Liquid Oxygen	
2	Plant Operation Modes	• Max. LOX mode • Max. LIN mode • Split mode	
3	Split mode capacity	• Preferable plant production ✓ Mode 1: 30% LOX & 70% LIN ✓ Mode 2: 50% LOX & 50% LIN • To be specified by the Supplier.	
4	Guaranteed power Consumption (kWh / hr)	• To be Specified by the Supplier • Power consumption details of all the equipment participating in continuous core plant operation shall be submitted along with the selected make/model/specification for plant design. Refer Form 19 in PART 5.	
5	Turn down production, % of rated plant capacity	80 % (of the rated production)	
6	Regeneration time for TSA Molecular Sieves	4 hrs	
8	Product Quality / Purity	LOX	Better than 99.8% (v/v)
		LIN	Better than 99.995% (v/v)
9	Continuous Operation period before Deriming (Defrosting)	2 Years	
10	Time required: Clean up	≤ 4 hr	

	Liquid / Warming /De-riming	
11	Starting time: (from the start of the turbo expander, with liquid to O2 purity reaching the specified value)	≤ 12 hrs
12	Starting time: (After Temporary Stop to O2 purity reaching the specified value)	< 4 hrs

1.2.3 DESIGN INPUTS

S. No	Description	Units	Minimum	Nominal	Maximum
A. Ambient Condition					
1	Ambient Air Temperature	°C	15	30	45
2	Relative Humidity	%	30	60	100
3	Barometric Pressure	bar (a)	1.002	1.003	1.004
B. Electrical Power*					
1	Frequency	Hz	-	50	-
2	Voltage Fluctuation	V	-	415	-
* Tolerances on the Frequency & Voltage shall be as per Indian Standards and as per the details of the Electrical systems in S. No 1.4 of the RFP document.					

C. Other Considerations:

- I. Altitude: +5 m MSL.
- II. Precipitation:
 - a) Annual Average rainfall in a year: 1369.4mm
 - b) Maximum Daily rainfall: 347.2mm
 - c) Maximum hourly rainfall: 121mm
- III. Earthquake Zone: Zone III as per IS1893:2002
- IV. Wind Velocity:
 - a) Max. Wind velocity at 10 m is 4 km/h.
 - b) Cyclone Wind 230 km /hr.
- V. Other Climatic Phenomena:
 - a) Saline and highly corrosive, <1000 m distance from the sea shore.
 - b) Thunder and Lightning
 - c) Sea breeze
 - d) Cyclone

Note:

1. Further details on site climatic conditions, the supplier shall seek clarifications if any during the pre-bid clarifications meeting. It is the supplier's responsibility to use the correct data for the Design considerations of the Air Separation Unit.
2. Atmosphere Air Quality and Raw Water analysis details provided in Annexure 7K & Annexure 7L respectively are indicative; however, the Supplier shall visit the site and assess the Water Quality and Atmosphere Air Quality at their own expenses. The Department shall provide the necessary clearances for the same.

Nominal: Plant optimization, design conditions which shall form the basis for the Performance Guarantee Parameters.

Maximum & Minimum: Design Conditions under which the plant shall be capable of operating with all products at Guaranteed purity and pressure.

1.2.4 SCOPE OF SUPPLY

The following list of equipment is given as a minimum quantity, and the Supplier shall provide all the necessary equipment, piping, and valves to

meet the plant's realisation and satisfactory operational requirements.

S. No	Item Description	Qty.	Unit
1	Main air compressor	1	Lot
2	Booster air compressor (if required)	1	Lot
3	Air Precooling Unit	1(W)+1(St.by)	Lot
4	Molecular sieves adsorbent vessels with after filters	1(W)+1(St.by)	Lot
5	Cooling Water System	1(W)+1(St.by)	Lot
6	Regeneration Heater	1	Lot
7	Cold Box	1	Lot
8	Main Heat Exchangers (Cold Box)	1	Lot
9	Expansion Turbine (both Warm & Cold if applicable as per design)	1 (Set: Cold + Warm if applicable)	Lot
10	Rectification Columns (Cold Box)	1	Lot
11	Liquid Nitrogen storage tank (250KL, Cryogenic tank) with PBU and vaporizer	1	Lot
12	Liquid Oxygen storage tank (250KL, Cryogenic tank) with PBU	1	Lot
13	LOX Loading Pumps along with flexible hose	1(W)+1(St.by)	Lot
14	LIN Loading Pump along with flexible hose	1(W)+1(St.by)	Lot
15	Road Transportation Tanker with Hauler for Liquid Nitrogen transportation (40 KL) with PBU and unloading pump	1	Lot

16	Road Transportation Tanker with Hauler for Liquid Oxygen transportation (40 KL) with PBU and unloading pump	1	Lot
13	Independent Instrument air and Plant air along with Accumulator	1	Lot
14	Online Analysers	1	Lot
14	Spare parts for erection, commissioning, and start-up	1	Lot

Note:

- Any other equipment/subsystem is not included in the above list, but is necessary for satisfactory operation of the Air Separation Unit and shall be considered in the scope of the plant design and supplied by Supplier without any price impact.
- The number of required equipment, including their detailed specifications to be specified by the Supplier.
- Supplier shall provide all necessary instrumentation, internals, and electrical components to meet the requirements.

1.2.5 SCOPE OF WORKS

A. Preliminary Design and Detailed Engineering works along with deliverables:

- Process Flow Diagram (PFDs).
- Preparation of mechanical designs in accordance with various codes, to suit the Process Operating conditions. This shall include calculations of wall thickness, thermal & mechanical stresses, design of internals and attachments etc.
- Preparation of material requisition containing equipment details, mechanical design, drawing, and specifications to enable the fabricator to prepare detailed fabrication drawings.
- Material specifications and corrosion allowance.
- Preparation of specifications for procurement of bought-out items, along with a bill of materials.

6. Development of Detailed Engineering drawings in PDS or PDMS, or any equivalent CAD tools, and specifications of sub-systems.
7. Review of vendor / manufacturers' design and drawings, and undertake engineering into the overall plant configuration.
8. Identification of the detailed scope of the Inspection and listing of items required to be inspected.
9. Heat Exchangers:
 - Technical specification along with ITP
 - Thermal Design
 - Mechanical Design to suit the process operating conditions.
 - Submission of Drawings & Design Data for Department & TPIA approval for realisation.

10. Mechanical & Rotating Equipment:

This includes all rotary and static equipment

- Preparation of technical specifications along with ITP.
- Carrying out mechanical design and stress analysis, wherever applicable.
- Submission of Drawings & Design Data for Department & TPIA approval for realisation.

11. Piping:

- P & IDs and Piping layout drawings with true-to-scale representation of all runs, fittings, valves, expansion loops, etc.
- Stress calculation, flexibility analysis, and freezing of configuration
- Isometrics of all piping.
- Detailed specification of insulation
- Design of supports, anchors, expansion loops, hangers, etc., including special equipment supports.
- Preparation of line schedules giving terminal details and

operating conditions, and test pressure.

- Preparation of detailed material take off, e.g., valves, pipe lengths, fittings, spools, flanges, gaskets, etc.
- Material specifications for pipes, fittings, flanges, valves, gaskets, etc.
- Procurement specifications covering all piping elements required for the project.

12. Equipment layout as per design and vendor inputs as applicable.
13. Detailed HAZOP study after completion of detailed engineering and implementation of the HAZOP study recommendations.
14. Preparation and submission of a project execution plan for Department Approval.

B. Supply, Inspection & Receipt phase:

- 1 Inspection of materials / equipment by Third party / Department, as per the approved Quality Assurance Plan / ITP.
- 2 Receipt and accounting of materials.
- 3 Inspection of materials including PMI after receipt at the site.
- 4 Codification, Storing & Stacking of the material at the proper place.
- 5 Preservation of material.
- 6 Maintain record of issue, receipt & balance material.

C. Erection & Installation phase:

1. Erection of Equipment on the foundations as per the drawings / layout.
2. Fixing Insulation.
3. Piping Fabrication & Erection.
4. Bench testing of Flow components and installation.
5. Interconnection of Equipment and piping wherever required.
6. Interfacing with other systems viz., Instrumentation, Control & Electrical systems.

D. Pre-Commissioning / Start-up Commissioning:

1. Generation of Plant-specific operating manuals for the unit and other utilities for sufficient, safe operations, start-up and shut down, and emergency handling
2. Preparation of flushing, pre-commissioning, and commissioning schedule along with the scheme and procedures for the unit & facilities
3. Programming and validation logic for commissioning and operation.
4. The pre-commissioning, commissioning, and start-up activities include inspection, checking/ correcting, and ensuring proper:
 - a) Packing and Seals
 - b) Alignment of Rotating
 - c) Equipment System Check/
 - d) Inspection Flushing
 - e) Leaks & Pressure Tests
 - f) Testing of Safety Devices
 - g) Hydro-testing of Equipment/ Piping where ever applicable
 - h) Commissioning of the entire plant
 - i) Finalisation of interlock/ loop schematics.
 - j) Trial run of the plant for the production of LOX & LIN, confirming to the Plant Specifications at Design conditions.

E. Performance Guarantee Testing & Final Commissioning

1. Ensuring emission norms and safety
2. Perform performance guaranteed testing for a period of 72 hours of continuous operation to demonstrate the guaranteed performance in accordance with the standard test procedure and document to be prepared in consultation with the Department.

3. Demonstration of all the operational modes, including turndown operation of the air separation plant after the performance guarantee test.
 4. Filling up of oils & lubricants, desiccants, chemicals, refrigerants, etc.
 5. Provide full-fledged training for Department Engineers.
 6. Obtaining all statutory clearances, permits, and approvals from local & statutory bodies for the operation of ASU.
- F. Any other activities as required for completeness of the system and not mentioned above.

1.2.6 DETAILS OF MAJOR PROCESS EQUIPMENT

The Air Separation Unit shall be complete with all the accessories and auxiliaries necessary for safety and satisfactory operation and shall include, but shall not be limited to, the main equipment listed below:

- a) Process Main Air Compressor (MAC): MAC includes the following main components:
1. Inlet filter, self-cleaning type, suitable for the site environment conditions.
 2. Centrifugal multistage integrally geared compressor oil-free
 3. Shaft sealing system.
 4. Automatic flow regulation system by Inlet Guide Vane (IGV).
 5. Automatic anti-surge control and protection system.
 6. Blow off valve and blow off silencer.
 7. Safety relief valve (interstage and final stage).
 8. Speed gear.
 9. Flexible couplings
 10. Vibration and axial position probes/ transducers for compressor bearings.
 11. Compressor Inter-cooler

12. Compressor After-cooler
 13. Electric Motor driver
 14. Lube Oil system for centrifugal compressors bearings
 15. Skid assembly including compressors, driver, auxiliary equipment and systems, instrumentation, junction boxes, and local control station
- b) Air pre-purifying and drying unit, dual vessel type, including internals, molecular sieves, interconnection piping, manual/automatic valves, instrumentation, and regeneration system.
- c) Booster Air Compressor (BAC) (if applicable), centrifugal multistage integrally geared and electrically driven. BAC includes the following main components:
1. Centrifugal multistage integrally geared compressor
 2. Shaft sealing system
 3. Automatic flow regulation system
 4. Automatic anti-surge control system
 5. Blow off valve and blow off silencer
 6. Safety relief valve (interstage and final stage)
 7. Speed gear
 8. Flexible couplings
 9. Vibration and axial position probes/ transducers for compressor bearings
 10. Compressor Intercooler
 11. Compressor After cooler
 12. Lube Oil system for centrifugal compressors bearings
- d) Expansion Turbine / Turbo Expander
- e) Main Heat exchangers (cold box) includes:
1. Process heat exchangers

2. Internal interconnecting piping and supports
 3. Manual and automatic valves
 4. Instrumentation
 5. Drain facilities
 6. External shell and self-supported steel structure
 7. Insulation materials (perlite, rockwool panels, and cover sheets)
 8. External and internal stairs and maintenance platforms etc.,
- f) Rectification column (cold box) includes:
1. Medium and low-pressure columns complete with internals
 2. Condenser/reboiler
 3. Sub-cooler
 4. Internal interconnecting piping and supports
 5. Manual and automatic valves
 6. Instrumentation
 7. drain facilities
 8. External shell and self-supported steel structure
 9. Insulation materials (perlite, rock wool panels, and cover sheets)
 10. External and internal stairs and maintenance platforms
- g) Complementary Equipment / Materials Required for the complete ASU shall include:
1. Interconnecting piping for process lines according to project piping classes inside the ASU BL, including supports and accessories
 2. Interconnecting piping for utility lines according to project piping classes inside the ASU BL, including supports and accessories.
 3. Set of control valves, on-off valves, solenoid valves, isolation

valves, manual valves, etc, for process and utilities lines.

4. Safety Relief Valves, including piping connections to relief points in a safe location.
 5. Warm and cold insulation for piping and equipment as necessary.
 6. Acoustic insulation and additional measures (acoustic hoods, silencers, baffles, etc), as necessary to meet the noise limitation requirements.
 7. Prefabricated structural steel for main structures and pipe racks, including erection materials
 8. Platforms, stairs, ladders, handrails, and grating, wherever necessary, for accessing the equipment, according to the plant requirements.
 9. Surface preparation and painting according to the Specification for Painting Scheme.
 10. Cable glands for instruments and junction boxes.
 11. First charge of adsorbents and/or catalysts, including provision for losses (quantities for one-year operation).
 12. First charge of lubricants (for one-year operation).
 13. Special tools for erection and maintenance.
- h) 250 KL Cryogenic storage tanks for LOX & LIN products (each 1 no). These cylindrical tanks shall be provided with self-pressure build-up units. LIN vaporizer, along with a suitable accumulator for the GN2 network feed.
- i) LOX & LIN loading pumps will be used with suitable Flexible Hoses to load the Road Transportation tankers from the Product storage tanks.
- j) 2 nos of 40 KL Cryogenic Road Transportation Tankers for LOX & LIN transportation.

1.2.7 GENERAL REQUIREMENTS OF MAJOR EQUIPMENT

1.2.7.1 AIR COMPRESSOR UNIT

- a) A centrifugal compressor shall be provided for compressing the ambient air to the required pressure in large volumes. The compression shall be achieved efficiently through single/multiple stages of high-speed impellers, ensuring reliable and continuous operation.
- b) Supplier shall work out the number of Air Compressors and their capacity.
- c) An automatic self-cleaning filter is to be considered at the inlet of the Compressor.
- d) The compressor shall be sized with 10% additional capacity.
- e) Compressor shall be provided with vibration and bearing temperature monitoring system as per Engineering Design Basis (Rotating Equipment).
- f) Surge protection shall be ensured through a Surge detector and blow-off (with silencer) as per the standard. Supplier shall provide logic for surge detection, control, and alarm.
- g) Compressor Station FFL is envisaged to be maintained at 0.5 m above the NGL level. However, the Air filtration system shall be located outside the compressor house.
- h) Compressors and drivers (including V-Belt drive gear units and couplings, if any) shall be designed to perform satisfactorily under the specified start-up conditions, part load / full load operation, maximum differential pressure operation, and relief valve setting pressure and up to trip speed. The supplier shall also assume full responsibility to undertake:
 - Torsional analysis of the complete compressor train, including the driver, except in the case of belt-driven compressors.
 - Selection, sizing, and rating of the transmission equipment between the compressor and the driver, and also of the base plates, sole plates, and slide rails.
 - Checking the conformity of the motor coupling flange with the

compressor coupling flange and supplying to the motor manufacturer, in due course of time, the drilling jig for the motor coupling flange, in case of rigid coupling drive.

- Stress Analysis of the piping from the intake filter/suction strainer up to the outlet flange of the final compression stage, pulsation suppression Devices/separators / after-coolers / air receivers, as the case may be.
 - Furnishing the design, type, and location of the supports for the piping and appurtenances as defined above under (iv).
 - Compressor Pulsation and Vibration Control as per API Std. 618.
- i) The permissible speed range of the centrifugal compressors for continuous operation shall be clearly stated by the manufacturer.
- j) The performance of the compressor units and the mechanical requirements shall be specified by the Manufacturer.
- k) The performance test of the compressor units shall be carried out by the Supplier according to ASME PTC-10 or ISO 5389 (latest edition)
- l) The compressor packages shall be designed and fabricated in accordance with all the rules of good engineering practice taking into account any unusual conditions. As a minimum, the following features shall be provided:
- Suitable protection of the equipment to ensure the safety of personnel during operation and maintenance
 - Maximum reliability
 - Ease of maintenance

1.2.7.2 AIR PRECOOLING UNIT

- Air Precooling unit (100% installed standby) shall be designed for cooling the compressed air before it is fed to the Air Purification Unit.
- Pre-cooling system shall be designed for cooling the incoming compressed air in such a way that the cooled air temperature shall be

free of moisture.

- The air precooling unit shall have fully automatic operation.
- The unit shall be capable of turndown, matching the plant turn down. The turndown features shall be described in detail engineering by the Supplier.
- Vessels/towers shall be designed, fabricated, and inspected as per ASME Code Section VIII Div. I. Internals shall be of stainless-steel material.

1.2.7.3 MOISTURE SEPARATOR

- a) Moisture separator shall be designed in accordance with ASME Sec. VIII Div. I.
- b) It shall be complete with ll accessories like safety valves, auto drain facilities, level gauges, level transmitter, and level switch, completely insulated with Aluminium clad.

1.2.7.4 AIR PURIFICATION UNIT (APU)

- a) The purification unit shall be a twin-bed desiccant system of heat-reactivated type. Waste nitrogen gases from the cold box may be considered for heat reactivation of the desiccant bed after heating up in the reactivation heater.
- b) APU shall be designed considering 400 ppmv CO₂ in ambient air, APU inlet air temperature of 20 °C, and CO₂ in the inlet air to the cold box less than or equal to 1 ppmv. Sufficient design margins for capacity deterioration due to desiccant/molecular sieve ageing and attrition shall be considered. The life of the desiccant/molecular sieve shall be indicated for the site conditions.
- c) The desiccant shall be activated alumina and molecular sieve designed to remove moisture, carbon dioxide, hydrocarbons, and other gases/compounds as dictated by process requirements.
- d) Required gas analysers to measure the impurities in the purified air, and a moisture analyser to be provided. The carbon dioxide and Moisture content in the process air shall be monitored with the help of online CO₂

& Moisture analysers, and the pressure drop across the Adsorber bed shall be monitored online with a Differential pressure transmitter.

- e) The quantities required for activated alumina and molecular sieve shall be calculated based on their respective dynamic adsorption capacities corresponding to the inlet air temperature. Over and above this, a 10% margin shall be added to the quantity of each adsorbent. Supplier shall ensure the desiccant manufacturer's recommendation for the dynamic adsorption capacity.
- f) Adsorbents shall be supported on corrosion corrosion-resistant stainless-steel screen. Filling and discharge nozzles for the desiccant filling and removal shall be provided. Manholes shall be provided in each adsorber vessel for maintenance purposes.
- g) A connecting platform for accessing manholes at the top of vessels shall be provided for easy maintenance.
- h) The adsorber vessels shall be manufactured as per ASME SEC. VIII Div. I and completely insulated outside and cladding with an aluminum sheet. Fatigue analysis of the adsorber vessels shall be carried out.
- i) Sizing of vessels shall be carried out by taking into account the attrition of adsorbent due to compression, consequent bed inactivity, and ageing. The system shall be provided with an automatic cycle changeover. The cycle time shall be a minimum of 4 hours. However, the supplier shall indicate the cycle times for adsorption, depressurization, regeneration heating, cooling, and re-pressurization.
- j) Pressure gauges, temperature gauges, low-pressure alarms, differential pressure indicators (across bed), safety valves on vessels, and other relevant instruments shall be provided.
- k) The control panel for the air purification unit shall be located in the control room as well as near the skid. Regeneration temperature shall be indicated in the panel. Other safety systems for alarms and trips shall be provided in the panel.

1.2.7.5 FILTERS

- a) Two numbers of after filters (1 working + 1 standby) of cartridge type shall be provided to arrest desiccant fines carryover to the cold box equipment.
- b) The filters shall have 99.0% efficiency for particle sizes larger than two (2) microns.
- c) Differential pressure indicators and DP alarm across the filters, interconnecting pipe work with isolating valves for selection of filters shall also be provided. Filter elements shall be cleanable without dismantling the piping.
- d) An in-built after filter to arrest the desiccant fines shall also be acceptable, if it is the supplier's standard design. However, in this case also, the supplier shall ensure that the filter rating & efficiency are 2μ @ 99% or better.

1.2.7.6 REGENERATION HEATER & DERIMING HEATER

- a) The regeneration heater shall be electrically operated & shall have adequate safety & control instrumentation.
- b) The regeneration heating shall be done by means of an externally located electric heater with thyristorised control panel. The heater shall have at least 20% excess capacity over the designed capacity. Heater shall be so designed and located as to facilitate ease of servicing, removal without disturbing the pipe work. Waste Nitrogen gas shall be used for the regeneration of the beds.
- c) The heater shall have a temperature gauge and temperature Control for cutting off the heater bank progressively depending on the heater load. The heater shall also be provided with safety features to cut off the heater in case of high skin temperature of heater elements and low flow of regeneration gas. Heater shall be designed as per ASME Sec. VIII Div.1.
- d) The deriming heater shall be electrically operated & shall have adequate

safety & control instrumentation

1.2.7.7 COLD BOX

- a) One Cold box consisting of the main heat exchanger, turbo expander, distillation column, condenser reboiler, etc., shall be supplied as a single unit.
- b) In general, the Heat exchangers shall be multi-pass plate fin type of brazed aluminum construction. Core shall be constructed of AA 3003 Aluminum.
- c) The number of exchangers used and their location inside the cold box, along with their specification, shall be furnished by the Supplier during detailed engineering. At least a 10% margin in the surface area requirement of all heat exchangers shall be provided
- d) The material for vessels & piping inside the cold box shall be austenitic Stainless Steel.
- e) The inside of the cold box shall be sufficiently insulated to prevent ingress of heat by expanded perlite insulation, and it shall be maintained at a slightly positive pressure (2 mm WC) by nitrogen gas purging. Internal purge piping, along with a purge gas pressure regulator and casing pressure indicator, shall be provided. The casing shall be provided with a low-pressure relief device.
- f) The cold box (at the outer periphery) shall be provided with ladders, platforms, and access doors at various levels to facilitate accessibility for operation and maintenance. Manholes shall be provided at the top & bottom.
- g) The expansion turbine shall be enclosed in a separate compartment with access doors for maintenance of the same.
- h) Various supports for the equipment inside the cold box shall be provided. All valves requiring manual operation shall have handles outside the cold box. Similarly, all indicating instruments shall have indicating dials brought out of cold box insulation with proper

identification for easy reading.

- i) All controls, control valves, and other equipment requiring periodic maintenance shall have adequate access for the same.
- j) The skin temperature of the cold box cladding shall not go below 5 °C less than ambient temperature.
- k) The various liquid drains from the cold box shall be vented at an adequate height where the liquids are vaporized by means of dry air. Vent piping shall be of SS.
- l) Cold box piping shall be designed as per ASME/ ANSI codes. All piping shall be stress analyzed. Piping shall have welded joints, and flanges shall be avoided. Piping joints shall be proof tested. Supplier shall submit the piping material specification during detailed engineering.
- m) Valves shall be extended stem type. Stem packing shall be of Teflon and located outside the casing. It shall be possible to remove seat rings without removing the insulation of the cold box. All valves shall be hydro tested at 1.3 times the design pressure. Supplier shall submit the valve material specification during detailed engineering.
- n) Cold Box Structure & Covering material shall be Carbon Steel with Quality Epoxy paint for a Saline environment.

1.2.7.8 EXPANSION TURBINE /TURBO EXPANDER

- a) The system shall have a high-efficiency, turboexpander that provides the low-temperature refrigeration required for the process. It shall also contain the lube oil package, seal gas piping system, along with associated piping and instrumentation as required for the plant.
- b) The turboexpander shall be equipped with a water-cooled aftercooler, which is mounted separately from the turboexpander skid. The rotating assemblies use a “plug-in” design, allowing removal without breaching the cold box insulation.
- c) One expansion turbine shall be provided. The expansion turbine may be connected to brake compressors, or oil brake system, or any other

system, to dissipate energy.

- d) The brake compressors shall be fitted with a suction air filter and discharge silencer, in case it is considered by the Supplier in his proposal.
- e) The turbines shall be provided with variable flow nozzles to account for temperature control & turndown. Necessary control shall be provided in the control panel.
- f) The turn down of the unit shall synchronize with the air separation unit turn down.
- g) The turboexpander unit shall be designed as per the applicable International standard.
- h) Turbine speed indication, overspeed alarm with shutdown controls, bearing temperature alarm, low seal gas pressure alarm, low oil pressure alarm & trip, vibration monitoring/detection system, etc. shall be provided in the control panel.
- i) The lube oil system shall comprise of SS oil reservoir of adequate capacity, an oil pump (one Working plus another Standby), an oil cooler, SS piping, duplex filters, an oil pressure and return oil temperature gauge, a pre-alarm, and a trip for low oil pressure. Means of lubrication for the coast-down period shall also be provided.
- j) The expansion turbine shall be housed adjacent to the cold box, and expeditious replacement of the rotor shall be possible.

1.2.7.9 DISTILLATION COLUMN(S)

- a) The column shall be made of stainless-steel material of low carbon content and designed as per ASME Sec. VIII Div. I. Aluminium alloy material is also acceptable if backed with a proven track record.
- b) A structure-packed column is preferable; however trays tray-assembled columns are also acceptable.
- c) The structure packing / trays provided inside the column shall be suitable for efficient separation of product gas/liquid and to achieve the required

purity in the entire turndown range. The material shall be of stainless-steel ASTM A240/ A312/ A403/ A182, low carbon grades 304L, 316L, 309L or stabilized grades 347/32 or Aluminium alloy.

- a) The column shall be equipped with all necessary instrumentation and control for level, liquid transfers, differential pressure, temperature indication, etc.
- b) Sufficient means to eliminate the accumulation of hydrocarbons in the fractionating column shall be provided.
- c) Number of columns, their sizes, and sizing of condenser re-boiler with respect to the required product mix shall be based on proven proprietary design of the supplier.
- d) Supporting arrangement of the bottom column shall be adequately designed to reduce the transfer of coldness from the column.

1.2.7.10 COOLING WATER SYSTEM

- Cooling water system shall be designed for cooling the water meant for Compressor Interstage cooling etc., The cooling water shall be chemically treated to remove the TDS before usage.
- Cooling water Chemical treatment system: The cooling water chemical injection system injects anti-microbiological, anti-scale, and anti-corrosion inhibitor chemicals into the cooling water to maintain proper pH, conductivity, and biological growth in the cooling water to keep from fouling water coolers.

1.2.7.11 ANALYSIS OF STREAMS

To monitor and analyse the input to the cold box and various streams produced during the fractional distillation inside the Cold Box, the following minimum online analysis requirements shall be provided for real-time monitoring of product streams. However, process streams analysis is only indicative mentioned in the Table below; all the online analysis requirements shall be as per the process design control for achieving the purity levels and safety studies (s. no. 1.2.13). Suitable

redundancy shall also be planned for online analysers. Reputed analyzers like M/s ABB, M/s Shaw, etc., shall be selected and the same shall be vetted with the Department for finalization. Standalone Analysers in the Analysis lab are also included in the requirement.

Sampling location Sampling stream		Measuring component	Measuring range
1	Feed to high-pressure column	CO ₂ THC H ₂ O	0...10ppm 0...10ppm
2	Low-pressure column, liquid phase	O ₂ CO ₂ THC	98...100% 0...10ppm 0...300ppm
3	Feed to low-pressure column (RL / PL)	O ₂	0...50%
4	Liquid nitrogen	O ₂ CO ₂ H ₂ O	0...10ppm 0...10ppm
5	Liquid oxygen	O ₂	98...100%
		CH ₄ , C ₂ H ₄	low ppm ranges
		C ₂ H ₆ , C ₃ H ₈	
6	Gaseous nitrogen	O ₂ THC H ₂ O	0...10ppm 0...10ppm 0...10ppm
7	Process air feed before the main condenser	CH ₄ , C ₂ H ₄	low ppm ranges
		C ₂ H ₆ , C ₃ H ₈	
8	Process air before the molecular sieve	CO ₂	0...10ppm

1.2.7.12 VAPORISERS / PRESSURE BUILDUP UNIT

a) Vaporizers / Pressure buildup units are used to convert liquid oxygen /

liquid nitrogen to gas by absorbing heat from ambient air.

- b) The vaporizers shall be of the atmospheric type. The vaporizers shall be provided with isolation valves in the upstream and downstream with manual changeover. Each Vaporizer shall be designed for continuous operation.
- c) The exchanging element shall consist of an axial aluminium fin, tack-welded and fitted on the SS pipe
- d) Vaporizers / Pressure buildup units shall have an isolation valve to guard against accidental flow of liquid to the gas outlet.
- e) All Vaporizers / Pressure buildup shall be provided along with a temperature indicator, alarm, and trip. Vaporiser shall have an overflow line and, thermal safety valve.
- f) Buffer pressure vessel for Instrument air shall also be considered.

1.2.7.13 PIPING REQUIRMENTS

- Piping shall be arranged in such a manner to avoid fouling with personnel movement / overhead piping / structural members, etc. Piping or tubing shall be properly supported with good engineering practices.
- Pipeline sizing shall be carried out as per the standards. All piping shall be terminated with ASME B16.5 flanges
- Piping material class, line designation, insulation thickness, etc., shall be clearly shown in the Piping & Instrumentation drawing (P&ID).
- Piping plan and isometrics with support marking for all piping.
- Prefabrication/site fabrication piping for process and utilities interconnections between equipment and units **towards completeness of the plant piping for the entire ASU plant.**
 - 1 Design & Stress analyses of all piping.
 - 2 All supports for piping shall be designed.
 - 3 Design of all spring supports & expansion joints, and all utility

stations.

- Supply of insulation and painting of all piping. BOQ for the insulation and paint shall be provided.
- Wherever Liquid nitrogen & Liquid Oxygen are in contact with piping, the material of construction of piping shall be austenitic SS of Low carbon grades 304L / 316L.
- All piping shall be adequately supported, guided, or anchored so as to prevent undue vibration, deflection/expansion, or loads on connected equipment and leakage at flanged joints. Piping at valves and equipment such as heat exchangers and pumps, requiring periodic maintenance, shall be supported in such a way that the valves and equipment can be removed with a minimum necessity of installing temporary pipe supports. Pedestal height for pipe supports shall be around 300 mm.
- Minimum level of overhead piping shall be such that a clear 2.2 mtr headroom is available below pipe/insulation/supports.
- Minimum height of equipment foundations shall be 300 mm from the finished grade level.
- All open vents to the atmosphere shall be vented to safe locations at least 3 meters above the nearest operating floor or platform located within a radius of 12 meters for discharges.

1.2.7.14 VESSEL, FILTER & EXCHANGER

- The vessels, filters, and exchangers shall be designed, built, inspected, and tested in accordance with the requirements of the TEMA, ASME Boiler and Pressure Vessel code, Section. VIII, Division 1, latest edition and addenda.
- Minimum thickness used for shell and heads shall be 6 mm (excluding C.A.)
- The thickness shall not be less than the adjacent shell thickness for

spherical or ellipsoidal heads.

- Heads shall preferably be in a single piece. Heads having more than one seam should have the minimum possible number of pieces. All seams shall be fully radiographed, irrespective of the radiography requirement as per standards.
- Loads (Shear & Moment) at base for vessels at erection, operating, and test conditions shall be submitted for review and approval.
- Supplier design shall completely comply with codes and specifications in this requisition as a minimum requirement.
- All requirements of the ASME code for low temperature service (such as part ULT of the ASME code) should be considered in the design of equipment.
- Heads shall be specified hemispherical or ellipsoidal, having a ratio of 2:1 as specified in the datasheet, except wherever specifically indicated & approved by the purchaser. Torispherical dished and flanged heads may be accepted if suitably formed, and when the knuckle radius is not less than 10% of the vessel inside diameter and the crown radius does not exceed the vessel inside diameter. Other head types shall be approved by the purchaser.
- The maximum allowable working pressure shall be limited by the shell or head, not by minor parts such as nozzle necks, reinforcing pads, cone-to-cylinder rings, etc.
- Wind load and seismic load shall be considered as per site conditions.
- It is the Supplier's responsibility to properly determine all thicknesses of all parts of the pressure vessels and satisfy all the requirements of the respective codes and specifications. The supplier must also ensure the stability of the equipment under all loads, including seismic, wind loads, and dynamic loads. and/or FEA at the nozzle to shell and pad to shell junction, and at any other attachments that induce local load on the shell or head.

- Supplier shall control the local stresses in pressure vessels due to reaction of support in various conditions (erection, hydro-test, start-up, operating, including seismic/wind/vibration loads) and shall provide appropriate provisions for this requirement, if deemed to be necessary through calculations.
- All manholes shall be fitted with forged flanges and covers with davits/hinges as shown on the relevant standard drawing. Also, all blind nozzles shall be furnished with blind, gasket, and relevant fastening.
- Supplier shall use test coupons in the vessels to predict the vessel's end-of-life.
- As a minimum, for achieving after-forming thickness (base-plate thickness exclusive of the thickness of the cladding material, if any), Supplier shall add an increase of 1mm or 3% to the required thickness (which is larger) and then round it up to the next even number. (Required thickness shall be obtained from a combination of loads, not pressure load solely. Moreover, the thickness of cladding / weld-overlay -if any- doesn't withstand any load.)
- Rigidity of all flanges shall be checked in accordance with ASME VIII, Division 1, Appendix 2. Rigidity factor for integral or optional flange types (KI) shall not be greater than 0.1. Supplier shall supply flanges satisfying this criterion. Assembly/erection procedure, as well as required calculations, shall be prepared by the Supplier.
- Nozzles, as well as pads and weld lines, shall not be located on the knuckle of 2:1 elliptical heads in any way. The supplier is responsible for taking care of these aspects.
- Critical discontinuities shall be verified by FEA based on Department demand.
- Fabrication shall not commence until the Supplier has received written authorization from the Department. However, the Supplier is responsible for any delay according to the project schedule.

- The anchorage configuration shall be indicated on general drawings.
- Thermal and mechanical design shall be submitted by the Supplier for review by TPI / Department.
- Supplier of heat exchangers and parts shall be responsible for the correct execution of all work and observance of all applicable technical regulations and specifications. Supplier shall also be responsible for his subcontractors.
- Material and corrosion allowance shall be consistent with the expected life specified herein before. Materials shall be as per ASME/ ANSI. Flanges shall be as per ASME B16.5 and ASME B16.47. Also, flanges shall not be slip-on type.
- The gaskets used for the hydro test shall be of the same type as those used for operation. Supply of blind bolts and gaskets for the test is in the Supplier's responsibility.
- Gasket material shall be asbestos-free with inner and outer S.S rings suitable for service, unless otherwise it is not suitable for service. Those gaskets or stud bolts used for tests (e.g., hydro-tests) are to be replaced with new ones for operation. Type of S.S. rings and S.S. material used in the gaskets shall be identical to the pressure vessels' S.S. internals.
- As a minimum, gaskets for internal flanges shall be asbestos-free and suitable for the service and conditions referenced in the relevant data sheets.
- The additional supplementary requirement for temperature embrittlement factor and impact properties after step cooling shall be met according to S62 and S63 of SA-387 Specification of ASME Sec II Part A.
- For all welds in nozzles where back gouging is not possible, the root pass shall be made with the TIG welding procedure. The Supplier shall supply materials strictly in accordance with the specification

attached.

- All low alloy heads shall be shaped by hot forming at temperatures defined by Code (i.e., low alloy heads shall be hot formed only).
- For any internal support attachments, a continuous groove weld with full penetration shall be used. All welds attached to pressure retaining components, as well as sharp edges, should be ground to a smooth contour.
- All weld toes shall be dressed.
- The grinding of weld reinforcements shall be carried out by use of an automatic grinding machine, not manual, to reduce the formation of notches and remove the notches formed in the corners of weld lines.
- Welding profile shall be suitably prepared to resist cracking and brittle fracture.
- All required repair work shall be reported to the purchaser, and repair work will only proceed after approval by the purchaser. The repaired weld shall be subjected, as a minimum requirement, to the same testing and inspection requirements as the original weld. If, during final inspection, additional defects are discovered, the total weld seam or area shall be examined. If a second repair is necessary, the purchaser's permission must be obtained well before proceeding with the repairs.
- The cost of all repairs and subsequent inspection/ heat treatment shall be the responsibility of the Supplier.
- Contour of forge parts before machining shall be in conformance with the final desired shape of the forge part after machining (as indicated in the ASME code). It means that minimum machining shall be the main objective.
- None of the clip pads shall cross or cover the weld lines/seams. All of the weld lines/seams shall be bare and uncovered (inside and outside).

- Cutting and beveling for S.S. items as well as clad items -if any- shall be performed using plasma cutting method and/or Mechanical cutting/machining. Grinding and cutting wheels shall be free of carbon steel constituents, and they shall be suitable for stainless steel materials.
- All pressure vessels and pipe weld joints shall be 100% radiographed.
- Roll bending direction of plates shall be lengthwise and should be marked by an arrow on the plates.
- The edge preparation of all items shall be based on the relevant WPS as well as the assembling procedure developed by the Supplier and approved by the purchaser.
- For double-welded butt joints (joints welded on both sides), the welding procedure shall specify the fabricator's standard inspection procedure used to assure metal soundness after gouging and cleaning the backside of the weld.
- Any non-radiographable welds of non-austenitic steel shall be inspected by magnetic particle and/or ultrasonic methods.
- Positive Material Identification test and ferrite check shall be done for Stainless and low-alloy steel.
- Inspection/repair procedure for commissioning shall be submitted to the purchaser.
- Test procedure/condition/drawings shall be submitted to the Department for comment/approval before proceeding with any test.
- Pickling and passivation of stainless steel parts of equipment, S.S piping, all the S.S parts of internals and externals shall be performed in accordance with the Supplier's specification and in complete compliance with ASTM A380 standard. Before commencement the work, the Supplier's specification shall be submitted to the purchaser for approval.
- Inside and outside surfaces of pressure vessels shall be thoroughly

cleaned and shall be free from grease, weld spatter, scatter, scale, slag, rust, and any other foreign matter before testing, and shall be thoroughly dried and cleaned after testing.

- Supplier shall supply and determine the location of lifting and tailing trunnions/lugs for transportation & erection with regard to loading/unloading and taxi arrangement, also site limitations.
- All nozzles shall be suitably protected during transportation using blind caps/covers. Preparation for shipping includes the necessary
- Supplier shall make sure that the package/ internal components have enough stability during erection by means of calculations and stiffen them, if necessary.
- All loss commodities packages to be temporarily skidded, providing stable and damage-free transportation.
- All requirements for preparing a safe and acceptable shipment shall be conducted by Supplier (i.e., transportation support saddles, spiders, nitrogen filling, foam coating for S.S. surfaces, seaworthy crates, etc..
- Supplier shall furnish a spare part list for static equipment commissioning.
- Supplier shall furnish a spare part list for water-cooled heat exchangers.

1.2.7.15 LIQUID STORAGE TANKS

The liquid Oxygen & liquid nitrogen produced in the distillation unit of ASU are to be filled in the LOX and LN2 storage tanks, respectively. This tank shall be of double-wall construction with perlite insulation and with a vacuum and shall be equipped with control devices and measuring instruments. There shall be a top filling and bottom discharge line for the filling/ transfer purpose. A pressurization coil shall be provided for pressure buildup in the tank. The liquid level is measured by a differential pressure gauge with necessary additional provision for connecting a

transmitter and to measure the pressure in the tank, a pressure gauge is provided. The inner vessel shall have two safety valves. The vessel is to be designed according to the pressure vessel code.

- a) The double-wall tank shall be designed to ensure that **Evaporation loss is not more than 0.30%**.
- b) The tanks shall be constructed of an austenitic SS inner shell contained within a carbon steel outer shell. The space between the shells shall be filled with non-inflammable insulation (perlite powder) material and maintained under vacuum.
- c) The storage tank shall be complete with all accessories, auxiliaries (e.g., pressurization coil, etc.), and safety features, including double safety valves, etc.
- d) Facility for liquid nitrogen injection from storage tank to distillation column shall also be provided.
- e) Facility for loading and unloading of liquid into or from a transportation tanker (for liquid nitrogen & Liquid Oxygen) shall be provided.
- f) Storage tanks shall have level transmitters with alarms, a pressure gauge, a temperature gauge, vacuum gauge for annular space vacuum measurement, as a minimum.
- g) The tank shall fully meet the statutory requirement of the Chief Controller of Explosives (CCOE) / Petroleum Explosive Safety Organization (PESO) / Static and Mobile Pressure Vessels (SMPV), Govt. of India, as applicable.

The detailed specification of the Cryogenic Storage Tanks is provided in Annexures 7C.

1.2.7.16 LIQUID TRANSFER SYSTEM

To facilitate the transfer of LOX & LIN from the fixed storage tank to a transportation tanker, a pump-fed system is envisaged. Liquid Oxygen and Liquid Nitrogen shall be pumped from Storage tanks to Mobile tankers

using transfer pumps at a flow rate of 1000 lpm, meeting the adequate head.

1.2.7.17 ROAD TRANSPORTATION TANKERS

- a) Transportation tankers shall be vacuum-insulated. Tankers are to be mounted on a semi-trailer, and the free end will be connected to the prime mover by means of a fifth wheel coupling. The tankers are in built on standard chassis with a prime mover. The prime mover is to be provided along with the driver's cabin.
- b) Transportation tankers shall be designed and fabricated as per relevant Standards/codes, and also considering road safety, PESO & RTO rules.
- c) The Transportation tank shall have a feature to transfer products to the storage tank using both self-pressure build coils and a transfer pump mounted on the trailer. A suitable transfer pump shall be selected.
- d) The capacity of transportation tankers, including prime movers (make & hauling capacity) + tanks + trailer, shall be clearly mentioned in the bid, for comparison.

The detailed specification of the Road Transportation Tankers is provided in Annexures 7B.

1.2.7.18 VENT STACK

Safe release of Liquid Oxygen and Liquid Nitrogen vapours shall be ensured through vent lines terminated at a suitable height as per safety norms. All vents of Safety Relief Valves to be manifolded and extended to the vent stack

1.2.8 CIVIL / STEEL STRUCTURE REQUIREMENTS

- All civil works shall be in the scope of the Supplier, including foundation & supply of anchor bolts. Scope of Supplier shall include supply of steel structure (ready for installation), shelters & their covering, primers & coating for inside concrete structures, layout plan for the buildings, paintings, etc.
- Suppliers' scope includes the supply and construction of the superstructure of all relevant structural works required for the

successful completion of works, for ASU.

- Detail design and engineering of buildings includes G.A. and Foundation, False Flooring, False ceiling, Air Conditioning, Plumbing Design, Communication & Network Wiring, Internal electrical Wiring, Fire & Gas detection related to buildings.
- Major works involved shall include the following, but not be limited to:
 1. Structural shed for Compressor Station
 2. Air Purification Unit
 3. Cold Box
 4. Vaporiser
 5. Pipe Rack
 6. Pipe supports
 7. Cable supports
 8. Operating / maintenance platforms
 9. Walkways
 10. Cross-overs
 11. Stairs
 12. Ladders
 13. Handrail, etc.
 14. Auxiliary Building & Fire Pump House, Water treatment plant, GLR, Fencing, Roads etc.
- Steel structure fabrication for all steel structures shall be of modular construction, and all shop connections shall be welded & field connections shall be bolted.
- All the foundation works are considered in the Supplier works scope, which includes:
 1. Foundation base plates for Steel structures and supports
 2. Foundation base plates for Loose equipment:

3. Skid frame for Equipment assembled on a skid.
- Supplier is responsible for providing Architectural drawing (Plan and Section) for the Control room and Substation building with the incorporation of interconnection piping, instrument cabling, electrical cabling and etc.
 - The following items shall be in the Supplier's scope of work and supply:
 1. Steel structures, including gratings & accessories
 2. Shelters including cranes, sandwich panels & accessories
 3. Concrete coating & covering where needed
 4. All steel structures, including platforms, ladders, handrails & stairs
 5. Bolts for equipment supports on structures, etc.,

1.2.9 MATERIAL HANDLING EQUIPMENT

- An EOT crane with suitable capacity (minimum 10 MT) shall be provided to meet the maintenance requirements of the compressor unit housed in the compressor shed.
- Suitable material handling facilities, viz. Monorail crane, chain pulley block, electric hoist, davit, etc., shall also be provided for the maintenance of other equipment, wherever required.
- The detailed requirements/specifications of the EOT crane and other material handling equipment shall be finalized during detailed engineering.
- The cranes shall be designed, engineered, manufactured, inspected & tested at the manufacturer's work & at the site after installation.
- EOT crane requirements:
 - a) EOT complete with all accessories and components, which shall include:
 - Gantry rail for crane, along with fixtures, end stoppers at all four

corners for complete bay length, as required.

- Festoon-type flexible cable, along with fixtures for complete long travel and cross travel for each crane.
 - Load break switches for the power supply (to be installed on the shop floor) and cabling.
- b) EOT crane shall be designed as per the duty class of M5 as per IS 3177 & IS 807.
- c) The bridge structure of EOT shall be made from box (double web) type, plate type, or fabricated from rolled sections. The structure shall be a double-girder type.
- d) A DC electromagnetic or electro-hydraulic thruster brake shall be used for the hoisting motion. Electro-hydraulic thruster-operated brakes shall be used for the cross and long travel motions. The brakes shall be such that they are applied when the power supply to the brake is interrupted, or when the circuit breaker is open, or when the controller is brought to the off position.
- e) Braking torque for LT and CT motion shall not be less than 125% of the maximum torque of the selected motor.

1.2.10 SCOPE OF DEPARTMENT

The following are under the scope of the Department:

- a) Identification of land/site at SDSC SHAR Sriharikota, for the establishment of the Air Separation Plant. It is the Contractor's responsibility to level the identified area for the plant construction, including the removal of bushes & debris, if any, as per the details given in the Civil requirements of S. No 1.6 in the RFP document.
- b) **Department shall provide construction power supply on a chargeable basis from a nearby available location.** The details are provided in the Electrical Details of S. No. 1.4 in the RFP document
- c) Identification of the raw water source at one point near the site for construction works. Suitable methods shall be employed for the

extraction of water as per the details given in the Civil requirements of S. No 1.6 in the RFP document.

- d) Approval of entry permits for the personnel, material & machinery.
- e) Reviewing & approval of the submitted plant documents by the contractor:
1. Process Design Reports along with detailed engineering works.
 2. Process Flow Diagrams (PFD) and Process & Instrumentation Diagrams (P & IDs).
 3. Architectural and Construction drawings of civil buildings.
 4. Equipment Layout and Foundations for Equipment / Tanks, etc.
 5. Auxiliary Systems: Water Treatment, Effluent treatment (if required), Air-Conditioning System, Fire Protection System, etc. as required for the plant
 6. Specifications of equipment/flow components for Procurement.
 7. Quality Assurance Plan.
 8. Safety & Reliability study reports.
 9. Programming and validation logics for commissioning and operation
 10. Other relevant documents as listed in the document elsewhere, etc

1.2.11 TECHNICAL REQUIREMENTS, TERMS AND CONDITIONS

- The Air Separation Unit shall be designed considering a life of 25 years.
- Design and Fabrication of the Air Separation Unit (ASU), including equipment's shall be in accordance with the process specification defined in this document. In addition, Supplier shall comply with all applicable codes, laws, and regulations of the jurisdiction in which the Air Separation Unit is to be operated.
- Air Separation Unit shall be suitable for operation under outdoor conditions as per the attached ambient and site conditions and utility data provided in the RFP document.

- If any discrepancy is found during the procuring, design, and fabrication stages, Supplier shall immediately inform the Department and shall obtain necessary clarification/approval before proceeding with the job any further.
- Guaranteed power consumption shall be quoted in kWh / hr. No positive tolerance shall be permissible for Guaranteed power consumption.
- No benefit shall be passed on to the Supplier in case the Guaranteed power consumption during performance guarantee test is lesser than the guaranteed figure provided by the supplier.
- All electrical motors/heaters/equipment shall be selected with 10% margin on its rated power for smooth running of the plant operation. Also, highly efficient electrical motors/equipment shall be selected for lesser electrical power consumption.
- Supplier shall complete/sign the attached letter of conformity and list their probable deviations from this requisition clearly in their quotation
- The Supplier shall guarantee:
 - a) that all materials are new and free from defects.
 - b) that all materials are properly stored, fabricated, and handled.
 - c) That noise emission level will comply with the requirements of this material requisition.
 - d) that sub-suppliers are well proven and referenced for the required application.
 - e) That uninterrupted operation period shall not be less than 2 years
- The supplier may submit a list of deviations and clarifications (if any) referred to the applicable codes, standards, and specifications of this RFP along with justification.
- Supplier shall ensure compliance with all Central, State & Local Govt regulations, laws, and requirements applicable to the work and seek & obtain approvals/ clearances from such statutory bodies/ agencies, as

required. Department role will be limited to only providing authorization in favour of the supplier, for which all the necessary paperwork shall be done by the supplier.

- The supplier may also propose alternative solutions for different configurations of the ASU unit with advantages assured in comparison to those described in the specifications.
- Any approval of documents and technical solutions shall in no way relieve Supplier responsibility and obligation.
- Any other equipment/ packages items / works etc not enlisted here but are appearing in the process package or within the battery Limits and are required to make the system complete in all respects for its safe and efficient operation are also included in the supplier's scope.
- Any additional items or features required, during detailed engineering for the completeness and trouble-free performance of the system, shall also be included in the supplier's scope without any price implications, as long as system performance & technical requirements are kept unchanged.
- All equipment and systems shall be designed for operational flexibility, future expansion, and suitability to the environmental and process conditions of the ASU plant, with provisions for preventive maintenance and compliance with statutory and hazardous-area safety codes
- Supplier shall provide data sheets of all equipment and submit them for Department & TPIA review and approval.
- Drawings, calculations, and documents shall be submitted as indicated in the RFD provided in Annexure 7A.
- Compliance with the provisions of this requisition does not relieve the Supplier of the responsibility of furnishing the equipment of proper design, mechanically suited to meet performance guarantees at the specified operating condition.

- The Air Separation Unit shall be guaranteed to operate satisfactorily, considering the site conditions. Performance guarantee will be tested after construction on-site during a test run.
- The detailed test procedure and methods of computation of results for performance guarantee shall be furnished by the Supplier for Department review and approval. The test procedure and the applicable tolerances will be mutually agreed upon with the Supplier before the release of the purchaser's order.
- The guarantee parameters shall be adjusted to account for variation in ambient conditions prevailing at the site during performance testing. Necessary calculations, correction curves shall have to be furnished by the Supplier for this purpose before the release of the purchaser's order, which shall be final.
- Performance & Guarantee Testing should be carried out within 1 month of commissioning. (refer Annexure 7J for indicative test procedure)
- All necessary instruments required for measuring performance guarantee parameters shall be provided in the system or arranged by the Supplier. These instruments shall be tested and calibrated from reputed test houses approved by the Department, TPIA and calibration certificates shall be issued before putting them into use.
- If the result of the Performance Test does not meet the Performance Guarantees of the Package, required modifications, alterations, additions, substitutions, or replacements in Equipment and/or design, etc. should be performed by Supplier at his own expenses.
- If the Performance Guarantees of the Package are not met during the first Performance Test and failure of Performance Guarantees is not due to causes imputable to the Department, all costs and expenses of Supplier's personnel related to subsequent Performance Test or to corrective measures for the period during which subsequent Performance Tests are being awaited or conducted, shall be borne by

Supplier.

- Sub Supplier/suppliers shall be approved by the Department prior to placement of sub-orders. List of sub-suppliers shall be submitted at the proposal stage / along with the Bid.
- Supplier shall supply a list of proposed Sub-Suppliers for each component, such as motors, instruments, bearings, etc., indicating Sub-Supplier's model number, type, etc., along with their catalogues, drawings, etc, with the first revision of the offer for Department approval. Supplier shall not be free to substitute any other manufacturer or model unless so accepted by the Department.
- For all purchased items, the overall responsibility for their suitability and performance shall be within the Supplier's scope. Supplier shall ensure that all requirements of inspection, testing, drawings, and documentation are compiled by Sub-Supplier.
- For all bought-out items, the Overall Responsibility as to their suitability and performance shall be that of the Supplier's scope. Supplier shall ensure that all requirements of inspection, testing, drawing, and documentation are complied with by sub-Supplier (if any).
- Any approvals given by the Department do not relieve the Supplier of any responsibility regarding guarantees, workmanship, and compliance with the specification and code.
- Supplier shall guarantee all the services provided by him (his sub-supplier and himself) for correctness, completeness, reliability, integrity, mechanical design, and detail engineering and fabrication activities etc., also Supplier shall guarantee the performance of the manufactured equipment during operations, start up, shut down, and tests during the equipment service life.
- 3D Model of ASU shall be prepared and delivered by Supplier using PDMS or equivalent software.
- The Supplier shall provide a detailed Process Flow Diagram and the

Heat & Material Balance table with expected figures for all streams.

- Material and Corrosion allowances shall be considered for a minimum of 25 years' safe operation.
- Material selection shall be made based on the referenced specifications as per ASME / ASTM Standards.
- All drain lines from drums/filters, etc., inside the package shall be grouped together as far as possible and shall be routed to drain into a common drain funnel.
- Supplier shall tabulate foundation loads, including shear and axial moment loads in erection, operation, and test conditions for seismic loads and wind loads.
- Supplier shall furnish details of anchor bolts (i.e. size, number, material, and setting plans)
- Air Separation Unit, including all accessories, shall be shop-painted. Surface preparation as per SA 2 ½, and one coat of proper primer and one coat of proper intermediate, and one finish coat.
- Supplier shall estimate the nozzle loads and shall submit supporting calculations for Department & TPIA review.
- Material for pressure vessels and piping shall be procured as per codes & Standards provided in the RFP.
- The selection of materials of each component of the unit shall be based on the design pressure, temperature, and other conditions of operation, and in no case will be inferior to that indicated in applicable Codes and Standards. Low carbon grades 304L, 316L, 309L, or stabilized grades 347/321 shall be used. ASTM grades shall be indicated for all the materials in the supplier's documents.
- The corrosion allowance adopted for all equipment shall be according to the actual corrosion requirement of the fluid in contact with different materials. However, in no case shall the corrosion allowance for carbon steel parts be less than 1.5 mm, other than for vessels. Corrosion allowance for carbon steel vessels shall be a minimum of 3 mm.

- Supplier shall furnish complete information about pump characteristics (Water, LOX & LIN pumps): Head, Efficiency, Power, NPSH vs. Capacity for the fluid pumped, and head vs. capacity for Max. and Min. Sizes of impeller.
- The compressor shed/ building shall have suitable material handling facilities (EOT crane of adequate capacity) for maintenance.
- All couplings, gears, and exposed rotating parts shall be provided with adequate guards. Drive belts, if any, shall be anti-static type.
- Each machinery module shall have its own local panel, as applicable
- During engineering design, the Supplier shall indicate the overall noise level of the whole package unit in operation. This information shall be considered for the evaluation of the total noise impact of the whole plant at the fence limit. Supplier shall submit the expected noise data sheet.
- The noise level shall be less than 85 dBA maximum at 1 meter from the edge of each skidded equipment or single equipment installed alone. In case of exceeding the specified noise level, Supplier has to solve the noise exceeding problems, providing all additional measures and materials at their own cost.
- Instrument air and plant air requirements shall be produced inside the Air Separation Plant Battery Limits. This includes requirements for the startup and shutdown of the Air Separation Unit.
- Before the start of fabrication, Supplier shall submit the QC plan and ITP to the Department & TPIA for approval.
- Supplier shall submit the design calculations to the Department for approval before fabrication. Fabrication shall not commence prior to Department approval of documents.
- Supplier shall provide a Lubrication Schedule in detail, for lubrication details covering initial fill and three years of normal operation.
- Supplier, along with the offer, shall submit a layout drawing, on which will be shown the proposed process streams and service fluids at ASU.

1. Incoming services:
 - ✓ Instrument air (for startup)
 - ✓ Plant air (for startup)
 - ✓ Cooling water supply
2. Outgoing process streams and services:
 - ✓ GAN
 - ✓ Liquid Nitrogen
 - ✓ Liquid Oxygen
 - ✓ Waste Gases
 - ✓ Instrument air
 - ✓ Plant air
 - ✓ Cooling water return
 - ✓ Condensate
- In case of doubts of interpretation or conflicts among the specifications, the following decreasing order of priority shall be applied:
 1. Duty specifications and data sheets
 2. Client's specifications and documents mentioned or attached to this specification
 3. The Technical Specification provided
 4. National and International applicable standards and codes, as listed in this Specification, Local Laws and Rules
- Air Separation Plant internal communications network shall be in the scope of the Supplier which includes Telecommunication and Intercom. The Supplier shall procure and install adequate equipment of reputed make after review & clearance from the Department.
- Supplier shall provide necessary office Furniture (Tables-5 nos & Chairs- 15 nos), Personnel Computers for maintaining Digital records (2 nos, spec provided in S. no 1.3.5.9 of RFP), Cupboards for maintaining & preserving Plant records (6 nos), Sufficient number of Cupboards / Storage Cabinets for preserving Plant Spares &

Consumables in Stores area. The actual quantity shall be finalised along with the Department. The procured Furniture, Personnel Computers, Cupboards / Storage Cabinets shall be of reputed make and shall be cleared by the Department for procurement.

1.2.12 PROCESS CONTROL

- Adequate measurements for flow, temperature, pressure, level & purity checks shall be provided as per design.
- It is the Supplier's responsibility to design the Air Separation Unit package as required to permit safe and orderly start-up, shutdown, and operation.
- Supplier's recommended start-up, shutdown, and operating procedure will be reviewed by the Department. The above procedure shall be included in the operating and maintenance manual and submitted.

1.2.13 SAFETY STUDIES

- The supplier should submit the HAZOP study for the ASU Plant at their own cost based on PFD, P&ID, Plot Plan, and Equipment data sheets, and a safety-related equipment checklist. The supplier should provide information about the reported accidents in similar Plants elsewhere during HAZOP meetings.
- The HAZOP study meeting should be held in the presence of the Supplier, Department, and Third party.
- The supplier should submit at least three qualified and internationally well-known companies as third parties for HAZOP for Department approval.
- Supplier is responsible for the implementation of any required modifications and changes based on HAZOP study recommendations at their own cost.

1.2.14 SAFETY REQUIREMENTS

- The layout of the plant shall facilitate easy and adequate accessibility to all operating and regular maintenance areas.

- The layout of the plant and storage system shall be in accordance with statutory regulations and approved by the Chief Controller of Explosives (CCOE)/Petroleum Explosive Safety Organization (PESO) /Static and Mobile Pressure Vessels (SMPV), Govt. of India.
- All safety features comprising interlocks, alarms, trips, etc. shall be incorporated in the composite plant, its accessories, and auxiliaries.
- Silencers shall be provided wherever air or gas venting is involved to minimize the noise level to 85 dBA.
- Plant piping shall be routed and supported on an elevated pipe rack.
- All valves and instruments shall be accessible.
- Adequate space shall be provided for the removal of equipment components for routine maintenance.
- All Safety Relief Valve outlets shall be routed to a safe location.
- Permanent warning sign boards shall be provided, wherever electrical hazard exists, when the plant is in operational and/ or when the plant is in standby condition.

1.2.15 STATUTORY LICENSES

The supplier has to obtain Statutory Licenses & Approval from the concerned Agencies. These include:

- **Factory Act Compliance:**
 1. Registration under the Factories Act, 1948, and state factory rules.
 2. Approval of factory building plans & machinery layout.
- **MSIHC/MAH compliance:**
 1. An MAH class industry is any industry where the quantity of hazardous chemicals exceeds the threshold quantity listed in MSIHC rules.
 2. If quantities of hazardous chemicals exceed thresholds, a safety report, an on-site emergency plan, and safety audits shall be prepared and submitted to Department for approval.

- **PESO Clearances:** PESO approvals are required for layout, storage/transportation tanks.
- **Pollution Control Board (PCB) Clearances**
 1. Consent to Establish (CTE) shall be obtained before construction from SPCB.
 2. Consent to Operate (CTO) shall be obtained before starting production from SPCB.
 3. Compliance with:
 - a) Air Act, 1981-Emissions norms for DG sets, compressors
 - b) Water Act, 1974: -Effluent treatment system. Effluent Treatment Plant / ZLD, if any, to meet statutory requirements shall be provided.
 4. Environment Protection Act, 1986: Risk assessment studies, hazardous waste management.
 5. Minimum distance from sensitive areas and other industries, which is 200 meters for orange category industries.

1.2.16 PERFORMANCE GUARANTEE TESTING

1. The Supplier shall guarantee that design capacities, outputs, efficiencies, utility, emission, and raw materials consumption and turndown requirements for the ASU Plant as a whole are met under conditions of safe and steady operation and under automatic control.
2. Indicative Performance Guarantee Testing procedure is provided in Annexure 7J.
3. Performance test shall be determined by averaging the results of 3 consecutive operating days (72 hours) at the specified full load condition. The test result will be averaged over the test run period.
4. Necessary instruments for the performance testing shall be arranged by the Supplier and shall be tested and calibrated before undertaking the performance test.
5. Performance Tests conducted to meet design requirements shall be

evaluated during a continuous plant test run of 72 hours duration. Such tests shall normally be undertaken to include the entire ASU Plant at the same time. However, individual independent systems within the ASU Plant shall be tested separately during the commissioning phase.

6. The following guaranteed parameters shall be demonstrated by the Supplier during the performance test:
 - a. Liquid Oxygen – Rated flow, Purity & Pressure
 - b. Liquid Nitrogen – Rated flow, Purity & Pressure
 - c. Gaseous Nitrogen – Rated flow & Pressure
 - d. Outlet temperature of feed air from the Precooling unit
 - e. Carbon dioxide (< 1ppm) and moisture in the feed air to the cold box
 - f. Power consumption for the core operating plant to deliver the products with the required production capacity and specification

Power consumption details of Core plant equipment's for the plant running on 24X7 as per the Plant design includes, and is not limited to the following list,

S. No	Equipment	kWh / hr
1	Main Air Compressor	
2	Product Compressor (if required)	
3	Precooling System	
4	Regeneration gas Heater	
5	Process Pumps	
6	Break generator for Expansion Turbines	
7	Lube oil systems	
8	Cooling water system	
9	Instrumentation & Control	

10	Control room AC and Essential plant lighting	
11	Any other equipment considered for the core plant running as per the plant design	
12		
	Total kWh / hr	

- g. Turn-down Capacity – without any venting.
 - h. Cooling water consumption & Temperature rise of cooling water
 - i. Pressure drop across the unit
 - j. Vaporizer capacity for consumption for process requirements
 - k. Instrument air availability for startup and shutdown
7. If a test is interrupted and such interruption is due to design defects in equipment, and/or systems, the following shall apply:
- The tests shall be abandoned, design aspects shall be verified, and every endeavor shall be made to identify the fault. And the defects are to be rectified by the Supplier at his own expenses.
 - A new test shall then be made to cover the stipulated period of test as if no earlier test had been attempted.
8. Operation at turn-down rates either for the complete ASU Plant, or for an independent system within the ASU Plant, or for an equipment item forming part of the ASU Plant shall be performed over a continuous period of 72 hours, which shall be separate from the performance tests described above.

1.2.17 SPARE PARTS

- Necessary Spare parts for erection, pre-commissioning / commissioning & start-up shall be in the supply scope of the Supplier. Supplier shall submit a list of commissioning spares with quantities. The commissioning spares shall be sufficient for trouble-free commissioning of the system at the site. Any commissioning spares required during commissioning, over and above the commissioning spares supplied,

shall be made available by the supplier without any cost and time implication to the Department.

- **Supplier shall submit a list of spare parts with recommended quantities for the 3-year operation and maintenance of the equipment.** Proper coding and referencing of spare parts shall be provided with identification to the appropriate equipment.
- Supplier shall submit a list of OEM-recommended spares/capital spares and their quantities, taking into account related factors of equipment reliability, effect of equipment downtime upon production or safety, cost of parts, and availability of supplier's service facilities around the proposed location of equipment.

1.2.18 PRESERVATION

- All unpainted surfaces shall be protected from corrosion during shipment and subsequent outdoor/indoor storage by coating with a rust preventive.
- Spare parts shall be preserved from environmental corrosion, and preservation methods shall be suitable for long-term storage.
- All internal parts shall be coated with rust preventive before shipment.
- Supplier shall furnish a procedure for the prolonged storage of the supplied equipment/ material at the site.

1.2.19 PROTECTION & PAINTING

- Surface preparation and painting shall be done as per the painting scheme reviewed and approved by the Department.
- Stainless steel surfaces, both inside and outside, shall be pickled and passivated.
- Machined and bearing surfaces shall be protected with varnish or a thick coat of grease.

1.2.20 INSPECTIONS, TESTING, AND CERTIFICATION

- Inspections and testing shall be carried out for all the equipment with

reference to the minimum requirements of the Scope of Inspection and the inspection procedure.

- Equipment shall be subjected to stage-wise expediting, inspection, and testing at the supplier's / sub-supplier's works by an authorized third-party inspection agency / Department.
- Any or all the tests, at the Department's option, shall be witnessed by works by an authorized third-party inspection agency / Department. However, such an inspection shall be regarded as a check-up and shall in no way absolve the supplier of his responsibility.
- The type and extent of tests shall be in strict compliance with the contractual codes, standards, data sheets, and/or specifications attached to the material requisition.
- All test and inspection certificates shall be furnished for Department reference and records.
- Certified copies of all Statutory / Third-party inspection authorities shall be furnished to the Department.
- All the pressure-containing components of equipment shall be complete with material certifications as required by the applicable code.
- Based on both the scope of inspection and the inspection procedure, the Supplier shall submit their own Quality Control Plan (QCP) / ITP for Department approval and shall include:
 1. Inspections and tests specified by the referenced Codes, Rules, and Standards,
 2. Hold points
 3. Supplied certifications
 4. Acceptance criteria etc.,
- The Supplier shall advise in writing three weeks in advance date and place where materials and/or equipment will be available for inspection and test.

- All welding activities shall be performed in accordance with an approved welding procedure, regardless of whether any specifications or International codes apply. Therefore, the relevant welding map, welding procedure specification (WPS), and procedure qualification record (PQR) shall be submitted for approval before the start of the relevant activity.
- All NDT procedures, such as RTE procedure, MPE procedure, PMI procedure, PWHT procedure, etc., shall be submitted for approval before start of the relevant activity.
- Supplier shall prepare and submit for review and approval the following procedures:
 1. Fabrication Quality Control Plan (Inspection & Test Plan)
 2. Welding key form, including WPS, PQR
 3. Testing procedure
 4. Post-weld heat treatment procedure (if any)
 5. Non-Destructive Examination procedures

1.2.21 THIRD PARTY INSPECTION

In addition to the inspection of the contractor /supplier, the primary agency responsible for inspection of the equipment/components/materials/ services shall be a Third-Party Inspection (TPI) agency who shall be chosen from the following list:

- Lloyds Register Industrial Services Pvt Ltd (LRIS)
- Det-Norske Veritas (DNV)
- Technischer Uberwachungs Verein (TUV)
- Bureau Veritas

In the event of nonavailability of any of the aforesaid TPI agencies in a particular location, the Department may, at its own discretion on a case-by-case basis, permit engaging an alternative TPI agency based on a proposal from the Supplier.

The TPI agency shall be responsible for:

1. Review and approval of detailed engineering works except for the proprietary designs.
2. Review and approval of procurement specification
3. Review and approval of system realization works
4. Review and approval of plant construction/system fabrication drawings & works
5. Raw material inspection, stage-wise inspection during fabrication/testing at the premises of Supplier / Sub-contractor/ test labs/ Sub-Supplier (as applicable) as per approved QAP.
6. Final inspection and issue of the inspection release note at the above locations.
7. Review and approval of Quality Assurance Plans (QAP) / subsystem & integrated system level performance testing and commissioning procedures.
8. Other Third-Party Inspection Agency works as listed elsewhere in the RFP.

1.2.22 DOCUMENTATION

- The Supplier shall attach a transmittal letter to every document submission along with the Bids, and after placement of the Purchase Order.
- The supplier documents shall be updated based on the Department comments (if any) and submitted for a new approval within two weeks from the date of comments received.
- The final drawings shall be complete with the stamped sentence "final certified drawings", signed by the Supplier, TPIA and shall be submitted to the Department.
- Department approval or comments shall concern the general aspect of the design and shall not relieve the Supplier from their responsibilities regarding the respect of the requirements contained in the material

requisition.

- The Instruction manuals shall include all the documents and bulletins necessary for clear descriptions and instructions for installation, pre-commissioning, commissioning, start-up, operation, and maintenance purposes, tailored for the present project. The instruction manual shall be issued in the English language.
- The final dossier (complete plant documentation) covering all the documents listed in Annexure 7A & elsewhere in RFP shall be submitted by the Supplier.

1.2.23 LIST OF DOCUMENTS TO BE FURNISHED WITH THE OFFER

Indicative plant layout along with details for the following:

1. Equipment Manufacturer's Catalogue & Brochures
2. Datasheet of equipment
3. Plot area requirement
4. Drawings - GA drawing; C/S drawing; Equipment Layout drawing,
5. PFD – Process Flow Diagram
6. P&ID – Process & Instrumentation Diagram
7. Equipment's Performance Curves
8. List of recommended spares for trouble-free operation. The list should cover all spare parts for 3 years' operation along with information like Manufacturer P/N, description, quantity required etc.,
9. List of Erection & Commissioning spares
10. List of Special tools & tackles (as per OEM recommendation)
11. Basic data for civil design/foundation details
12. Utility Data – along with water required during construction (m³)
13. List of approvals/ clearances to be obtained from statutory bodies/ agencies with tentative timelines
14. Inspection Test Plan
15. Equipment manufacturer's General Reference List, along with power rating. Selected Equipment make & Model for core plant operations

towards estimation of power consumption.

16. Procedure for Performance Guarantee Test
17. Supplier shall provide the necessary details for the Plant as given in the FORM 17 in PART 5 of the RFP document.

1.2.24 DOCUMENTS TO BE FURNISHED AFTER AWARD OF CONTRACT

The following documents shall be provided. A total of three (3) hard copies and one (1) copy on magnetic media (USB memory stick or CD-ROM) shall be provided within sixty (60) days after issue of the purchase order.

1. Detailed dimensional, general arrangement drawing of the total systems for the entire air separation plant with cross-sectional details, bill of materials, and weight of individual parts for the purchaser's approval. (Approval does not relieve the supplier from responsibility).
2. Design calculations of all the systems, structures, and civil buildings.
3. The drawing showing the supporting arrangement on the floor, including static & dynamic loading details at each support to be submitted for the purchaser's approval.
4. Building drawings **and** Civil Load Data
5. List of bought-out items & their specifications.
6. Test certificates shall be furnished before dispatch of components. Test certificate for the following shall be furnished.
 - a) Material test certificate for all the major components.
 - b) Performance TC for the intended duty conditions.
7. Quality Control/Inspection documents generated during the stages of inspection, performance inspection, and final inspection.
8. Warranty certificates along with the consignment.
9. The Operation & Maintenance (O & M) Manual should be submitted to the purchaser prior to dispatch of the equipment in digital format. The following aspects are also to be covered in the O & M manual:
 - Manufacturer's Catalogues

- Operation manuals
 - Safety instructions
 - Maintenance manuals
 - Repair and overhaul manuals
 - Complete and comprehensive parts catalogue (including pictures if applicable), manufacturer P/N, and OEM P/N.
10. Complete and comprehensive Parts Catalogue Maintenance/repair manuals and parts catalogue for other repairable components, if they were not included in the Air Separation Plant O&M manual.

1.2.25 CODES, RULES AND STANDARDS

- Design, manufacturing and inspection of the Air Separation Plant shall be based on International standards accepted in India
- OSHA safety regulations, PESO regulations, as well as all valid statutory regulations applicable at all stages of the project life cycle shall be complied with.
- Compliance with all relevant requirements of static and mobile pressure vessel (SMPV) rules of CCOE.
- Compliance with applicable national or overseas codes and standards, as well as any statutory regulations in existence for a specific item
- Ease of operation and maintenance, including any necessary measures for ensuring the safety of personnel and equipment, as well as a conducive working environment. The layout of ASU and the storage system shall be in accordance with local & statutory regulations and shall have adequate access for regular operation & maintenance.
- The Design & Engineering of the Air Separation Plant shall comply with the specification, Codes, Rules, and Industrial Standards, latest edition listed here below or elsewhere in the requisition or its attachments, but are not limited to the list mentioned below:

S. No.	Description	Code

1	Air compressors	API Std 672 / API Std 617 ASME PTC-10 & ISO5389
2	Expanders	API Std 617
3	Process pumps (General service for cooling water pumps)	API 610
4	Cryogenic pumps	API 610
5	Lube oil system	API 614
6	Lube oil pumps	API 676
7	ASU related standards	EIGA, CGA
8	Vibration Monitoring Systems	API Std 670
9	Shell & Tube heat exchangers	TEMA / API Std 660 / ASME VIII Div. 1 or 2
10	Auxiliary Shell & Tube heat exchangers for rotating equipment	Mfr Std
11	Pressure Vessels	ASME Sec, VIII Div. 1
12	Plate exchangers	API Std 662 / Mfr Std
13	Welded-type heat exchangers	Mfr Std
14	Air Cooled Heat Exchangers	API 661
15	Pressure vessels & pressurized tanks	ASME VIII Div. 1 or 2
16	Piping, Valves & Fittings	ASME B31.3 / ASME B 16.5
17	Material Specification	ASME SEC II
18	Materials	ASTM Std. Code
19	Non-Destructive Examination	ASME Section V
21	Welding	ASME Section IX
21	Material quality certificate	EN 10204-3.1

22	ASU performance testing	ASME PTC 47.1
23	Cleaning, Pickling & Passivation	ASTM G93, A380
24	Relief Systems	API 520, 521 & ASME PTC25
25	Safety Standard for Compressors	ASME B19.1, B19.3

1.2.26 LIST OF PREFERABLE MAKES

The preferable makes for various equipments are given in the below table, Bidders shall specify the reputed make / model no / country of origin of equipment **while submitting the bid.**

S. No.	Description	Suppliers / Manufacturers
1	Air Compressor Inlet Filters	Spectrum Filtration / SPX / Camfil / AAF
2	Main Air Compressor	Siemens / Atlas Copco / IR (Cameron)
3	Booster Air Compressor	Atlascopco / IR (Cameron) / Siemens
4	Air Precooling Unit	Reynolds / Voltas / Johnson
5	Cold Box	Fives / Nikkiso/ Linde / Air Products
6	Transfer pump	Cryostar/ ACD / Cryomech
7	Molecular sieve	UOP / Zeochem
8	Packing	Sulzer
9	Storage tanks (LOX and LIN)	Vijay Tanks & Vessels / INOX / LINDE / VRV / Krison
10	Mobile tankers (LOX and LIN)	Vijay Tanks & Vessels / INOX / LINDE / VRV / Krison
11	Vaporisers	Incryo / IWI / Shell & Tube
12	Expander Unit	Cryostar / ACD
13	Main Heat Exchanger	Chart / Sumitomo / Fives
14	Main Condense-Reboiler	Chart / Sumitomo / Fives

15	Valves	Metso/ Fisher / Tyco / Orbinox / Severen
16	Regeneration Heater	Sandvik / Ex-Heat / Vulcanic / Elmess, Escorts
17	Cooling Water Pumps with motor	CRI / KSB/ Mather & Platt
18	Cooling Tower with fans and Accessories	Paharpur / Blue Chip / Advance

The above list indicates the department's preferred makes. However, alternate makes meeting all technical and performance requirements may be offered, subject to submission of complete details and prior approval of the department.

1.2.27 QUALITY ASSURANCE PLAN (QAP)

The Scope of inspection of Major Equipment is indicative as given below and it is given for critical equipment only. Supplier shall submit the Quality Assurance Plan immediately after placement of PO, for all the Equipment and complete plant realisation & commissioning towards planning & Execution of the Inspection activities, for review and approval by the Department.

1.2.27.1 STATIC EQUIPMENT

DESCRIPTION OF INSPECTION POINTS	HP	WP	RI	RD
1- Materials (Dimensions, Marking and Test Certificates)			✓	✓
2- Storage of Materials and Welding Consumables			✓	
3- Welders qualifications			✓	
4- Adherence to Approved Procedures (Welding, Heat Treatment, Etc.)			✓	
5- Adherence to Agreed Inspection Plan			✓	
6- Workmanship, Cleanliness			✓	
7- Weld Preparation and Fit-Up			✓	

8- Second Side of Welds After Back Gouging			✓	
9- Installation of First Set of Internals		✓		
10- Execution Of (Major) Repairs	✓			
11- Visual and Dimensional Inspection Before Heat Treatment		✓		
12- Heat Treatment Execution			✓	
13- Non-destructive Testing Personnel Qualifications			✓	
14- Non-destructive Testing (Review of All Radiographs)			✓	
15 Destructive Testing Results (Production Test plates)			✓	
16 Hardness Measurements in Final Condition			✓	
17- Alloy Verification or Chemical Analysis (PMI Test If Required)			✓	
18- Reinforcing Pad Air-Soap Test			✓	
19- Visual Check Shell Internal			✓	
20- Visual and Dimensional Inspection Prior To Hydrostatic testing		✓		
21- Hydrostatic testing			✓	
22- Installation of Internals			✓	
23- Surface Preparation Prior To Painting, Coating, Lining			✓	
24- Painting, Coating, Lining, Preservation, Pickling & Passivating		✓		
25- Final Visual and Dimensional Inspection	✓			
26- Ancillary Items (Spare Parts, Gaskets, Bolts and Nuts Etc.)			✓	
27- Nameplate, Tagging, Marking, Color Coding		✓		
28- Preparation for Shipment	✓			
29- Documentation Review Prior To Release				✓
- HOLD POINT (HP) - WITNESS POINT (WP) - RANDOM INSPECTION (RI): Where random inspection is specified, Approx. 10% of				

the material will be inspected. This percentage will be increased in case deficiencies are found, or doubts about quality arise.

- REVIEW DOCUMENTATION (RD)

1.2.27.2 COMPRESSOR

DESCRIPTION OF INSPECTION POINTS	HP	WP	RI	RD
1- Materials (Dimensions, Marking and Test Certificate)			✓	✓
2- Storage of Materials and Welding Consumables			✓	
3- Welders Qualifications				✓
4- Adherence to Approved Procedure. (Welding, Heat Treatment, Etc.)			✓	
5- Adherence to Agreed Inspection Plan			✓	
6- Workmanship, Cleanliness			✓	
7- Non-destructive Testing Personnel Qualifications				✓
8- Non-destructive Testing (Review of All Radiographs)				✓
9- Destructive Testing (If Any)				✓
10- Weld Preparation and Fit-Up			✓	
11- Execution Of (Major) Repairs	✓			
12- Heat Treatment Execution (If Any)				✓
13- Reinforcing Pad Air-Soap Testing				✓
14- Hydro Testing for Casing		✓		
15 Post Test Inspection		✓		
16 Balancing of Rotor, Impeller, Fan (Include Over speed Test If Required)		✓		✓
17- Gear Unit Run Test				✓
18- Hardness Measurements (In Final Condition)				✓
19- Alloy Verification or Chemical Analysis				✓
20- Lube Oil System: Hydro Testing				✓
21- Lube Oil System: Dimensional and Visual (Cleanliness)			✓	

22- Lube Oil System: Functional, Performance Test				✓
23- Mechanical Running Test	✓			
24- Mechanical Running Test with Spare Rotor	✓			
25- Safety and Alarm Devices			✓	
26- Performance Test	✓			✓
27- Noise Level Measurement		✓		
28- Vibrations Measurement		✓		
29- Dismantling (Check Bearings, Clearances, Wear, Etc.)		✓		
30- Run Out Measurement (Deflection Check)				✓
31- Capacity Control Test				✓
32- Gearing, Pinion Forging and Main Wheel Forging Or Casting				✓
33- Painting, Coating, Lining, Preservation, Pickling & Passivating			✓	
34- Ancillary Items (Glands, Cables, Thermometers, Etc.)			✓	
35- Final Visual and Dimensional Inspection	✓			
36- Nameplate, Tagging, Marking, Color Coding		✓		
37- Preparation for Shipment	✓			
38- Documentation Review Prior To Release				✓
- HOLD POINT (HP) - WITNESS POINT (WP) - RANDOM INSPECTION (RI): Where random inspection is specified, Approx. 10% of the material will be inspected. This percentage will be increased in case deficiencies are found, or doubts about quality arise. - REVIEW DOCUMENTATION (RD)				

1.2.27.3 EXPANDER

DESCRIPTION OF INSPECTION POINTS	HP	WP	RI	RD
1- Materials (Dimensions, Marking and Test Certificate)			✓	✓

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2- Storage of Materials and Welding Consumables			✓	
3- Welders qualifications				✓
4- Adherence to Approved Procedures (Welding, Heat Treatment, Etc.)			✓	
5- Adherence to Agreed Inspection Plan			✓	
6- Workmanship, Cleanliness			✓	
7- Non-destructive Testing Personnel Qualifications				✓
8- Non-destructive Testing (Review of All Radiographs)				✓
9- Destructive Testing Results (Production Test Plates)				✓
10- Alloy Verification or Chemical Analysis			✓	
11- Execution Of (Major) Repairs	✓			
12- Heat Treatment Execution (If Any)			✓	
13- Run Out Test of Shaft				✓
14- Balancing of Rotor (Included Over speed Test If Required)		✓		
15- Visual and Dimensional Inspection Prior To Hydro Testing		✓		
16- Hydro Testing		✓		
17- Mechanical Running Test	✓			
18- Noise Level Measurement		✓		
19- Vibrations Measurement		✓		
20- Heat Stability Test				✓
21- Safety and Alarm Devices		✓		
22- Dismantling (Check Bearings, Clearances, Etc)		✓		
23- Painting, Coating, Lining, Preservation, Pickling & Passivating			✓	✓
24- Ancillary Items (Spare Parts, Gaskets, Bolts and Nuts Etc.)			✓	✓
25- Final Visual and Dimensional Inspection	✓			

26- Nameplate, Tagging, Marking, Color Coding			✓	
27 Preparation for Shipment	✓			
28 Documentation Review Prior To Release				✓
- HOLD POINT (HP) - WITNESS POINT (WP) - RANDOM INSPECTION (RI): Where random inspection is specified, Approx. 10% of the material will be inspected. This percentage will be increased in case deficiencies are found, or doubts about quality arise. - REVIEW DOCUMENTATION (RD)				

1.2.27.4 PUMPS

DESCRIPTION OF INSPECTION POINTS	HP	WP	RI	R D
1- Materials (Dimensions, Marking and Test Certificate)			✓	✓
2- Storage of Materials and Welding Consumables			✓	
3- Welders Qualifications				✓
4- Adherence to Approved Procedure. (Welding, Heat Treatment, Etc.)			✓	
5- Adherence to Agreed Inspection Plan			✓	
6- Workmanship, Cleanliness			✓	
7- Non-destructive Testing Personnel Qualifications				✓
8- Non-destructive Testing Reports				✓
9- Visual and Dimensional Check of Castings Prior To Fabrication			✓	
10- Weld Preparation and Fit-Up			✓	
11- Execution Of (Major) Repairs	✓			
12- Hydro testing Casing, Barrel, Bowls, Dish, Head		✓		
13- Balancing of impeller / rotor (Multi Stage Pump)		✓		
14- Mechanical Running Test		✓		

15 Performance Test		✓		
16 Noise Level Measurement		✓		
17- Vibrations Measurement		✓		
18- NPSH Test		✓		
19- Painting, Coating			✓	
20- Ancillary Items (Glands, Cables, Thermometers, Etc.)			✓	
21- Final Visual and Dimensional Inspection	✓			
22- Nameplate, Tagging, Marking			✓	
23- Preparation for Shipment	✓			
24- Documentation Review Prior To Release				✓
- HOLD POINT (HP) - WITNESS POINT (WP) - RANDOM INSPECTION (RI): Where random inspection is specified, Approx. 10% of the material will be inspected. This percentage will be increased in case deficiencies are found, or doubts about quality arise. - REVIEW DOCUMENTATION (RD)				

1.3 DETAILS OF INSTRUMENTATION & CONTROL SYSTEMS

1.3.1 GENERAL ICS TERMS & CONDITIONS OF THE CONTRACT

1. Party shall provide a reliable Instrumentation and control system for Air separation plant for remote process operations.
2. This chapter provides tentative specification of all instrumentation and control system elements involved in Air Separation plant. However, party shall submit the detailed field element specifications as per process requirements & in line with the tentative specifications in the document for department approval during detailed engineering.
3. Party shall consider Hot stand by PLC/DCS with dual IO chain & Hot stand by SCADA system for the automatic operations of ASU with latest state of Art systems.
4. Party shall submit proposed field instruments as per details given in subsequent chapter and PLC-SCADA/DCS architecture along with technical bid for review.
5. Party shall submit of bid letter along with one set of Instrumentation & Control System proposal document duly signed and stamped on each page as token of acceptance of all Instrumentation & Control System conditions.
6. Data sheets for all the sensors/ instruments/ equipment required in the proposal shall be listed in detail and shall be signed & stamped.
7. Technical details, Bill of Materials, data sheets, catalogues etc. as applicable and any other drawing, document as mentioned in the proposal shall be submitted.
8. Supplier shall submit proofs in the technical bid such as PLC/SCADA based system Purchase order Copy, & its Work completion certificate as a part of similar systems handled in other government or private organization.
9. As the system going to be realized is very critical, Instrumentation & Control System Supplier should be an OEM or Authorized SI of PLC/SCADA. If Authorized System Integrator, Valid certificate from OEM shall be submitted.
10. Also, supplier shall have experience in handling the PLC & SCADA System

offered at least for a period of 5 Years.

11. Party shall confirm minimum 10 years support for all critical field instruments & PLC/DCS modules. Party shall provide declaration from OEM for PLC/SCADA Systems.
12. The supplier should select the Data Acquisition and Control components as per the system requirements and shall be approved by department.
13. The supplier shall provide detailed Architecture, Instrumentation & Control System BOM & project execution plan.
14. The supplier shall obtain clearance for configuration, panel engineering drawings, I/O wiring schemes and technical specifications of all the items from Department during the design review.
15. The supplier shall incorporate the modifications suggested by Purchaser during the design review, Factory Acceptance Test and Site Acceptance test phases, without any additional charges.
16. Party shall demonstrate the system as per department requirements and shall incorporate additional items to meet the requirement without any additional cost.
17. If any of the item supplied as part of this contract is not meeting the system requirement or any compatibility/ interface issues with other systems are found at any stage of the project, same shall be replaced with suitable items without any additional cost.
18. The supplied items shall have been manufactured within 18 months from the date of placement of PO. Older items are not accepted. All necessary certificates shall be submitted.
19. Any special tools and test equipment's needed for the maintenance/ handling of PLCs/DCS and other items are to be offered by vendor.
20. Bidder shall deploy sufficient team at site to carry out wiring/ configuration works immediately after system configuration is approved by department.

21. Minimum 2 experienced Persons for PLC programming & Development of SCADA Systems shall be deployed during execution until successful completion of first production.
22. List of Documents to be submitted along with offer
 - a. Datasheets of all Instrumentation & Control System elements in the system
 - b. Drawings - Control system architecture with all elements
 - c. P&ID Diagram
 - d. List of recommended spares
23. List of ICS documents to be submitted after placement of P.O.
 - a. QAP
 - b. Factory acceptance Test format all elements in the system
 - c. User requirement document & system requirement document
 - d. Site acceptance test format
 - e. Final P&ID, BOM, Architecture
 - f. Cable routing scheme
 - g. CCTV & intercom configuration
 - h. Fire detection and Alarm (FDA) integration scheme with SCADA
 - i. Networking scheme
24. Generation of following **documents** are in the scope of the party and shall be provided **after execution** to department in Hard & Soft copy.
 - a. Supplier shall provide soft copy (3 nos.) and 3 hard copies of as built circuit diagram for each panel
 - b. Full set of as-built drawings (system configuration, GA, as-built wiring, cable layout, instrument layout, etc.).
 - c. Design documents –IO Configuration & Program, and operational check lists.

- d. Final BOM with make & model number and serial number of all Instrumentation & Control System elements in the system.
- e. Control room layouts e.g., console room, PLC room and electrical panel layout with all dimensions in millimetres.
- f. Channel base frame drawings for console room, rack room and electrical panels room.
- g. All technical catalogues and datasheets of all items.
- h. Power supply distribution diagram
- i. Memory loading calculations/ Scan time calculations
- j. Address mapping/ Protocol/ Pin Detail wherever required as per requisition
- k. System grounding drawing.
- l. Installation manual containing installation procedure for programmable logic controllers and other items.
- m. Power-on, start-up and internal testing procedures.
- n. Software debugging and system configuration procedures.
- o. Calibration and maintenance manual containing maintenance procedures including replacement of parts, application modification etc.
- p. All test results & certificates (Internal tests by vendor, Factory Acceptance Test, test results, Site Acceptance Test, etc.).
- q. The following Documents are to be provided after successful commissioning with proper revision numbers & date of generation. IEEE 12207 standards to be followed. Documents shall be submitted for necessary clearances as and when required. Necessary modifications with revision number shall be carried out by the party.
 - i. User requirement document
 - ii. Software requirement specification (SRS)
 - iii. System design document (Sy.DD)

- iv. SCADA Design Document (SDD)
- v. Detailed design document (DDD)
- vi. Traceability Matrix Document (TMD)
- vii. Data flow diagram & State transition diagram document
- viii. Data Dictionary
- ix. PLC Code document
- x. State diagram
- xi. Test case (White box & Black box testing) Document
- xii. Sensor Calibration & line simulation report
- xiii. Operation Manual
- xiv. Console Manual with safety precautions
- xv. Contingency procedure document
- xvi. Troubleshooting & Maintenance Manual
- xvii. T&E document
- xviii. Factory Acceptance report
- xix. Site Acceptance report
- xx. Configuration Procedure Document
- xxi. Checklist document
- xxii. Calibration & Test certificates of all Instrumentation & Control System elements as a document
- xxiii. Panel HV Test reports, Panel material certificates
- xxiv. Safety manual for PLC
- xxv. BOM with part number, Make, Model, Serial number of each element, Quantity, Datasheet and their Test certificates
- xxvi. Other documents as per department requirement as per site commissioning.

- xxvii. T&E document with all test cases as a document
 - xxviii. Final consolidated Quality Audit Plan, Factory Acceptance Test & Site Acceptance Test document
 - r. Passwords/ Licenses/ Operating keys, etc.
 - s. Any other relevant document not listed above
25. Any change in User Requirement Document (URD) shall be incorporated by the Supplier during development phase based on the department requirements.
26. Department is and will be the sole and exclusive owner of all right, title and interest in and to the PLC Application code & SCADA projects and all associated Intellectual property rights and that party has no right to any application code or intellectual property rights therein. All final PLC Codes, SCADA project, all sub system, third party device configuration passwords, codes, etc and all copies, in whole or in part, are and shall remain the property of the department. As per Indian copyright act, Reuse of this codes in any other project is prohibited.
27. All PLC project, SCADA project, field elements backup should be provided.
28. List of **Instrumentation & Control System Drawings** shall be submitted, during detailed design and final completion of project.
- a. Each drawing submitted by the Supplier shall be clearly marked with the following details.
 - i. Name of the Owner: Satish Dhawan Space Centre, ISRO
 - ii. Project Title:
 - iii. Purchase Order No:
 - iv. Title of the Drawing clearly identifying the system, equipment or part.
 - v. Drawing, Revision Number and Date.
 - vi. Name of the Supplier:
 - vii. Drawings duly signed in "checked" and "approved" columns.
 - viii. Scale to which the drawing is drawn.

- ix. Cross references to all relevant drawings.
 - x. All relevant notes to the drawing
 - xi. All notes necessary for understanding and execution of work shown on a drawing shall be presented on the same drawing.
 - xii. All legends to all notations & details of revisions carried out
 - xiii. Bill of materials shall be tabulated, wherever required.
 - xiv. All titles, noting, markings and writings on the drawing shall be in English
- b. For all revisions of the drawing, Supplier shall ensure that all revisions are clearly encircled with revision numbers marked on the drawing.
 - c. Supplier shall also ensure that general details of revisions are indicated for each revision in the revision block of the drawing along with the date and signed by the approving authority.
 - d. All Drawings shall be drawn either in CAD or E-Plan. Drawing Source file shall be provided after completion of final drawings of all panels.
 - e. Any change in make apart from preferred make list in subsequent chapter shall be put up for department approval.

1.3.2 INSTRUMENTATION & CONTROL SYSTEM DELIVERABLES AFTER PLACEMENT OF ORDER:

A. Preliminary Deliverables

1. Preliminary P&ID diagram for each system
2. List of field elements for each sub system along with order code
3. PLC/SCADA Configuration drawing for all systems
4. Sizing of cables, cable layout and schedules
5. Interfacing with electrical systems
6. Surge protection scheme

7. Redundancy & Fail- safe consideration (Instrumentation & Control System & equipment)
8. Cable connectivity drawing among systems/ facilities
9. Network connectivity drawings
10. Network/ Checkout cable routing & CCTV mounting scheme

B. Detailed Engineering Deliverables:

1. Erection plan
2. Site Layout & Panel placement scheme
3. Detailed P&ID drawings
4. User requirement flow diagram
5. Wiring Scheme for each IO
6. Detailed specification of field devices, data sheets and its part code
7. Panel drawings/ Console drawings & its positioning details
8. Interface details for all third-party devices with PLC
9. Field JB details
10. Detailed UPS power, Raw power and DC power distribution scheme
11. Final IO list – Sub System wise List
12. Final cable routing – Trays/ trench, etc.
13. Final field elements list & erection
14. PLC/SCADA configuration/ detailed BOM & development
15. Third party device integration scheme to PLC/SCADA
16. Interlock & wiring drawings
17. Cable layout & routing drawings, Cable type details for each sub system.
18. Earthing/ grounding schemes
19. Interfacing all sub systems
20. Spares list to be maintained for each system

21. Deliverable documents/ drawings for all systems
22. Finalizing the specification of items in each system in consultation with department. (Document shall be submitted for each facility/ system)
23. Quality Audit Plan (QAP) for each element and as whole system shall be submitted
24. Documents: Quality Audit Plan, Failure Mode Effects and Criticality Analysis (FMECA) studies for all systems, Factory Acceptance Test & Site Acceptance Test procedure document and User requirement document - URD (In terms of flow chart) shall be provided.
25. Training
26. Control philosophy
27. CCTV Camera location to cover all process areas.
28. Single line diagrams of all process connections
29. Dual UPS power distribution scheme
30. Trench connectivity to all facilities

Specification shall include – “Comprehensive Annual Maintenance Contract (AMC) procedure of all systems, Factory Acceptance Test procedure, Site Acceptance Test procedure, Quality Audit Plan, monthly check list, Quarterly checklist, half yearly check list and Annual check list

- C. **Design Reviews:** The following documents shall be submitted as a part of design review of data acquisition system after award of contract
- a. P&ID diagram
 - b. List of field instruments and control elements
 - c. GA drawing of the PLC panels
 - d. PLC configuration indicating I/O modules, network switches, Ethernet to fibre optic converters, etc.
 - e. Wiring diagram for AI/DI/AO/DO
 - f. Detailed I/O list

g. Rack power distribution scheme.

D. **Detailed Quality Assurance Plan (QAP)** shall be submitted for approval from department before predelivery inspection.

1. Approved Quality Audit Plan by department internal technical review team will be followed by department to qualify and clear the system supplied.
2. Purchaser reserves the right to inspect all phases of supplier's operations. Therefore, it is the responsibility of the supplier to provide the necessary support for the inspection agency and get the works inspected at all stages of work as identified in quality assurance plan. The supplier shall carry out required supervision and inspection as per quality assurance plan and furnish all assistance required by the purchaser in carrying out inspection work during this phase.
3. Site Acceptance Test (SAT) procedure for the following tests shall be submitted for the approval prior to inspection,
 - a. Calibration of field instruments
 - b. Functional checks, compliance to specifications, load test and burn-in test of all items.
 - c. I/O loop End to End checks, line calibration.
 - d. Software testing including failure modes, validation of diagnostics data, event & alarms log view, data logging, report generation etc.,
 - e. Submission of all necessary documents as listed above.
4. Upon successful completion of project, system is subjected to test and evaluation by purchaser's representatives. T&E plan will be handed over to supplier to which he has to adhere and carry out tests. System will be accepted upon clearance from T&E committee.
5. Training on Instrumentation and control system
 - a. Training should be provided for **Minimum 6 persons** deputed by purchaser on configuration and implementation.
 - b. The training shall be for a minimum duration of 5 days in a phased way based on activities in Plant. Training on both PLC and SCADA at OEM

- training premises shall be provided. Training calendar or scheme shall be provided to department for approval
- c. Operator training shall be provided to SDSC-SHAR team, with proper course content, at site after installation of the system.
 - d. The quoted price shall be inclusive of training cost
6. Supplier shall be responsible for transporting all the system to site, unloading and storage. No equipment shall be delivered without obtaining dispatch clearance from Purchaser. All the equipment shall be properly packed to avoid any damage during transportation / handling / storage.
7. Supplier shall undertake the responsibility of the Instrumentation & Control System items during transportation to Sriharikota and during erection, testing and commissioning of the same at suitable location identified by SDSC, SHAR and until handing over the commissioned system to SDSC, SHAR after its acceptance.
8. Work program
- a. The supplier shall give a preliminary program schedule for executing the contract as per the scope of work, along with proposal. Upon award, supplier shall prepare a detailed program schedule for review / approval by purchaser. Supplier as per exigencies of work shall revise and update program periodically.
 - b. Weekly progress review meeting will be conducted alternatively at purchaser / supplier site to discuss progress changes and modification on design, drawings and qualitative / quantitative requirements
 - c. Daily work report to be submitted to concerned personnel identified by purchaser from the date of site clearance.
 - d. Changes and modifications to the specifications, designs, drawings and qualitative / quantitative requirements
 - e. Supplier shall obtain approval for the designs and drawings from the purchaser before initiating the action for procurement / fabrication.

- f. Purchaser is free to modify the designs or drawings during design review. Supplier has to carry out modifications without any extra cost and obtain the approval from purchaser towards meeting the systems requirements.
9. The commissioned Instrumentation & Control System are to be subjected to Test and Evaluation by the Purchaser Committee. This is to ensure that system is meeting all its intended requirements as per the given specifications. Any deviations observed shall be resolved by the supplier at no extra cost.
10. Party shall **be** responsible for maintaining the system after realisation during O&M. All necessary spares that are required for maintaining the system is in the scope of the party
11. The supplier shall execute the works in compliance with the contract, good engineering practices and code requirements.
12. Instrumentation & Control System elements shall not be manufactured from Border sharing countries. Even OEM or bidder registered in India, the ownership/ manufacturing shall not be from border sharing countries. Proper authorization from Ministry shall be submitted by the party for considering the offer. All necessary documents shall be submitted.

1.3.3 INSTRUMENTATION AND CONTROL SYSTEM REQUIREMENTS

1.3.3.1 Field Instruments requirements

1. Sensors & field instruments shall be selected based on plant requirements with redundancy for critical measurements.
2. Party should select bus based (Profibus-PA/ Ethernet APL) field instruments for measurement and control.
3. The active field device which are for powering field devices shall communicate with PLC/SCADA with Ethernet based protocol and with necessary communication ring redundancy.
4. Redundant sensors/ transmitters shall use separate active field powering device. Configuration shall be submitted for department approval.
5. All necessary devices description files for field instruments are in the scope of the supplier. Also, necessary software tool for configuring, calibrating field instruments are in the scope of vendor. The software tool shall be installed in Engineering station.
6. Conventional HART (4-20 mA) based field instruments shall be selected wherever bus-based field instruments are not available and shall be selected with approval of department.
7. Party shall consider bus-based actuator elements such as positioners, Thyristors, etc. If bus-based actuators are not available, 4-20mA based actuators shall be selected with approval of department.
8. Active field devices (AFD) / compact field unit (CFU)/ APL Switch to power field instruments shall be interfaced to PLC via Ethernet only. AFD/ CFU/ APL switch shall be separately provided for measurement and control elements. Redundant field elements shall have independent AFD/CFU/APL.
9. All the field instruments like pressure, level, vacuum, mass flow, temperature transmitters and control valves etc., shall be provided with Bus interface to **AFD/CFU/APL switch** in STAR/ Ring topology.

10. For powering transmitters, proximities, limit switches, etc., Power rail based Intrinsic safe isolators shall be used for hazardous area and power rail based normal isolators for safe area.
11. Dual redundant solenoid valves for operation of EP valves. Proximity sensors for ON/ OFF status of EP valves. Smart valve positioners with integral I/P converters of control valves.
12. Proximity sensors shall be of Namur type and with detachable connector, which shall be powered through isolator.
13. All signal isolators shall be powered through dual power fed modules.
14. For all temperature measurements, DIN rail mount transmitters are preferred
15. All field instruments shall be factory calibrated as per the standard & traceable to National Institute of Standards and technology (NIST) and certificates shall be submitted to department.
16. All necessary SS junction boxes shall be provided for field termination and GRP JB for hazardous areas. SS & GRP JBs shall be provided with gland dummies.
17. Supply & fixing of slotted SS Cable trays of required width with cover and laying of field sensor cables is in the scope.
18. Supply of all necessary Data/ Power/ signal cables of armoured/ flexible type and laying of cables are in the scope of the party.
19. Generation of independent main and redundant commands for remote operation of EP valves, control valves & pumps.
20. Explosion proof certified sensors & devices as per site requirement shall be used, wherever applicable. Otherwise, minimum IP65 certified devices shall be supplied.
21. Oxygen leakage detection sensors and fire detection sensors as per safety standards.
22. Display of critical parameters & monitoring at SCADA round the clock i.e. 24 X 7 basis

23. The number of transmitters/ devices per Ring or Tree network shall not exceed 75% current consumption of AFD/CFU/APL Switch or 75% data load whichever is less. At least two spare channels shall be available per AFD/CFU/ APL Switch.
24. For critical measurements, Independent AFD/CFU/ APL Switch's shall be provided for main and redundant transmitters. So that any failure in in one chain shall not affect the communication of other transmitters data.
25. If any weighing system is planned, all Weighing system shall be interfaced with PLC through IO modules only, no separate indicator is envisaged. Local indicator shall be planned wherever necessary. All calibration shall be through PLC only.
26. All specifications of each field instrument shall be submitted to department for approval.
27. Redundant analysers shall be supplied along with the item and shall be interfaced to PLC.
28. All accuracies of field instruments and their response time shall be finalised during detailed engineering phase.
29. An Asset management system to manage all field instruments shall be provided along with a dedicated PC and same will be connected to IO network.
30. One number of Hand-held communicators for PA and HART devices configuration shall be supplied.

1.3.3.2 PLC / DCS Requirements

1. Supplier shall supply, installation, and commission the PLC/DCS/PAC components like PLC, communication modules, power supply modules, I/O modules, 3rd party interface devices, I-MCC interface modules, weighing system interface modules, AFD/CFU/APL of field devices and associated PLC accessories. Authorised PLC/SCADA SI shall be deployed for PLC/DCS development.
2. A common hot standby PLC shall be planned for all ASU systems/operations and shall be located adjacent control room and visible from Control console and Remote IOs shall be located in respective process area or adjacent to PLC

panel. The positioning of RIO panels will be decided during detailed engineering phase.

3. All PLC IO modules shall be conformal coated modules.
4. Hot standby PLC/PACs with Ethernet & with ring or Criss-Cross configuration shall be considered & with communication ring between IO's and other Electrical & field devices.
5. Dual 230VAC chassis-based power supply shall be planned each PLC-RIO chassis which shall be powered from UPS-1 & 2.
6. Total scan time of PLC shall not exceed 100ms or shall be configured based on the process requirement during detail engineering.
7. All communication speed between AFD or CFU or APL Switch / IO/ PLC /SCADA stations/ third party devices shall be of 100 Mbps or better.
8. The system shall have provision to operate from PLC as well as from MCC with suitable hardware interlocks. In case of PLC/SCADA failure, system shall be operated from MCC.
9. Dedicated hardwire system shall be provided for the system to bring down the plant to safe state.
10. In PLC/DCS Mode, all controls of the Electrical sub systems shall be controlled & Commanded by PLC. PLC to be linked with intelligent motor management system (iMCC) for acquiring current, voltage, ON/OFF status etc.
11. In MCC mode, all systems shall be controlled from push buttons in MCC. Heaters shall be controlled from Single loop Controller in MCC, wherever required. (No push button in control room except, hardwire emergency off button.) Emergency off button shall be place in console with LOTO box.
12. All control panels of sub systems shall be interfaced with PLC for acquiring all parameters and shall have remote on-off feature from PLC/SCADA either through hardwire from PLC-DO or through communication from PLC/SCADA. Command wiring scheme will be decided during engineering phase based on features of sub systems interfaces.
13. All the spare digital and analog inputs shall be wired up to Marshalling

chamber. Each IO module shall have 20% spare channels and shall be terminated.

14. A dedicated Instrumentation Marshalling chamber with screw/ Spring gage type terminal blocks shall be provided to terminate all Signals for ease troubleshooting and shall be positioned adjacent to Instrumentation Rack.
15. Party shall employ an authorised system integrator / OEM for carrying out Instrumentation network design, cable layout, selection of network components etc., He shall submit detailed report comprising of information about max. scan cycle of the individual buses, communication load, throughput and recommend if any special earth & tools requirements etc., The SI/ OEM shall train the technicians (Party + department) for installation of network components, connections during panel wiring at factory and instruments installation at site.
16. All PLCs, IOs & iMCC in safe area shall of same make.
17. Each RIO panel shall have separate UPS distribution scheme and dedicated DIN mounted dual 24VDC power supply with DIN mounted Energy meters for UPS & DC measurements.
18. All electrical motor/ pumps, etc. parameters shall be acquired through iMCC/ Drives.
19. If any thyristor power controller is used in the system, it shall have suitable communication card to communicate to PLC. The commanding of thyristor shall be from PLC-AO.
20. A dedicated IOT device with inbuilt memory (minimum 32GB) to log critical parameters with 1 sec update rate independent of SCADA shall be provided, which will fetch data from PLC. Necessary software shall be provided along with the gateway.
21. A dedicated Racks shall be provided as follows
 - a. PLC & its network elements
 - b. IO Modules of respective systems along with its necessary interface elements (If all racks all planned in a single location, integrated panel shall

- be selected with approval of department)
- c. SCADA Server racks
 - d. DC Power supply rack with its energy meter and IO modules to monitor the status of Surge protection Device (SPD), MCBs, etc., of UPS & DC distribution rack.
 - e. UPS power distribution rack
 - f. Network Accessories rack
 - g. CCTV Rack with all necessary recording devices.
22. Powering scheme shall be submitted for approval.
23. System diagnostics shall be capable of identifying, locating and reporting the faults such as Processor fault, Communication fault, I/O module fault, Power supply fault, Over temperature monitoring, Permanently close/ open (stuck on or off) fault, Memory fault, Signal redundancy fault or any other additional diagnostic alarm if available as a standard shall also be provided by vendor.
24. If Field mounted IO Cabinets is planned, it shall be of IP 54 as a minimum protection or better.
25. All accuracies, channel density, resolution, response time will be decided during detailed engineering phase.
26. General PLC Features
- a. The hot stand by controller shall be supplied with the CPU, input/output module, memory, power supply, and all power & interface cables necessary to function as a complete and operable Programmable Automation/Logic Controller system.
 - b. Modules are defined herein as devices that can be removed individually from its position for replacement and are keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules.
 - c. The Programmable Automation/Logic Controller shall have downward compatibility, whereby all new module designs can be interchanged with

all similar modules, in an effort to reduce obsolescence.

- d. The Programmable Automation/Logic Controller shall have the ability to support TCP/IP data communication link like Ethernet/IP, PROFINET, Modbus TCP and other third-party networks.
- e. All system modules, including the Programmable Automation/Logic Controller, may be removed from the chassis or inserted into the chassis while power is being supplied to the chassis without faulting the controller or damaging the modules (removal and insertion under power (RIUP)).
- f. The Programmable Automation/Logic Controller shall include an integrated Real Time Clock (RTC). This clock value shall be in the form of a predefined tag and shall be accessible via logic or remotely.
- g. The Programmable Automation/Logic Controller shall have the capability of providing proportional, integral, and derivative (PID) control in real time, preferably with pre-emptive priority multitasking.
- h. The Programmable Automation/Logic Controller shall support Auto-Tuning functionality without additional software and it should be the in-built functionality
- i. Controller shall have the ability to monitor and override I/O.
- j. IO module shall have status lights for each input and output module.
- k. IO modules shall have suitable isolation between power and IO channels.
- l. The Programmable Automation/Logic Controller shall be configurable to accept only firmware updates from authorized users.
- m. The Programmable Automation/Logic Controller project files shall be configurable to allow modification only by authorized users.
- n. The Onboard Communication port in Programmable Automation/Logic Controllers should be used only for Programming not for HMI or I/O Communication. Dedicated communication card shall be provided for IO Communication & SCADA Server communication.
- o. The Programmable Automation/Logic Controller shall be capable of direct communication with standard commercial Ethernet products, without the

use of software or hardware gateways.

- p. Dedicated dual communication card in each PLC chassis for control network and other dual communication card for SCADA network.
- q. Supervisory Network: The open technologies of Ethernet and TCP/IP shall be utilized for communication between the control system server and the operator stations. The control system server and its associated operator stations must be capable of connecting to two fully independent Ethernets run in parallel. No repeater or bridge connection between the Ethernet is acceptable as a means of achieving this function. This Network shall be used for connection of Servers, Workstations and OWSs to the controllers.
- r. Control Network: The process control network/remote I/O network is used to connect the controller to field (Remote) I/O and shall be an open, flexible, high-performance network.
- s. Control Network Redundancy: To ensure maximum reliability, communications shall be redundant. The communications system shall be capable of sustaining loss of one media channel without loss of data or performance and Loss of communications shall not cause loss of control at the local subsystems. Also, loss of a local subsystem (either a single node or both of a redundant pair) shall not cause the loss of network communication.
- t. The Programmable Automation/Logic Controller system shall be true hot back up i.e., redundant with separate chassis, separate dual power supply, controller and communication modules
- u. The Programmable Automation/Logic Controller Enhanced Redundancy System shall provide higher system availability. This shall be realized by switching control to a secondary controller chassis if anything in the primary controller chassis fails. The Programmable Automation Controller Redundancy System should be able to operate without any local I/O, and having all I/O configured as remote I/O
- v. The Programmable Automation/Logic Controller Redundancy shall use fiber-optic media to connect the primary and the secondary control system

and shall have bump less transition between controllers.

- w. Runtime modification done in Main controller should automatically get updated in stand-by controller without any exporting and importing of logic, it should be a true Hot Back-up system.
- x. PLC shall be cyber security certified.
- y. The system shall be of modular construction and expandable in future by adding additional modules which shall be easily accessible for maintenance and repair.
- z. The PLC sizing shall meet the specified scan time taking into consideration all the I/Os specified in the requisition including installed spare IOs and IOs for future spare space. Other activities like diagnostics routines, output / dump of data to peripherals, development of sequence blocks or any other activity which consume processor time shall also be accounted while computing scan time.
- aa. Operation of the PLC shall be completely unaffected by a momentary power loss of the order of 20 milliseconds. This shall be demonstrated during Factory Acceptance Test.
- bb. Minimum 2 Nos. of perpetual license with full functionality for PLC shall be provided

1.3.3.3 SCADA Requirements

1. One set of hot standby SCADA server shall be provided for communicating with the above PLC for Data acquisition and interfacing with SCADA clients for control & monitoring.
2. All DCS/ PLC/PLC-IO's/SCADA/ iMCC shall be of same make. Architecture shall be submitted including all network elements during technical bid.
3. The proposed SCADA shall be common for all ICS & Electrical systems.
4. SCADA shall support Dual subnet features.
5. No bridging allowed in client stations.
6. No stacking / VLAN allowed in ethernet switches. Independent switches

shall be considered with necessary fiber & copper interfaces.

7. Server – Client shall support Dual subnet, i.e. Each server and client shall be configured with two IP address in different subnet.
8. Screen update times shall be one second or less.
9. The available security service should protect against unauthorized use but still allow authorized users to use the system efficiently and shall be an integral part of the system.
10. There will be a factory library for standard face plates and controller instructions that will be maintained and supported by the vendor.
11. Data servers shall be configurable to run on both a primary and a backup server. The system should automatically switch to a backup server if communication with the primary computer fails. Whenever primary restores, all data shall be backfilled from running server.
12. The servers should handle failure detection and failovers automatically for all components (OWSs) of the system.
13. The HMI shall support data servers as a means to communicate with any OPC server.
14. The HMI clients shall be able to view tag data from any HMI server or data server in the application as well as displays. The HMI shall support remote editing
15. The alarm system shall have the ability to monitor any analog or digital tag for alarms. The alarm system shall have the ability to define up to 4 different severity classes to visually distinguish alarms. In the alarm summary display, a user can acknowledge an alarm. The alarm will then appear as acknowledged to all OWSs in the application. Custom alarm summary objects shall be able to be embedded on any display
16. The system shall ensure Operator WorkStation security by authenticating users against a set of defined user accounts and access privileges.
17. All the communication between SCADA server to PLC and SCADA server to SCADA clients shall be provided with redundancy.

18. Unlimited SCADA tags shall be considered. Each SCADA server shall support minimum 10 HMI client simultaneously. Each SCADA sever shall have minimum of 3 Web client license.
19. Critical process parameters of shall be logged at minimum 500 ms interval (As per department requirements) and other parameters at 1 sec interval. Logging shall be configured in both Hot stand by SCADA Server also. All parameters including internal parameters, all alarms and events shall be logged in both servers.
20. Sub-system wise mimic screens to monitor the process status and real time operations and Sub-system wise I/O screens for loop checking, simulation and scaling shall be available. Solid worx/ Autocad 3D model of equipment's can be used to develop MIMIC. All components in the system shall be represented in MIMIC. 3D view of MIMIC is preferable.
21. Real time MMI-PLC-IO network configuration screens with critical diagnostic information and messages shall be available. Diagnostics screen for PLC hardware components, 3rd party devices, transmitters and control valves etc., with faceplates for each device.
22. Any other screens shall be provided as per the Department.
23. Development of SCADA Screens, as per ISA standards, are in the scope of vendor.
24. All internal switches shall be of DIN mounted L2 Managed Switch with ring features and shall use shielded Twisted pair of Cat6 /7 cable.
25. All necessary OS, Software & firmware updates shall be updated at free of cost up to end of warranty period.

1.3.3.4 Other Necessary Requirements

1. Supply and interfacing of auxiliary systems like Operator Consoles, Panels/Junction boxes, UPS Distribution Panels along with Surge protection Device (SPD), Cables etc. are also in the scope of the supplier.
2. All necessary licenses for third party devices to integrate with PLC is in the scope of the vendor.

3. Operator console surface shall be of acrylic surface on MDF wood. 3D drawing of consoles shall be submitted during detailed engineering for approval.
4. Power, Control and Communication cables shall be supplied, laid in trenches and cable trays as applicable.
5. 20% spare accessories like relays, switches, lamps, fuses, circuit breakers, isolators, terminals etc.
6. Medium voltage and control cable shall be separated from each other by adequate spacing or by running through trenches or cable trays.
7. Cable installation shall be provided minimum cable bending radii as recommended by manufacturer.
8. All cables shall be anti-rodent and fire-retardant type.
9. Cables shall be neatly arranged in the trenches/trays in such a manner that crisscrossing is avoided and trays shall be properly closed.
10. All cables shall be identified close to their termination point by cable tags
11. Parallel redundant UPS of suitable capacity with individual battery bank and individual stabilizer with capacity of adding additional 25% load in future, shall be considered for chain 1 & 2 as per specification in Electrical section. Suitable isolation transformer with distribution panel shall be supplied and erected. The battery and UPS shall be separated by placing it two different rooms. Suitable battery monitoring system shall be provided. All UPS & battery parameters shall be acquired by PLC and shall be logged in SCADA.
12. All UPS 230VAC power supply for PLC/IO Panel shall be powered with Type 1/2 Surge protection Device (SPD).
13. Automatic transfer switch shall be planned for single input equipment's.
14. The panel wiring shall be started only after getting approval from the department.
15. CCTV camera power distribution shall be planned in a separate panel with approval of department.

16. DIN mounted 24VDC Switch mode power supply (SMPS) of suitable rating shall be planned for Instrumentation & Control System with derating factor of 80%.
17. Separate instrumentation earth pit with less than 2 Ohms shall be established by the vendor. Extension of Instrumentation, power & Body earth with suitable cable/ copper Strip shall be terminated to respective earth pits. Instrumentation & Control System earth strip shall be of copper to respective panel locations.
18. All panels, equipment, JBs, etc shall be properly earthed.
19. Loop checking shall be carried out by Supplier including checking the interconnections, configuration and overall system functioning.
20. Status of all power supplies, MCBs, Power fed modules, Fibre converters, Ethernet switches shall be acquired by the PLC.
21. UPS output load current & voltage shall be monitored for both UPS-1 & 2 through Energy meters in each Instrumentation & Control System panels.
22. All the miscellaneous items like JB, cable glands, lugs, terminal blocks & internal wirings required for realizing are in the scope of Bidder.
23. Open terminals shall generally be avoided. Fused terminal may be used wherever necessary. All terminals shall be of mechanical screw clamp/screwless type with pressure plates. Self-insulating crimping wire lugs shall be used for all terminations on terminal blocks, whereas forked tongue type or lug with eyehole type shall be used for termination on screwed terminals such as on relays, push buttons, lamp etc. Terminal blocks shall be rated for 600 V.
24. Terminals shall be non-hygroscopic type made up of unbreakable, fire-retardant, safe extinguishable, halogen free polyamide compound. Terminals shall be suitable for wires up to 2.5 sq. mm base solid or stranded conductor in general. For power cables, higher size terminals shall be used. The metal parts of terminals shall be of high quality (pure electrolytic) copper and shall be tin or nickel plated (of thickness up to 15 micron). Terminal strips shall be arranged group-wise for incoming and outgoing

cables separately. Terminal blocks for intrinsically safe wiring shall be separate. 20% spare terminals shall be provided, as a minimum, preferably in each terminal strip.

25. Suitable AC environment shall be maintained for PLC/IO Panels.
26. **CCTV Systems:** Necessary IP based weather proof fixed or PTZ cameras of 5MP shall be provided in and around the plant for monitoring with network video recorder, Wall displays for SCADA & CCTV monitoring associated network elements. As SDSC-SHAR is highly secured area, all the rooms and process areas shall be covered by CCTV camera. The feeds will be extended to SDSC-SHAR Surveillance system. CCTV Network and SCADA network shall not use same switch. Dedicated ethernet switch shall be planned for CCTV with required number of ethernet ports.
27. **Fire detection and Alarm (FDA) System:** The FDA system shall be interfaced with SCADA system. FDA shall have suitable communication card in such a way that, it shall be interfaced to other SCADA systems also.
28. All critical instrumentation and controls systems shall be conformal coated.
29. Party shall submit HAZOP recommendations.
30. **GPS unit** (1 Nos.) for SCADA server time synchronization shall be provided and with Master clock generator with dual feed antenna, NTP Output, IRIG-B (FO) Output & RS485 Output. Network Slave clocks with date and time shall be supplied to place inside control room.
31. **Operator Console:** Based on control room dimension, consoles shall be planned along with revolving chair. Console shall hold 4 Nos. of displays for SCADA, one display for CCTV and two numbers of chairs per console.
32. All Servers, workstations, PCs, Operating systems, other software's, etc. registration/ activation shall be on credential details provided by department & it will be provided at the time of activation.

1.3.4 DATA ACQUISITION & CONTROL SYSTEM PROGRAMMING

Data Acquisition and Control (PLC & SCADA) programming shall be developed as per IEEE 12207 standards.

1.3.4.1 Environment software

1. Environment software comprising of PLC hardware configuration, I/O acquisition, simulation tags for all I/Os, main or redundant signal override function, scaling function etc., shall be developed.
2. The acquired I/Os of main and redundant are to be validated by taking into account of concerned channel diagnostics data, channel discrepancy and simulated value etc.,
3. Design of environment software shall be submitted for approval. After development, the same will be thoroughly reviewed & tested during pre-delivery inspection (Factory Acceptance Test-FAT) by department.

1.3.4.2 The Application software

1. The application software design shall be carried out based on User Requirement Document and submit for review & approval by department.
2. The application software shall be developed covering the following general requirements,
 - a. Automatic sequence of operation
 - b. Initial conditions, running interlocks, surveillance checks etc,
 - c. Failure cases, contingency conditions etc.,
 - d. Discrete mode of operation (Individual components/ overall all sub-system)
 - e. User friendly messages and pop-up windows for guiding the operator on steps of operation, warning, alarm & trip conditions etc.,
3. The PLC/PAC & SCADA software development shall be carried at Party's Site for Functional Checks only and remaining development shall be carried at our site (SHAR). Bidder shall deploy minimum 2 experienced persons at site to carry out above software development works immediately after system configuration is approved by department. Both should have thorough knowledge on PLC/PAC & SCADA systems with minimum 5-year experience in PLC/PAC & SCADA programming of PLC Brand offered for the system.
4. After successful testing & commissioning, the source code of PLC, SCADA, IMCC, etc. should be handed over to department.

5. Party shall not transfer any of the Instrumentation & Control System data outside SDSC-SHAR.
6. As SDSC-SHAR is secured zone, all external access to SDSC-SHAR IT systems is restricted. Usage of external disks, storage devices, etc. are prohibited. SDSC-SHAR will provide antivirus for the all the process and general-purpose system.

1.3.4.3 Steps in Data Acquisition and Control software development, review & testing

1. Submission of environment software design document for approval from department.
2. Development of environment software by Party at site.
3. Review & testing of environment software by Party & department.
4. Based on review, modify/update environment software, documents and submit for approval.
5. User Requirement Document document for application software design will be given by department, if any modifications are required, same shall be carried out by Party.
6. Submission of application software design documents, as listed in previous chapter, shall be submitted for approval.
7. Application software development & testing by Party.
8. Submission of test case (black & white box with nominal & off-nominal test cases) documents for department review & approval.
9. Review & testing of application software by Party & department.
10. Modify/update application software, documents (including User Requirement Document) and submit for approval.
11. Carry out trial runs of individual sub-systems, simulation and dry runs of integrated system for casting process, dummy casting process trials and live casting process by Party and department.
12. Modify/update environment and application software for fine tuning and update documents, and then submit for approval.

1.3.5 TECHNICAL SPECIFICATION FOR ICS ELEMENTS

1.3.5.1 Programmable Logic Controller

Description	Essential Specification
Type	Hot standby fault tolerant CPU
Mounting	Main and Redundant CPU racks shall have independent chassis and shall be placed in a single Panel.
CPU features & redundancy	1. CPU for high-availability processes, with two HSBY CPUs of the same type. 2. Bump less changeover to the redundant CPU feature shall be available in the event of a fault, without any loss of information and control. 3. Minimum work memory for CPU shall be greater than or equal to 16 MB. 4. Memory card in PLC shall be considered in such a way that, program shall not erase in case of system shutdown or power failure. During bootup, automatically program shall be transferred to PLC. 5. Scan time of PLC/DCS shall be maintained less than or equal to 100 msec or shall be configured based on the process requirement during detail engineering. 6. Number of ports in PLC: Ethernet ports-2 Nos or more
CPU rack power supply	Each PLC chassis shall have 2 Nos. of 230VAC/ 24VDC power supply modules in redundant configuration (In case of 24VDC PS module, Dual SMPS shall be used for each PLC Power supply module).
Interface for communication between PLC to I/O modules & 3 rd party devices.	1. Communication technologies like; Profibus/ Profinet/ Modbus RTU/ Modbus (TCP/IP)/ Ethernet shall be used as per OEM standard for interfacing 3rd party devices to PLC. 2. Bus/Ring topology with redundancy. 3. Two communication cards in each PLC chassis shall be considered in each chassis for Field network communication.

Description	Essential Specification
	4. Two communication cards in each PLC chassis shall be considered in each chassis for SCADA network communication. 5. Additional communication cards shall be considered as per system configuration.
Synchronization between CPUs	FO communication between CPUs shall be provided. – 1 Gbps
Self-diagnostics features	Required for each and every module available in the PLC (i.e., CPU, PS, I/O modules, other communication interface modules etc).
Programming languages	All IEC61131 languages shall be supported.
User programme password protection	Password protection and block encryption and shall be cyber security certified.
Programming and downloading to PLC	- Licensed professional version of PLC programming tool shall be provided. - Any other necessary license required to configure PLC-to-peripherals communication shall also be provided.
3 rd party interface in IO chassis	Suitable interfaces shall be provided to link 3 rd Party devices to PLC/ SCADA
Interface Modules in each IO chassis	Each IO chassis shall have Dual interface module and shall communicate to PLC through Ethernet only in ring communication/ criss cross communication.
Environmental Specifications	Operating temperature: Ambient to 50°C or better Humidity: 75% or better Degree of protection: IP 20 or better
Quantity	1. 2 Nos. of PLC in Hot standby Mode along with all necessary accessories 2. 2 Nos. of latest and licensed professional version of PLC programming tool shall be provided.

1.3.5.2 Analog Input Module

Description	Essential Specification
Make	Same as Processor make offered
Type	8 Channel Analog Input Module, Differential
Input type	0/4 - 20 mA (Configurable) & 1-5 V
ADC	16 bits or better including sign bit
CMRR	≥ 60 dB or better
Input Impedance	≥ 10 Mega ohms or better, 250 Ohms max
Internal conversion resistor	250 Ohms
Accuracy	0.2% for full scale or better
Isolation	Three-way isolation: Galvanic/ Optical between channel to channel, Channel to Power supply and channel to ground
Operating Temperature	Ambient to 50°C
LED	LED indications shall be available
Diagnostics	Individual channel diagnostics feature shall be available
Quantity	- As per the requirement and 20% spare channels in each IO module which shall be terminated. - Individual Channel diagnostics shall be provided.

1.3.5.3 Analog Output Module

Description	Essential Specification
Make	Same as Processor make offered
Number of Channels	4 channel or better
Measurement error	0.25 % of full scale or better
Common mode between channels	≥ 60 dB or better
Analogue output type	Current: 4...20 mA and 0...20 mA Output Load Driving Capability to be specified
Load impedance ohmic	≤ 500 Ohm
AO	As per requirement
Analogue output resolution	14 bit or better
Isolation	Three-way isolation shall be available. (Galvanic/ optical)
Diagnostics	Individual channel diagnostics feature shall be available
Status LED	Required for each channel
Operating Temperature	Ambient to 50 DegC
Quantity	As per the requirement and 20% spare channels in each IO module which shall be terminated.

1.3.5.4 Digital Input Module

Description	Essential Specification
Make	Same as Processor make offered
Type	16 or 32 Channel Digital Input Module (32 channel is preferable)
Input type	Current sink (logic positive)
Discrete input voltage	24 V DC positive
Input compatibility	Potential free Contacts
Sensor power supply	24 VDC
Insulation resistance	> 10 MOhm at 500 V DC or better
Protection type	Reverse polarity protection
Status LED	Required for all channels
Isolation	Three-way isolation shall be available. (Galvanic/ optical)
Diagnostics	Channel/ group diagnostics feature shall be available
Operating Temperature	Ambient to 50°C
Quantity	As per the requirement and 20% spare channels in each IO module which shall be terminated.

1.3.5.5 Digital Output Module

Description	Essential Specification
Make	Same as Processor make offered
Type	16 or 32 Channel Digital Output Module (32 channel is preferable)
Input type	Current sink (logic positive)
Discrete output type	Solid state
Discrete output logic	Positive

Discrete output voltage	24VDC
Discrete output current	0.1 A or better per channel when all channels are Operated.
Isolation	Three-way isolation: Galvanic/ Optical
Diagnostics	Channel/ group diagnostics feature shall be available
Status LED	Required for all channels
Isolation	Galvanic/ Optical
Operating Temperature	Ambient to 50°C
Quantity	1. As per the requirement and 20% spare channels in each IO module which shall be terminated. 2. Individual Channel diagnostics shall be provided
Note: IO Chassis shall have dual 230VAC/24VDC chassis power supply and dual communication module to communicate with PLC in ring/ Criss-Cross communication. Redundancy of IO shall be selected based on process critical parameters.	

1.3.5.6 Supervisory Control and Data Acquisition system (SCADA)

Description	Essential Specification
Make	Same from PLC manufacturer or PLC-OEM recommended SCADA
SCADA package	Server-Client
Type	Data acquisition, Control & Process monitoring.
Operating system	Windows server latest edition
Graphical user interface	Man, Machine Interface (MMI)/ Human Machine Interface (HMI)
General Features	1. No bridging in clients, No stacking of switches, No VLAN in single ethernet switch for multiple device access and SCADA shall support dual sub net in networking of SCADA Server-Client.

Description	Essential Specification
	- SCADA shall support redundant Ethernet communication to hot standby PLC configuration system. - Dual Subnet SCADA communication feature shall be available between Server-client network. - Hot standby SCADA server-client configuration. - Mimic refresh rate shall be less than 1 second for a density of 100 tags. - Shall support minimum 15 Nos. of simultaneous client access. - OPC Support license to be available in one of the ASU SCADA clients to access the ASU plant data from Schneider & Siemens SCADA server for monitoring the activity. - Dynamically configurable Mimics, - Real time & Historical data trends display, - Data logging & Report generation in user prescribed format (excel, pdf). - Customized reporting feature shall be developed as per department requirement. - Alarms & Events Logging. - Access security management
Mimics	- Sub-system wise screens to monitor the process status (As per dept requirement). - Sub-system I/O screens for loop checking, simulation and scaling (As per dept requirement).

Description	Essential Specification
	- MMI-PLC-IO network configuration screens with critical diagnostic information and messages. - Diagnostics screen for PLC hardware components, 3rd party devices, transmitters and control valves etc., with faceplates for each device. - Alarms screen (Sub-system wise filtering to be provided). - Trends screen (Sub-system wise trends to be provided). - Any other screen as per the user requirement. - Standard symbol support, genie (tag group editor), 3D animation features, mathematical functions, scripts support etc - A Overall plant MIMIC in 3D shall be provided in SCADA
Trends	- Real time & historical trends. - X- axis & Y- axis ranges shall be user selectable. - Trend configuration shall be user-friendly & shall be available during Run-time. - Trends data export to MS Excel (.xls) and pdf format. - Print option for trend chart. - Trend analysis tool shall be provided as per the user requirement.
Data logging	- Min. 1 s data logging interval for critical parameters (100 tags.). - All logging shall be with SQL

Description	Essential Specification
Alarms & Events Logging	1. Alarms & Events shall be logged separately. 2. Sub-system wise filtration option shall be provided. 3. Logging shall be as per user defined format. 4. Sub system wise Grouping of alarm & event features shall be developed.
Report Generation	1. Reports shall be generated for logged data, alarms & events as per the user defined formats. 2. From- & To- date and time shall be user selectable. 3. Time interval shall be user selectable. 4. Options to export data in MS Excel, MS Access, SQL formats. 5. Print report option shall be provided.
License	1. Supply of full development: 1 set for HSBY server. (It includes both development license as well as run time license) – Unlimited Tags license. 2. Supply of full development: 1 Nos. Standalone Engineering stations. (It includes both development license as well as run time license) – Unlimited Tags license. 3. Supply of Run-time license suitable for Clients: Minimum 5 Nos. 4. Web clients for SCADA Server: 6 Nos. (3 Nos in each SCADA server shall be deployed as view only web client)

1.3.5.7 Hot stand by SCADA Server

Description	Essential Specification
Processor	Intel 2 x twelve core Xeon processor or better.
Memory	256 GB ECC (Error correcting Code) DDR4 memory/ latest Memory mirroring feature should be available in BIOS.
System Fans	Hot pluggable fans and redundant fans should be there.
Drive Bays	12 or more SATA / SAS hot pluggable drive bays.
Drive controller	Integrated SAS / SATA controller
Hard drives	1. 2 X 2 TB SATA / SAS HDD with RAID1 for OS 2. 2 X 10 TB (or more) SATA / SAS HDD with RAID5 for data having support for one global hot spare for both OS and Data.
RAID Controller	Onboard or add -on controller to configure the above RAID.
Optical Drive	Internal DVD-RW
Expansion slots	2 slots or more after configuring the requirements.
Graphics	Integrated graphics controller.
Network	➤ 4 X 100/1000 onboard Ethernet (not considering management Ethernet port). ➤ 2 Nos. of Add On 4 X 100/1000 Gbps card shall also be available
I/O ports & Connectors	4 USB on-board
Input device	USB keyboard and mouse

Description	Essential Specification
Monitor	23.8" - 24" LED Full HD monitor with ultra-thin bezel. Stand shall have provision to adjust height, swivel and rotate the picture as per requirement. Monitor shall have dual DP/ HDMI port and USB ports.
Operating system	Windows Server 2025 or latest which can be downgraded as per requirement for SCADA.
Power supply	2 x hot plug power supply (230V AC @50 Hz) unit. Indian power cords to be supplied.
Form factor	Rack mountable.
Management/ software	1. Remote management should have its own processor, memory and Ethernet interface. 2. Web interface for remote system management. 3. Provision to monitor the health of server, power, fan, thermal and raising alert. 4. System management software to monitor the system health at local console & over network. 5. Redundant connection (red connect) management license for CPU to SCADA servers with associated interface card. 6. Any other relevant software as required for SCADA 7. MS Office 2024 perpetual license or Latest for each server. 8. All licenses shall be perpetual
Warranty	3-3-3 years
Quantity	2 Nos.

1.3.5.8 Engineering Workstation

Description	Essential Specification
Processor	Intel Xeon processor with eight cores or more
Chipset	Intel chipset or latest
Hard disk capacity	2 x 2 TB SSD or more
Memory	32 GB DDR4 ECC (Error correcting Code) RAM
Graphics	4GB Graphics or more
Network Interface	Onboard – 1 NOs of 1Gpbs port Add on – 2 Nos. of 4 x 100/1000 Ethernet
Ports & Connectors	4 numbers of USB ,2 numbers of DP/mini-DP ports 1 audio line in; 1 audio line out
Optical Drive	Slim SATA Super Multi DVD writer
Power supply	Suitable 230V AC (India)
Monitor Screen	23.8" - 24" LED Full HD monitor with ultra-thin bezel. Stand shall have provision to adjust height, swivel and rotate the picture as per requirement. Monitor shall have dual DP/ HDMI port and USB ports.
Graphics	8 GB graphics card with quad HDMI.
Operating system	Licensed version of Windows 11 (64 bit) pro/ ultimate or latest.
Accessories	Mini DP to DP Converter – 1 Nos for each work station Mini DP to HDMI Converter - 1 Nos for each work station HDMI Cable of length 5 Meters – 1 Nos for each work station

Description	Essential Specification
Software to be supplied and loaded on system.	- MS Office 2024 Professional perpetual license or latest. - MS Visio Professional 2024 or latest perpetual license
Optical Mouse & Keyboard	➤ Standard USB Optical Mouse with scroll. ➤ Standard USB keyboard
CDs for all software & drivers	Required (Including OS Recovery USB)
Warranty	3-3-3 years
Quantity	1 Nos.

1.3.5.9 Client PCs

Description	Essential Specification
Processor	INTEL i7 latest Processor
Hard Drives	2 TB SATA HDD or better
DDR RAM	32 GB DDR4 or Better
Network Interface (Ethernet) Card	Onboard: 1 Gbps port -1 Nos Add On card: 4 port x 1 Gbps card – 2 Nos
Graphics	2 GB Graphics Card
Optical Drive	DVD-RW
Power Supply	230V AC, 50Hz Indian Power Cords to be Supplied.
Operating System	Licensed Version of Windows 11 (64 Bit) Ultimate/ Pro or Latest with all latest updates – Perpetual
Software to Be Supplied	The following software shall be supplied for each PC. DVD-RW Associated RW Software.

	2. MS Office 2024 licensed Professional or Latest perpetual license. 3. System Management Software, Drivers and Utilities Software to Be Supplied - -If any.
Monitor	23.8" - 24" LED Full HD monitor with ultra-thin bezel. Stand shall have provision to adjust height, swivel and rotate the picture as per requirement. Monitor shall have dual DP/ HDMI port and USB ports.
Keyboard	Standard Qwerty Full Stroke Type
Optical Mouse	Standard USB Mouse.
CD's For All Software & Drivers	Required.
Quantity	4 Nos. (2 Nos for SCADA & 1 Nos for CCTV, 1 Nos. of Asset management system)
Furniture	Computer table: The table shall be elegant and have CPU shelf to house total workstation with lock, slide out keyboard tray and two lockable drawers and a full back revolving chair. It shall be supplied for each PC, after getting approval from department.

1.3.5.10 Thin Client Unit

Description	Essential Specification
Operating system	Windows Win 10 IoT/ Embedded Win 7/8
CPU	Intel or AMD Series
Flash/ SSD	16 GB Flash or better
RAM	4 GB RAM DDR3 or latest
I/O peripheral support	1. 1 x Display Port

Description	Essential Specification
	2. 1 x One DVI-I port with DVI-I to VGA Adaptor 3. Min 2 x USB 2.0 ports (one front, one rear)
Networking	10/100/1000 Gigabit Ethernet – 2 Nos
Monitor	23" or equivalent size LED HD Resolution Monitor with VGA & DVI Ports of OEM make
Audio	1/8-inch mini jack
Mountings	Vertical feet standard VESA mounting bracket for mounting to flat surfaces, such as walls shall be supplied
Accessories	USB Keyboard and Optical Mouse
Software	MS Office Viewer Device Manager Software & other related software
Others	Support to install IPSAN driver to access mass storage.
Power	240 VAC, 50 Hz. With Energy Star certification
Quantity	1 Nos (For remote web viewing)

1.3.5.11 Layer-2 Managed Switch

Description	Essential Specification
Ethernet Port	All UTP ports shall support 1000 TX and minimum 2 SFP ports shall be available. No. of ports shall be selected as per requirement. Minimum 4 spare UTP ports shall be available.
Fibre Port	Min 2 x FX (FX/ SFP) or more
Fiber Type	Single Mode
Fiber Distance	2 Nos of 10 Km SFP or better- Single mode LC SFP module shall be provided with each switch
Wavelength	1310 nm

Description	Essential Specification
IEEE	It shall comply IEEE standard
MAC Address Table	2K or better
Buffer Size	1 Mb or better
VLAN	Available
Quality of service	IPV4
Management	Web Interface and SNMP
Ring redundancy features	Shall be Available
Spanning Tree	STP, RSTP or better
Power input	Power input – Dual Power 230 VAC/ 24 VDC with configurable fault relay contact
Protection	Necessary power supply protection feature shall be available
Mounting	DIN Rail
Operating Temperature	Ambient to 50 Deg C or better
Patch Cord	2 mtr Armoured duplex Patch cord with LC-LC connector shall be supplied with each switch
Quantity	➤ 2 Nos – PLC to IO Network @ control room ➤ 2 Nos – PLC to SCADA server Network @ control room ➤ 2 Nos – SCADA Server- Client Network @ control room ➤ 1 Nos for CCTV Cameras ➤ 1 Nos of FDA/ GPS ➤ Additional network switches for each IO rack as required.

1.3.5.12 Control Console

Description	Essential Specification
Manufacturer	Preferred Make: Pyrotech / Evans/ Winstead/ cosmos
Service	Housing MMIs, CCTV items, Telephones & wireless sets etc.,
General	1. The consoles shall be fully modular in design and construction. 2. Consoles shall be ergonomically designed for operator comforts and suitable for housing MMIs, CCTV, Telephones & wireless sets etc., 3. Console system shall have option of being one or two tiers high.
Construction features	1. Each Cabinet shall be made of high-quality wood ASS with very good finish. The top layer of the surface shall be capable of withstanding day to day usage of the work surface (Free usage) without losing the high-quality finish. The surface should be made of tough material that withstands mild abrasions without losing finish. 2. Work surface: Made up of 12mm Acrylic solid surface (ASS) and 25mm of MDF wood. Desired colour shade matching with control room interiors will be decided by user 3. Shall have Ball bearing pull out CPU trays, height adjustable & pull-out key board trays, mouse wire holes, Solid floor panels with cable entries, movable equipment shelves, rails for DIN mounting equipment's. 4. Structure: Powder Coated Aluminium Sturdy Structure and extreme side Aesthetic Legs.
Door	Front & rear hinged ASS wood doors with magnetic lock & light interlock switch.

Monitor tiers	1. Heavy duty pipes have swivel head. The monitor angle can be adjusted up/down/left/right and also vertical height can be adjusted as desired. 2. Flexible telephone tray. 3. Extreme ends with aesthetic elements.
Electrical	1. The Console System should provide a concealed cable routing system. 2. The separation necessary between network and power cabling shall be taken care off. All trays should be easily accessible during installation and maintenance. The horizontal cable tray should have arrangement to accommodate plug connectors and sockets of varying sizes. 3. Power distribution for console equipment's with 5/15 amp surge protector, 3 pin sockets, MCBs & TBs. 4. RJ-11 (4 Nos.), RJ-45 (10 Nos). Earthing kit.
Light	Required. LED lamp
Quantity	1. Engineering console- 1 Nos. (4 Bay console – 3 for SCADA & 1 for CCTV) 2. Ergonomically designed, Executive type, revolving chair with wheels - 4 Nos. 3. One side of wall in control room shall be executed with Wall panelling for placing 4 Nos. of 65-inch monitors with rear access, in control room. Wall panelling dimensions and position of the panel will be decided during execution. 

1.3.5.13 IO Panel

Description	Essential Specification
Service	Housing I/O modules, DCPS, Isolators, IS Relays, FOC, Video to Fibre Converters, etc
Type	Free standing
Cable entry	Bottom entry. ➤ Base Mounting Height shall be raised as per site requirements for free entry of cables with opening in all four sides
Door	Required (Front & Rear access shall be considered as per site requirement). Only front access is preferred.
	Front door: Double/ triple leaf lockable with transparent glass in Doors (Acrylic sheet shall not be considered)
	Concealed type hinges & a 180° swing.
Temperature	Ambient to 50° C
Painting	Inner: Glossy white color Outer: Siemens grey color (RAL7032)
Shield bus	Through screw connection
Mounting and wiring	• Double compression SS glands • Separate Fuse TBs/ TB for analog, digital and different voltage level signals of Screw/gage terminal type
Dimensions	Height of Max. 2100mm shall be considered or width and depth shall be considered as per requirement.
Material	1) Sheet material thickness: CRCA-COLD rolled 2mm
	2) Gland plates thickness: 3mm
	3) Gasket for door & cover: neoprene
	4) Plugs for spare cable entries: required

Description	Essential Specification
Channels	Shall provide with bolt & nut
Anti-vibration pads	15 mm thickness
Light	Fluorescent lamp
Lifting	Eye-bolts
Plugs	For incoming & outgoing
Metal tag name plate	Required
Clamps	Required
Fixtures	Required
Bolts, nuts & gaskets	Required
Earthing	- Power Earth & Instrumentation Earth shall be separated with isolated bush. - Insulated Copper earth strip for Instrumentation shield earth. - Copper earth strip for body/power earth
Pocket	Plastic pocket shall be provided to keep manuals/ wiring diagrams
Latching	Each door shall have internal latching.
Temperature monitoring	Panel Temperature monitoring sensor shall be available and shall be interfaced to respective IO modules.
Fan failure detection	Fan failure detection relay shall be interfaced with PLC IO for remote monitoring.
Lock & key	Required & spare lock & key set shall be available for each rack
Spares	20 % spare entries to be provided for incoming & outgoing cables. 20 % spare for terminal blocks.

Description	Essential Specification
	20 % spare space for future requirement.

1.3.5.14 24 VDC Power Supply

Description	Essential Specification
Input voltage	230 V AC $\pm$ 10%, 50 Hz
Output voltage	24 V DC $\pm$ 1% with adjustable range from 22V to 28V or better
Output current	It shall be selected as per requirement
Overload & short circuit protection type	Required
Over voltage protection	Required
Ripple	50 mV peak – peak or better
Mounting	DIN rail mounted
Coating	Protective Coating Shall be available
Communication Interface	Ethernet (Preferred) - Option
Operating temperature	Ambient to 50 Deg C
Fault	Fault contact relay shall be available in power supply
Oring	DIN Mounted Diode Oring Module shall be provided. ORING Module shall indication of availability of each power supply connected to it. It shall have protective coating.
Oring Output Measurement	Each Oring Module output voltage & current shall be monitored using transducers with communication output. It shall be interfaced with stand-alone IO chains of MCB status monitoring.

Quantity	As per requirement. Stand-alone power supplies shall not be used.
Distribution	1. Power supply Set-1: Measurement elements, Isolators, Fiber optic switches (RIO Rack) 2. Power supply Set-2: Command System (Solenoid valves, actuators, etc. – RIO Rack) 3. Power supply Set-3: For all elements in PLC rack 4. Power supply Set-4: CCTV, FDA & other sub systems 5. Based on process requirement additional sets shall be deployed which will be finalised at the time of detailed engineering.

1.3.5.15 RTD Sensor

Description	Essential Specification
Type of sensor	Pt100, 4 – wire, Duplex Type
Accuracy	Class-A
Termination Head Type	Weather proof or Ex. Proof Head IIA/ IIB/ IIC- as per site requirement
No of Conduit Entry / Entries	Single Entry
Cable Gland	1/2" NPT/ As per process requirement
Head Extension Type	Adjustable connection with water sealing
Process Connection	Based on site requirements in a flange thermowell
Glands	Double compression cable gland in Nickel plated Brass - FLP
Tip Length	As per design requirements

Tip Diameter	
Sheath Diameter	
Sheath Material	SS316
Termination Style	Nut with Knurling's (Preferred)
Temperature Coefficient:	0.00385 Ohms/ °C
Temperature Range:	As per requirement
Sensor wire	PTFE insulated; Nickel coated copper stranded wire.
Tag Plate	Shall be provided with sensor details
Sensor Immersion Length	As per site requirement
Mounting location, Range & Quantity.	As per site requirement with redundancy

1.3.5.16 Oxygen Monitor

Description	Essential Specification
Sensor type	Electrochemical, SMART version
Measuring Gas	Oxygen
Measuring Range	25%Volume
Accuracy	+/- 1%of measure value
Response Time	30 Seconds Maximum
Expected Sensor Life	36 Months (Minimum)
Transmitter type	Intrinsically safe, 4-20mA with HART compatible 2 wire transmitter for electrochemical sensors.
LCD Display	64 x128 pixels, 3 buttons controls

Environment Protection	IP 67 or, suitable to use in Zone-1, Gas group IIA, IIB, T4./ Based on area of installation to be selected.
Sensor diagnostics dongle	Required.
Mounting location, Range & Quantity.	As per site requirement with redundancy

1.3.5.16 Proximity Sensors

Description	Essential Specification
Type	Inductive
Switching element function	NAMUR NC
Operating distance & Diameter	It shall be selected as per site requirements
Nominal voltage	8 V DC
Switching frequency	0 to 400 Hz
Reverse polarity & short circuit protection	Required.
Indication of switching state	Required (LED).
Mounting type	Cylindrical, threaded type with check nuts.
Protection	IP 65 or better. Intrinsically safe to Zone 1, Gas group IIA, IIB & T4.

Connection type	Multi pin circular connector and suitable cable with min. 15 meter length shall be supplied with each proximity sensors.
Sensing face	PBT
Housing material	SS
Standards	IEC/EN 60947, DIN EN 60947 (NAMUR)
Certificate	Test certificates are required.
Mounting location, Range & Quantity.	As per site requirement with redundancy

1.3.5.17 Temperature Transmitter

Description	Essential Specification
Input	4 wire RTD/ Thermocouple
Output	Profibus-PA/ Ethernet APL If bus based not available, party can offer HART based 4-20 mA transmitter with approval of department.
Mounting	To Clip onto top-hat DIN rail/ Head mount (DIN mount is preferred)
Alarm	High Alarm configuration feature shall be available
Power Supply	Bus powered
Failure Mode	User selectable Up or Down scale Indication
Accuracy	+/- 0.1 % of span
Line voltage filter	50 Hz
Update time	<= 0.5 sec or better
Terminals	Screw terminals
Display	Dual-line LC display with additional display elements (option for DIN mount) & Head mount with display shall be provided.
Mounting location, Range & Quantity.	As per site requirement with redundancy

1.3.5.18 Pressure Transmitter

Description	Essential Specification
Operating Principle	Capacitance
Type	Absolute (Pressure & Vacuum measurement)

Range	As per process requirement (Uniformity of ranges shall be maintained- It will be approved by department)
Integral display	LCD display
Output	Linearized
Accuracy	0.1% of span
Long term stability	0.2% full scale over a period of 5 years.
Electro Magnetic Compatibility (EMC)	As per EN 61326 or equivalent.
Calibration certificate	Required and traceable to National Institute of Standards and technology (NIST) / National Accreditation Board for Testing and Calibration Laboratories (NABL).
Power supply	Bus powered
Output signal	Profibus PA/ Ethernet APL. If bus based not available, party can offer HART based 4-20 mA transmitter with approval of department.
Span / Zero adjustment	Required.
Transmitter diagnostics	Standard & all advanced diagnostics are required.
Protection	IP 65 or better
Over range protection	Required. 150 % of maximum pressure.
Process connection	½" NPT (F)
Cable Entry	½" NPT Female with double compression cable gland.
2-valve manifold	SS316 and shall be suitable to pressure ratings.

Mounting	In Line or flange mount. If flange mount, PTs shall be grouped system wise in a SS enclosure and pressure shall be extended through a QC-DC coupling.
Mounting location, Range & Quantity.	As per site requirement with redundancy

1.3.5.19 Level Transmitter (DPT)

Description	Essential Specification
Type	Differential pressure type
Operating Principle	Capacitance
Integral display	LCD display
Output	Linearized
Accuracy	0.1% of span
Long term stability	0.2% full scale over a period of 5 years.
Electro Magnetic Compatibility (EMC)	As per EN 61326 or equivalent.
Calibration certificate	Required and traceable to National Institute of Standards and technology (NIST) / National Accreditation Board for Testing and Calibration Laboratories (NABL).
Power supply	Bus powered
Output signal	Profibus PA/ Ethernet APL If bus based not available, party can offer HART based 4-20 mA transmitter with approval of department.
Transmitter diagnostics	Standard & all advanced diagnostics are required.
Span / Zero adjustment	Required
Protection	IP 65.

Pressure Range:	Based on Tank dimensions
Process connection	½" NPT (F)
Cable Entry	½" NPT Female with double compression cable gland.
5-valve manifold	Required SS316
Mounting location, Range & Quantity.	As per site requirement with redundancy

1.3.5.20 AFD/CFU/APL-Switch

Description	Essential Specification
Application	To power bus-based transmitters (Active Field device/ Compact field unit/ APL Switch)
No. of channels	4 or 8
Communication	Ethernet
Loading	Minimum 1 channel for 4 channel AFD/ 2 channel for 8 channel AFD shall be left free for future connection
Redundancy	Ring / STAR connection (Dual connectivity shall be available) Preferred: RING with Ethernet connectivity
Certificate	Minimum Zone-2 certified.
Mounting location, Range & Quantity.	As per site requirement with redundancy

1.3.5.20 Pressure Switch

Description	Essential Specification
Medium	As per process requirement
No of contacts	2 NO + 2 NC 5 A rated at 250 V A.C
Protection	IP 65 or better
Range:	As per process requirement
Cable Entry	½ " NPT 2 nos.,
Mounting location, Range & Quantity.	As per site requirement with redundancy

1.3.5.21 Flow switch

Description	Essential Specification
Type	Non-contact
Sensing element	Ultra sonic or as per standard
Mounting location	As per pipeline dimensions
Switch type	Micro switch
Flow range (LPM) & line pressure	As per design
Over range protection	1.5 times of Max. flow
Accuracy	± 2% of span
Switch contacts	DPDT, Potential free
Contact rating	5A resistive load at 24 V DC
Switch setting	Tamper proof and external adjustment
Protection	IP 65.
Cable Entry	½" NPT Female with double compression cable gland.

Body material	SS or as per Standard
Temperature	As per process requirement
Certificate	Calibration test certificates are required.
Mounting location, Range & Quantity.	As per site requirement with redundancy

1.3.5.22 Level Switch

Description	Essential Specification
Aux. Supply	24VDC
Output contact	3 or 5 CO as per tank size
Input sensors	3 or 5 sensors as per tank size
Sensitivity	1 k ohm to 200 k ohm adjustable
Trip time delay	Less than 1 sec
Protection	IP 65 , Intrinsically safe certified or better
Range:	As per process requirement
Fittings	Required
Cable Entry	½" NPT Female with double compression cable gland
Body material, sensing element, fittings	Suitable for corrosive environment
Mounting location, Range & Quantity.	As per site requirement with redundancy

1.3.5.23 Mass Flow Meter

Description	Essential Specification
Sensor working principle	Coriolis force

Size of the sensor	As per process requirement
Sensor material of construction	316L Stainless Steel
Nominal flow range	As per process requirement
Liquid Mass flow meter accuracy	0.10% of RDG on mass flow rate for up to 20:1 turn down ratio or better
Liquid Mass flow meter repeatability	±0.05% of rate or better
Density Accuracy	±0.5Kg/m ³ or better
Density Repeatability	±0.2Kg/m ³ or better
Density Range	As per process requirement
Temperature accuracy	±1°C or better
Temperature Repeatability	±0.2°C or better
Temperature Range	As per process requirement
Flow tube pressure rating (SS sensors)	As per process requirement
Materials of construction - Wetted parts	316L
Housing	304LSS
Junction	Epoxy polyester painted Aluminium
Core protection	CF-3m SS
Power supply	Bus powered or 18 – 36VDC (Nominal 24VDC)
Mounting	Remote mount configuration
Input signal	One 4 wire sensor input connection with ground

Output signal	a. Profibus -PA/ FF/ Ethernet. If above communication option not available, One active 4 – 20mA HART output reporting mass/volume flow b. One active frequency/pulse output to report mass/volume flow, which can be used to indicate flow rate or total (Preferrable)
Interface / Display	LCD display. Display should be provided for process variables and Engineering unit.
Communication	Profibus -PA/ FF/ Ethernet
Process interface	As per process requirement

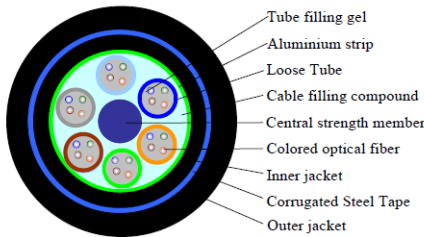
1.3.5.24 Single loop PID controller

Description	Essential Specification
IP Rating	IP20
Display Type	Dual 4 Digit LED
Supply Voltage	230Vac/ 24Vdc
Input Types	4-20mA, 1-5V, Pt ₁₀₀ RTD
PV Accuracy	0.2% of reading ±1LSD
Control Types	On/Off, PID
Output Types	Logic, relay, triac, DC, 4-20 mA Analog Output
No of Alarms	4
Set-point Programmer	required

Min Analogue IO	Input	2 (4-20mA)
	Output	2 (4-20mA)
Min Digital IO	Input	4
	Output	4
Communication interface		Ethernet
Mounting location		Electrical MCC for local operations – For temperature or pressure.
Quantity		As per site requirement

1.3.5.25 Fiber Optic Cable

Description	Essential Specification
Fiber type	Single mode
Fiber count	24 nos.
Number of loose tubes	6 nos. (4 fibers per tube)
Color of tubes	Blue, Orange, green, Brown, Gray and natural / Different color shall be available for each tube.
Attenuation at 1300 nm	0.5 db/km or better
Fiber coating diameter	245 +/- 10 microns or better
MFD	9.2 +/- 0.4 microns or better @ 1310 nm or better
Clad diameter	125 +/- 1 microns or better
Diameter of cable	15 mm nominal or better

Inner sheath thickness	Black PE 1.0 mm
Outer sheath thickness	HDPE > 0.5 mm Colour of outer sheath will be provided at the time of specification approval for production.
Armor	Corrugated ECCS tape
Moisture barrier	Water swells able tape or poly tape
Tensile strength	> 2000 N
Crush resistance	> 2000 N
Impact resistance	25 Nm – 10 impacts
Minimum bend radius	20 D
Repeated pending	30 times
Torsion resistance	10 cycles
Marking	Marking of length for every meter along with customised letter which will be provided at the time of specification approval for production.
Cable Pic	
Quantity	1000 meters with +/- 10% tolerance + as per site requirement.

1.3.5.27 16 Armoured Data Pair Cable

Description	Essential Specification	
REQUEST FOR PROPOSAL FOR ESTABLISHMENT OF 50 MTPD CRYOGENIC AIR SEPERATION PLANT	Ref. No: 2025001463	
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Code used	BS-5308
Conductor	1.5 Sq.mm annealed tinned copper conductor of 7 strands.
No. of Cores	16 Pair
Primary insulation	XLPE insulated core.
No. of twists/meter	Minimum 20 twists/meter
Core identification	By colour
Voltage grade	1100 V
Cable identification	Running length of the cable shall be printed at least at every 1-meter interval.
Pair identification	With numbers at interval of not more than 250 mm as per Supplier standards.
Shielding	Individual + Overall: Aluminium Mylar tape & ATC drain wire with PTP tape.
Drain wire size	0.5 Sq.mm or better
Drain wire material	Multi-stranded bare tinned annealed copper in continuous contact with aluminum side of the shield.
Drain wire resistance	Drain wire resistance including shield shall not exceed 40Ω/km
% coverage / overlap	100% / 25%
Inner sheath	Extruded Black FRLS PVC type ST-2.
Armouring	Galvanized steel round wire.
Outer sheath	Extruded flame retardant 90 °C PVC to IS-5831 type ST-2/IEC 502. Color light blue. a) PVC oxygen index: over 30% or better b) PVC temperature index: over 250 °C c) Fire retardant: yes, as per IEC-332 part3, CAT A d) Smoke density: 0.6

	e) Acid gas emission: 0.2 f) Anti rodent
Electrical properties @ 20 °C	1) Conductor resistance: maximum 20Ω/km or better 2) Insulation resistance: minimum 5000M Ω or better 3) Mutual capacitance: maximum 75pF or better 4) L/R ratio: maximum 40μH/ Ω or better 5) Test voltage: Conductor to conductor: 1000 V for 1 minute. 6) Conductor to shield & Armour: 1000 V for 1 minute.
Marking	Marking of length for every meter along with customised letter which will be provided at the time of specification approval for production.
Tests	All the tests shall be conducted as the part of pre-delivery inspection.
Quantity	2000 meters with +/- 10% tolerance + as per site requirement.

1.3.5.28 1 Pair / 3 Pair Armoured Data Cable

Description	Essential Specification
Code used	BS-5308
Conductor	0.5 Sq.mm annealed tinned copper conductor of 7 strands.
No. of Cores	1 Pair/ 3 Pair
Primary insulation	XLPE insulated core.
No. of twists/meter	Minimum 20 twists/meter
Core identification	By colour
Voltage grade	1100 V
Cable identification	Running length of the cable shall be printed at least at every 1-meter interval.

Shielding	Individual + Overall: Aluminium Mylar tape & ATC drain wire with PTP tape.
Drain wire size	0.5 Sq.mm or better
Drain wire material	Multi-stranded bare tinned annealed copper in continuous contact with aluminum side of the shield.
Drain wire resistance	Drain wire resistance including shield shall not exceed 40Ω/km
% coverage / overlap	100% / 25%
Inner sheath	Extruded Black FRLS PVC type ST-2.
Armouring	Galvanized steel round wire.
Outer sheath	Extruded flame retardant 90 °C PVC to IS-5831 type ST-2/IEC 502. Color light blue. a) PVC oxygen index: over 30% b) PVC temperature index: over 250 °C c) Fire retardant: yes, as per IEC-332 part3, CAT A d) Smoke density: 0.6 or better e) Acid gas emission: 0.2 or better
Electrical properties @ 20 °C	1. Conductor resistance: maximum 40Ω/km or better 2. Insulation resistance: minimum 5000M Ω or better 3. Mutual capacitance: maximum 75pF or better 4. L/R ratio: maximum 25μH/ Ω or better 5. Test voltage: Conductor to conductor: 1000 V for 1 minute. 6. Conductor to shield & Armour: 1000 V for 1 minute.
Marking	Marking of length for every meter along with customised letter which will be provided at the time of specification approval for production.

Tests	All the tests shall be conducted as the part of pre-delivery inspection.
Quantity	1. 1 Pair cable: 2000 meters with +/- 10% tolerance + as per site requirement. 2. 3 Pair cable: 2000 meters with +/- 10% tolerance + as per site requirement.

1.3.5.29 Heat Resistant Cables for RTD

Description	Essential Specification
Conductor	7/0.32 Dia stranded, annealed, tinned copper conductor to have effective cross-sectional area of 0.5 sq.mm as per IS 8130
Insulation	0.4 mm PTFE insulation or appropriate to withstand ambient temperature of Max 150 deg C
Type	Flexible cable
No. of cores	8
Color-coding	Suitable distinctive color-coding with polyester taping shall be provided over the cores
Shielding	Cores shall have common shield of 0.25mm Dia annealed, tinned copper conductor braid with 85% min coverage
Overall sheathing	0.5mm PTFE insulation or appropriate as mentioned above
Temperature	The cable should withstand temperature of minimum 80 to 150 deg C
Quantity	1000 meters with +/- 10% tolerance + as per site requirement.

1.3.5.30 Armoured CAT-6 Cable

Description	Essential Specification
Bandwidth	250 MHz or better
Speed	1 Gbps or better
Conductors	23 AWG solid bare copper or better
Central separator	PE Cross separator
Insulation	High density polyethylene
Inner sheet	PVC
Outer Jacket	Black HDPE
Cable diameter	7.5 +/- 0.5mm
Rip cord	Nylon rip cord shall be available
Bending radius	8 x OD or better
Inner Diameter	5.6mm (Nominal)
Tape Cable Diameter	Nominal 9mm
Application	Direct Burial Application
Impedance	100 Ohms (nominal), 1 to 250 MHz
Conductor resistance	9.2 Ohms / 100 Mtr max or better
Mutual capacitance	5.6 nF for 100 Mtr or better
Operating voltage	72V or better
Insulation resistance	Shall be more than 100 Mega Ohms

Operating Temperature	20°C to 75 °C
Compliance	ANSI/TIA-568-C.2, ISO/IEC 11801
Marking	Marking of length for every meter along with customised letter which will be provided at the time of specification approval for production.
Quantity	2000 meters +/- 10% tolerance + as per site requirement

1.3.5.31 DO Relay

Description	Essential Specification
Primary element type	Electro-magnetic/ Solid state relays
Input	24V DC/230V AC
Mounting location	I/O racks/ IJB – DO of PLC with connected to Relay.
Output	Potential free contacts with minimum 2 Nos. of NO/NC per relay.
Quantity	As per site requirement (All Digital output shall be terminated in relay module)

1.3.5.32 DC Voltage Transducer

Description	Essential Specification
Rated Input Voltage	50 VDC for 24VDC Measurement
Output signal	Communication Output It shall be interfaced with PLC through a communication card in RIO Rack.
Power supply	24 VDC
Measuring accuracy	+/- 0.5 % or better

Isolation	It Shall be available between Input, Output and Power supply
Input Resistance	> 1 Mega Ohms or better
Load Resistance	>2 Kiloohms or better for Voltage output & ≤250 Ohms or better for current output
Isolation withstanding voltage	> 2.5 KV (Min for 1 Min)
Response time	400 ms or better
Mounting	DIN Rail

1.3.5.33 DC Current Transducer

Description	Essential Specification
Use	24 VDC Diode ORed Output Monitoring in PLC panel
Operating principle	Scale down, rectification & conversion
Auxiliary power supply	24 VDC
Input parameter (I in Amp)	As per load
Output	Communication Output – It shall be interfaced with PLC through a communication card in RIO Rack.
No. of signal outputs	Dual
Output ripple (Accuracy class)	0.2 % of span or better
Input / output Isolation	Galvanic or optical
Mount	DIN Rail

1.3.5.34 DIN Mounted Single Phase Energy Meter

Description	Essential Specification	
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Rated Input Voltage (Measurement voltage)	300 VAC or Nearby range (It shall be greater than 280VAC)
Frequency of Input Voltage	50 Hz
Output Signal	Communication Output – It shall be interfaced with PLC through a communication card in RIO Rack.
Power Supply	24 VDC/ 230 VAC
Display	Local Display shall be available to monitor voltage, Current, etc
Measuring Accuracy	+/- 0.5 % or better
Mounting	DIN Rail

1.3.5.35 Single Phase Surge Protection Device (SPD)

Description	Essential Specification
Use	UPS 1&2 Input in PLC panel
Type	Type 1/2 with status output
Mounting	Pluggable Surge protection Devices between LN, LE, DIN Rail Mounting

1.3.5.36 Control Valve

Description	Essential Specification
Actuator type	Electro-Pneumatic operation.
Seat type	As per process requirement.
Direct/ reverse acting	As per process requirement.
Material for Body, Stem & Seat.	SS
Valve size	As per process requirement.

Process connection	As per process requirement.
Pneumatic input	As per process requirement.
Manual override	Optional.
Fail safe	(Air or Power) Fails to close.
Electrical input & output	Profibus PA/ FF/ Ethernet/ 4-20 mA Built-in I/P converter and position transmitter.
Cable entry	As per process requirement.
Diagnostics	Standard and all advanced diagnostics are required.
Pressure gauges	Required. (Make: Wika/ General Instruments/ AN instrument or equivalent)
Air filter regulator	Required. (Make: Placka/ Norgren/Shavo or equivalent)
Location	Indoor and Non-Hazard location.
Test certificates	Calibration, Materials and Leak test certificates are required.
Quantity	As per process requirement.

1.3.5.37 Dual redundant Solenoid Valve

Description	Essential Specification
Type of valve& operation	As per process requirement
Fluid handled	As per process requirement
Flow factor (Kv)	As per process requirement
Media temperature	As per process requirement
Orifice size	As per process requirement
Body material	CF8 (SS304)
Seal material	VITON/ NBR- As per process requirement

Port connection / valve size	As per process requirement
Min. Operating Pressure	As per process requirement
Max. Operating Pressure	As per process requirement
Solenoid Enclosure	Terminal box as per IP 65
Cable entry	As per process requirement
Solenoid voltage	24 V DC/ 230VAC - As per process requirement
No of solenoids	Dual coil dual solenoid valve
Solenoid insulation	Class F or better
Power consumption	As per process requirement

1.3.5.38 Signal Isolators

Description	Essential Specification
Primary element type	Intrinsically safe
Digital Input (DI)	Potential free/ Namur type sensor (1 in 1 Out, 1 In 2 Out)
Digital output (DO)	To operate intrinsically safe indication lamps.
Analog input (AI)	0 to 20 mA / 4 to 20 mA
Analog output (AO)	0 to 20 mA / 4 to 20 mA / 1 -5 V
Inputs isolators	1 in 2 Out. Or 1 in 4 Out AI isolators with source/ sink selectable option
Power rails with cover and power modules	Required with redundancy. Power rail feature shall be available.
Quantity	To be provided for all AI & AO channels. DI & DO shall be selected as per process requirement.

1.3.5.39 DIN Mounted IoT Gateway

Description	Essential Specification
CPU	32-bit RISC dual core - 800 MHz or better
Operating System	Linux RT
Flash	4 GB or better
RAM	1 GB or better
RTC, RTC Back-up, Buzzer	It Shall be available
Ethernet port	Minimum 2 Nos of 100 Mbps port shall be available with 100 Mbps
USB port	1 Nos shall be available
Serial port	Minimum of 1 Nos Serial port shall be available (RS-232, RS-485, RS-422, software configurable)
SD card	32 GB or more SD Card shall be provided
Power supply	24 VDC +/- 5%
Input Protection	Electronic protection shall be available
Operating Temp	Ambient to 50°C
Protection Class	IP20
Mounting	DIN Rail
Programming License	1 Nos. of latest and licensed full version of IoT programming tool shall be provided -Dongle based license for all IoT Devices. If dongle is not available, soft license shall be provided with approval of department.
Programming	IoT shall be remotely accessed in existing network from common control room

1.3.5.40 Weather Proof PTZ Camera

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Description	Essential Specification
Image Sensor	1/3" CMOS or better
Resolution	5 MP or better resolution with 25 fps or better
Optical Zoom	Zoom 30x or better with Starting focal length $\leq 5\text{mm}$
Min. illumination	0.1 lx for Color; 0.05 lx for B/W or better
Shutter	1/1 to 1/10,000 or better
S/N Ratio	≥ 50 dB
PAN travel	360 deg endless
Tilt	0 to 90 deg or better
Optical Zoom	30x or better
Lens Control (Focus, Iris)	Auto/Manual
White Balance	Auto/Indoor/Outdoor
Video Compression	H.264 or latest
Video Streaming	Minimum three streams with data rates configurable up to 8 Mbps or better with full frame rate
Interface	RJ-45, 10/100 Mbps Ethernet
Security	Should support User account and password protection HTTPS, IP Filter, User access log
Protocol support	IPv4/v6, TCP, UDP, RTP, RTSP, HTTP, HTTPS, NTP, SMTP, DHCP, PPPoE, UPnP, IGMP, SNMP, DNS, DDNS, Unicast and Multicast
Sd card	Built in SD card slot with support up to min 128 GB. 128 GB Memory card need to be given along with each camera.
Storage	128 GB Memory card to be provided for local storage
Mounting	Wall mount of same Make

Communication	ONVIF Profile S or more
IP Rating	IP 66 or better – Certificate shall be provided
Temperature	Ambient to 50 deg or better
IR Lighting	30 mtrs or more with ON/OFF Control
Input power	230V AC +/- 10%, 50Hz or 24VDC/ 12VDC & PoE or any other power supply with approval of department shall be considered.
Accessories	Mountings and connector kits, Installation Guide with installation tools and User's Manual, Installation, Management tools, with Service manual, etc.
Certifications	BIS, IP66
Open Platform	API/SDK shall be provided
Country of Origin	Country of Origin (COO) shall be declared from OEM for quoted models and company (including their parent company);
General safety	The MAC address of the cameras/devices shall be registered in the name of OEM; Documentary evidence shall be submitted from OEM;
Quantity	Based on Civil layout of ASU, it will be decided

1.3.5.41 Weather Proof Fixed Camera

Description	Essential Specification
Type	5 MP IP Bullet Camera
Image Sensor	CMOS 1/ 2.5" or equivalent for 5 MP
Day/ Night	Support shall be available
Lens Type	Fixed

Focal Length	Minimum 4.0 mm or less
Iris	Fixed or Auto
Angle of View	Better than 75° (H)
Angle Adjustment	Bracket shall be supplied with adjustment of pan 0~360°, tilt 0~75°, rotate 0~360°
Shutter	1s to 1/10000s or better
Min. Illumination	Colour mode: 0.05 Lux or better B/W mode: 0 lux with IR or better
Gain Control	Auto/ Manual
S/N Ratio	better than or equal to 50 dB
IR Distance	30 meter or better
Video Compression	H.265, H.264, M-JPEG
Main Stream	2592 x 1944 (5MP)
Number of streams	Triple
White Balance	Auto & Manual
Audio Compression	G.711A or equivalent
Protocols	IPv4/v6, TCP, UDP, RTP, RTSP, HTTP, HTTPS, NTP, SMTP, DHCP, PPPoE, UPnP, IGMP, SNMP, DNS, DDNS, Unicast and Multicast
Communication	ONVIF Profile S or more
Network	1 RJ45 10M/100M self-adaptive Ethernet port
Edge Storage	Built-in microSD/SDHC/SDXC slot shall be available, up to 128 GB
Memory Card	128 GB Memory card shall be supplied for camera
Remote Connection	Minimum of 4 users shall access the camera at a time

Power Supply	DC12V&PoE
Working Temperature	Ambient to 50°C
Ingress Protection	IP66 or better – Certificate shall be provided
Country of Origin	Country of Origin (COO) shall be declared from OEM for quoted models and company (including their parent company);
General safety	The MAC address of the cameras/devices shall be registered in the name of OEM; Documentary evidence shall be submitted from OEM;
PVC JB	Heavy duty 100 mm x 100mm x 50 mm IP66 certified PVC JB for Mounting camera along with all necessary accessories. Camera will be mounted on JB Cover.
Quantity	Based on Civil layout of ASU, it will be decided

1.3.5.42 Network Video Recorder

Description	Essential Specification
Main processor	Embedded processor
Operating system	Embedded LINUX
IP camera inputs	32 channels
Bidirectional audio	1 channel input; 1 channel output; RCA
Interface	2 HDMI (1 HDMI up to 1920x1080 or better) – Shall support up to 5 MP
Recording resolution	5MP for 32 Channels
Display resolution	1920 × 1080; 1280 × 1024; 1280 × 720; 1024 × 768 or better resolutions
Compression	H.265/H.264/MJPEG/MPEG4 or latest

Recording bit rate	256 Mbps or better
Recording mode	Manual; Schedule (Regular [Continuous], Motion Detection, Alarm, Motion Detection +Alarm); Stop
Trigger events	Recording; Tour; Alarm; Email; FTP; Buzzer; Screen Tips
Video detection	Motion Detection; Motion Detection Zones Video Loss and Camera Blank; Privacy Masking
Sync playback	1/4/8/16
Internal storage provision	Minimum 2 SATA ports
HDD redundancy	RAID 0 and 1 or better
Internal storage	4 TB SATA HDD (Must be supplied and installed by Supplier) – It shall have dual 4 TB Hard disk
Ethernet	1 x RJ-45 port (10/100/1000 Mbps)
USB	Minimum 2
No. of clients for video monitoring	Each NVR shall support minimum 5 clients for monitoring the videos simultaneously. Any necessary licensed software is required, same shall be provided.
Power	230V AC +/- 10% or with External power Adapter
Operational Compatibility	The NVRs should be integrated with all types of cameras supplied
Accessories	To be supplied with NVR ➤ HDMI – HDMI – 3Mtr cable – 1 Nos ➤ Active HDMI Over Ethernet cable Extender (Tx & Rx) for 60 mtr – 1 Nos ➤ Passive HDMI Over Ethernet cable Extender (Tx & Rx) for 30 mtr – 1 Nos ➤ 2 TB External HDD for CCTV backup – 2 Nos

Mounting Kit	NVR shall have 19" Rack Mount Kit
Quantity	1 Nos.

1.3.5.42 65 Inch LED TV

Description	Essential Specification
Size	65 inch (diagonal size) or more
Inputs	HDMI – 2 Nos, Ethernet
Resolution	Full HD
USB	Minimum 2 Ports
Accessories	All necessary accessories shall be supplied such as remote, Adjustable wall mount kit, power cord, etc.
Quantity	3 Nos.

1.3.5.43 Server Rack

Description	Essential Specification
Size	Minimum of 36 U (Preferred to have similar height of PLC Rack -Accordingly to be selected)
Mount	Rack Mounting for Servers
Doors	Transparent Glass doors shall be provided at both front and Rear side.
Fans	Shall be provided
Castor	Castors with brake shall be provided
Cable Manager	Shall be provided to meet system requirement
Power manager	Dual power manager shall be provided to meet system requirement
Keyboard/ Mouse tray	Shall be provided

Trays	Cantilever Trays & Server positioning trays shall be provided to meet system requirement.
Earth strip	Shall be provided
Tube light	Fitting shall be provided
Side panels	Side panels shall be provided with cam lock or Lock& Key
Items to be placed	Servers, 1 Nos of Server monitor, GPS receiver, Network video recorder

1.3.5.44 Armoured 1.5 Sq.mm & 2.5 Sq.mm Power cable

Description	Essential Specification
Name of the Item	- Core 2.5 Sq.mm Armored Copper cable - Core 1.5 Sq.mm Armored Copper cable as per IS 1554 (part-1)-1988
Type	1.1 KV
Conductor	Multi-strand (≥ 7 Nos) High conductivity Annealed Tinned electrolytic grade copper as per IS:8130/84
Insulation	PVC TYPE1-A as per IS5831 (1984)
Binder	Polyester tape
Inner sheath	Extruded PVC compound confirming to type ST2 as per IS5831 (1984)
Outer sheath	Extruded PVC compound confirming to type ST2 as per IS5831 (1984)
Armour	Galvanized round steel wire Armour as per IS-3975 (1999)
Core Identification	3 cores – Red, Black, Green
Core Identification	The cable identification shall be provided by embossing the details on the outer sheath- parameters like Manufacturers name, Trade mark, type of cable, voltage grade, type of insulation, type

	of outer sheath, nominal cross-sectional area of conductor, etc. as per section -5 of IS-1554 part-1 (1988)
Cable Drum identification	The details mentioned in section -5 of IS-1554 part-1 (1988) shall be stenciled on each drum for identification
Packing	➤ Cables shall be supplied in standard drum of 1000 Meter length with +/-5% tolerance ➤ Both ends of cable shall be accessible for testing purpose ➤ Cable ends shall be suitably sealed to prevent any ingress of moisture and fully protected against mechanical damage ➤ Each drum shall be marked in indelible paint with details as per IS specifications ➤ One drum in each category can be 500 meters +/- 5% tolerance
General conditions	➤ Cable shall be of brand new and in good condition ➤ Extra PVC/ Rubber caps for each drum shall be provided ➤ Insulation and sheath materials are shall be resistance free to oil, Alkali, etc. ➤ Dimensions of the Insulation, Inner sheath, Armour and outer sheath shall be as per relevant IS standards. ➤ All test certificates shall be supplied along with the item ➤ Before dispatch, party shall submit Type test certificate/ Routine test certificate, etc.

1.3.5.45 Other Instrumentation & Control System Items

The following items shall be considered as per process requirements. All specifications shall be submitted for approval.

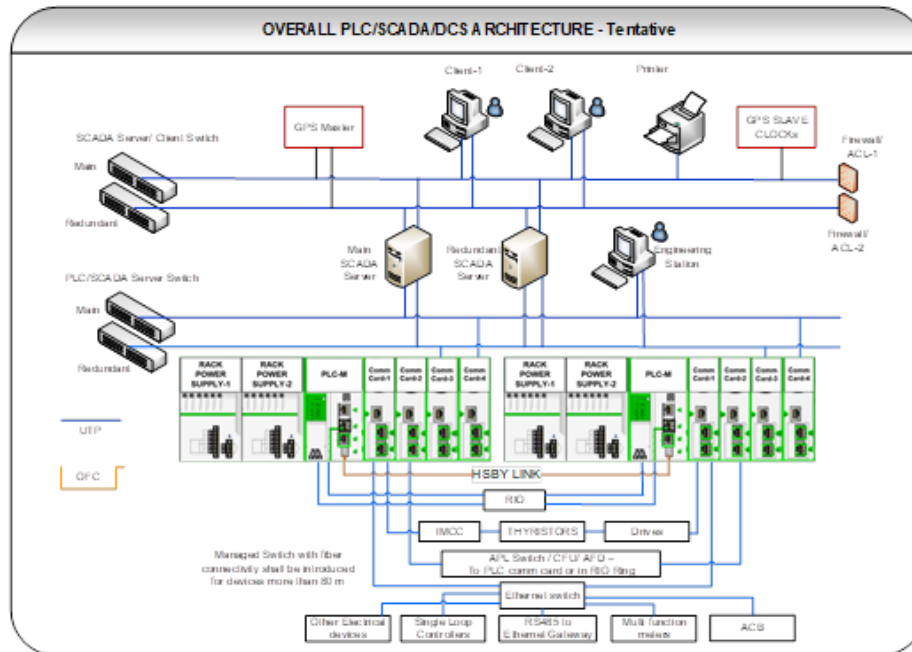
1. Weighing system, if provided
2. PLC-Weighing module if provided – Same as of PLC make
3. GPS Receiver & GPS Slave clock
4. Annunciator

5. Flame proof Junction boxes & non-Flame proof Junction boxes
6. Push buttons / Emergency Push Buttons/ Indication-Lamps/ hooters/MCCB/MCB
7. Terminal Blocks/Fuse TBs
8. Double/ Single compression Glands
9. Asset Management system for field instruments

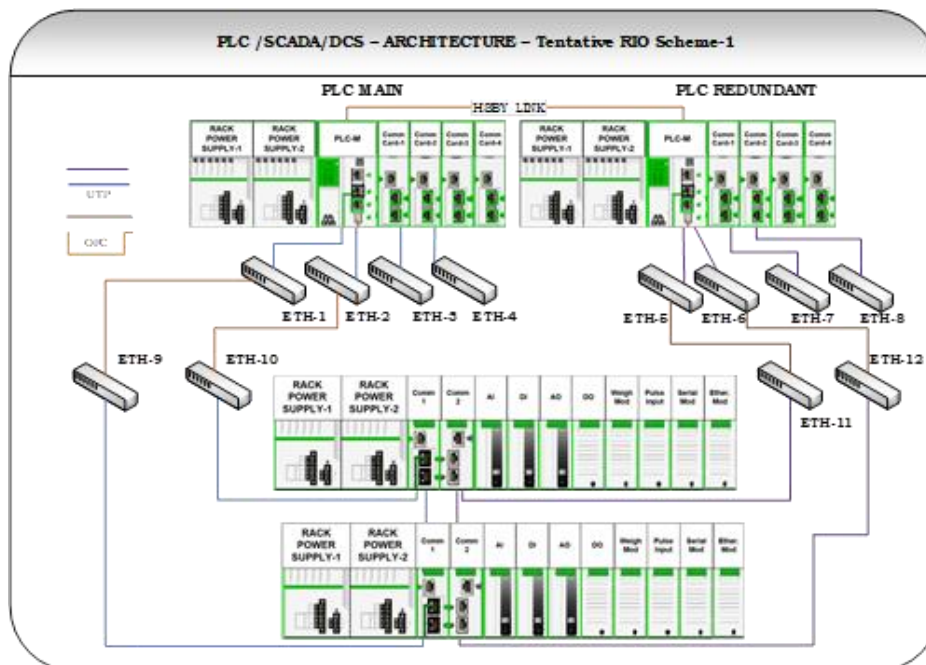
Any other field instruments which are not listed above shall be provided along with their specifications in offer.

1.3.6 PLC/SCADA TENTATIVE ARCHITECTURE

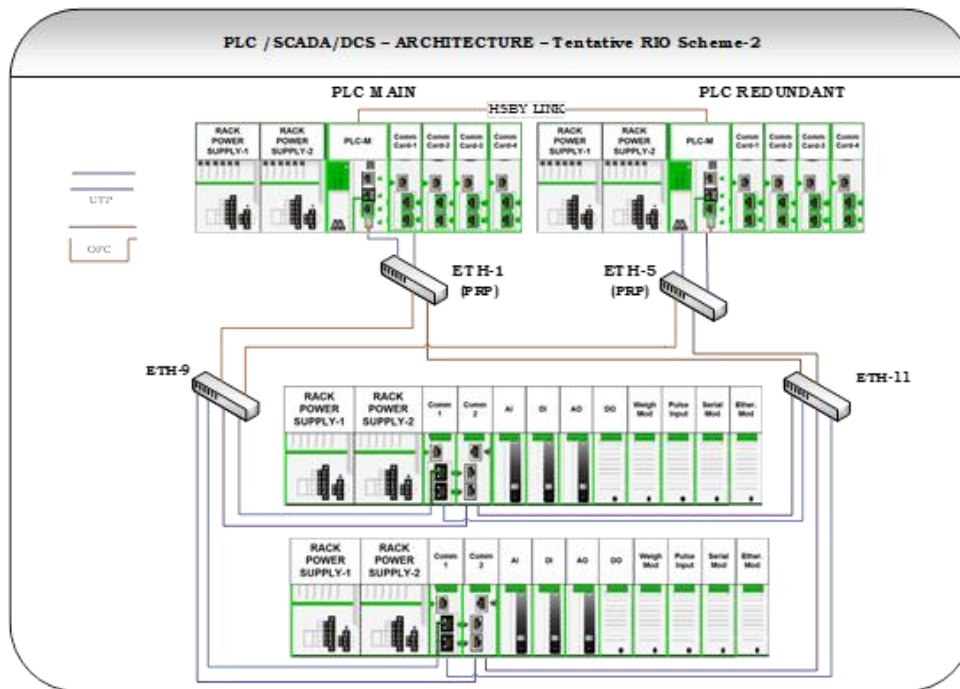
1.3.6.1 Tentative Overall PLC/SCADA/DCS Architecture



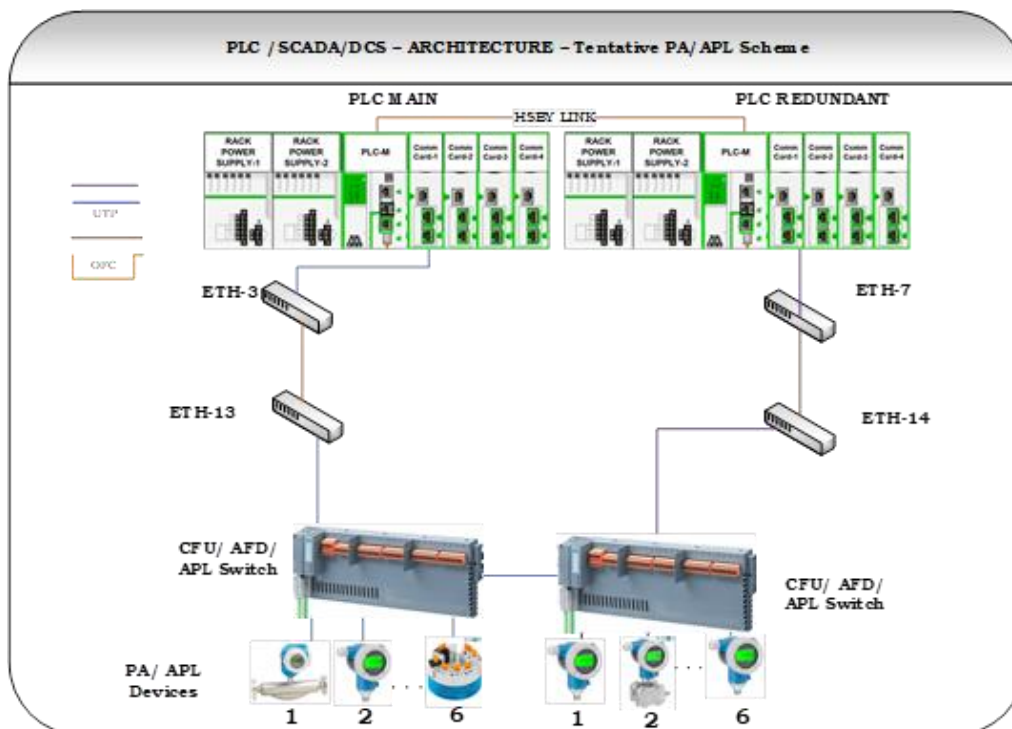
1.3.6.2 Tentative PLC-RIO Scheme-1



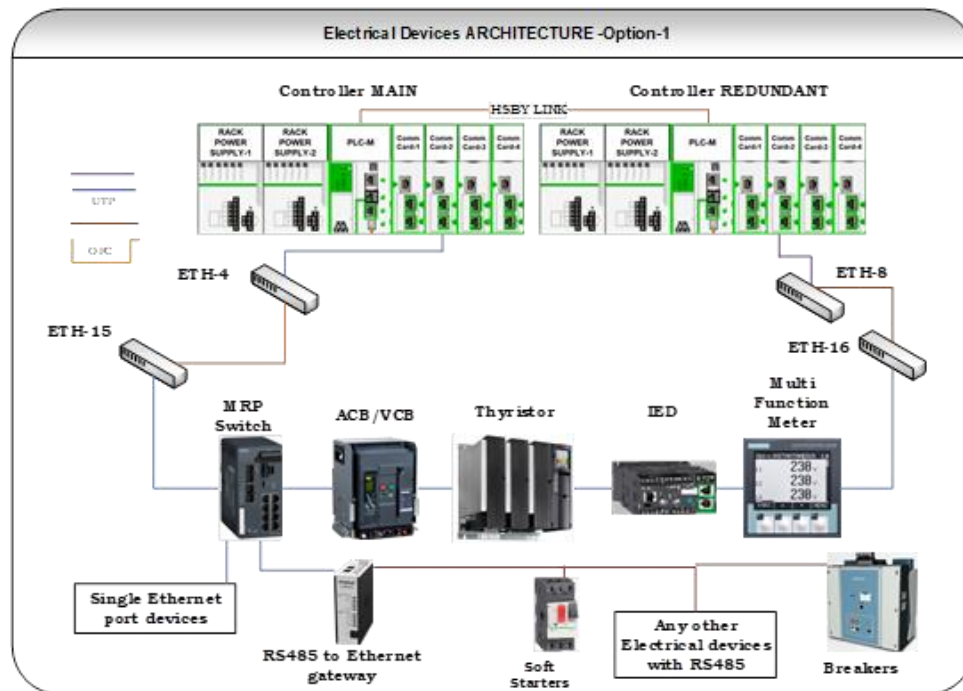
1.3.6.3 Tentative PLC-RIO Scheme-2



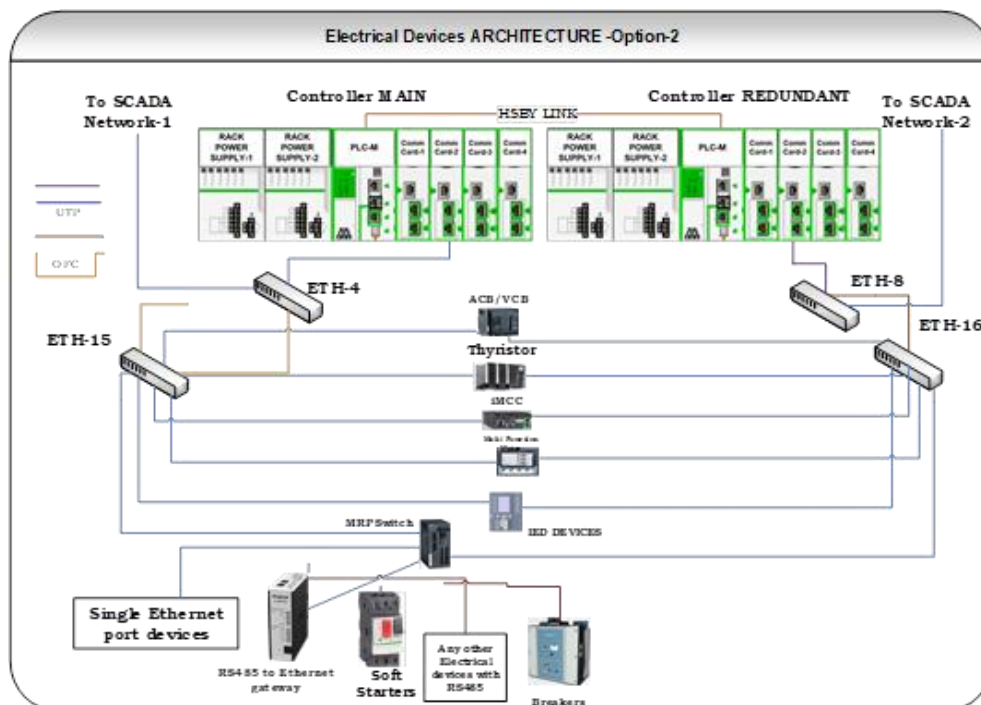
1.3.6.4 Tentative PLC-APL/PA Network Scheme



1.3.6.5 Tentative PLC-Electrical System Interface Scheme-1



1.3.6.6 Tentative PLC-Electrical System Interface Scheme-2



1.3.7 LIST OF PROBABLE MAKES AND TENTATIVE BOM

S. No	Item	Preferred Make	Quantity Required
1	PLC (PLC, Backplane, 4 Nos of Comm Card, Dual 230 VAC Chassis Power supply, HSBY FO Link)	Siemens/ Schneider/ ABB/ Rockwell/ Yokogawa/ Honeywell (PLC, DCS, SCADA shall be from same OEM)	2
2	Analog Input Module		As per process requirement with 20% spare channels in each module
3	Analog output Module		
4	Digital Input Module		
5	Digital Output Module		
6	SCADA Software Unlimited tags		As per Tech spec
7	SCADA Server	HP/ Dell	2
8	Engineering workstation	HP/ Dell	1
9	SCADA Client PC	HP/ Dell	4
10	Thin client PC	HP/ Dell	1
11	Layer-2 Managed Switch (IO-PLC, PLC-Server, Server-Client, CCTV, FDA)- DIN Mounted	Extreme/ Antaira / Moxa/ Schneider/ Siemens/ Advantech/ Allied Telesis	8 + Dual Switch in each RIO panel
12	Control Console	Pyrotech electronics	1

S. No	Item	Preferred Make	Quantity Required
		private limited/ Evans / Winstead/ Cosmos/ Fox/ Barco/ Tresco	
13	IO Panel	Rittal/ Pyrotech/ president	As per process requirement
14	24VDC SMPS with Diode Oring module	Siemens/ Pheonix /Puls / Aplab/ Omron	10
15	RTD Sensor	Rosemount / Omega/ Wika/ Baumer/ Tempsens/ Exotherm	As per process requirement
16	Oxygen Monitor	Drager/ Ambetronics	
17	Proximity sensor	P&F, IFM	
18	Temperature Transmitter	Rosemount / Siemens/ E&H/ Yokogawa	
19	Pressure Transmitter		
20	Level Transmitter (DPT)		
21	AFD/CFU/APL Switch	Siemens/ STAHL / P&F/ Phoenix	
22	Pressure Switch	Switzer/ IFM	

S. No	Item	Preferred Make	Quantity Required
23	Flow switch	IFM/ Switzer / P&F	
24	Level switch	IFM/ Switzer / P&F	
25	Mass Flow meter	Micromotion/ Siemens/ Yokogawa/ E&H	
26	Single loop Controller	ABB/ Eurotherm	
27	Fiber optic cable	HFCL / HTL/ 3C / SCHNEIDER/ TYCO/ RPG	1000 m + As per site requirement
28	16 Armoured Data Pair Cable (Min of 2000m to supplied and actual required to be provided by party)	Uniflex / Delton / Delta / Lapp / Paramount cables / Polycab / RPG	2000 m + As per site requirement
29	1 Pair Armoured Data Cable (Min of 2000m to supplied and actual required to be provided by party)	Uniflex / Delton / Delta / Lapp / Paramount cables / Polycab / RPG	2000 m + As per site requirement
30	3 Pair Armoured Data Cable (Min of 2000m to supplied and actual required to be provided by party)	Uniflex / Delton / Delta / Lapp / Paramount cables / Polycab / RPG	2000 m + As per site requirement

S. No	Item	Preferred Make	Quantity Required
31	Heat Resistant Cables for RTD (Min of 1000m to supplied and actual required to be provided by party)	Uniflex / Delton / Delta / Lapp / Paramount cables / Polycab / RPG	1000 m + As per site requirement
32	Armoured CAT-6 Cable	Amphenol/ Dlink/ comscope/ molex/ HTL/ polycab	2000 m + As per site requirement
33	DO Relay	OEN/ OMRAN /Phoenix/ P&F	For all PLC-DO output
34	DC voltage transducer	Rishabh/ NK technologies/ LEM	For each DCPS
35	DC Current transducer	NK technologies/ LEM	
36	DIN Mounted Single Phase Energy Meter	Schneider/ Siemens	2
37	AC Voltage Surge protection Device (SPD) (Type 1 / 2)	Pheonix/ Dhen/ Citel	As per process requirement
38	Control Valve	Fisher/ El-o-matic/ Micropneumatic/ Flow serve/ MIL	

S. No	Item	Preferred Make	Quantity Required
		controls/ Siemens	
39	Solenoid Valve	Norgen/ Asco/ Parket/ Festo/ Burkert	
40	Power rail Isolators (IS & Non IS - I to I, I to 2I, 1 in 1 out relay, 1 in 2 out relay), redundant power fed modules, power rail	P&F/ MTL	
41	DIN Mounted IoT Gateway	Schneider/ Exor	1
42	Weather proof PTZ Camera	Sparsh/ Norden	Camera to cover all rooms
43	Weather proof Fixed Camera	Sparsh/ Norden	
44	Network Video recorder (32 Ch)	Sparsh/ Norden	1
45	55 Inch Display	LG/ Samsung/ Panasonic	2
46	Server Rack	Valrack/ APC/ Rittal	1
47	2.5 sq.mm Armoured 3 core power cable	Uniflex / Delton / Delta / Lapp / Paramount cables / Polycab / RPG	2000 m + As per site requirement

S. No	Item	Preferred Make	Quantity Required
48	1.5 sq.mm Armoured 3 core power cable	Uniflex / Delton / Delta / Lapp / Paramount cables / Polycab / RPG	1500 m + As per site requirement
49	Other Instrumentation & Control System Items		
a	Weighing system	Minebea / Mettler /Precia Molen/LCGC	As per process requirement
b	Weighing module for PLC	Same as PLC brand	As required
c	GPS Receiver & Clocks	SANDS	1
d	DIN mounted Layer-2 firewall	Hirschmann	2
e	Annunciator	GIC	As required
f	Fire Alarm System interface card	Honeywell, Ravell (As per supplied panel – refer process requirements)	1 Set
g	Flame proof / Weather proof Junction boxes	P & F/ Baliga/ Rittal	As per process requirement
h	Push buttons / Emergency Push Buttons/Indication-	Siemens/ Schneider / L&T / Technic	

S. No	Item	Preferred Make	Quantity Required
	Lamps/ hooters/ MCCB/ MCB		
i	Terminal Blocks/Fuse TBs	Phoenix/ Wago / Weidmuller	
j	Double/ Single compression Glands	Baliga/ Comet/ Weidmuller	
k	Asset Management Systems	As Per PLC/DCS	1 Nos
l	PA & HART communicator with all necessary libraries & accessories	Rosemount/ Beamex	1 Nos

Note: Any other make proposed by bidder shall be approved by department

1.3.8 STANDARDS TO BE FOLLOWED

S. No.	Standard Number	Description
1	ISA5	Documentation of Measurement. and Control Instruments and Systems
2	ISA7	Instrument Air Standards Committee
3	ISA12	Electrical Equipment for Hazardous Locations
4	ISA18	Instrument Signals and Alarms
5	ISA20	Instrument Specification Forms
6	ISA37	Measurement Transducers
7	ISA42	Nomenclature for Instrument Tube Fittings
8	ISA50	Signal Compatibility of Electrical Instruments
9	ISA52	Environments for Standards Laboratories
10	ISA60	Control Centers
11	ISA71	Environmental Conditions for Process Measurement and Control
12	ISA74	Continuous Weighing Instrumentation
13	ISA75	Control Valve Standards
14	ISA76	Composition Analyzers
15	ISA82	Electrical and Electronic Instrumentation
16	ISA84	Electrical/Electronic/Programmable Electronic Systems (E/E/PES) for Use in Process Safety Applications
17	ISA88	Batch Control Systems
18	ISA90	Instrumentation and Computer Grounding

S. No.	Standard Number	Description
19	ISA91	Criticality Ranking for Instrumentation
20	ISA92	Performance Requirements for Industrial Air Measurement Instrumentation Related to Health and Safety
21	ISA95	Enterprise/Control Integration Committee
22	ISA96	Valve Actuator Committee
23	ISA97	In-Line Sensors Committee
24	ISA98	Personnel Certification Standards Committee (ISA CAP & CCST Certifications)
25	ISA99	Industrial Automation and Control Systems Security
26	ISA101	Human-Machine Interface
27	ISA102	Development Electrical Systems
28	ISA103	Field Device Tool Interface
29	ISA104	Device Integration
30	ISA105	Commissioning, Loop Checks, and Factory & Site Acceptance/Integration Tests for Industrial Automation Systems
31	ISA106,	Procedure Automation for Continuous Process Operations
32	ISA107	Advanced Measurement Techniques for Gas Turbine Engines
33	ISA108	Intelligent Device Management
34	ISA111	Unified Automation for Buildings
35	ISA112	SCADA Systems

S. No.	Standard Number	Description
36	IS:8493	Power Supply (24 V DC)
37	IEC:60529, ATEX 1499	Isolators
38	IS 12083: PART 1 , IS 5051: PART 1	Relay
39	IS:13122:part 1, IS:2848& IS:7358	Temperature Transmitter
40	IS:13122:part1, EN:60079	Pressure/ Vacuum Transmitter
41	EN:12953-9, EN:12922-11	Pressure Switch
42	IS:3624, IS:8276	Pressure Gauge, Vacuum gauge
43	EN:60947-5-6, IEC:60947, EN:60079	Proximity Sensor
44	IEC 60079	Encoder
45	IS 5608 & IS 8130	Data Cables
46	IS:9281: Part-1	Weighing System
47	IEC:61131: part 1-part 8	PLC, I/O modules and buses
48	ISPD-V2, IEEE- 12207, PLC open V1.0	PLC software
49	IS:3043	Earthing

S. No.	Standard Number	Description
50	IS:15908, IEC:61508	Fire detection and alarm systems
<i>Any other latest standards are also to be listed by the party</i>		

1.4 DETAILS OF ELECTRICAL SYSTEMS

1.4.1 INTRODUCTION:

The electrical systems are intended to ensure safe, reliable, and uninterrupted operation of the Air Separation Plant. The design shall provide a reliable power distribution network capable of supporting continuous plant operation, while incorporating emergency shutdown and safe operating procedures in line with process safety requirements and with the requirements of this RFP.

The overall objective is to:

- Ensure continuous, safe, and reliable power supply to all critical ASU process and utility loads under both normal and emergency conditions, incorporating redundancy, dual incomers, and automatic source transfer features in accordance with applicable IS/IEC and CEA standards.
- A structured emergency shutdown and control philosophy shall be implemented through interlocks, protection logic, and integrated monitoring systems, enabling safe isolation, quick restoration, and full compatibility with plant SCADA for centralized supervision and event logging.

All equipment and systems shall be designed for operational flexibility, future expansion, and suitability to the environmental and process conditions of the ASU plant, with provisions for preventive maintenance and compliance with statutory and hazardous-area safety codes

1.4.2 SCOPE OF CONTRACTOR FOR ELECTRICAL SYSTEMS WORKS/SUPPLY

Scope of work under “Electrical Systems” is to design and realize a 3 – 5 MVA capacity substation in 33kV /11kV /6.6kV /3.3kV /0.433kV indoor substation as required and capable to cater the various linear & nonlinear loads in different facilities under ASU Plant.

- Electrical Part –Design the reliable configurations and Realization of Electrical Equipment in Substation and various Hazardous & Non-Hazardous facilities under ASU.
- Testing and Commissioning –All Electrical systems shall satisfy the requirements of Chief Electrical Inspector to the Govt. of India (CEA), IE

rules, PESO certification and as per BIS, NBC and IEC standards. Statutory approvals from the agencies and departments shall be obtained.

Incoming 33 kV HT panel at ASU is in the scope of this RFP and All downstream electrical systems covering HT/MV panels, LT panels, DG sets, UPS systems with batteries, transformers, bus ducts, cables, earthing and lightning protection systems, illumination works and all associated equipments up to the end connection point of the ASU process equipments shall be fully covered under the scope of this RFP.

The specifications provided in this section define the basic electrical requirements for the Air Separation Plant substation and associated electrical works. However, any additional equipment, materials, or works necessary to ensure the complete establishment, functionality, reliability, and operational readiness of the ASU plant shall also be deemed to be included in the scope even if not explicitly mentioned herein.

The scope of electrical works/supply covers the complete design, engineering, supply, installation, testing, commissioning and documentation of all electrical systems associated with the ASU plant and its connected facilities considering hazardous and non-hazardous zones as per relevant standards and recommended industrial practices of similar plants.

The scope broadly includes, but is not limited to, the following:

1. Design and engineering of the complete electrical power distribution system covering HT, MV, LT and control voltage levels.
2. Preparation of single line diagrams, load lists, protection coordination schemes, earthing layouts, and bills of quantities for all electrical works.
3. Supply, installation, and commissioning of incoming 33KV panel and 11 kV / 6.6 KV / 3.3 KV switchgear panels with advanced protection, metering, and control facilities.
4. Supply and installation of power transformers (Oil immersed or dry type) suitable for the ASU load requirements and ambient conditions.
5. Supply, installation, and commissioning of LT systems including PCC, MCC, iMCC, VFD panels, and distribution boards as required.

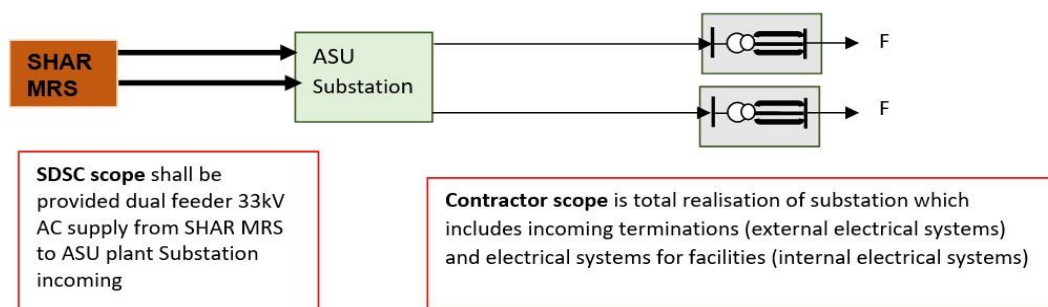
6. Design and installation of copper bus ducts, rising mains, and interconnections between transformers, LT panels, and MCCs as required.
7. Design and execution of DG systems with AMF/ASTS control panels and their operational philosophy to meet plant safety operating procedures as required.
8. Design and installation of suitable capacity UPS systems with modular Li-ion battery banks of required backup capacity for process controls, instrumentation, and critical systems.
9. Design and execution of earthing and lightning protection systems in compliance with IS 3043 and as per the department guidelines.
10. Design and provision of internal and external illumination systems including lighting for hazardous and non-hazardous areas.
11. Laying and termination of HT, LT, control, and communication cables with adequate segregation, identification, and testing.
12. Design, supply, and integration to the plant SCADA systems and remote monitoring systems for electrical network supervision and data logging as required.
13. Implementation of electrical safety systems, interlocks, and emergency shutdown provisions.
14. Supply of all associated accessories, supports, consumables, and tools necessary for completion of electrical works.
15. Electrical rooms shall be provided with automatic fire-detection as per NFPA standards and department FDA requirements. Major HT/LT panels shall have localized fire suppression modules as required.
16. Testing, inspection, and commissioning of all systems including functional, performance and protection trials.
17. Preparation and submission of all design deliverables, datasheets, test reports, and as-built documentation as per approved formats.
18. Deployment of a qualified electrical operation and maintenance team for day-to-day monitoring, preventive and corrective maintenance of all electrical systems during the specified operation phase as required and defined under this RFP.

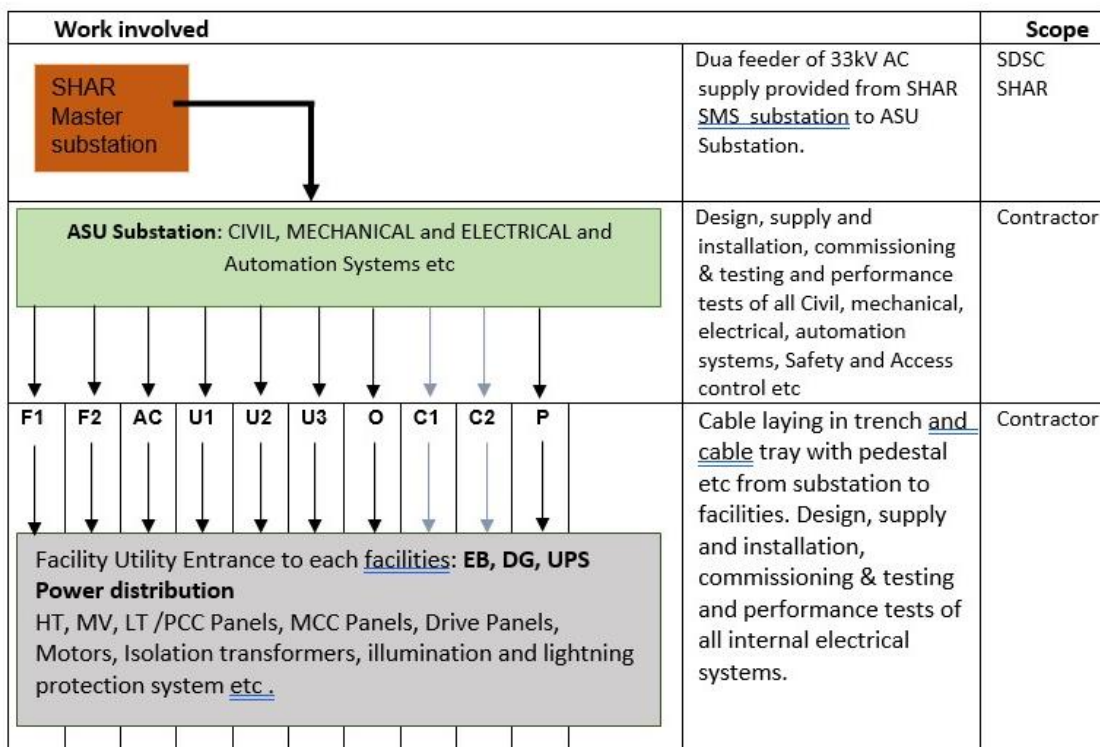
19. AMC of all electrical systems supplied under electrical systems of this RFP.

1.4.3 SCOPE UNDER DEPARTMENT

- Department will provide two independent 33 kV feeder lines from the SHAR substation, including end terminations at both ends (source and ASU substation). Beyond these terminations, all downstream electrical works (supply of 33kv panels to till the final operation of the plant) entirely under the scope of the ASU electrical works defined in this RFP.
- Department will provide construction power supply on chargeable basis from a nearby available location within a maximum radius of 250 meters from the ASU site. The contractor shall make all necessary arrangements to tap, extend cable and distribute the supply from this point as per departmental safety and installation guidelines. A standard temporary power requirement format will be issued by the department, which shall be strictly followed by the contractor during all construction activities to ensure electrical safety of personnel and equipment. The required construction power shall be made available within 10 to 15 days after formal request and submission of the approved format.
- Department shall carry out periodic verification of site electrical safety arrangements during the construction phase. However, the entire responsibility for safe installation, operation, and maintenance of the construction power network shall rest solely with the contractor, including protection, earthing, and compliance with statutory and Departmental safety norms.

1.4.4 SCOPE MATRIX





F1: Feeder 1(EB), **F2 :** Feeder 2(EB), **AC:** Air conditioning System, **U1:** UPS power supply1, **U2:** UPS power supply2, **U3:** UPS power supply3, **O:** outside lighting, **C1:** Communication cable1, **C2:** Communication cable2, **P:** path lighting

1.4.5 ELIGIBILITY CRITERIA FOR DESIGN, PROCUREMENT, INSTALLATION & COMMISSIONING OF ELECTRICAL SYSTEMS:

Following mandatory requirements shall be complied by the contractor / sub-contractor / firm who is executing electrical works. These shall be reviewed and cleared by Department for proceeding with Electrical works.

- Experience in the design and realization of indoor substations with a capacity of ~3 MVA, 33/11/6.6 /0.433kV as per latest BIS & IEC standards.
- Minimum ten years of experience in the design, procurement, realization and maintenance of substation equipment and hazardous & non-hazardous equipment within the facility
- Executed at least two similar projects involving substation, HT/LT panels, transformers, DG/UPS systems, or electrical works of comparable capacity in process / utility / ASU / chemical plants.

- Shall have minimum 33 KV licence from any govt body from state of Andhra Pradesh / equivalent certificate from other states of India.
- Shall have an in-house or associated design and engineering team with qualified electrical engineers capable of preparing SLDs, protection coordination studies, and detailed engineering documentation as required and as per this RFP.
- The site execution team shall include at minimum:
 - a. Project Electrical Engineer (B.E./B.Tech, min 10 years' experience),
 - b. Electrical Supervisors (Min 3 years' experience)
 - c. Experienced and qualified electricians (ITI, min 3 years' experience)

1.4.6 CLASSIFICATION OF ELECTRICAL SYSTEMS (General)

The power distribution scheme of the ASU Plant and associated equipment shall ensure Reliability, Availability and Clean Power within acceptable tolerance limits to the project facilities and associated auxiliary facilities which fall under the electrical systems of entire ASU Project. This is categorized into two forms of electrification i.e., external electrification and internal electrification.

- a) **External Electrification (Substation):** Constitutes establishing of suitable capacity sub-station if required with the equipment's such as transformers, DG sets with day tank & UG diesel tank, HT ,MV & LT switch gear panels, UPS systems, batteries, battery chargers, incoming HT cable and outgoing LT cable feeders to all the facilities, street lighting, track lighting, High mast lighting, post lighting, area lighting, aviation lighting and emergency lighting and auxiliary equipment in the ASU Plant.
- b) **Internal Electrification (Facilities):** Constitutes MV panels, iMCCs & VVVF Drive panels, LDBs, PDBs, UPS DBs, Special lighting, emergency lighting, bay lighting, process equipment, mechanical drive equipment, hydraulic equipment, lift equipment, cables, earthing and lightning protection systems within the facilities including cabling for Normal/DG/UPS in parallel redundant configurations.
- External Electrification:

The power supply can be broadly classified as:

1. Normal Power Supply in three chains (AP Transco Power Source)
 2. Captive Power Supply in three chains (Local DG Source)
 3. Uninterrupted Power Supply in two chains (UPS)
 4. Emergency Power Supply (EPS-Inverter Power /non-Critical UPS)
- It is required to design power distribution scheme based on individual maximum demands of Project and its associated auxiliary facilities, to be fed by the sub-station, installation of transformers, DG Sets, UPS, HT, MV and LT panels, switchgear protection equipment, earthing systems and outgoing feeders, lighting systems, centralized emergency lighting systems, lightning protection system etc. Two/three feeder's module of MV/ LT Panels with Auto changeover provision are proposed to cater for providing reliable power. The capacities of these feeders need to be designed as per the capacity of each facility. The Power change over should not affect to the other loads. Spare switchgear at least one in each rating have to be incorporated in the distribution panels and future expansion of thirty percentages to be considered.
 - Internal Electrification (Hazardous & Non-Hazardous area):
 - a) Internal electrification is classified into three areas.
 - Two feeders from two/three modules of MV/LT panels, iMCC& drive panels with Auto changeover facility are proposed to cater the critical loads. It also caters to illumination, power outlets, air conditioning loads etc.
 - Power distribution for mechanisms like motors, pumps and other critical loads operated in hazardous area.
 - UPS loads like mission loads, process instrumentation & control loads, fire detection, gas & pollution monitoring system. Also, Emergency Power Supply for centralized emergency lighting, CCTV, Timing, safety and deluge system loads distributed across the facilities.
 - The capacities of these feeders need to be designed as per the capacity of each facility. Spare switchgear at least one in each rating have to be incorporated in the distribution panels and provision for future expansion up of thirty percent need to be considered.

b) Power Supply and Power Network details:

- The HT & MV Power supplies are broadly classified as:
- Normal power supply (33kV, 3 phase AC system)
- Normal power supply (11kV, 3 phase AC system)
- Normal power supply (6.6kV, 3 phase AC system)
- Normal power supply (3.3kV, 3 phase AC system)
- *Emergency power supply through DG sets (0.433kV, 3 phase AC system)

c) The LT Power supplies are broadly classified as:

- Normal power supply (415 V, 3 phase AC system)
- Emergency power supply through DG sets (415V, 3 phase AC system)
- Un-interruptible power supply (400V, 3 phase AC system)
- Emergency power supply (400V, 3 phase AC system)

d) The Electrical Systems input power will be provided from Department and the facility level (ASU plant electrical systems) shall be designed for satisfactory operation for 33kV +6% to -9% with NGR. The facility multi voltage levels of HT & LT shall be designed as per the electrical standards and the voltage and frequency variations are within the limits without affecting the equipment.

1.4.7 POWER SUPPLY CONSIDERATIONS

The following design consideration shall be considered as per the ASU process requirements and operational redundancy philosophy

Design basis	HT power	HV/MV power	LT power	Emergency (LT power) *
No of Line feeder intake	2 (Dept)	1+1	1+1	1
Nominal voltage	33 KV, 3 Phase AC	11 KV / 6.6 kV / 3.3kV, 3 Phase AC	415 V, 3 Phase AC	415 V, 3 Phase AC
Frequency	50 Hz	50 Hz	50 Hz	50 Hz
<i>*DG power supply shall be considered in case of power failure to bring the system in safe state.</i>				

The voltage level for motors shall be as follows or as required for the process:

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a	Up to 0.2 KW :	Single phase 240V AC / 3 phase 415V AC supply
b	Above 0.2 KW and upto 150 KW :	3 phase, 415V AC supply
c	Above 150 KW and upto 1000 KW:	3 phases, 3.3kV/6.6kV/11 kV AC supply
d	Above 1000 KW :	3 phase, 11 kV AC supply

1.4.8 ELECTRICAL SYSTEMS DESIGN CONSIDERATIONS & PHILOSOPHY

- Design Philosophy:
 1. Substation to cater the high demand arising out of air-conditioning, lighting and equipment load for each facility.
 2. Adequate redundancy shall be incorporated throughout the power distribution. One feeder fails/one transformer fails/one DG fails / one UPS fails then other feeder should take over the loads within a stipulated change over time. For critical applications, loss of power is not acceptable.
 3. Electrical safety and Protections need to be incorporated in the design and implemented in the circuits for personnel and equipment safety as per standards. The protection grading need to be studied using software simulations and then arrive at the selection of relay and its setting so as to trip the downstream panel first near to the load end.
 4. All electrical equipment should have safety interlocks both mechanical & electrical with fail-safe operations to be followed in the circuits.
 5. All electrical equipment and items need to withstand for saline atmosphere/ Sea shore environment and ambient temperature of 50 deg Centigrade with 99%of RH.
 6. All cables / wires shall be minimum flame retardant and halogen free or better type cables to be considered to meet the usage of each facility as per the safety norms.
 7. The UG cables are XLPE insulated or special cables with multi stranded aluminium and copper conductors (armoured & unarmoured). All cables which are used inside the facility are copper only and the insulation and sheaths shall be suitable to various applications in each facility.

8. Cable trench/ cable vertical shaft/ cable trays/ cable tray in the false floor /cable tray in the false roof/ cable entry to the facility/Hume pipes with manhole provision for cable crossings/ cable entry in the hazardous area / steel infill access floor in the panel rooms are envisaged.
9. The size of the rooms for Transformers, HT panels, MV/LT panels, bus ducts, DG sets with day tanks, UPS with battery bank, master control room to be arrived based on the capacity of the panels, heat dissipation, sufficient space for maintenance, easy replacement & expansion. Equipment & personnel safety and future expansion of the Equipment etc shall be followed as per IE rules, CEA norms and latest standards.
10. All bus bars, cables, wires and internal electrical equipment shall be high grade copper.
11. Battery bank shall be isolated with the main equipment and separate room with control, monitor and data logging provision to be considered.
12. Minimum two times the rating of arrived full load for the feeder's, switchgears and other power components to be considered.
13. Dedicated iMCC and VVVF drive panels for various mechanisms and process equipment are envisaged.
14. All motors shall be class F insulation and temperature rise shall be limited to class B or better. Special coating like non-hygroscopic coatings, suitable for operation near sea shore environment.
15. All motors are to be selected for VVVF dual drive applications with protective panel.
16. Special equipment's like isolation transformer, active and passive filters are required for harmonics suppression at load end and substation level. Maintain the Power quality for entire plant as per standards.
17. Surge protection devices to be incorporated in the circuit for utility and sub secondary levels.
18. Isolated barriers to be incorporated by bifurcating hazardous and non-hazardous locations.
19. All electrical equipment used in the hazardous area should be explosion proof / flame proof equipment or intrinsic safe circuits for control.

20. All light fittings shall be of high energy efficient and aesthetic. The building management shall be considering for saving energy.
21. Illumination system shall meeting the proper LUX level requirement of process, office, testing lab, control room, tank bay, road, surveillance and substation etc. The illumination system calculation for shall be carried out by using latest software's like DIALUX and AGI32.
22. Aviation illumination system for high raised facilities like lightning protection and where ever applicable as per latest ICAO regulations.
23. Power outlets shall be considered for different capacities and different locations in each facility for various equipment and along the process area, pipe lines and high raised towers etc. The selection of the Power outlets shall be suitable for various applications.
24. Automation for both external and internal electrification is envisaged with suitable SCADA. Remote commanding, monitoring & logging provision to be provided. The control, monitoring and data logging of substation & facility level parameters need to be extended to remote location (12km away from the launch pad site) if required.
25. Isolated or integral lightning protection system for each facility to be considered.
26. Grid Earthing, grounding and shielding to be followed for various equipment used in substation and facility are:
27. Separate Earth Pit for Body /power, Static Earth Pit for Storage Tanks & pipes / personnel, Instrumentation pit for low-power instrumentation, safety pit for pyro equipment, lightning pit for lightning Protection, neutral pit for transformers, DG sets and isolation transformers. The Transient Earth Clamp shall have connected to each earth pit with reference earth pit.
28. Substation earthing equipment and its associated systems to be considered for personnel and equipment protection.
29. Preparation of technical reports such as single/one-line diagrams, schematic diagrams, GA drawings, power flow analysis, ampacity calculations, short circuit & Arc studies, voltage drop calculations, reliability analysis (FMECA), protection coordination and grounding analysis etc using

different software's like CAD, ePLAN, ETAP, MATLAB etc. Maintenance manuals, procedures and check list for the electrical equipment in substation and facility levels.

30. Generation of factory & site acceptance test reports and QA plans as per relevant standards with latest amendments, as built documents, selection of the equipment, procedures for execution of electrical equipment and CEA approval documents.
 31. Preparation of substation layouts, SLDs, equipment layouts, GA drawings, schematic drawings, auto changeover schemes, Automation architecture for Power control, monitoring and logging, Illumination drawing layouts, Cable routing drawing layouts, Cable tray drawing layouts, earthing drawing layouts, lightning protection drawing layouts, maintenance procedures for various equipment in substation and each facility.
 32. All panels should be totally type tested panels as per standards. The panels stage and final inspections shall be carried out at OEM premises only.
 33. Substation and facility equipment like Vacuum Circuit Breaker, Vacuum Interrupter, Air circuit breaker, Numerical Relay, Merging units, Ring Main Units, HT panels, MV panels, LT Panels and Automation should be from same OEM.
- All electrical systems under this RFP shall be designed and engineered in accordance with the latest applicable IEC, IS, IEEE, and CEA standards and codes, including all relevant amendments in force at the time of design approval. In case of conflict between two standards, the more stringent requirement shall prevail, ensuring safety, reliability, and suitability for continuous ASU plant operation.
 - The design shall fully comply with the Central Electricity Authority (CEA) Regulations, Electrical Safety Rules, and all other statutory provisions applicable to high-voltage and low-voltage installations in India.
 - All electrical systems shall be designed with clear segregation of essential, non-essential, and safety-critical loads. Essential and safety-critical loads shall have dual incomers, redundant feeders, and automatic source transfer provisions.

The classification shall form the basis for UPS, DG, and emergency shutdown design philosophy to ensure uninterrupted operation of ASU process systems.

- System voltage ratings, short-circuit levels, and equipment insulation coordination shall be finalized during detailed engineering to ensure operational compatibility with the ASU process loads.
- The Electrical Systems input power will be provided from Department and the facility level (ASU plant electrical systems) shall be designed for satisfactory operation for 33kV +6% to -9% with NGR. The facility multi voltage levels of HT & LT shall be designed as per the electrical standards and the voltage and frequency variations are within the limits without affecting the equipment.
- The electrical system design shall incorporate appropriate earthing, fault protection, interlocks, and automatic transfer features to ensure personnel safety, equipment protection, and continuous power availability to critical ASU loads.
- In case of installations involving storage or handling of fuels (Diesel Generator systems, fuel tanks, or oil-immersed transformers), all designs and layouts shall comply with PESO guidelines and licensing requirements. Necessary PESO approvals shall be obtained prior to commissioning.
- The design shall ensure that all electrical installations are suitable for continuous process operation of ASU plants, with redundancy, fail-safe operation, and smooth switching between sources (grid/DG/UPS).
- The design shall ensure high power quality and system stability under variable load conditions, maintaining:
 - ✓ Total Harmonic Distortion (THD) $\leq 5\%$ for voltage and $\leq 8\%$ for current
 - ✓ Power factor ≥ 0.98 at PCC during normal operation (APFC shall be considered if required)
 - ✓ Voltage unbalance $\leq 2\%$ across phases
 - ✓ Frequency variation $\leq \pm 5\%$ of nominal (under normal conditions)
- Appropriate harmonic filters, isolation transformers, or VFD harmonic mitigation measures shall be incorporated where ever required.
- Electrical layouts and SLDs shall be developed to ensure selective fault isolation and redundant supply paths to critical process and safety systems.

- The design shall ensure compliance with fire protection and explosion safety requirements. Flameproof equipment shall be provided for hazardous zones (if any), conforming to IS/IEC standards.
- All designs shall consider environmental conditions such as high humidity, saline atmosphere, and ambient temperature up to 50°C. Adequate ventilations, protection, and corrosion-resistant materials shall be incorporated.
- The design shall provide for operational flexibility through sectionalized busbars, inter-panel couplers, and bypass schemes, enabling maintenance without shutdown of essential plant operations.
- All control and monitoring systems (relays, meters, UPS, DG, transformers) shall be SCADA-integrated with appropriate communication protocols (IEC 61850 / Modbus TCP IP) for remote supervision and diagnostics.
- Earthing and lightning protection systems shall be designed per IS 3043, ensuring safe dissipation of fault and surge energies while maintaining equipotential bonding across the installation.
- Lighting and small power systems shall be designed to achieve uniform illumination and energy efficiency, ensuring compliance with IS standards.
- All designs shall include adequate space for future expansion (typically **25%** spare feeder capacity) in panels, bus ducts, and cable trenches to accommodate process augmentation.
- The design shall include clear interface definitions between electrical, civil, and mechanical systems, including foundations, cable entries, oil containment, and ventilation paths.
- Design documentation shall identify testing provisions and access points for relay calibration, protection testing, and cable insulation verification as part of pre-commissioning checks.
- The design shall integrate safety interlocks and ESD (Emergency Shutdown) logic for all critical power systems, enabling safe and orderly plant shutdown during emergency or power failure.
- All materials, clearances, and mechanical designs shall ensure seismic withstand capability corresponding to Seismic Zone III (or higher as applicable).

- All drawings, data sheets, and design documents shall be prepared in metric units and follow a uniform title block and revision control system as defined under this RFP.
- The final design shall ensure ease of maintenance, modularity, and operator safety, supporting long-term reliability and uninterrupted ASU plant operation.
- Electrical design shall include suitable starting arrangements for large compressors, blowers, and turbo expanders using soft starters, VFDs ensuring minimal voltage dips, mechanical stress reduction, and smooth process operation with redundancy and ride-through protection.
- The electrical design shall be coordinated with OEM-supplied process equipment such as compressors, expanders, control packages and etc to ensure compatibility of motor ratings, starting torque, harmonics, and interlocks. The Contractor shall obtain and incorporate OEM electrical data and interface requirements during detailed engineering.
- Dedicated UPS or emergency DG-backed feeders shall be provided for refrigeration compressors, cryogenic pumps, valve actuators, and heating circuits (defrost/warm-up) to prevent freezing and maintain controlled shutdown in case of power interruption as per OEM philosophy.
- Electrical systems shall interface seamlessly with plant safety systems for controlled emergency shutdowns. All interlocks and trip circuits shall be hard-wired, fail-safe, and segregated from power circuits in compliance with IEC 61511 safety integrity standards.
- Sensitive loads associated with cryogenic and oxygen handling systems shall be protected through enhanced surge protection, lightning arresters, and transient suppression devices coordinated as per IEC 61643, ensuring plant-wide voltage surge immunity.
- To counter non-linear loads from VFDs and large drives, the system shall include harmonic filters, reactive power compensation, and power factor correction to maintain voltage THD $\leq 5\%$ and PF ≥ 0.98 at the point of common coupling, as per IEEE 519 and IEC 61000.

- Automatic load shedding logic shall be implemented to isolate non-essential loads during supply limitations while ensuring uninterrupted power to critical process and safety systems. Coordination with DG/UPS controllers shall be ensured for seamless operation.
- Electrical architecture shall adopt dual incomers, dual feeders, and bus couplers for essential systems. Auto-changeover and manual bypass shall be included to enable maintenance or fault isolation without affecting ASU plant operation.
- Design shall account for adequate ventilation to transformer, panel, and air conditioning to UPS rooms for maintaining safe temperature rise limits. HVAC loads shall be considered in electrical sizing and redundancy calculations.
- All systems shall incorporate high-efficiency transformers (As per IS 1180 highest efficiency standards), LED lighting, low-loss cables, and demand management features. Energy meters shall record harmonics, demand, and load profiles for performance optimization and energy audits.
- Electrical systems shall support continuous monitoring of breaker operations, transformer temperature, UPS health, and DG data. Predictive maintenance algorithms and digital dashboards shall be used for early fault detection and system reliability enhancement as per OEM philosophy.
- All electrical systems shall communicate with the plant SCADA for status, alarms, and control commands. Critical trip and interlock signals shall be hardwired for fail-safe operation, while monitoring and diagnostics shall be integrated through standard protocols such as IEC 61850 or Modbus TCP/IP.
- Wherever electrical equipment is located in classified hazardous zones, it shall be of explosion-proof construction suitable for Zone 1 or Zone 2 as applicable, certified by BIS, PESO, or IECEx. Cable glands, junction boxes, and accessories shall also conform to the same protection classification and certification standards.
- Electrical metering and SCADA systems shall support monitoring of voltage, current, power factor, harmonics, and energy trends for all major feeders. Provisions shall be made with Energy Management System (EMS) to enable load optimization and energy efficiency reporting.

- The design of all electrical rooms, control rooms, UPS and battery rooms, transformer bays, and DG enclosures shall consider fire detection and suppression systems in accordance with the requirements and terms defined under the Fire Detection and Alarm (FDA) section of this RFP.
- Major electrical panels such as HT panels, PCCs, MCCs, UPS panels, and control desks shall be provided with automatic fire suppression systems (clean agent type – Novec 1230 / FM-200 or equivalent) wherever applicable, designed and installed as per NFPA 2001 and NFPA 70 (NEC) guidelines, ensuring protection without damaging live electrical equipment.
- Transformer and DG areas shall be equipped with localized fire detection and extinguishing provisions, including portable CO₂ extinguishers, fire-rated barriers, and spill containment measures, conforming to NFPA 850 and IS 2190 standards.

1.4.9 DESIGN DELIVERABLES

A. Preliminary Design Deliverables

1. Preliminary design shall cover all essential activities for establishing the conceptual configuration and baseline engineering of the complete electrical system for the ASU plant, integrating process, utility, and auxiliary power requirements.
2. The designer shall finalize the list of process and utility equipment along with their electrical loads, duty cycles, and criticality to establish the electrical load summary and diversified demand for the entire plant.
3. Based on the consolidated load data, preliminary studies shall be carried out to determine supply voltage levels, redundancy requirements, transformer capacities, and ratings of HT/LT equipment.
4. Preparation and finalization of preliminary Single Line Diagrams (SLDs) covering HT and LT distribution, DG and UPS interconnections, and source changeover philosophy, redundancy at all levels and ensuring supply continuity for essential and shutdown loads.

5. Preparation of preliminary schemes showing configuration of HT panels, LT panels, DG synchronization logic, UPS input/output connections, and essential load segregation.
 6. Development of equipment layout drawings for HT panel rooms, transformer bays, DG rooms, UPS rooms, cable trenches, and auxiliary areas, in coordination with civil and mechanical teams.
 7. Based on the layouts, freezing of electrical room dimensions, floor load-bearing capacities, and structural reinforcements required for heavy equipment such as transformers, panels, and DG sets.
 8. Preparation of preliminary cable trench and duct bank layouts, including routes for HT, LT, and control cables, ensuring segregation, ventilation, and accessibility for maintenance.
 9. Preliminary lighting and earthing system schemes, indicating illumination levels, fixture types, earthing pit locations, lightning protection coverage, and interconnections.
 10. Preparation of preliminary protection and interlock philosophy, including relay hierarchy, tripping logic, and load transfer sequences to ensure safe and fail-proof operation.
 11. Finalization of preliminary FAT and quality procedures applicable for major equipment during detailed design and manufacturing, in consultation with OEMs and as per the department requirements.
 12. Development of a Preliminary Design Basis Report (DBR) summarizing design assumptions, standards applied, short-circuit level estimates, redundancy strategy, and system configuration.
 13. Submission of all preliminary deliverables for Department review and approval before commencement of detailed engineering.
- B. Detailed engineering Design Deliverables
1. Detailed engineering shall build upon the approved preliminary design and shall cover all analytical studies, final equipment design, documentation, and coordination with OEMs and Department representatives.
 2. Execution of detailed electrical system studies, including load flow, voltage drop, short-circuit, harmonic analysis, protection coordination from source substation

to ASU equipments, and earthing grid calculations in line with RFP requirements.

3. Finalization of equipment sizing, selection, and detailed technical specifications for all HT/LT panels, transformers, DG sets, UPS systems, bus ducts, cables, earthing, and lighting systems.
4. Preparation and submission of Guaranteed Technical Particulars (GTPs) and detailed data sheets for each equipment item, based on OEM inputs and verified against RFP specifications.
5. Preparation of final equipment GA drawings, foundation loads, and interface drawings for approval, incorporating clearances, access paths, and mechanical/civil coordination.
6. Submission of final SLDs, protection and control schemes, interlocking diagrams, wiring and termination drawings, and SCADA interface drawings.
7. Detailed cable sizing, routing, and voltage drop studies, including final cable schedules, tray/trench layouts, and gland/termination details.
8. Preparation of detailed QAP for each major equipment category, defining inspection stages, FAT/SAT scope, witnessing points, and acceptance criteria.
9. Development of Factory Acceptance Test (FAT) and Site Acceptance Test (SAT) procedures for all major systems, including transformers, panels, UPS, DG sets, and cables, as per approved QAP.
10. Coordination with OEMs for submission of detailed design documents, type/routine test certificates, SCADA integration data, and software/hardware interface lists.
11. Preparation of bill of quantities (BOQ) and bill of materials (BOM) for procurement based on finalized designs and OEM submissions.
12. Preparation of earthing and lightning protection layouts with calculated conductor sizes, pit locations, lightning protection coverage zones, and interconnections.
13. Finalization of lighting and small power distribution layouts, detailing circuit grouping, illumination levels, emergency circuits, and UPS-backed connections.

14. Detailed SCADA and automation documentation, including I/O lists, communication architecture, network topology, and cybersecurity considerations.
15. Development of testing and commissioning plans covering all systems and defining pre-commissioning checklists, inspection formats, and test acceptance criteria.
16. Preparation of as-built templates and documentation structures for drawings, QAP records, FAT/SAT reports, and commissioning dossiers.
17. Final Design Document Package shall include:
 - a. Approved SLDs, GA drawings, and interconnection diagrams.
 - b. Electrical calculations (load flow, short circuit, voltage drop, relay coordination).
 - c. Equipment data sheets and GTPs.
 - d. Layouts for panels, rooms, trenches, and earthing systems.
 - e. QAP and FAT/SAT procedures.
 - f. Protection logic and communication schematics.
 - g. Test and inspection formats.
 - h. The finalized detailed design shall form the basis for procurement, fabrication, installation, testing, and commissioning of all electrical systems for the ASU plant.
 - i. The design deliverables shall be reviewed and approved by the Department and any deviations from RFP specifications shall require written justification and prior approval.
 - j. All final submissions shall be provided in editable CAD and PDF formats, organized in a structured electronic index, forming part of the project's permanent engineering record.

1.4.10 LIST OF DRAWINGS

A. Single line diagrams:

1. Over all electrical one-line diagram.
2. Single line diagram for HV& MV Switchgears.

3. Single line diagram for LV Switchgears.
4. Single line diagram for DG power distribution.
5. Single line diagram for UPS power distribution.
6. Single line diagram for DC Charger.
7. Auxiliary supply distribution, lighting & receptacle panels single line diagram.
8. Substation lighting & receptacle panel single line diagram.

B. Electrical circuit diagrams:

1. Typical standard drawings for HV/MV motor starter control circuit diagrams.
2. Typical standard drawings for LV Motor starter and feeder control circuit diagrams.
3. Typical standard drawings for control station circuit diagrams.

C. Electrical interconnection diagrams:

1. Electrical / Instrument inter connection diagram.
2. HV, MV&LV switchgears wiring interconnection diagrams.
3. UPS & DC chargers wiring inter connection diagram.
4. Variable speed drives/Power converters wiring interconnection diagram.

D. General lists & Schedules:

1. Electrical load schedule.
2. Electrical cables schedule.
3. Communication Cable Schedule.
4. MV & LV switchgear schedules.
5. Electrical cables drum index/schedule.
6. Communication cables drum index/schedule.
7. Motor control philosophy schedule.
8. Local control stations schedule.
9. PDCSI/O list.
10. Logic diagram for offered systems.

11. General arrangement drawing of electrical equipments having connection points of earthing, electrical and control cables.
12. Catalogued information for all electrical system, equipment and materials.

E. Technical datasheets:

1. Data sheet for HV, MV & LV switchgears and TTA panels.
2. Data sheet for power transformers.
3. Data sheet for DG SET.
4. Data sheet for UPS.
5. Data sheet for DC battery charger.
6. Data sheet for electrical cables.
7. Data sheet for LV variable speed drive.
8. Datasheet for LV, MV & LV electric motors.

F. Layouts & Drawings:

1. Underground cable routing.
2. Cable tray/ ladder routing.
3. Cable laying layout.
4. Earthing layout.
5. Heat tracing layout
6. Substation equipment arrangement Layout.
7. Substation cable laying layout.
8. Substation cable routing arrangement of views/sections.
9. Substation earthing layout.
10. Substation lightning protection layout.
11. Fixing and installation details for all electrical works, such as cabling.

1.4.11 LIST OF APPLICABLE STANDARDS FOR ELECTRICAL SYSTEMS

- All design, engineering, manufacturing, testing, installation, and commissioning of electrical systems under this RFP shall conform to the latest

applicable IS and IEC standards, IEEE and CEA regulations, and other recognized international codes relevant to ASU plants.

- In case of any conflict between two standards and the specifications of this RFP the more stringent requirement shall prevail, subject to Department approval. If any standard or code is not specifically mentioned in this RFP, the corresponding and most recent relevant IEC standard shall be followed to ensure safe, reliable, and continuous operation of the ASU plant.

S. No	Description	Applicable Standard / Code
1	General wiring, design, and installation practices	IS 732 / IEC 60364
2	Earthing and grounding of electrical systems	IS 3043 / IEEE 80
3	Selection and installation of switchgear	IS 10118
4	Safety and electric supply regulations	CEA Regulations
5	Rotating electrical machines	IS 325 / IEC 60034
6	Power capacitors and reactive power systems	IS 900 / IS 12360
7	Electrical equipment for industrial machinery	IEC 60204-1
8	National Building Code – electrical provisions	NBC 2016 (Part 8)
9	High voltage switchgear and controlgear	IEC 62271 series
10	Low voltage switchgear and controlgear	IEC 60947 series
11	LV panel assemblies (PCC, MCC, IMCC)	IEC 61439
12	Internal arc classification for switchgear	IEC 62271-200
13	Contactors and motor starters	IEC 60947-4-1
14	MCCBs and ACBs – performance and testing	IEC 60947-2
15	Power transformers – general requirements	IS 2026 / IEC 60076
16	Distribution transformers	IS 1180
17	Transformer oil – inhibited type	IS 335 / IEC 60296

S. No	Description	Applicable Standard / Code
18	XLPE insulated HT/LT power cables	IS 7098 (Part 1 & 2)
19	Conductors for insulated cables	IS 8130 / IEC 60228
20	Lightning and surge protection systems	IEC 62305 / IS 2309 / IEC 61643
21	Lightning and earthing components (EEC, clamps)	IEC 62561 series
22	Permanent connections for earthing	IEEE 837
23	DG set performance and testing	ISO 8528 / IS 10001
24	DG emission and acoustic limits	CPCB / CEA Norms
25	UPS systems – performance and testing	IEC 62040
26	Li-ion batteries – safety and transport	IEC 62619 / UN 38.3
27	Battery maintenance and testing	IEEE 1184
28	DC control wiring and cables	IS 1554 / IS 694
29	Lighting design and illumination levels	IS 3646
30	Luminaire construction and testing	IS 10322 / IEC 60598
31	Street and industrial lighting fittings	IS 1913
32	Electrical installations in hazardous areas	IEC 60079 series
33	Energy-efficient motors (IE3 / IE4 class)	IEC 60034-30
34	Harmonics and power quality limits	IEEE 519
35	Protection relays and measuring systems	IEC 60255
36	Substation automation and communication	IEC 61850
37	Protection coordination in power systems	IS 3231 / IEEE 242

S. No	Description	Applicable Standard / Code
38	Electromagnetic compatibility (EMC)	IEC 61000 series
39	Quality, environment, and safety management	ISO 9001 / ISO 14001 / ISO 45001
40	Energy conservation in lighting systems	ECBC / NBC Part 8
41	Electrical safety procedures for O&M	IS 5216 (Part 1 & 2)
42	Fire and explosion proof equipment	IS 15382 / IS 14665
43	Safety audit and occupational health	IS 14489
44	Department Quality Assurance Plan	Department QAP / TPI Guidelines

1.4.12 TECHNICAL SPECIFICATIONS

1.4.12.1 HT PANELS

1. HT panels shall be designed, manufactured, assembled, and tested in accordance with the latest editions of IEC 62271 series with all latest amendments.
2. Switchgear shall be metal-clad, draw-out, fully compartmentalized indoor type, with separate and segregated compartments for busbars, circuit breakers, cables, and control wiring.
3. The switchgear shall comply with the Internal Arc Classification (IAC) as per IEC 62271-200, with minimum rating of IAC AFLR for 1 second, ensuring operator safety during internal faults.
4. All panels shall be type-tested for temperature rise, dielectric strength, short-time withstand, peak withstand, and making/breaking capacities as per IEC 62271-100 / 62271-200. Type-test certificates shall be provided for department review during drawing approval

5. The system rated voltage, insulation levels, and short-circuit capacity shall be finalized during detailed engineering. However, equipment shall be designed to withstand at least 25% higher fault levels than the calculated value.
6. Vacuum Circuit Breakers (VCBs) shall be provided as interrupting devices, meeting the mechanical endurance class M2 and electrical endurance class E2 per OEM recommendations and IEC standards.
7. Busbars shall be electrolytic copper, tinned, and rated for continuous current with 30% spare thermal margin and adequate short-time withstand capability for at least 1 second and as decided during detailed engineering.
8. The busbar supports and insulation system shall withstand thermal and mechanical stresses during fault conditions without displacement or deformation.
9. The busbars shall be supported with high-strength, non-hygroscopic, flame-retardant insulating supports and shall have uniform potential grading across the assembly.
10. The minimum degree of protection shall be IP4X for the external enclosure and IP2X for internal compartments. Enclosures shall be vermin-proof and corrosion-resistant.
11. Each panel shall be provided with mechanical interlocks between the breaker, earthing switch, and racking position to prevent unsafe operations.
12. Each cubicle shall be provided with earthing switches of make-before-break type, with visible indication, operable only when the breaker is in the test or isolated position.
13. Cable terminations shall be bottom-entry type, suitable for armoured XLPE cables, with adequate space for cable bending radius, cable supports, and termination lugs.
14. Numerical relays complying with IEC 60255 / IEC 61850 shall be used for all protection, control, and interlocking schemes. Relays shall have event recording, disturbance recording, and communication ports for SCADA integration.

15. All relays, meters, and Intelligent Electronic Devices (IEDs) shall be communicable over IEC 61850 or Modbus TCP/IP protocols, with redundant ports to ensure SCADA interoperability and data reliability.
16. The Incomers shall be provided with digital Power Quality Meter (class -S PMD) with digital ammeter & digital voltmeter. All outgoing feeders shall be provided with digital Multifunction Meter with communication protocol and shall be communicated to ASU SCADA systems as required.
17. Control wiring shall be tinned copper, FRLS/LSZH insulated, properly ferruled and numbered, and routed neatly with PVC sleeves. All control terminals shall be front-accessible.
18. Breakers shall be motorized, electrically operated, with spring-charged mechanisms, anti-pumping and trip-free features, suitable for remote/local control.
19. Auxiliary circuits shall operate on 110V / 230V AC or 24V DC as per scheme, with redundancy in control supplies through dual chargers and battery backup or as per the other systems control philosophy under ASU.
20. Panels shall include space heaters with thermostatic control, internal illumination lamps, and maintenance sockets to ensure safe operation in high-humidity environments.
21. The structure shall be made of cold-rolled steel, minimum 2.0 mm thickness, with epoxy polyester powder coating (minimum 80-micron DFT) suitable for coastal industrial atmosphere.
22. Each panel shall be provided with nameplates, feeder identification tags, mimic diagrams, and engraved labels for all instruments and terminals.
23. CTs and PTs shall conform to IEC 61869 series, with metering and protection cores of appropriate accuracy classes (0.2s/0.5s/ 5P / 10P), and rated burden as per design and guidelines given by department during detailed engineering.
24. Instrument transformers shall be easily accessible for testing and maintenance, with shorting links provided for secondary terminals.
25. Switchgear shall be designed for future extensibility, allowing addition of panels on either side through plug-in busbar joints and removable covers without major shutdown.

26. Panels shall be designed and tested for seismic withstand, ensuring no displacement or mechanical damage under seismic zone III conditions or higher, as applicable.
27. All HT and LT panels shall be designed considering arc fault containment and shall include pressure-relief flaps, interlocks, and safety shutters. Arc flash energy levels shall be limited by design coordination, and warning labels shall be provided at all switchgear locations as per IEEE 1584 recommendations.
28. The complete assembly shall undergo Factory Acceptance Testing (FAT) as per the approved QAP, including breaker functional checks, relay configuration, communication verification, interlock simulation, and insulation testing as per the IEC standards.
29. Site Acceptance Tests (SAT) shall include IR measurement, secondary injection testing of relays, functional tests of interlocks, remote operations, and SCADA data verification.
30. The HT switchgear shall be fully integrated into the ASU SCADA System, providing breaker status, trip alarms, voltage, current, load, energy parameters, and event logs and as required for the department.
31. The design shall ensure that all protection and control functions can be operated manually during SCADA failure or maintenance.
32. The HT switchgear assembly shall include spare VCB truck, 10% spare control fuses, spare auxiliary relays, one set of CT/PT shorting links, five set of indicator lamps, and one set of plug-in relay test blocks as standard spares.
33. In addition, a set of breaker control coils, spring-charging motor, closing/tripping coils, auxiliary contacts, and cable terminations shall be supplied as mandatory spares for each breaker type.
34. All drawings, protection logic diagrams, relay setting sheets, and communication configuration files shall be provided in editable and PDF formats before dispatch for Department approval.
35. The entire HT panel system shall be designed to operate reliably under ASU plant load variations, including process load fluctuations, DG synchronization, and UPS source transfer conditions.

36. The offered panels shall be from approved OEMs listed in the RFP annexure, with proven installations in industrial substations of similar capacity and duty.
37. All workmanship, wiring, finishing, and assembly shall comply with high-quality industrial standards, ensuring long operational life, low maintenance, and easy accessibility.

1.4.12.2 POWER TRANSFORMERS

1. Power transformers shall be designed, manufactured, and tested in accordance with the latest editions of IS 2026, IEC 60076 series, IS 1180, and all applicable CEA and statutory regulations.
2. Transformers shall be either oil-immersed (ONAN / ONAF) or dry-type cast resin as finalized during detailed engineering, based on ASU plant layout, location constraints, and process requirements.
3. Transformers shall be of outdoor or indoor type, naturally cooled, with provision for forced air cooling if required. Cooling class shall be indicated clearly (ONAN / ONAF / AN / ANAF).
4. The design of transformers under this RFP shall ensure continuous duty, suitable for ASU process loads with high reliability and minimum maintenance requirements.
5. Each transformer shall be rated for continuous operation at rated kVA, capable of handling 110% overload for one hour as per IEC 60076 without exceeding permissible temperature rise limits.
6. Transformers shall be designed for site ambient temperature up to 50°C, high humidity, saline atmosphere, and dusty industrial environment with Class F insulation or better.
7. The rated voltage ratio and vector group shall be finalized during detailed engineering.
8. Impedance percentage shall comply with IS / IEC recommendations and shall be selected to ensure system short-circuit levels and voltage regulation remain within acceptable limits.
9. Each oil-immersed transformer shall be equipped with On-Load Tap Changer (OLTC) having motorized drive, automatic voltage regulation (AVR), tap

position indicator, and remote/local control facility and first filling of the oil with 10% extra is included in the scope.

10. Dry-type transformers, where used, shall be cast resin type with Class F or H insulation, low partial discharge (<10 pC), and self-extinguishing resin. Cooling shall be natural or forced air type with temperature sensors for each winding.
11. Transformer core shall be made of cold-rolled, grain-oriented (CRGO) silicon steel or equivalent amorphous material, designed for minimum core losses and magnetostriction.
12. Windings shall be made of electrolytic grade **copper**, continuously transposed, paper-insulated for oil-filled and resin-cast for dry-type transformers, with robust axial support against short-circuit forces.
13. The tank and structure shall be fabricated from mild steel of adequate thickness, provided with lifting lugs, drain valves, and inspection covers. The tank shall be designed for pressure relief and vacuum withstand as per IS 2026.
14. Oil preservation system shall be of conservator type with oil-level gauge, breather (silica gel / dehydrating type), and Buchholz relay for oil-immersed units.
15. Transformers shall include temperature and protection devices such as winding RTDs, oil temperature indicator (OTI), winding temperature indicator (WTI), pressure relief device, and magnetic oil level gauge (MOG).
16. All sensors, indicators, and protection devices shall have potential-free contacts wired to the local marshalling box and connected to SCADA for remote status, alarms, and trip signals.
17. Each transformer shall be provided with high-voltage surge arresters conforming to IEC 60099-4, connected between HV terminals and earth if required and as decided during detailed engineering.
18. The tank and radiators shall be hot-dip galvanized or epoxy-polyurethane painted, minimum 100-micron dry film thickness, suitable for coastal and humid conditions.
19. Noise level shall not exceed CPCB / IEC limits for industrial installations. Acoustic treatment or barriers shall be provided where transformers are close to control areas.

20. Transformers shall be designed for short-circuit withstand capability in accordance with IEC 60076-5. The manufacturer shall submit short-circuit withstand and impulse test type certificates.
21. Neutral earthing shall be through a solid grounding as per system design, with coordination to protection settings.
22. For oil-immersed transformers, oil quality shall conform to IS 335 / IEC 60296, inhibited type. Test certificates for dielectric strength, moisture content, acidity, and tan delta shall be submitted before dispatch.
23. Oil-immersed transformers shall be provided with oil containment pits, drain valves, and fire barriers as per IS 10028 and NBC. Transformer yards shall include fire detection and extinguishing arrangements in line with statutory fire protection codes. Dry-type transformers shall be preferred where indoor installation is required.
24. Transformers shall include marshalling boxes with terminal blocks, control wiring, space heaters, illumination lamp, and thermostatic control. All field terminations shall be accessible and clearly identified.
25. Current transformers (CTs) for protection and metering shall be mounted in the marshalling box or LV chamber, with shorting links and test terminals.
26. All transformer parameters such as voltage, current, power, frequency, winding and oil temperature, tap position, and alarms shall be integrated into the SCADA system for monitoring and diagnostics.
27. Factory Acceptance Test (FAT) shall include ratio test, insulation resistance, winding resistance, vector group, induced over-voltage, applied high-voltage, no-load and load loss measurement, temperature rise test, and OLTC operation tests.
28. Site Acceptance Test (SAT) shall include oil testing, IR measurement, winding resistance, polarity verification, and functional check of all accessories, protection devices, and SCADA signals.
29. All routine, type, and special test certificates shall be furnished for Department approval. Type-test certificates shall not be older than five years for offered design.

30. Transformers shall be supplied complete with first fill of oil (for oil-immersed type), dehydrating breather, radiators, valves, thermometers, tap-changer drives, foundation bolts, and all accessories.
31. All transformers shall be supplied with GA drawings, foundation load data, oil quantity details, earthing connections, and control wiring schematics, duly approved before dispatch.
32. Each transformer shall have unique nameplates with rating, impedance, vector group, cooling class, serial number, year of manufacture, and reference to type-test report.
33. The design shall ensure ease of maintenance, long operational life, and compatibility with SCADA and DCS systems of the ASU plant for monitoring, fault diagnosis, and predictive maintenance.
34. All offered makes shall be from approved OEMs listed in the RFP annexure with minimum five years of proven industrial service record.

1.4.12.3 BUS DUCTS AND BUSBAR TRUNKING SYSTEMS

1. Bus ducts and busbar trunking systems shall be designed, manufactured, and tested in accordance with the latest editions of IEC 61439.
2. The design of bus ducts under this RFP shall be suitable for interconnection between transformer secondary terminals and main PCC panels, and for other inter-panel connections as required in the ASU substation layout.
3. Bus ducts shall be of non-segregated or segregated phase type, indoor or outdoor as applicable, with fully enclosed metallic housing ensuring personnel safety and operational reliability.
4. Conductors shall be of high-conductivity electrolytic grade copper, silver/tin plated, conforming to IS 5082, designed to carry rated current continuously without exceeding permissible temperature rise limits.
5. The busbar rating shall be finalized during detailed engineering based on connected transformer and PCC ratings, but shall include minimum 30% spare current-carrying capacity for future expansion and overload tolerance.

6. Busbars and joints shall be rated for short-circuit withstand corresponding to the system fault level with a minimum short-time withstand duration of 1 second and dynamic peak withstand current as per IEC 61439-6.
7. The bus duct enclosure shall be fabricated from cold rolled or aluminium alloy sheet, minimum thickness 2.0 mm, with reinforced structure to prevent deformation during short-circuit stress or handling.
8. The enclosure shall be dust-proof, vermin-proof, and moisture resistant, with ingress protection rating IP55 for outdoor and IP4X for indoor installations.
9. The entire bus duct shall be factory-assembled in modular sections with bolted flanges, neoprene gaskets, and necessary expansion joints to accommodate thermal expansion due to load variations.
10. Bus joints shall be bolted type with high-tensile hardware, spring washers, and Belleville discs to ensure constant pressure. All joints shall be accessible for inspection and maintenance.
11. All live conductors shall be insulated using heat-shrinkable or epoxy coating, with color-coded phases (R-Y-B) and neutral/earth identification per IS 5578 / IS 11353.
12. The neutral conductor, where provided, shall have a cross-sectional area not less than 50% of the phase conductor, and the earth conductor shall have a minimum cross-sectional area of 100% of phase conductor for safety continuity.
13. Earthing bars shall run continuously throughout the length of the duct, bonded to each section with bolted links to ensure equipotential bonding between transformer, duct, and PCC.
14. At building entry or fire zone separation points, fire barriers and sealing arrangements (fire stop putty or ceramic-filled collars) shall be provided to maintain fire integrity of walls/floors as per IEC 60695 and NBC requirements.
15. Bus duct supports shall be independent and self-standing, spaced not more than 1.5 m for horizontal runs and 1.2 m for vertical risers. Structural supports shall be galvanized or epoxy-coated mild steel with vibration isolation pads.

16. The bus duct design shall account for site conditions — ambient temperature up to 50°C, humidity up to 95%, and corrosive coastal air typical of ASU industrial plants.
17. All joints, covers, and gaskets shall be suitable for outdoor exposure and resistant to UV radiation, moisture, and oil contamination.
18. Factory testing shall include visual inspection, insulation resistance, high-voltage dielectric test, phase verification, contact resistance measurement, and dimensional checks as per IEC / IS standards.
19. Site testing shall include continuity, insulation resistance, torque verification of joints, and temperature rise checks under loaded condition during commissioning.
20. The bus duct shall be supplied with all hardware, expansion joints, flexible connectors, gaskets, hangers, supports, fire-sealing kits, and terminal connections to complete the installation between transformer LV bushings and PCC incomers.
21. All metallic enclosures shall be epoxy powder coated (minimum 80-micron DFT) or hot-dip galvanized, with color shade RAL 7032 or equivalent for uniformity with switchgear panels.
22. Each bus duct shall be supplied with GA drawings, sectional views, support details, jointing diagrams, torque specifications, and erection manuals for Department approval prior to installation.
23. The installation of bus ducts shall be carried out under supervision of OEM-certified personnel, and field measurements shall be verified prior to dispatch of final duct lengths.
24. All materials, workmanship, and installation practices shall comply with relevant IS, IEC, and NBC provisions, ensuring operational safety, fire resistance, and maintainability consistent with ASU substation design philosophy.

1.4.12.4 PCC / MCC PANELS

1. PCC and MCC panels shall be designed, manufactured, and tested in accordance with the latest editions of IEC 61439 (Part 1 & 2) and all other relevant standards with latest amendments.
2. The panels shall be factory-fabricated and fully type-tested assemblies (TTA) from approved OEMs, suitable for continuous operation in industrial ASU plant environment, including high humidity, saline air, and continuous process duty.
3. Panels shall be of modular, floor-mounted, cubicle type, fully compartmentalized, front or double-front operated, and designed for ease of extension on either side without major modification and meeting form **3b / 4b** separation as per IEC 61439.
4. The busbar system shall be made of **electrolytic grade copper**, rated for continuous current as per load requirements with 30% spare capacity and short-circuit withstand rating matching the system study results (minimum 1 second duration).
5. The busbars shall be fully insulated or sleeved with heat-shrinkable sleeves to prevent accidental contact and to minimize phase-to-phase clearances.
6. All panels shall be fabricated from CRCA steel sheets, minimum 2.0 mm thickness for structural members and 1.6 mm for compartment covers. Enclosures shall be epoxy-polyester powder coated (minimum DFT 80 microns) in RAL 7032 shade or equivalent.
7. Panel construction shall be fully compartmentalized, with separate busbar, switchgear, cable termination, and control wiring compartments, designed for arc containment and ease of maintenance.
8. Incomer and outgoing feeders shall be equipped with ACBs or MCCBs of suitable ratings, having microprocessor-based releases providing protection, measurement, communication, and event logging. (SFUs will not be accepted)
9. All ACBs & MCCBs shall comply with IEC 60947-2 and shall support communication through Modbus / IEC 61850 / Ethernet TCP/IP protocols for integration with the SCADA system.

10. PCC panels shall have incomers and bus couplers of draw-out ACB type, with mechanical and electrical interlocks to prevent simultaneous closing of incomers.
11. MCC panels shall include fixed / withdrawable starters, DOL / star-delta / soft starter / VFD feeders as per motor ratings and process requirement. Withdrawable modules shall be interlocked for “OFF – Test – Service” positions.
12. Intelligent MCCs (iMCC) shall include intelligent motor controllers, communication gateways, and embedded diagnostics for real-time monitoring of current, voltage, thermal overload, fault history, and operational statistics.
13. VFD panels shall use energy-efficient drives complying with IEC 61800, with built-in protection, EMC filters, and harmonic mitigation as per IEEE 519. Each drive shall have bypass contactor provision to allow motor operation in bypass mode during maintenance.
14. Motor feeders shall include thermal overload relays, fuses, short-circuit protection, and ground fault detection; control wiring shall be FRLS/LSZH copper with proper ferruling and labelling and ratings shall be selected as per type 2 charts of OEMs
15. Each panel shall have a front-accessible control wiring chamber, with tinned copper control wiring (minimum 2.5 sqmm for power control circuits, 1.5 sqmm for signal circuits).
16. Control circuits shall be 230 V AC for general controls and 24 V DC for interlocking, SCADA, and protection signals. Separate DC control supplies shall be provided from redundant DC systems as required and decided during detailed engineering
17. Digital multifunction meters for incomers and all the feeders (Class 0.5s) shall record V, I, kW, PF, frequency, energy, and harmonics.
18. In addition, power quality meters shall be provided on main incomers and DG sources to measure harmonics, transients, dips/swells, and event waveforms.
19. Panels shall have ACB/MCCB releases capable of communication and trip history logging. Protection functions shall include long-time, short-time, instantaneous, and earth fault protection.

20. The system shall support SCADA communication, and all protective, metering, and status data shall be available over Modbus TCP/IP or IEC 61850 network for integration with the central monitoring system.
21. Internal arc protection shall be considered in design, with pressure relief vents, arc-resistant flaps, or fault current limiting where necessary for personnel safety.
22. The minimum short circuit capacity of the panel shall be 70 kA at main PCC levels and 50kA at MCC levels or better as per the design during detailed engineering.
23. Cable terminations shall be bottom/top entry type with gland plates, designed for armoured cables with adequate bending radius, spacing, and identification tags.
24. Bus coupler panels shall be provided between sections for flexibility and shall include automatic or manual changeover as per process requirement.
25. Switchgears shall be selected such that 25% higher rating than required and suitable protection setting shall be degraded where ever required.
26. Each PCC/ MCC section shall have **25%** spare feeders **for each rating** for future expansion, and bus duct/extension provisions shall be included for easy add-on of additional modules.
27. The construction shall ensure that maintenance on one feeder or section does not require shutdown of the entire panel; isolators and test links shall be provided for sectional isolation.
28. Each panel shall have clearly visible mimic diagrams, feeder nameplates, LED indications, and engraved ferrules for all wiring, complying with standard color codes for easy identification.
29. Testing shall be carried out in accordance with IEC 61439 and IS 8623: routine, dielectric, functional, and insulation tests at manufacturer's works (FAT) and pre-commissioning checks at site (SAT).
30. Type test certificates shall be provided for short-circuit withstand, temperature rise, degree of protection, and dielectric strength tests. Certificates shall not be older than 5 years.

31. Each ACB and MCCB shall have closing/tripping coils, shunt/under-voltage releases, and spare auxiliary contacts (minimum 2 NO + 2 NC).
32. Earthing arrangements shall include a main earth bar running the full length of the panel, bolted to every cubicle with separate earth terminals for each outgoing feeder.
33. All panels shall be suitable for installation on RCC or metallic plinths; necessary base frames and foundation bolts shall be included in supply.
34. Spare parts and accessories to be supplied with each panel set shall include:
 - a. One set of ACB/MCCB sets.
 - b. 10% spare control fuses, indicating lamps, auxiliary relays, and pushbuttons.
 - c. One set of shunt and UV trip coils for each type of breaker.
 - d. One set of auxiliary contacts, CTs, and PTs (for metering).
 - e. One spare ACB release unit (if identical across incomers).
 - f. One communication module (redundant) for each type of gateway or ACB.
 - g. One set of terminal lugs, glands, and identification tags for site terminations.
 - h. Two Megger make IR meter and clamp meter and multimeter.
35. Special tools and software for protection relay configuration, breaker parameter setting, and communication diagnostics shall be supplied along with associated licenses.
36. Panels shall be integrated with plant SCADA.
37. Panel drawings shall include SLDs, GAs, wiring diagrams, interlocking logic, and terminal schedules, submitted for approval before manufacturing.
38. Each assembled panel shall be identified with a unique tag number, permanently affixed nameplate, and manufacturing serial number for traceability and maintenance reference.
39. The design shall prioritize operator safety, maintainability, and reliability, consistent with the ASU's continuous process operation and redundancy philosophy.

1.4.12.5 CABLES AND CABLE MANAGEMENT SYSTEMS

1. All HT and LT power cables under this RFP shall be designed, manufactured, and tested in accordance with the latest editions of IS 7098 (Part-1 & 2) and other applicable IS/IEC standards with latest amendments.
2. The design of electrical cable systems shall ensure reliable, safe, and low-loss transmission of power for ASU substation applications, with due consideration for ambient temperature, grouping, and soil conditions.
3. HT power cables shall be XLPE insulated, armoured, and FRLSH/LSZH sheathed, suitable for the rated voltage of the system finalized during detailed engineering.
4. LT power cables shall be XLPE insulated, armoured, and FRLSH/LSZH sheathed, conforming to IS 7098 suitable for continuous operation at 1.1 kV rating.
5. All HT power cables under this RFP shall be of aluminium conductor construction only, suitable for the rated voltage and system short-circuit levels, in accordance with IS 7098 (Part 2) and IEC 60502-2.
6. All LT power and control cables shall be of copper conductor type to ensure higher conductivity, reliability, and thermal performance under continuous process operation of the ASU plant.
7. Cable type selection, i.e., 3-core (3C), 3.5-core (3.5C), or 4-core (4C) configuration, shall be finalized during detailed engineering based on load current, system earthing arrangement, and operational philosophy.
8. All cable conductor materials and constructions shall conform to IS 8130 and IEC 60228, ensuring flexibility, strand compactness, and compatibility with terminations and glands specified under this RFP.
9. All cables shall have stranded circular or compacted conductors complying with IS 8130 and rated for 90°C continuous operating temperature (for XLPE insulation) and 250°C short-circuit withstand temperature for 1 second.
10. Cables shall be designed for the maximum continuous current based on installation conditions and shall include a minimum 50% spare thermal margin for load growth.

11. Cable sizing shall be based on current-carrying capacity, voltage drop, short-circuit withstand strength, derating factors for ambient temperature, soil resistivity, and cable grouping conditions.
12. Voltage drop shall not exceed 3% for HT feeders and 5% for LT feeders at full load.
13. Cable terminations and joints for HT cables shall be heat-shrink type (outdoor/indoor), suitable for the voltage class and tested as per IEC 60502-4. Termination kits shall be from reputed OEMs like Raychem, 3M, or equivalent.
14. LT cable terminations shall use double compression nickel-plated brass glands and tinned copper crimp-type lugs with insulating sleeves. All terminations shall be crimped with calibrated hydraulic tools.
15. Cable routing shall follow approved route drawings. HT and LT cables shall be laid in independent trenches or trays maintaining physical separation as per IS/IEC safety clearances.
16. Minimum bending radius shall be $12 \times$ cable OD for armoured cables and $8 \times$ OD for unarmoured cables. Cables shall not be laid with kinks, overlaps, or mechanical stress.
17. Cable trays shall be of perforated or ladder type, fabricated from hot-dip galvanized (HDG) mild steel or aluminium sheets (minimum 2.0 mm thick), complying with IS 10702.
18. Tray supports and brackets shall be designed for 2.5 times the load of filled trays, spaced at 1.2 m for horizontal runs and 1.0 m for vertical runs. Supports shall be galvanized or epoxy coated for corrosion protection.
19. Cable trenches shall be RCC type with removable covers, provided with slope, drainage, and anti-waterlogging measures. HT and LT cables shall be routed in separate trenches with warning tiles and protective layers.
20. Cables in trenches shall be laid on a 150 mm sand cushion, covered with protective bricks or tiles, and backfilled with selected soil. Red-colored PVC warning tapes shall be laid 300 mm above the top layer.
21. Earthing and bonding: cable armour of HT and LT power cables shall be bonded to earth at both ends, ensuring continuity across joints. Cable trays and supports shall be bonded to the main earthing network.

22. Cable identification: each cable shall be tagged at both ends and at every 10 m interval using engraved stainless-steel tags indicating source, destination, and feeder number.
23. Fire protection: all cables shall be FRLSH/LSZH to limit smoke and toxic emissions. Fire-sealing compounds or collars shall be installed at all wall/floor crossings to maintain fire integrity.
24. All routine and acceptance test shall be carried out at OEM factory in the presence of department and TPI. A detailed QAP will be finalized during detailed engineering.
25. All cable accessories such as glands, lugs, ferrules, tags, cleats, clamps, saddles, and sealing materials shall be supplied as part of this contract, ensuring a complete installation.
26. Installation workmanship shall comply with CEA Safety Regulations and IS/IEC standards; cables shall be laid by qualified personnel using appropriate pulling rollers, drums, and hydraulic crimping tools.
27. All joints and terminations shall be inspected and tested by qualified engineers before backfilling or closing trenches.

1.4.12.6 EARTHING AND LIGHTNING PROTECTION SYSTEM

1. The earthing and lightning protection systems under this RFP shall be designed, supplied, and tested in accordance with IS 3043 and as per department practices at SHAR.
2. The complete earthing system shall ensure safe discharge of fault currents, lightning surges, and leakage currents to earth without exceeding the permissible step and touch potential limits specified in IS 3043 / IEEE 80.
3. The system shall include body earthing, neutral earthing, lightning protection earthing, and equipment earthing, instrument earthing interconnected through a properly designed buried earth grid network.
4. Separate earth electrodes shall be provided for each category — body, neutral, instrument and lightning — interconnected through an equipotential network at one or more designated points using transient earth clamps as required and directed by department.

5. The earthing network shall be designed to achieve the following target resistance values at the main earth grid
 - a. Body and equipment earthing – ≤ 5 ohm
 - b. Neutral earthing – ≤ 1 ohm
 - c. Lightning protection system – ≤ 5.0 ohm
 - d. Instrumentation earthing - ≤ 1 ohm
6. Each earth electrode shall be executed using 50mm dia 12 m long GI pipes and as per IS 3043 and as approved by the Department
7. As a minimum, the following number and configuration of earth electrodes shall be provided for each earthing system:

#	Type of Earthing	Typical Configuration (m)	Minimum No. of 12 m GI Pipes for Dual Earthing	Remarks
1	Body & Equipment Earthing (Normal)	2 × 2 square grid	8 Nos. (4 pipes per grid × 2 sets)	For body earthing of all major electrical equipment such as transformers, HT/LT panels, DG sets, MCC panels, etc.
2	Body earthing (UPS)	2 × 2 square grid	8 Nos. (4 pipes per grid × 2 sets)	For body earthing of UPS
3	Neutral Earthing (Transformers, UPS)	3 × 3 grid	18 Nos. (9 pipes per grid × 2 sets)	For each Transformer
4	Neutral Earthing (DG)	3 × 3 grid	18 Nos. (9 pipes per grid × 2 sets)	For each DG

#	Type of Earthing	Typical Configuration (m)	Minimum No. of 12 m GI Pipes for Dual Earthing	Remarks
5	Instrumentation Earthing	4 × 4 grid	32 Nos. (16 pipes per grid × 2 sets)	For control and instrumentation panels
6	Lightning Protection Earthing	1 × 1 grid	18 Nos. (1 pit per down conductor × 18)	Dedicated earthing for lightning down conductors and roof-mounted protection systems.
7	Any other earthing as required for plant	as per OEM	As per OEM	Shall be included in the scope.

8. The interconnections between electrodes and grid shall be by GI strips of adequate cross-section sized for prospective fault current and 1 second thermal withstand.
9. The above GI pipes are bare minimum requirements and If the measured earth resistance of any earthing system does not achieve the target values specified, additional earth rods or plates shall be installed and interconnected within the grid until the required resistance is achieved. The final values shall be demonstrated through fall-of-potential or clamp-on testing methods in the presence of the Department and TPI.
10. All individual earthing systems (body, neutral, instrumentation, lightning) shall be interconnected through Transient Earth Clamps (TEC) or equivalent devices at designated grid points to ensure uniform potential rise and safe dissipation of transient currents during lightning or fault conditions. Equipotential bonding shall be maintained across the entire earthing system to minimize voltage gradients within the ASU plant area.

11. All Neutral earthing, 32x6 / 50x6 copper strip shall be used and for body and lightening earthing, 25x6 / 50x6 / 32x6 GI can be used and which shall be decided during detailed engineering.
12. Copper strips or conductors shall be sized based on maximum prospective fault current, with adequate thermal and dynamic withstand capability for 1-second fault duration.
13. Earthing electrodes shall be GI pipes or maintenance-free chemical-type earth electrodes as approved by the Department.
14. Each earthing electrode shall be provided with inspection pit, test link, RCC collar, and earthing identification plate, facilitating easy testing and maintenance.
15. Earth mat/grid design calculations shall be performed considering soil resistivity, system voltage, fault current, X/R ratio, and permissible potential gradients.
16. Each earth electrode shall be installed with a minimum of 30 kg of Earth Enhancement Compound (EEC), placed uniformly around the electrode along its entire depth to achieve and sustain the desired resistance values. The compound shall be of proven make, maintenance-free, non-corrosive, and certified for long-term moisture retention and low resistivity as per IEC 62561-7 / IEEE 80.
17. Equipment such as transformers, DG sets, UPS, HT/LT panels, bus ducts, and metallic enclosures shall each be provided with two independent earth connections to the main earth grid.
18. Cable armours, glands, and trays shall be bonded to earth at both ends through copper jumpers to ensure continuity.
19. The neutral point of each transformer and DG set shall be earthed individually through solid earthing as per system configuration finalized during detailed engineering.
20. The lightning protection system shall be designed in accordance with IEC 62305, based on the rolling sphere or protection angle method, ensuring 100% coverage of all exposed electrical structures and buildings.

21. Air terminals (lightning rods or finials) shall be of GI or copper, installed on substation and plant roofs, transformer bays, and building structures at suitable heights to provide complete protection.
22. Down conductors from lightning arrestors shall be of copper strip or copper-bonded steel conductor, running through shortest possible path to the earth grid. This lightning protection may be executed in GI also as per the department guidelines.
23. Each down conductor shall be connected to at least two distinct earth pits to provide redundancy and equal potential distribution during discharge.
24. Surge Protection Devices (SPDs) shall be provided on all incoming HT and LT feeders, UPS inputs and outputs, and control circuits to limit transient surges in compliance with IEC 61643.
25. Each SPD shall be coordinated with the lightning protection system to ensure proper energy grading between primary (Class I) and secondary (Class II) arresters.
26. Earth resistance testing shall be carried out for each pit individually and for the complete grid using a 3-point or fall-of-potential method. Measured values shall be recorded, verified, and submitted to the Department.
27. Step and touch potential measurements shall be conducted to verify compliance with IEEE 80 limits before commissioning.
28. All earth pits and conductors shall be mapped and numbered; the earthing layout drawing shall show pit locations, interconnections, test points, and route details.
29. Corrosion protection: all buried copper / GI parts shall be coated with bituminous paint; joints above ground shall be enclosed and sealed against moisture ingress.
30. Testing documentation shall include pre-commissioning, commissioning, and post-installation earth resistance test reports, pit numbering sheets, and CAD layout showing final as-built condition.
31. The above earthing scheme is the bare minimum requirement and any other earthing required to fulfil the ASU operations and as suggested by the OEM of ASU shall also be considered in the scope.

32. All earthing and lightning protection works shall be executed under qualified supervision, using calibrated test instruments, and witnessed by the Department during testing and acceptance.
33. All workmanship, materials, and installation shall meet the highest standards of safety, reliability, and durability suitable for industrial substation operation under ASU environmental conditions.

1.4.12.7 UPS SYSTEMS AND BATTERY BANKS

1. The UPS systems and associated battery banks under this RFP shall be designed, manufactured, and tested in accordance with IEC 62040 and other relevant standards with latest amendments.
2. The design of UPS systems shall ensure uninterrupted and high-quality power supply to all critical loads such as control systems, PLCs, instrumentation, SCADA, and emergency lighting for the ASU plant.
3. UPS systems shall be of modular, online, double-conversion topology (VFI class), providing full isolation between input and output and continuous protection against voltage, frequency, and waveform disturbances.
4. The system shall operate with redundant configuration (minimum N+1) and be capable of parallel operation of multiple modules for capacity or redundancy as required during detailed design.
5. Each UPS module shall be hot-swappable, allowing maintenance or replacement without load interruption.
6. UPS input and output circuits shall be provided with isolation transformers to ensure galvanic isolation and noise suppression between the mains, DG supply, and sensitive loads.
7. Each UPS shall have dual input sources — one from the normal LT power supply and one from the DG-backed LT supply — with automatic changeover to maintain continuity under supply failure.
8. The UPS output shall feed dedicated UPS output distribution panels equipped with dual incomers, bus couplers, and appropriately rated outgoing feeders for individual load groups.

9. The UPS shall have an overall efficiency $\geq 95\%$ in online double-conversion mode and $\geq 98\%$ in ECO mode. Input power factor shall be ≥ 0.98 and input THDi $\leq 5\%$.
10. UPS design shall include static bypass, manual maintenance bypass, and synchronization capability between UPS output and bypass source to ensure uninterrupted transfer.
11. Isolation transformers and Automatic Voltage Regulators (AVRs) shall be provided where required to stabilize incoming supply and ensure clean output power within $\pm 1\%$ voltage regulation and ± 0.1 Hz frequency regulation.
12. UPS capacity shall be finalized during detailed engineering based on actual critical load requirements, but each system shall be designed with 25% spare capacity for future expansion.
13. Battery banks shall be Li-ion (preferably LiFePO₄ or better) with integrated Battery Management System (BMS) for cell-level monitoring, balancing, fault detection, and communication with UPS and SCADA.
14. The BMS shall provide parameters such as voltage, current, temperature, SoC (state of charge), SoH (state of health), alarms, and event history through Modbus / TCP / IEC 61850 interface.
15. Each battery system shall provide backup autonomy as specified in the RFP annexure (minimum 30 minutes unless otherwise stated) under plant required load conditions.
16. Batteries shall be designed for a minimum 10-year service life and shall comply with UN 38.3, IEC 62619 safety standards, and relevant national transport/storage regulations.
17. Battery racks and enclosures shall be modular, corrosion-resistant, and designed for adequate ventilation and mechanical safety. Fire-retardant cable insulation and spill-proof containment shall be ensured.
18. Battery rooms & UPS rooms shall have dedicated AC systems as per the OEM standards.
19. Each UPS shall include comprehensive protection: input/output over-voltage, under-voltage, overload, short-circuit, inverter over-temperature, battery low-voltage, and phase imbalance.

20. UPS shall feature automatic battery test, equalization charging, float/boost control, and shall record event logs and alarms in non-volatile memory.
21. The UPS system shall support remote monitoring and diagnostics through SCADA, providing online parameters, alarms, event history, and performance analytics.
22. Communication protocols shall support IEC 61850 or Modbus TCP/IP, and SNMP for integration with plant network management and SCADA systems.
23. The UPS and battery systems shall be type-tested for safety, EMC, and performance; certificates shall be submitted for review. Routine tests shall include insulation resistance, functional, load, and autonomy tests.
24. Factory Acceptance Test (FAT) shall cover complete system simulation under full and partial load, static bypass operation, battery charge/discharge test, and communication verification.
25. Site Acceptance Test (SAT) shall include verification of autonomy, transfer function, alarms, and SCADA communication integration before final commissioning.
26. Spare parts and accessories to be supplied with each UPS system shall include:
 - a. 10% spare fuses, indicator lamps, fans, and control relays.
 - b. One set of communication interface cards & display cards of UPS
27. The manufacturer shall provide type-tested certificates for UPS, batteries, BMS, and isolation transformers, along with GA drawings, control schematics, wiring diagrams, and SCADA point lists.
28. The entire UPS and battery system shall be designed for 24 × 7 continuous operation, ensuring reliability, maintainability, and safety consistent with ASU process requirements.
29. The system shall be from approved OEMs listed in the RFP annexure, with proven installations in similar industrial environments and technical support within India.
30. All workmanship, wiring, labeling, and finishing shall comply with industrial standards; terminals shall be accessible, insulated, and tagged as per approved drawings.

31. The UPS and battery installation shall be covered under warranty and post-commissioning AMC along with periodic preventive maintenance, remote monitoring support, and software updates for BMS/UPS controllers.

1.4.12.8 DG SETS AND AUTOMATIC SOURCE TRANSFER SYSTEMS (ASTC)

1. The Diesel Generator (DG) system under this RFP shall be designed to supply only the essential loads required for safe shutdown, control, instrumentation, and critical auxiliaries of the ASU plant, and not to support the full process plant load.
2. DG sets shall comply with ISO 8528, IS 10001, IEC 60034, CEA Regulations, and CPCB emission and noise standards with latest amendments.
3. DG sets shall be rated for continuous duty (Prime Power Rating) with derating for site temperature, altitude, and humidity conditions typical of ASU installations.
4. The generator voltage, frequency, and rating shall be finalized during detailed design, ensuring adequate margin for transient and motor starting currents of essential loads.
5. DG sets shall be configured with Automatic Start / Stop (AMF logic), ensuring automatic startup in the event of mains failure and smooth changeover through Automatic Source Transfer System.
6. The automatic switch-over system shall be designed to ensure uninterrupted power supply to control systems, safety interlocks, UPS input feeders, and emergency lighting during grid failure.
7. DG sets shall start automatically upon sensing grid supply failure and shall shut down after the normal supply is restored and stabilized for a preset time, ensuring a fail-safe power transfer sequence (As required for the plant operations and emergency shut down)
8. The ASTC panels shall be microprocessor-based, providing AMF command, load sharing, protection, and smooth transfer between DG and normal sources with interlocks to prevent back-feeding.

9. The DG system shall include auto shutdown interlocks linked with ESD (Emergency Shutdown) signals to safely stop the generator when plant shutdown or isolation is initiated.
10. Each DG set shall have control and protection features including over-speed, low oil pressure, high coolant temperature, under/over-voltage, over/under-frequency, reverse power, earth fault, and fuel low-level alarms.
11. DG sets shall be provided with fuel storage and day tanks of adequate capacity to operate the system for minimum 8 hours under full essential load, with PESO-compliant fittings, leak detection, and fire-safe valves.
12. Acoustic enclosures and exhaust systems shall conform to CPCB noise regulations, achieving noise level ≤ 75 dB(A) at 1 meter distance under normal operating load.
13. The DG control panel shall include electronic governors for precise frequency control ($\pm 1\%$), digital multifunction meters, and PLC/relay logic controls integrated with SCADA for remote monitoring.
14. The DG system shall be integrated with the plant SCADA to transmit start/stop status, load, voltage, frequency, fuel level, alarms, and trip events in real time.
15. The system shall ensure that all critical feeders, UPS inputs, and instrumentation circuits automatically shift to DG-backed supply without manual intervention and without affecting control logic sequencing.
16. Manual start, stop, and emergency shutdown pushbuttons shall be provided on the DG control panel for safety and testing operations.
17. The DG system shall include battery starting arrangement, battery charger, and DC supply monitoring with alarms for low voltage and charger failure.
18. The Automatic Synchronizing Panel shall allow for parallel operation if multiple DGs are installed, ensuring stable load sharing and seamless transition between DGs and grid under controlled conditions.
19. The following spares and accessories shall be supplied as part of the base scope:
 - a. One spare set of fuel, lube, and air filters for each DG.
 - b. One spare set of control fuses, relays, and lamps.
 - c. One spare AMF controller module.

- d. One set of DG engine controller set.
 - e. Consumables like Engine oil, filters and etc as required during total AMC phase as per OEM guidelines.
 - f. Any other mandatory spares recommended by DG OEM.
20. The DG system shall be tested for automatic start/stop, source transfer, synchronization, protection functions, and ESD integration during FAT/SAT, witnessed by the Department. The design shall ensure safe operation, reliable shutdown support, and compliance with ASU process safety requirements.

1.4.12.9 LIGHTING AND ILLUMINATION SYSTEMS

1. The lighting system under this RFP shall be designed, supplied, installed, and tested in accordance with IS 3646, IS 10322, IS 1913, NBC, CPWD specifications, and other applicable IS/IEC standards with latest amendments.
2. The design of lighting and illumination systems shall ensure adequate, uniform, glare-free, and energy-efficient lighting for all indoor and outdoor areas of the ASU plant, including electrical rooms, control rooms, transformer bays, and approach roads.
3. All lighting design calculations shall be based on the lux levels specified below (minimum maintained levels at working plane):
 - a. Control Rooms / Panel Rooms – 300 to 500 lux
 - b. Transformer / DG Rooms – 200 lux
 - c. Cable Cellars / Utility Areas – 150 lux
 - d. Outdoor Yards / Roads / Pathways – 100 Lux
4. All luminaires shall be LED type, suitable for continuous industrial duty with a minimum system efficacy of 120 lumens/Watt, THD < 10%, and power factor ≥ 0.95 and voltage range of 100 to 300V.
5. LED drivers shall be of constant current, high-efficiency type with surge protection (minimum 4 kV internal and 10KV external) and shall comply with IEC 61347 and IEC 61547.
6. All lighting fixtures shall have a minimum life expectancy of 50,000 hours (L70) at rated operating temperature and voltage conditions.

7. Indoor lighting fixtures shall have a minimum IP54 protection and be made of powder-coated steel or die-cast aluminium housings with polycarbonate diffusers suitable for electrical room and control room environments.
8. Outdoor and yard lighting fixtures shall be of weatherproof type, IP65 or higher, constructed of corrosion-resistant die-cast aluminium with toughened glass covers and silicone gaskets.
9. Lighting poles for outdoor illumination shall be of Glass Reinforced Polymer (GRP) construction, suitable for industrial and coastal environmental conditions, with high mechanical strength, UV resistance, and corrosion-proof properties.
10. Poles shall be of 5–9 m height (will be decided during detailed engineering), designed to withstand wind speeds up to 180 km/h, and supplied complete with base plates, foundation bolts, and earthing terminals.
11. Each pole shall be provided with a dedicated weatherproof polycarbonate junction box (minimum IP65 protection) mounted near the base for terminations, fuses, and maintenance access. The pole design shall ensure safe internal cabling, smooth surface finish, and electrical isolation from metallic parts, complying with IEC.
12. Hazardous area lighting, wherever applicable in ASU plant zones or flammable storage areas, shall be of Ex-proof type (Zone 1 or Zone 2) conforming to IS/IEC and as recommended by the department safety norms.
13. Emergency lighting shall be provided in all control rooms, escape routes, and electrical areas, powered by the UPS-backed supply, ensuring illumination for a minimum of 20 minutes after mains failure.
14. Escape route and exit lights shall be self-contained LED type with built-in batteries (NiMH or Li-ion), automatic charging, and status indicators.
15. Each switchboard and distribution board for lighting shall be provided with MCB protection, local switches, and control circuit labeling. Separate circuits shall be provided for emergency and normal lighting.
16. Lighting power distribution shall be derived from dedicated lighting panels fed from LT distribution boards, with separate neutral and earth continuity conductors to minimize voltage drop and flicker.

17. Lighting circuits shall be loaded to a maximum of 80% of rated capacity, and voltage drop shall not exceed 3% between distribution board and farthest point.
18. All wiring for lighting and small power shall use FRLSH/LSZH copper cables, minimum 1.5 sq.mm cross-section, in PVC/metallic conduits or cable trays as per layout.
19. Lighting layouts shall be designed using recognized software (e.g., DIALux or Relux) to ensure compliance with required lux levels. Calculations and drawings shall be submitted to the Department for approval prior to installation.
20. Fixtures, conduits, junction boxes, and fittings shall be corrosion-resistant and suitable for humid, saline industrial environments typical of ASU plants.
21. All lighting and power points shall be clearly identified with labels indicating circuit numbers, feeder references, and voltage levels.
22. Earthing of lighting fixtures shall be provided through continuous copper/galvanized steel earth continuity conductors, bonded to the main earthing grid.
23. Lighting control philosophy:
 - a. Normal lighting – controlled through local switches or panels.
 - b. Outdoor lighting – controlled through contactors with digital timer.
 - c. Emergency lighting – auto-changeover through UPS on supply failure.
24. Light fittings in electrical rooms, control panels, and battery areas shall be suitable for maintenance without disturbing energized equipment and shall use non-sparking, safety-rated fittings.
25. The lighting system shall include all accessories: junction boxes, conduits, GI saddles, supports, clamps, switches, sockets, fasteners, and control gear.
26. Factory and site testing shall include lux level verification, insulation resistance, continuity, polarity, and earthing continuity tests; results shall be recorded and submitted for approval.
27. The following spares and accessories shall be supplied along with lighting systems:
 - a. 20% spare LED lamps and fittings of each type.

- b. 20% spare drivers, fuses, switches, and contactors.
28. All luminaires, control gear, and accessories shall be supplied with test certificates, data sheets, and compliance declarations confirming conformity to BIS and IEC standards.
29. Lighting installations shall be designed for minimum maintenance, low power consumption and full compliance with energy conservation standards under the Energy Conservation Building Code.
30. As-built documentation shall include detailed lighting layouts, circuit schedules, lux calculation reports, and pole/fitting identification lists for Department records.
31. All materials and workmanship shall meet industrial installation quality, with proper terminations, labelling, and earthing of metallic components.

1.4.12.10 VARIABLE FREQUENCY DRIVE (VFD)

1. VFD systems shall be provided for process compressors, blowers, pumps, and other driven equipment as identified in the approved load list and single line diagrams.
2. All VFDs shall comply with the latest editions of IEC 61800 series, IEC 61000 (EMC and harmonics), and relevant IS standards for industrial variable-speed drives.
3. The drives shall be of PWM type, utilizing IGBT or equivalent semiconductor devices, suitable for variable torque and constant torque applications as per driven equipment characteristics.
4. Each VFD shall be rated for continuous operation at ambient temperature up to 50°C, with built-in thermal protection and derating curves furnished by the OEM.
5. The VFD shall be capable of handling 110% continuous overload for 60 seconds and 150% short-term overload for 10 seconds without tripping.
6. Each drive shall include input line reactors or DC link chokes to limit harmonics and protect against supply transients.

7. Active front-end or passive harmonic filter shall be provided where required to maintain system harmonic distortion below 5% voltage THD and 8% current THD at the point of common coupling.
8. Drives shall incorporate internal EMI filters to meet the EMC limits prescribed by IEC.
9. All VFDs shall be provided with bypass contactors (manual or automatic) to allow motor operation through direct-on-line supply during drive maintenance or failure.
10. Control modes shall include V/f, vector, and torque control with auto-tuning capability.
Closed-loop control shall be provided where required using encoder or speed feedback.
11. The VFD shall support soft start / stop with programmable acceleration and deceleration ramps, and shall prevent current inrush and mechanical shock to connected motors.
12. The VFD shall provide ride-through capability for supply dips of up to 15% for 500 ms, ensuring uninterrupted operation during transient conditions.
13. The drive shall have built-in protections including over-voltage, under-voltage, over-current, ground fault, over-temperature, phase loss, short circuit, and communication fault.
14. The VFD enclosure shall be minimum IP42 for indoor and IP55 for outdoor installations, fabricated from powder-coated CRCA steel or aluminium alloy.
15. Control and monitoring signals shall be made available through Modbus TCP/IP or IEC 61850 communication interface, suitable for integration with the ASU plant SCADA system.
16. Each drive shall have a local operator keypad / HMI with start-stop control, fault indication, and real-time parameter display.
17. Cooling shall be natural air or forced air type, with redundant fans for drives above 50 kW rating. Filter media shall be replaceable and easily accessible for maintenance.

18. Each drive shall be tested at the factory as per IEC 61800-5-1 for dielectric strength, insulation resistance, functional performance, and protective trip verification.
19. Site testing shall include IR test, functional run, parameter verification, acceleration / deceleration tests, and communication link validation with SCADA.
20. Mandatory spares for each rating VFD system shall include:
 - a. One set of control fuses and relays,
 - b. One spare fan module (for forced-cooled units),
 - c. One spare IGBT module or power card (as applicable for each type),
 - d. One communication interface card, and
 - e. One keypad/HMI unit.
21. The VFDs shall be sourced from approved OEMs with a minimum five years of proven service in similar ASU or continuous process industries.
22. The drives shall be supplied complete with input / output isolators, contactors, protection MCBs, filters, and control wiring, ready for integration into MCC or iMCC panels.
23. The VFDs shall be designed for 24×7 continuous operation, ensuring high reliability and low downtime, consistent with ASU plant duty cycles.
24. VFDs shall be selected from reputed OEMs who can ensure availability of technical support, firmware upgrades, and spare parts for a minimum period of five (5) to six (6) years beyond the date of commissioning. The bidder shall submit a declaration from the VFD OEM regarding post-supply service commitment, spare part availability, and technical assistance during the entire AMC and post-warranty period.

1.4.12.11 HAZARDOUS AREA ELECTRICAL INSTALLATIONS (IF REQUIRED)

1. All electrical equipment, fixtures, fittings, and accessories installed in areas classified as hazardous (Zone-1 and Zone-2) shall be designed, manufactured, and tested in accordance with the latest editions IEC 60079 series, and PESO regulations.

2. Hazardous area classification drawings and zone demarcation shall be provided by the ASU process and safety team. All electrical design, cable routing, lighting, and equipment selection shall strictly follow the approved classification.
3. All equipment installed in Zone-1 or Zone-2 areas shall be of flameproof (Ex-d), increased safety (Ex-e), or intrinsically safe (Ex-i) type construction, as applicable to the location and service, with valid ATEX / IECEx certification.
4. Flameproof lighting fixtures, sockets, distribution boards (DBs), switches, and junction boxes shall be constructed of heavy-duty die-cast aluminium or stainless-steel enclosures, certified for the gas group and temperature class of the area.
 - a. Lighting fixtures shall comply with IS/IEC 60079-1
 - b. Flameproof sockets and DBs shall comply with IEC 60079-7.
5. Cables in hazardous areas shall be armoured FRLSH/LSZH type, terminated with flameproof glands conforming to IS/IEC 60079-1 and 60079-15, using neoprene or silicone sealing gaskets and washers.
6. Cable entries shall use approved Ex-d flameproof double compression glands and stop plugs for all unused openings. No field drilling or modification of certified enclosures shall be permitted at site.
7. Earthing and bonding of all metallic enclosures, fixtures, and cable armours in hazardous areas shall be done through dedicated copper/GI earth conductors, ensuring low-resistance continuity as per IS 3043 and IS/IEC 60079-14.
8. Junction boxes and fittings shall be placed in well-ventilated, accessible zones with proper spacing from process lines and oxygen/nitrogen discharge points, as per process safety norms.
9. All luminaire mounting poles, brackets, and supports in hazardous areas shall be non-sparking, corrosion-resistant, and properly earthed. Cable terminations shall be located outside hazardous volume wherever possible.
10. Inspection, maintenance, and testing of hazardous area electrical installations shall follow IS/IEC 60079-17, including regular visual checks, insulation tests, earth continuity verification, and replacement of damaged gaskets or sealing materials.

11. All installation and maintenance personnel engaged for hazardous area works shall be competent and certified in hazardous area electrical practices as per IS/IEC 60079-14.
12. All certificates of conformity, flameproof approvals, and test reports shall be compiled and submitted to the Department prior to energization of hazardous area equipment.
13. The entire hazardous area electrical system shall be covered under warranty and AMC along with other electrical systems of this RFP. Preventive maintenance of flameproof fittings and integrity of seals shall be carried out at least once in six months under AMC scope.

1.4.13 CIVIL CONSIDERATIONS FOR ELECTRICAL INSTALLATIONS

- All civil and structural provisions associated with electrical installations under this RFP shall be designed and executed in compliance with relevant IS/ IEC and CEA and department guidelines. These requirements ensure structural integrity, electrical safety, and maintainability of all electrical installations.
- All civil and structural works related to transformer foundations, switchgear rooms, UPS/battery rooms, and cable trenches shall comply with IS codes, IEC guidelines, and the National Building Code (NBC).
- Structural design of floors and foundations shall account for static and dynamic loads of transformers, HT/LT panels, DG sets, and UPS systems as per equipment data.
- Pedestals and bases for transformers, panels, and bus ducts shall be designed with vibration isolation and grouting provisions suitable for industrial operation.
- Electrical rooms shall be designed with adequate clear heights, floor space, and door openings to facilitate equipment movement and maintenance access.
- Cable trenches, ducts, and floor openings shall be provided as per approved electrical routing drawings, ensuring proper segregation between power, control, and communication cables.
- Flooring of substation and control rooms shall be of anti-static, dust-free, and oil-resistant finish suitable for electrical environments.

- Cable trenches and transformer foundations shall be designed with appropriate waterproofing, drainage slope, and non-corrosive covers to prevent water ingress.
- Earthing pit locations, earth mat layouts, and embedded earthing strips shall be coordinated with electrical drawings before concrete pouring.
- Walls and partitions separating electrical areas (e.g., HT room, LT room, UPS room) shall meet fire resistance and safety clearance requirements.
- Ventilation, air circulation, and temperature control arrangements shall be provided in accordance with equipment thermal dissipation and manufacturer recommendations.
- Structural provisions shall be made for lighting fixtures, cable trays and supports as per final electrical layouts.
- Finishes and access routes shall allow for safe cable laying, operation, and maintenance throughout the lifecycle of the ASU substation.
- Coordination between civil and electrical disciplines shall be ensured during all design and construction stages to avoid interference and rework.
- For outdoor installations required protection shed shall be considered.

1.4.14 REALISATION

- Design, procurement, installation, testing and commissioning of substation equipment like HT panels, MV panels, LT panels, HT & LT cables, Bus Duct, Change over panels, reactive correction equipment, DG sets, UG tanks for high speed diesel storage, UPS, Battery bank, earth mat & grid, bonding & shielding at substation and facility equipment, earthing system have vertical 12m driven Pipe/pits & rods which include digging of pit, earth bonds for various structures, equipment's & feeder's protection coordination selection, Civil requirements and interfaces etc. The realization of substation equipment shall be as per CEA norms and IE rules.
- Design, procurement, installation, testing and commissioning of facility equipment like MV& LT equipment includes motors, drives & iMCC, cables, component & feeder's protection coordination selection, grounding, bonding &

shielding, Civil requirements and interfaces etc as per standards and in the hazardous facilities.

- Design and realization of 1X20KL underground High-speed diesel storage tank for DG Sets and obtain the statutory approvals from the agencies and department.
- Capable for carrying out Civil and Mechanical structures built for the Indoor substation facility and associated structures, the requirements like construction, foundation & grouting with various grade concrete, cable trenches, erection of steel /FRP Mast at high raised level & catenary steel wires, guy rod, various structures, cable trays, fabrication, drilling, welding and bonding etc.
- Preparation of substation layouts, SLDs, equipment layouts, GA drawings, schematic drawings, auto changeover schemes, Automation architecture for Power control, monitoring and logging, Illumination drawing layouts, Cable routing drawing layouts, Cable tray drawing layouts, Terminal connection layouts, earthing drawing layouts, lightning protection drawing layouts, maintenance procedures for various equipment in substation and each facility.
- Experience in Testing and commissioning of all Electrical System which includes external & internal electric equipment with Automation and the load test for each feeder, feeder auto changeover, verification of safety interlocks, verification of protection coordination for the relays / feeders, simultaneous operations for load capabilities and total performance tests etc.
- Experience in Charging the Substation and switching ON feeders for various facilities in the presence of Electrical Inspector, CEA, India and Statutory certification obtained from the CEA, India which includes preparation of documents.

1.4.15 INSTALLATION AT SITE

- Contractor shall carryout installation of items supplied/free issued at site complying with SDSC safety regulations and security protocols. Contractor is responsible for receipt and safe storage of items till commissioning and handover to Department. Contractor shall establish temporary storage/fabrication/office facilities at site. Existing systems at site will be

provided by Department to Contractor for modification. Contractor shall be responsible for obtaining all applicable statutory clearances.

- Construction/Erection/Realisation Stage Services
- Permanent Power supply: Provision for Power supply incoming source to the ASU Plant shall be provided by the Department at one location only. The Voltage level shall be decided as per the detailed design phase. (charges to be decided).
- Construction Power Supply shall be tapped from nearest facility (~300m length)or derived from the available source by the contractor on chargeable basis. Contractor shall make its own arrangements during planned maintenance /power failures. Panels with energy meter, Earthing, HT & LT Cables required outside ASU Plant. Electricity at one point in site for erection works / Operations.
- Construction power is chargeable basis only and the amount shall be deducted on monthly basis. The construction power supply tariff will be varied time to time.
- Inspection & Supervision of Construction Site as per IE rules & safety norms and maintain the construction power supply with proper maintenance schedules. Extension of Power supply to various agencies and preparation of Electricity bills/ Measurement readings.
- Inspection & Supervision of CIVIL works for Substation and associated structures by Third Party.
- Inspection & Supervision of ELECTRICAL works for Substation and various Hazardous & Non-Hazardous facilities by Third Party.
- Inspection and Preparation of as-built drawings, correction of schematics, verification, check lists and inventory of items etc.
- Operation and Maintain the Log book as per the standard practices.
- A reputed third-party inspection agency shall be engaged by Contractor for independent inspection at all levels as per approved Quality Assurance Plan. The inspections shall include review of configurations, Power flow calculations & analysis, ampacity calculations, protection coordination, earth grid calculations, schematic circuits, Technical Specifications, GA drawings of all

Electrical equipment's, witnessing & testing activities at manufacturing shop and site as per latest standards – BIS, IEC, IECEX etc.

1.4.16 TESTING, INSPECTION AND COMMISSIONING

- All electrical systems under this RFP shall undergo FAT, SAT, and Performance Guarantee Tests as per approved QAP and relevant IS/IEC standards during detailed engineering.
- Tests shall cover functionality, protection, interlocks, SCADA integration, and safety verification at factory and site. All results, certificates, and calibration records shall form part of the final commissioning dossier, and systems shall be energized only after approval from the Department confirming satisfactory completion.
- Commissioning shall be done by the Contractor as per approved procedure /QAP procedure. The testing & commissioning and total performance tests shall be carried out in the presence of OEM, third party and agencies shall be followed as per approved documents and latest standards.
- The major equipment's are HT panels, MV & LT panels, transformers, DG sets, UPS, Bus duct, Cables, MCC panels, Drive Panels, Light fittings, earthing and lightning Protection system etc.

1.4.17 DOCUMENTATION & QAP REQUIREMENTS

1. All drawings, data sheets, and documents submitted shall be prepared in accordance with the Department's document control procedure and approved before manufacturing or execution.
2. QAPs shall be prepared for all major equipment, defining the sequence of inspections, witnessing points, test stages (FAT/SAT), acceptance parameters, and documentation requirements.
3. The QAP shall identify Type Tests, Routine Tests, and Special Tests applicable to each equipment category and shall specify compliance with relevant IS/IEC standards.

4. Factory and site inspections shall be carried out jointly by the Department and authorized TPI agency as per approved QAP. Non-conformances shall be recorded, corrected, and reverified before acceptance.
5. As-built drawings shall incorporate all modifications made during installation and commissioning.
6. Final submission shall include: (05 sets hard and 01 set soft)
 - a. As-built Single Line Diagrams (SLDs) for all voltage levels.
 - b. As built drawings of all electrical equipments
 - c. Cable schedules and routing layouts.
 - d. Earthing and lightning protection layouts.
 - e. Protection coordination reports and relay setting sheets.
 - f. SCADA I/O list and communication network diagram related to electrical systems.
 - g. Test certificates and calibration records for all equipment.
 - h. Detailed commissioning report comprising all documents related to electrical systems.
7. Operation and Maintenance (O&M) manuals for each major equipment (HT panels, transformers, UPS, DGs, etc.) shall be provided, including start-up procedures, preventive maintenance schedules, fault diagnosis charts, and spare part catalogues.
8. Mandatory spares for three years of operation shall be included in the base supply, and the list shall be submitted for approval during detailed engineering.

1.4.18 WARRANTY

- All equipment and systems covered under this RFP shall be provided with a comprehensive warranty as per this RFP's contract conditions, ensuring complete responsibility for performance, reliability, and safety of the electrical installations.
- During the warranty period, all defective materials, components, or workmanship issues shall be rectified or replaced free of cost, including associated testing and recommissioning of affected systems.

- After expiry of the warranty period, the supplier shall provide a Annual Maintenance Contract (AMC) in line with the requirements of this RFP and as per the operational needs of the ASU plant.

1.4.29 SPARES

Recommended Spares List shall be provided

Commissioning & Startup	
Major equipment	10%
Minor equipment (PDB, LDB), Power outlets, flame proof light fittings, JB's	20%
Meters, instruments, sensors and electronic items like IO cards etc	20%
Consumables like Lamps, sockets, terminals, lugs, insulation tapes, glands, cable ties, tags etc	30%
Software updates	1%
Test kits , tools and etc	10%

ITEM	Erection, Pre Commissioning, Commissioning and Start-Up
VCBs and ACBs Panels	10%
MCCB/Fuse Elements	20%
Bulb for Signal Lamps	50%
Signal Lamp	50%
Selector Switch	5%
Push Button	5%
Local Control Station	5%

Multifunction meter for Control Station and Switchgear	5%
Pushbutton	5%
Selector switch	5%
Other equipment's	OEM recommended

1.4.20 LIST OF PREFERRED MAKES

#	Equipment Description	Approved Makes	Remarks
1	HT Switchgear (VCB Panels, 3.3 / 6.6 / 11 kV /33KV)	Siemens / ABB / Schneider Electric / Eaton	Indoor metal-clad type, IEC 62271 compliant
2	HT Vacuum Circuit Breakers (VCB modules)	Siemens / ABB / Schneider Electric / Eaton	Compatible with offered switchgear panels
3	HT Current & Voltage Transformers (CTs / PTs)	Kappa / Siemens	As per IEC 61869 series
4	LT Switchgear Panels (PCC / MCC / iMCC / Distribution Boards)	Siemens / ABB / Schneider Electric / Eaton	Type-tested assemblies as per IEC 61439
5	Air Circuit Breakers (ACB)	Siemens / ABB / Schneider Electric / Eaton	Draw-out type, microprocessor-based trip unit
6	MCCBs / MCBs / Contactors / Relays	Siemens / ABB / Schneider Electric / Legrand / Eaton	Modular design, coordination Type-2 certified

#	Equipment Description	Approved Makes	Remarks
7	Intelligent Motor Control Centers (iMCCs) / Starters	Siemens / ABB / Schneider Electric / Rockwell Automation / Eaton	With communication interface IEC 61850 / Modbus TCP
8	Power Transformers (Oil-immersed / Dry Type)	ABB / Schneider Electric / Siemens / CGL	IS 2026 / IS 1180 / IEC 60076 compliant
9	Bus Ducts / Rising Mains	Siemens / Schneider Electric / Legrand / ABB	Copper conductor, IEC 61439-6 compliant
10	Cables – HT (XLPE, Armoured, FRLSH / LSZH)	Polycab / KEI / Finolex / RR Kabel / Havells	IS 7098 (Part 2) compliant
11	Cables – LT (XLPE, Armoured, FRLSH / LSZH)	Polycab / KEI / Finolex / RR Kabel / Havells	IS 7098 (Part 1) compliant
12	Cable Glands & Lugs	Dowells / Comet / Hex / 3D / Jainson / Braco	Nickel-plated brass, double compression type
13	UPS Systems (Modular Online Double Conversion)	Riello/ Schneider Electric / ABB / Vertiv	IEC 62040 compliant, Li-ion battery compatible
14	Li-ion Battery Banks & BMS	LG/Samsung / BYD / Amara Raja	LiFePO ₄ technology preferred

#	Equipment Description	Approved Makes	Remarks
15	DG Sets & AMF/ASTC Panels	Caterpillar / Volvopenta / Cummins / Perkins	CPCB-IV+ compliant, ISO 8528 standard
16	Automatic Power Factor Correction (APFC) Panels	Siemens / ABB / Schneider Electric	Automatic / thyristor switching
17	Surge Protection Devices (SPDs)	Phoenix Contact / DEHN / Siemens / OBO Bettermann / Schneider Electric / Erico	IEC 61643 compliant, Class I / II coordinated
18	Power & Energy Meters (ABT / Multifunction)	Secure / Elmeasure / Schneider Electric / Siemens / L&T	Class 0.2s / 0.5s, DLMS compliant
19	Relays & Protection IEDs	Siemens / ABB / Schneider Electric / Eaton	IEC 60255 / IEC 61850 compliant
20	SCADA / Automation Hardware (RTU / PLC / HMI)	Siemens / Schneider Electric / ABB / Honeywell / Mitsubishi	IEC 61850 / Modbus TCP/IP protocols
21	Lighting Fixtures (Indoor / Outdoor LED)	Philips / Havells / Endo light	IS 10322 / IS 3646 compliant, IP54 / IP65 rated
22	Industrial Sockets, Switches, and Accessories	Mersen / Hensel / Legrand / Schneider Electric / BCH	IEC 60309 compliant
23	Portable Test & Measurement Instruments	Megger / Fluke / Chauvin Arnoux	NABL calibration certified

#	Equipment Description	Approved Makes	Remarks
<i>Note: Wherever technically feasible, the make and selection of major components, panels, switchgear, relays, instruments, and accessories shall be from the same OEM to ensure uniformity, compatibility, ease of integration, and simplified maintenance of spares during operation and AMC period. The above list indicates the department's preferred makes. However, alternate makes meeting all technical and performance requirements may be offered, subject to submission of complete details and prior approval of the department.</i>			

1.5 DETAILS FOR SAFETY AND FIRE FIGHTING SYSTEMS

1.5.1 Safety & Firefighting Systems

Following safety and firefighting systems to be considered for ASU based on NFPA, OISD and BIS standards.

1.5.1.1 Fire pump house and reservoir

The water source and fire pump house with suitable pumping capacity shall be planned and the firefighting system shall be designed to meet the fire water flow requirement for fighting one major fire for minimum 2 hours as per relevant standards.

1.5.1.2 Water Based Fire Fighting Systems:

- **Deluge System:** Automatic-cum-remote operated deluge system for fire suppression of storage tanks to be installed as per statutory norms. The design of the deluge system shall be as per IS 15325. The tank cooling deluge spray system with design density of 10.2 lpm/m² shall be installed for tanks.

Applicable standards are as follows:

- IS 15325 - 2003 Design and Installation of Fixed Automatic High and Medium Velocity Water Spray System.
- OISD 117 Fire Protection Facilities for Petroleum Depots, Terminals and Pipeline Installations, August 2000.
- NFPA 15: 2007 Standard for Water Spray Fixed Systems for Fire Protection.
- **Fire Hydrant System & water monitor system:** Fire Hydrant system is intended to eliminate the need for excessively long runs of hose for manual firefighting. With a standpipe system installed in the Plant, the fire fighter can connect hose to a permanently installed valve on the standpipe system and, with not more than 30m hose, can fight a fire anywhere on a given area. Fire hydrants are required to be provided for all the facilities of ASU as per statutory norms. System design shall be as per IS 13039, NFPA 14. Double hydrants all around the facilities to be provided at max. 30m distance between hydrant post. Pipeline sizing considering 2 double hydrants being operated simultaneously. The hydrant post outlet should be situated 1 meter above the ground / floor level and should be of 100mm diameter for double headed hydrant. At any instant, two fire hydrants are

proposed to be operated for fire suppression.

The size of stand pipe is 100mm and Type A with single outlet is planned for the facility. Stand pipe specification regarding material, shape, dimensions, construction, workmanship, finish, and performance test shall be as per IS 5714 -1981, 'Specification for Hydrant Stand Pipe for Fire Fighting'. Hydrant stand pipe shall be provided with PCC slab at the base at least 1m x 1m to avoid soil erosion.

The landing valve assembly consists of valve, 63mm female instantaneous outlet and blank cap. The landing valve shall be of "Type A – Landing valve single outlet". It's specification regarding materials, shape, dimensions, and performance requirements shall confirm to IS 5290:1993, "Landing Valve – Specification". The hydrant pipe outlet will be situated 1 meter above the ground level.

Water monitors for high-rise facilities of above 15m to be considered in place of hydrant landing valve.

Applicable standard for Hydrant System

- IS 5714 -1981, Specification for Hydrant Stand Pipe for fire Fighting.
- IS 5290 - 1993, Landing Valve – Specification.
- IS 636 - 1988, Specification for Non-Percolating Flexible Fire Fighting Delivery Hose.
- IS 903 - 1993, Fire Hose Delivery Couplings, Branch Pipe, Nozzles and Nozzle Spanner – Specification.
- NFPA 14: 2007 Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems.

1.5.1.3 Clean Agent Fire Suppression System (Total Flooding)

Clean agent fire suppression systems are waterless and deploy immediately without leaving behind oily residue or water that can damage irreplaceable assets.

Clean agent systems utilize either reacting or non – reacting gaseous suppressants in order to extinguish fires. When heat or smoke is detected, an electronic signal is sent to the control unit to send the clean agent gas through the cylinders and piping network.

With technological advancements, the control unit for the clean agent fire suppression system can optimize the pipe valves to only send the clean agent directly to the hazardous zone. These systems also have the capability to link to audio and visual alarms, close vents and doors to prevent the spread of fire, and even turn off electrical equipment.

As the clean agent floods the room, the oxygen content is diluted enough to stop the fire and prevent combustion. This system can be a life and asset saver to limit the damage to equipment and prevent the spread of a fire.

The system can be activated either in Auto mode with detection of any two fire/smoke/heat detectors at the area covered.

In case of fire, the system shall be activated automatically by the output signal of any two of the smoke detectors to solenoid valve. The output of pressure switch in clean agent - halocarbon fire suppression system shall be monitored in 24 hour basis.

To operate clean agent fire suppression system on emergencies, 24V DC power supply for solenoid valve shall be available on 24-hour basis.

Standard to be followed are as follows:

- IS 15517 - 2004 Gaseous Fire Extinguishing Systems - HFC 227ea (Hepta Fluors Propane) Extinguishing Systems
- NFPA 2001:2004 Standard on Clean Agent Fire Extinguishing System

1.5.1.4 Modular Type Fire Suppression System for Electrical Panels

Modular clean gas fire suppression system (Direct local flooding system) is to be provided for electrical panels in Electrical panel rooms, UPS rooms, Substations. Modular Gas Suppression Systems are proposed for quenching electrical fires. The system to detect automatically and extinguish fire at source, at its very early stage. It should be suitable for application where the potential fire risk is located within an enclosed or confined space (Electrical panels etc.) Fire suppressant is directly applied to the fire, immediately on the fire affected area in the enclosed volume of panels.

The detection of fire is primarily made by a polymer/polyamide tube with necessary rodent protection as per UL standard which can detect the fire anywhere (Sensing temperature between 100 -120 Deg C) along its length. The tube is highly flexible and can be conveniently routed to cover the various hazard

areas in electrical panels. One end of the fire detect tube is connected to the Clean Agent cylinder and the other end to an end of line adaptor through a non-return valve. The polymer tube shall be a fixed temperature sensing tube made up of a polymer material to cater to long term leak resistance, flexibility accurate and consistent heat sensitivity and high pressure withstanding capacity.

Design of system shall be as per NFPA 2001-2015 and design concentration suitable to Class C with 35% safety factor. The clean gas agent shall be stored in the pressure not more than 50bar. Design temperature shall be taken as 20 Deg C. All items like valves, valve assembly, cylinders, Fire detection and suppression system tubing, line adapters, pressure switches etc., shall be UL/VDS/FM/LPCB listed and UL/VDS/FM/LPCB marked. Fire detection and suppression system tubing shall be designed for effective distribution of extinguisher agent for inside the panel.

1.5.1.5 Fire Detection and Alarm Systems

Fire Alarm System consists of required numbers of loop Fire Alarm Control Panel (with expandable loop features) with intelligent addressable multi sensor fire detectors, addressable manual call points (MCP), remote response indicators, SMF batteries, addressable hooter (sounder), auto dialers (optional), repeater panel, interfacing devices, mounting accessories and detector test kit.

100% hot redundancy shall be provided in the FACP control unit & other critical component like CPU, memory, memory control, power supply cards, RAM etc. to ensure uninterrupted operation of the FDA system. The standby cards shall perform the entire functions of the system when the main CPU & other control cards fail without affecting the functioning of FDA system. Any failure of cards shall be brought to the notice by audio – visual alarm.

The FDA system interlocking with firefighting system for automatic actuation **shall be** considered for gas flooding systems of respective areas.

Standards: NFPA72/IS 11360-1985/IS2189/IS-2175/EN54

Approvals: UL/FM

The power supply shall be made available to the electrical loads of the system is 230V±10%, single phase ac, and sufficient isolation shall be provided from the loads. The system shall contain necessary DC power supply and battery to cater to 72 hours back up in no alarm condition in case of failure of them in power supply.

The proposed fire detection and alarm system (FDA) shall cover in different facilities. The detectors shall be analogue addressable intelligent multi criteria detectors. One detector shall cover 9 sq. m area. The respective FDA panel shall be planned at the facility control room and all the FDA panels shall be networked & shall be with Modbus RTU/ Modbus TCP/ Suitable protocol with Modbus TCP Converter for interfacing and the status of all the panels shall be monitored from Centralized control room which is located at Zero point, SDSC SHAR.

1.5.1.6 Oxygen Sensors:

Electrochemical type oxygen leak detectors shall be installed in critical locations. The purpose of oxygen detector is to detect both, the enriched oxygen level and depleted oxygen level in the atmosphere. The normal oxygen concentration in the atmosphere is 20.8%. The low level concentration alarm shall be set to 19% and high level concentration alarm shall be set to 23%.

Whenever alarm set points are exceeded, Audio-Visual alarms are annunciate at shop floor levels, safety consoles (local and remote) and at respective operator consoles at control centre and also at security posts for warning respective operational personnel for initiation of safety measures.

General Specification:

Standard Range	: 0-25%
Accuracy	: $\pm 0.5\%$
Response Time	: 20sec to 90 % of scale
Operating Temperature	: -20 °C to 50°C
Operating pressure	: $\pm 10\%$ Ambient
Humidity range	: 0- 90 % RH

1.5.1.7 Safety Showers and Eye Wash Units:

The construction and performance requirement shall confirm to IS 10592-1982, 'Specification for Industrial Emergency Showers, Eye and Face Fountains and Combination Units'.

The design parameters to be considered for eye wash unit are as follows.

S.N.	Parameter	Description

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1	Height of Eyewash Nozzles	830mm-1140mm(Eyewash Nozzles should be minimum 15.3cm away from any obstruction
2	Flow Rate through Nozzles	>12 LPM
3	Water spray jet from Nozzles	Soft and not injurious to user
4	Height of spray jet from Nozzles	100mm to 300mm
5	Valve operation	i) Operated within one second or less and stays open till shut off intentionally keeping users hand free for cleaning eyes ii) The force required to open valve is less than 100N

The design parameters to be considered for safety shower unit are as follows.

S.N.	Parameter	Description
1.	Height of Shower head	2100mm to 2400mm
2.	Flow Rate	>76 LPM at 30PSI (2kg/cm ²)
3.	Diameter of water column	510mm at 1500mm from ground level
4.	Flow pattern	Centre of the water pattern shall be at least 400 from any obstruction.
5.	Valve operation	i) Operated within one second or less and stay open till intentionally closed (stay open construction) ii) The force required to open valve is less than 100N

1.5.1.8 Breathing Air System

The need of breathing air units in the Plant arises in case of any untoward incidents which causes depletion of oxygen percentage less than the minimum required. The need shall be assessed based on the following criteria.

A. Risk assessment

- **Potential hazards:** Fire, Toxic, Asphyxiation etc.
- **Number of people working in the facility:** Min. 2 people to attend the emergency
- **Type of task being performed:** Attending Fire/leak/ spillage etc
- **Potential failure of equipment's:** Leakage through joints / Fire

B. Quantity of BA required

- **Type of task:** Heavy (min. 56 lpm of lung demand)
- **Duration of task:** One hour

C. Number of points:

Based on approach of Max. 30m distance to any point

D. Tap point locations:

Near emergency escape route/ doors

- Breathable quality air for operational personal is generated from breathing air pack (BAP) installed in the Plant.
- The outlets are terminated with **QCDC Female couplings** of 15 NB size.
- Breathing air supplied shall confirm to OSHA norms with following specifications:

Specifications of compressed air for breathing apparatus (Maximum content as per EN 12021)					
O ₂	CO ₂ (PPM)	CO (PPM)	Oil (mg/m ³)	Water vapour (mg/m ³)	Odor & Taste
21% ± 1%	500	15	0.5	110 mg/m ³	Not Specified

1.5.1.9 Portable Fire Extinguishers:

Portable fire extinguishers are not meant to deal with large fires. They are very valuable in the early stages of fire. Fire extinguishers shall be provided for the protection of both the building structure and the occupancy hazards contained therein regardless of the presence of any fixed fire suppression systems. Facility building protection shall be provided by fire extinguishers for Class A fires. Buildings having an occupancy hazard subject to Class B or Class C fires, or both, shall have a standard complement of Class A fire extinguishers for building protection, plus additional Class B or Class C fire extinguishers, or both. Following criteria shall be followed for selection and installation of fire extinguishers.

- Fire extinguishers shall be conspicuously located where they are readily accessible and immediately available in the event of fire.
- Fire extinguishers shall be located along normal paths of travel, including exits from areas.
- Fire extinguishers shall not be obstructed or obscured from view
- In large rooms, and in certain locations where visual obstructions cannot be completely avoided, means shall be provided to indicate the extinguisher location.
- Fire extinguishers having a gross weight not exceeding 40 lb (18.14 kg) shall be installed so that the top of the fire extinguisher is not more than 5 ft (1.53 m) above the floor.
- Fire extinguishers having a gross weight greater than 40 lb (18.14 kg) (except wheeled types) shall be installed so that the top of the fire extinguisher is not more than 3½ ft (1.1 m) above the floor.
- Applicable standards:
 1. IS2190 – Selection installation of portable fire extinguishers
 2. OISD 117: Fire Protection Facilities for Petroleum Depots, Terminals and Pipeline Installations, August 2000.
 3. IS 10658 - 1999 Specification for Higher Capacity Dry Powder Fire Extinguisher (Trolley Mounted).
 4. IS 15683 - 2006 Portable fire Extinguishers - Performance and

Construction – Specification.

5. IS 2878 - 1986 Specification for Fire Extinguisher, Carbon Dioxide Type (Portable and Trolley Mounted).

1.5.2 LIST OF PREFERRED MAKES

S. No	Item	Preferred make
1	MS pipes	Jindal / TATA / Suryaroshini (Surya) / SAIL/Ratnamani / zenith / MSL/Mukat /Welspun / Prakash
2	MS Pipe fittings	Echhjay / CD Engg / Arvind / B&M / VS / Abbas / Eby industries / Tube Products / Rajmani / Sangvi
3	Butterfly valves and ball valves	L&T make
4	Paint primer and paints	Asian paints / berger paints / goodlass paints / Shalimar paints / Jerlac paints / CDC Carboline / German polycoats / Grand polymers
5	Pressure gauges	H Guru / Wika / Manometer India
6	Deluge valve with trim kit / Alarm valve with trim kit	HD fire
7	QBD / Spray Nozzles / Sprinklers	HD fire / TYCO
8	Safety relief valve	TYCO / AIRA
9	Wrap coat	IWL
10	Y-strainer	SUNGOV
11	Fire pump	Kirloskar / Mather &platt
12	Pressure transmitter	ABB / Rosemount
13	Compressor	Ingersol Rand / ELGI/Kirloskar pneumatic

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S. No	Item	Preferred make
14	Pressure switch	Switzer / Indfoss / Danfoss
15	Electrical Motor	Kirloskar /Crompton Greaves/Bharat Bijili /CEMP /Marathon / Siemens/Mather&platt
16	Solenoid valves	ASCO / Normex
17	High capacity nozzles	Spray Jet / TYCO
18	Gate valves	Upadhyay / equivalent
19	Foot valves / Check valves	Normex
20	Eye wash & Body shower	Unicare / Udyogi plastics
21	Fire Extinguishers	Minimax / Firex
22	Cables	Orbit / Poly cab / Paramount

The above list indicates the department's preferred makes. However, alternate makes meeting all technical and performance requirements may be offered, subject to submission of complete details and prior approval of the department.

1.6 TECHNICAL REQUIRMENTS FOR CIVIL AND AIR CONDITIONING WORKS

1.6.1 SCOPE OF CIVIL WORKS

Name of Work: Establishment of Infrastructure for Cryogenic Air Separation Plant at Satish Dhawan Space Centre SHAR.

1.6.2 NOTE TO BIDDERS:

- (i) The ASU facility is to be planned in the premises of ISRO-SDSC SHAR at Sriharikota-524124, Andhra Pradesh. The facility is envisaged as Production Plant for LOX and LIN for meeting Launch requirements of ISRO.
- (ii) The tentative Plant Layout is attached.
- (iii) The detailed planning of buildings, civil structures, foundations, paved areas, pedestals, roads, storm water drains, water treatment plant etc., are to be planned as per relevant IS standards & NBC codes, PESO norms / AP pollution control board norms / ISRO safety norms etc.
- (iv) Specifications and details for structural work including finishes, joineries, false ceiling, PH works, roads, etc., are detailed in subsequent Chapters.

MAIN ELECTRICAL INCOMING (33KV)

Incoming source will be provided by department

TRANSFORMER YARD

ELECTRICAL SWITCH-ROOM
Dimensions (LxBxH) as per IEC/IS and CEA regulations and as per IEC/IS and CEA regulations

CHAIN LINK FENCE WITH GATE

MAIN AIR COMPRESSOR HOUSE
Main Air Compressor AC, After Cooler, EOT crane to be provided, Air suction filter ASF, Structural shed, Dimensions (LxBxH) to be specified by holder

AUXILIARY BUILDING
DCS, Staff Room, Documentation Room, SPTA Room, Maintenance Room, Security Office, Wash Room, Electrical Panel Room, AHU, Lab, Tanker Filling Pump, LOX & LIN STORAGE TANKS, DWARF WALL, TANKER PARKING BAY (PCC PAVED AREA)

CONCRETE ROAD

WATER TREATMENT PLANT

RAW WATER

GLR (500m3 capacity)

FIRE PUMP HOUSE
MOTORABLE crane to be provided

ACCESS WAY

PIPE WAY

LOX ST-1

LIN ST-1

LOX TANKER

LIN TANKER

LOX & LIN FILTER PUMP

HEATER AHU

ADSORBER VESSELS AV

SSF SIDE STREAM FILTER

CT COOLING TOWER

FP FILTER PUMPS

MAIN GATE

5, FALSE FLOORING & FALSE CEILING FOR DCS AND LAB,

6, FALSE CEILING FOR STAFF, DOCUMENTATION AND SPTA ROOM,

EQUIPMENT LIST

TAG	DESCRIPTION
AC	MAIN AIR COMPRESSOR
ASF	AIR SUCTION FILTER
AFC	AFTER COOLER
AV	ADSORBER VESSELS
AH	HEATER
CB	COLD BOX
SSF	SIDE STREAM FILTER
LOX ST	LOX STORAGE TANK
LIN ST	LIN STORAGE TANKS
LIN PBU	LIN STORAGE TANKS PBU
CT	COOLING TOWER
LOXFP	LOX TANKER FILLING PUMP
LINFP	LIN TANKER FILLING PUMP
CTP	COOLING TOWER PUMPS
FP	FILTER PUMPS
DCS	DISTRIBUTED CONTROL SYSTEM
LAB	ANALYSIS LABORATORY

NOTE:

- COMPRESSOR HOUSE TO BE CONSTRUCTED WITH STRUCTURALS
- AUXILIARY BUILDING, FIRE PUMP HOUSE AND ELECTRICAL SWITCH STATION SHALL BE OF BRICK CONSTRUCTION (4M HEIGHT)
- GLR, COOLING TOWER AND WATER TREATMENT PLANT SHALL BE OF RCC CONSTRUCTION
- AIR CONDITIONING TO BE PROVIDED
 - A. DCS & LAB - $21^{\circ}\pm 2^{\circ}\text{C}$
 - B. STAFF ROOM, DOCUMENTATION ROOM & SPTA ROOM - $25^{\circ}\pm 2^{\circ}\text{C}$

CHAIN LINK FENCE WITH GATE

5, FALSE FLOORING & FALSE CEILING FOR DCS AND LAB,

6, FALSE CEILING FOR STAFF, DOCUMENTATION AND SPTA ROOM,

SAATCHI DRAWING SPACE CENTRE MEHAR
SDSC - MEHAR - SRIDHAR KOTA

Rev: 4 (01/01/2024)

Drawn by: SDSC/MEHAR/01/2024

Checked by: SDSC/MEHAR/01/2024

Scale: 1:100

Sheet: 1 of 1

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1.6.3 BRIEF SCOPE OF WORK:

The successful tenderer shall carryout “Site survey, Detailed Planning, Design, and Construction of all Civil, PH & Road works pertaining to Air Separation Unit (ASU) in all respects as per approved construction / working drawings and specifications”

- (i) The tentative layout drawing for the ASU plant is attached along with this tender. Preliminary and Detailed architectural drawings are to be developed by the contractor as per the design requirement (which is also in scope of the contractor) and clearance is to be obtained from Department.
- (ii) Based on the cleared architectural drawings, detailed structural design & MEP design, etc., has to be carried out and drawings are to be submitted for Department clearance. The work shall be executed according to the cleared drawings only.
- (iii) Structural design / drawings shall be specifically got proof checked by reputed institutions like IIT/NIT/other approved Departments and go-ahead clearance is to be obtained from Department before starting civil construction works, at site. The scope of enabling proof checking of designs from IIT/NIT/ other approved Departments, is also in the scope of Contractor.
- (iv) The contractor shall be responsible for executing all items required for completing the facility in all respects, to make it habitable and ready for functioning, as per the direction of Department.
- (v) The work has to be executed within the strict time lines and hence contractor shall mobilize all their resources to achieve the target. Agency shall also increase their efforts to compensate for hindrance's occurred, if any, during the execution of work. However, nothing extra shall be paid in this regard.
- (vi) The scope of civil works shall include all items under civil scope to make it habitable and ready for functioning, as per direction of Department.

S No.	Building / Facility	Remarks
1	Battery limit: The total plant is to be setup within a minimum	All around the plant 2m height chain link fencing with 450mm height RR masonry

S No.	Building / Facility	Remarks
	Battery limit of 200m x 200m plan area.	dwarf wall [above FGL] is to be provided with 6m wide MS gates & cattle trap
2	Site Topography: - The nearest BT road level to be considered as + 10.0 m EL. - The existing ground level is about + 9.7 m EL - Formed ground level and inside roads of ASU to be maintained at + 10.15 & 10.3 m EL respectively - Finished floor level of Auxiliary buildings to be maintained at + 10.6 m EL - Finished floor level of other structures with in ASU premises to be fixed as per design	
3	Auxiliary building houses rooms with minimum carpet area as mentioned against each rooms for DCS room [6m x 8m], Lab room [6m x 4m], AHU room [6m x 3m], Electrical Panel room [6m x 3m], Wash rooms [6m x 3m], Staff room [6m x 6m], Documentation room [6m x 3m], SPTA room [6m x 4m], Maintenance room [6m x 5m], Security room [6m x 3m] with 2	RCC framed structure with foundation as per design and masonry infill walls and finishes as per design & specifications

S No.	Building / Facility	Remarks
	Mtr wide Corridor with RCC flat roof of clear height of 4.5 Mtr	
4	Tanker parking bay with RCC paved area as per design for parking LOX & LIN tankers as size as per design	VDF finish RCC paved area of minimum M35 grade concrete to be considered in design for Class AA loading or actual load of road tankers whichever is maximum
5	RCC foundations / Pedestals for LOX & LIN storage tanks, Adsorber vessels, fire pumps, filter pumps, etc. as per design	
6	RCC substructure with suitable foundation for Cold Box as per design including suitable RCC paved area all-around the cold box structure with minimum 5 mtr width.	RCC foundation shall be designed as per the design loads of the cold box structure of about 45 m height
7	Structural steel shelter for housing compressor & associated systems	Shelter to be planned to suit the equipment layout as per design satisfying all the safety & functional requirements. RCC foundation for substructure for supporting structural steel shed of size & height as per design. Structural steel frame work for columns, ties, portal frames, roofing etc. as per design. Roofing with 50mm thick metal puff panel with suitable water proofing system. Walls cladded to full height supported on structural steel frame all around with Galvalume sheet with suitable ventilation / weather proofing as per design.

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S No.	Building / Facility	Remarks
		RCC paved area all-round the compressor shed with minimum 5 mtr width.
8	RCC foundation for compressor, After cooler, Air filter, etc.	RCC foundation for compressor shall be designed as per IS codes
9	RCC pedestals for housing Cooling towers as per design	
10	RCC structure for Water Treatment Plant, Raw Water wells and 500 CUM capacity GLR as per design	
	A] Raw water source	Two numbers of 6m dia, 8m deep open well with RCC wall steining shall be constructed as per standard design.
	B] Water Treatment Plant	Water Treatment Plant of capacity as per plant design comprising water treatment units like Aerator, Sedimentation tank, Pressure Filters, etc. as per Hydraulic design.
	C] Softener Water Treatment Plant	Softener Water Treatment Plant of capacity as per plant design.
	D] 500 CUM capacity (indicative which shall be decided as per design) GLR with three compartments	One compartment for Treated water, One compartment for Softener Water and One compartment for Fire Water as per plant design.
11	RCC framed Electrical switch room building as per design	Building to be planned to suit the equipment layout as per design satisfying all the safety & functional requirements. RCC framed structure with foundation as per design and masonry infill walls and finishes as per design & specifications

S No.	Building / Facility	Remarks
12	RCC framed Fire Pump room building as per design	Building to be planned to suit the equipment layout as per design satisfying all the safety & functional requirements. RCC framed structure with foundation as per design and masonry infill walls and finishes as per design & specifications
13	RCC framed LOX & LIN filling pump room building as per design	Building to be planned to suit the equipment layout as per design satisfying all the safety & functional requirements. RCC framed structure with foundation as per design and masonry infill walls and finishes as per design & specifications
14	Concrete foundation / pedestals for LIN & LOX storage tanks PBU with RCC paved area	As per design
15	RCC pedestals support for Pipes racks	RCC pedestals shall be designed and constructed for all the service lines as per design
16	RCC cable trenches with RCC cover slabs	Separate RCC cable trenches for Electrical & Instrumentation cables shall be planned & constructed as per design
17	Transformer yard	All civil pedestals for transformers and other equipment in transformer yard with proper chain link fencing with dwarf wall and gate arrangement as per design. The yard shall be filled with 40mm aggregate as per standards.
18	Roads and Pathways	The roads, pathways which are essential are indicated.

S No.	Building / Facility	Remarks
		Contractor has to plan proper access paths to all the facilities within the battery limit. Outer Main road shall be 5.5 Mtr wide RCC road as per design. All other roads / paths shall be 3 Mtr wide RCC road as per design.
19	Storm water drains	Brick Masonry storm water drains for proper disposal of storm water as per design
20	Internal & External PH works including Septic tanks	Internal & External PH works as per NBC standards. Septic tanks for proper disposal of sewage as per design
21	Open areas inside the plant	All the open areas inside the plant excluding Roads / Pathways / Structures / service lines etc. shall be covered with 40mm aggregate or suitable material as per design standards to avoid vegetation growth
22	Miscellaneous civil works	Any miscellaneous civil works, which are found essential for technical completion of the ASU plant but not mentioned explicitly in above scope, shall be deemed to be included in the specification. Accordingly, such works shall be included by the Bidder as part of the offer.

Following are the brief design considerations and the bidder may follow latest Bureau of Indian Standards for design and detailed engineering and the same shall be considered while submitting the bid.

1.6.4 ARCHITECTURAL

The Air Separation Plant proposed in SDSC SHAR, is a state of Art Plant which will produce LOX and LIN to meet ISROs requirements for various launch vehicles.

ESSENTIAL DETAILS

S. No	Parameter	Description
a)	Battery limit size	Approx. 200m x 200m. Overall dimension may get changed due to plant layout design which shall be considered in quote and no extra cost will be paid.
b)	Height	Structures of different Heights as per design.
c)	Building type	Conventional RCC structure is preferred for Auxiliary building, Water Treatment Plant, GLR, Fire Pump House, Electrical Switch room, Filling pump room etc. PEB for Compressor shelter.
d)	Basic drawings	Schematic layout is provided in this document by Department
<i>Interested parties may visit the site (with prior permission from Department) before submitting the bid.</i>		

1.6.5 PLANNING CONSIDERATIONS

S. No	Description
a)	Preliminary plant layout is attached with this tender. The detailed planning of buildings, civil structures, foundations, paved areas, pedestals, roads, storm water drains, water treatment plant etc., are to be planned as per relevant IS standards & NBC codes, PESO norms / AP pollution control board norms / ISRO safety norms etc.

1.6.6 CIVIL SCOPE

A. FOUNDATIONS FOR COMPRESSORS, PUMPS, BLOWERS, MOTORS, AND AUXILIARIES

The Contractor shall carry out **detailed engineering, design, drawings, material procurement, construction, testing, and handing over** of the following:

- Foundations for compressors, pumps, blowers, motors, and auxiliaries.
- Pedestals, inertia blocks, anchor bolt systems, grouting, and vibration isolation.
- Associated civil structures such as equipment supporting platforms, trenches, cable ducts, drain sumps, access steps, and foundation ties.
- Minor structural steel works such as frames, supports, and pipe racks immediately connected to the foundation system
- Concrete Grade: **M35 (minimum)** or as approved based on design; machine foundation top surfaces shall be finished to level ± 2 mm.
- Reinforcement: Fe500/Fe550 HYSD bars, with proper cover blocks and spacers.
- Formwork: Rigid and watertight; vibration cutouts to be formed accurately.
- Grouting: Non-shrink, free-flow cementitious grout beneath base plates and anchor bolts.

- Earthing lugs, inserts, and embedded conduits to be placed as per drawings.
- Foundation bolts shall be held in accurate position using templates.
- Surface preparation for equipment seating area to be trowel smooth, free from laitance and oil.

B. PIPE PEDESTALS SUPPORTING PROCESS AND PRESSURE PIPELINES & FOUNDATIONS, RING WALLS, PILE CAPS, AND PEDESTALS FOR VERTICAL AND HORIZONTAL STORAGE TANKS.

The scope includes all related works such as excavation, backfilling, compaction, formwork, reinforcement, concrete, finishing, embedded items, drainage, and miscellaneous structural steel works connected to the above.

- Reinforced concrete of **minimum M35 grade** to be used.
- Anchor bolts, inserts, and supports shall be accurately embedded as per mechanical drawings.
- Provide expansion and anchor pedestals as per pipe stress requirements.
- Pedestal caps to have smooth finish, level tolerance ± 2 mm.
- Reinforcement: Fe500/Fe550D HYSD bars.
- All foundations shall be laid on approved compacted surface.
- Concrete curing minimum 7 days (or as per IS 456) using wet hessian or curing compound.
- Levels and dimensions to be checked before and after casting.
- Proper drainage to be ensured around foundations.

C. RCC PAVED AREA DESIGNED FOR MOVEMENT AND PARKING OF FULLY LOADED TANKERS/TRAILERS

The scope includes all related works such as excavation/filling, sub-base preparation, compaction, formwork, reinforcement, concrete, finishing, drainage, joints etc.

- Minimum pavement thickness: **230 mm RCC (M35) over 150 mm WMM base, on 200 mm compacted granular sub-base (GSB).**
- Subgrade CBR $\geq 8\%$ with improvements as required.
- Joints: provide contraction joints with dowel bars, sealed with polysulphide.
- Reinforcement: Fe500 mesh with adequate spacing for crack control.
- Provide **drainage slope 1:100** towards collection pits or surface drains.
- Include **bollards, kerb stones, and speed humps** where required.
- 380mm thick RR Masonry dwarf wall upto 600mm above FGL for retaining Earth

D. TRANSFORMER YARD CIVIL WORKS

- Provide **RCC foundations and plinths** for transformers, switchgear panels, and associated equipment as per vendor loads and layout.
- Include **firewall walls** between transformers as per statutory norms.
- **Oil collection pit** with RCC sump and drain channel to oil–water separator.
- **Cable trenches** (brick/RCC) with removable RCC covers.
- **HBG metal surface layer** (75 mm compacted thickness) over geotextile for yard area for fire safety and drainage.
- **DG shed and associated storage tanks as per design**

E. CHAIN-LINK FENCE WITH RR DWARF WALL

- **RR masonry dwarf wall:** height = 0.6 m above GL, thickness = 380 mm, laid in 1:6 cement mortar or as per design
- **RCC coping:** 75 mm thick with chamfered edges.
- **MS angle posts (ISA 50×50×6 mm)** embedded in RCC pockets @ 2.5 m c/c, hot-dip galvanized.
- **Chain-link mesh:** 3.15 mm dia GI wire, 50 × 50 mm mesh, IS 2721 compliant, fixed with GI binding wire and tensioned using GI bar.

- **Corner posts & gateposts:** heavier section ISA 65×65×6 mm with diagonal stays.
- **Gate:** mild-steel framed, double-leaf swing gate with locking arrangement.

F. RCC INTERNAL ROADS / PATHWAYS

- Minimum pavement thickness: **200 mm RCC (M35)** over **150 mm WMM base**, on **1500 mm compacted granular sub-base (GSB)**.
 - Subgrade CBR ≥ 8 % to be maintained
- Provide contraction/expansion joints with dowel bars and joint sealant.
- **Cross-fall:** 1:50 for roads, 1:40 for footpaths.
- **Kerb stones:** precast M30 concrete, size = 300×150 mm.
- **Drainage:** side drains in RCC or masonry with covers, discharging to storm-water line.

G. WATER TREATMENT PLANT (WTP)

- Design for **20 cum/hour treated water output**.
- Civil scope includes:
 - **Filtration unit foundation & plinth** for mechanical filters and softeners
 - **Pump room & operator platform (RCC framed structure)**
 - **Chemical dosing tank foundations and chemical room floor**
 - **Drain channels, inlet/outlet pits, and approach steps**
- Structural design as per IS 3370 (water-tight structures).
- Provide **waterproof plaster (20 mm thick)** inside tanks with integral waterproofing compound.

H. DESIGN & CONSTRUCTION OF SHELTER FOR COMPRESSOR

1.6.7 INDICATIVE SPECIFICATIONS AND DESIGN CONSIDERATIONS:

ARCHITECTURAL

Description
As per the detailed Architectural drawings submitted by contractor & finalized by Department
Finished floor level shall be +300 to 600 mm from FGL.
Entire flooring shall be with cement concrete base with soling. Finished with vacuum dewatered RCC flooring & Hardonite flooring
Walls: i) External wall consists of two layers on either face of column – Outer face of column: 200mm thick Solid cement concrete block masonry External wall upto 1200 mm height from FFL as per architectural drawing. ii) External cladding allround with Galvalume sheet 0.5mm thick from roof level to lintel level as per architectural drawing.
Staircase: MS ladder for accessing top for maintenance.
Doors & Windows MS gate to restrict entry.

STRUCTURAL

Description
The basic structural material chosen for the structural elements is RCC FOR FOUNDATION AND STEEL FOR SUPER STRUCTURE.
Foundation: i) Reinforced cement concrete CAST IN SITU or PRECAST isolated / combined footings shall be provided for supporting the structure based on site soil data and detailed design. ii) Back filling with local sand, sub base to flooring, Anti termite treatment.(Local sand quarry will be shown by department within 5 Km lead)
Super-structure: i) Primary Members - Main frame (column and rafters) using high strength HR steel built up sections, having minimum yield strength of minimum 345 MPA or to suit design as per IS-800 specification. ii) Secondary Members - Purlins, girts and eave structures using Cold form members having minimum yield strength of 345 MPa or suit design as per IS-801 specification and conform to the physical specifications as per IS-808.

Description

- iii) **Bracing systems** - Longitudinal cross bracing using tubular sections to provide lateral stability against wind as per design and IS code.
- iv) **Bolts** - High Strength Tensile Hex Bolts and Nuts of 8.8 grade or equivalent. Anchor bolts as per IS 2062 or equivalent. Galvanized MS Hex bolts and Nuts of 4.8 grade or equivalent as per IS 1367.
- v) **Welds** - All shop connection shall be welded with appropriate arc welding and shall be in accordance with IS-816, IS-819, IS-1024, IS-1261, IS-1323 IS-9595 as appropriate. The webs should be welded on to the flanges at both the faces at top and bottom of columns, beams and any other sections.
- vi) **Sealant** - Sealant used for cladding shall be butyl based two parts polysulphide or eaves, no staining materials are allowed. This is to be applied at all the side laps and end laps of roof panels and around. The sealer shall be non-plastic, non-shrinking, and non-toxic and shall be superior adhesive metals, plastics and painted at temperatures from 51 to 104 Degree Centigrade.
- vii) **Closure** - Solid or closed cell closures matching the profile of the panes shall be installed along the eaves, rails and other locations.
- viii) **Gutters and down comers** - Gutters and down spouts shall be adequately designed to ensure proper roof drainage system. And shall be fabricated out of the same metal sheet; material shall be same as the sheeting. Down comers shall be UPVC with same profile covering.
- ix) **Painting and finishes** - The primary and secondary steel shall be sandblasting / shot blasting to Sa2.5 and be coated with one coat of anti-corrosive primer 40 μ and two coats of anti-corrosive paint.
- x) **Structural steel framing and flashings / fascia around the openings** for fixing lovers, vents, windows, doors, rolling shutters etc. considering the size of the rolling shutters, particular attention shall be paid to the design /size of the framing provided to support the rolling shutters.

Provision for laying of GI strips for earthing conductors for lightning arrester on roof shall be considered and designed.

1.6.8. 500 CUM DOMESTIC WATER GLR AND PUMP ROOM AT WTP LOCATION.

The **construction of 500 Cum GLR** involves Jungle clearance, Earth work in excavation, re-filling, PCC, foundation, RCC walls, RCC Slab & beams, Steel reinforcement, centering & shuttering, water proof plastering for internal & external surface of wall, anti-fungal protective lining for internal surface, five

layer water proofing cum heat insulation treatment, 110mm dia rain water pipe, making khurras, 7.5x7.5cm angular fillet along the parapet wall, providing grooves of uniform size in the top of washed stone grid plaster, safety foot rest, readymade heavy duty FRP manhole frame & covers, puddle flanges, wall reclining aluminum ladder, G.I vent pipes, structural steel works for MS ladder at external wall, external painting etc., complete in all respects as per the architectural, structural and PH drawings enclosed with the tender document, with due compliance to the General notes in the drawings, technical specifications and other provisions detailed in the tender documents

500 CUM Domestic water GLR at WTP location is divided into three compartments of Raw water, Treated Water, softened water GLR.

Execution and construction of WTP structure shall be strictly as per Architectural, Structural & PH drawings, technical specification & guidelines issued from department and as per directions of EIC.

The **construction of Pump room for WTP as per design** adjacent to 500Cum GLR involves Jungle clearance, Earth work in excavation, re-filling, PCC below foundation and sub-base to floor, RCC foundation, RCC columns, RCC Slab & beams, window sill, coping, RCC pedestals, Steel reinforcement, centering & shuttering, brick masonry wall, half brick partitions, structural steel works for MS doors, MS grill, ladders, base plate & anchor bolts, IPS flooring, plastering for internal & external surface of wall, ceramic tile dadoing & anti-skid tile flooring in wash room, five layer water proofing cum heat insulation treatment, 110mm dia rain water pipe, making khurras, 7.5x7.5cm angular fillet along the parapet wall, providing grooves of uniform size in the top of washed stone grid plaster, internal & external painting, internal and external PH works, aluminum window & ventilators with UV resistance polycarbonate sheet etc., complete in all respects as per the architectural, structural and PH drawings enclosed with the tender document, with due compliance to the General notes in the drawings, technical specifications and other provisions detailed in the tender documents

1.6.9 20 CUM PER HOUR CAPACITY WATER TREATMENT PLANT (ELECTROMECHANICAL, CIVIL & PH WORKS)

The Supply, Installation, testing & commissioning of 20 Cum per hour capacity water treatment plant work involves Supply, Installation, testing &

commissioning of one number each (i) vertical dual media MSEP pressure filter, (ii) vertical MSEP activated carbon filter, (iii) vertical MSEP softener& (iv) chlorine dosing system, S/I/T/C of two number three phase centrifugal pumps along with pressure gauge, Gun metal gate valves, non-return valves, CI foot valves and associated CPVC pipe lines for commissioning of WTP etc., complete in all respects as per the PH drawings enclosed with the tender document, with due compliance to the General notes in the drawings, technical specifications and other provisions detailed in the tender documents

The water is pumped using filter feed pumps (with minimum duty of 10 Cum/hr& 30 M Head) to WTP units consisting of Dual Media Filter, Activated Carbon Filter & Softener arranged in series.

The above requirements of WTP units may be revised and enhanced based on test results of water, if required, as per site conditions, design and as per direction of EIC.

IPH works for one toilet proposed in WTP for operator and pump man, are also to be considered with 1 EWC, 1 WHB, 1 no. 500 L Loft tank above loft slab in toilet area and related fixtures as per Architectural & PH drawings.

1.6.10. EXTERNAL WATER SUPPLY GRAVITY MAINS FROM WTP TO ALL FACILITIES.

External water supply line work involves providing and laying pipes as per design Including Jungle clearance, earth work in excavation, re-filling, D.I/C.I/CPVC specials, joints (flanged/tyton/double flanged), providing and fixing gun metal gate valve, sluice valve, air relief valves, pressure gauges, water meters construction of valve chambers, R.C.C. thrust block, Steel reinforcement, centering & shuttering for thrust blocks, R.C.C hume pipes for road crossing, RCC road markers etc., complete in all respects as per the PH drawings enclosed with the tender document, with due compliance to the General notes in the drawings, technical specifications and other provisions detailed in the tender documents.

1.6.11. STRUCTURAL DESIGN CONSIDERATIONS

A. GENERAL

SI. No	Description
a)	The basic structural material chosen for the structural elements is RCC for FOUNDATION AND SUPER STRUCTURE.
b)	Foundation: - Reinforced cement concrete Foundation for supporting the structure based on site soil data and detailed design. - The depth of foundation and safe bearing capacity shall be taken based on soil investigation report. - At the proposed site, Soil investigation shall be carried out by the contractor for exploring the allowable bearing pressure, the founding level, type of foundation and for other parameters required for design and execution of structures, as per relevant IS codes.
c)	<i>Note: The general terrain in the proposed site is plain. The soil is medium dense sand. The SBC at 2 Mtr depth may be taken as 15 T/Sqm [indicative] for preliminary study purpose. However, the final designs shall be governed by actual soil investigation carried out by successful contractor. Tendered is advised to visit the site before quoting.</i>

B. STRUCTURAL DESIGN CRITERIA

SI. No	Description
a)	Dead Loads - shall generally be determined in accordance with IS: 875
b)	Imposed Loads - shall generally be determined in accordance with IS: 875.
c)	Wind Loads - shall be derived as per provisions in IS: 875 (Part 3) and IS 875-2015 Part 5. - Basic wind speed of the site shall be taken as 50 m/s - Probability factor, Terrain, height, and structure size Factor, topography factor and Importance Factor for Cyclonic Region shall

Sl. No	Description				
	be considered as per IS : 875 (Part 3) and Design wind pressure shall be worked out accordingly.				
d)	Seismic Loads - Seismic design and detailing shall be in accordance with IS:1893, IS: 13920 and IS: 4326 as applicable. i) Building is located at Sriharikota, Andhra Pradesh, Zone – III, as per seismic zone map of IS 1893 (Part 1) – 2016. ii) Seismic Parameters iii) Zone Factor as per the code for Zone III iv) Importance Factor – 1.5. v) Response Reduction Factor shall be as per the code. vi) Damping ratio shall be as per Code				
e)	Load Combinations and Partial Safety Factors: The structure and all components are generally designed for the combinations as per IS:456 [RCC] & as per IS 800 [Structural steel component]& as per Seismic code and as per requirement based on design. Load combinations should satisfy the provisions in IS 875:Part 5				
f)	Environmental Exposure: The structure shall be designed for SEVERE exposure conditions. Special care has to be taken for steel members against corrosion attack. Suitable care to be taken in concrete mix design also considering environmental conditions as per relevant IS codes and anti-corrosive coating shall be provided to reinforcement bars as per IS codes.				
g)	Structural Concrete: Design Codes - Structural concrete shall be designed in accordance with the following standards: <table border="1"> <tr> <td>IS 456</td><td>Code of practice for plain and reinforced concrete</td></tr> <tr> <td>IS 875</td><td>Code of practice for design loads other than (part 1 to earthquake for buildings and structures</td></tr> </table>	IS 456	Code of practice for plain and reinforced concrete	IS 875	Code of practice for design loads other than (part 1 to earthquake for buildings and structures
IS 456	Code of practice for plain and reinforced concrete				
IS 875	Code of practice for design loads other than (part 1 to earthquake for buildings and structures				

Sl. No	Description	
	IS 1893	Criteria for earthquake resistant design of structure
	IS 4326	Code of practice for earthquake resistant design and Construction of buildings (Second Revision)
	IS 3935	Code of practice for composite construction
	IS 8147	Code of Practice for Aluminium Design
	IS4082	Recommendation on stacking and storage of construction materials and components at site
	IS 6061	Code of practice for construction of floor and roof with joists and hollow filler blocks (Part – 1 to 2)
	IS 6332	Code of practice for construction of floor and roofs using precast doubly-curved shell units
	SP7	National Building code of India 2005: Part 7 Constructional practices and safety.
	IS 822 (1970)	Code of procedure for inspection of welds
	Material Specification	
	Concrete	M35 Grade (minimum)
	Reinforcement	Shall be as specified in IS with high yield reinforcement ductile bars specified with a characteristic strength 500/550 N/mm ² (Fe 500D/550D bars) per latest codes.
	Material properties	
	Young's Modulus	E _c = 5000 * √(f _{ck}) N/mm ² (Clause 6.2.3.1 IS 456)
	Poisson's ratio	μ = 0.17; Coefficient of Thermal Expansion :10*10 ⁻⁶ /deg C

Sl. No	Description
	Deflection Short term deflection : Span / 350 (IS 456 cl.23.2 b) Long term deflection : Span / 250 (IS456 cl. 23.2 a) Lateral drift : Height / 500 (IS 456, cl. 20.5) and storey drift under seismic loads shall be as per IS 1893 (Part-1)
h)	Structural Steel Work: Design Codes - Structural steel work shall be designed in accordance with the following Standards. IS 800 : Code of practice for general construction in steel IS 808 : Dimensions of hot rolled beams, columns, channels & angle & sections. IS 816 : Code for use of metal arc welding for MS construction IS 1161 : Steel tubes for structural purposes IS 1363 : Hexagonal bolts, screws and nuts – grade C IS 1364 : Hexagonal bolts, screws and nuts – grade A & B IS 1367 : Technical conditions for Threaded Steel fasteners IS 2062 : Steel for general structural purposes IS 3757 : High strength structural bolts IS 8500 : Structural steel – micro alloyed (Medium & high strength qualities) IS 9595 : Recommendations for metal arc welding of carbon and carbon manganese steels. IS 3370 : Vibration pads installation Material Properties Young's Modulus : $E_s = 200 \text{ KN/mm}^2$ Coefficient of Thermal Expansion : $12 \times 10^{-6}/\text{deg. C}$

SI. No	Description
	(All structural steel section shall be of approved make/ brands like TATA, JSW etc.,) Seismic Design / Detailing - shall be in accordance with IS1893 and IS 13920 The structure shall be designed based on Limit state method of design wherein all parts of the structure are so proportioned that it does not cross the limit states as per the latest codes.
i)	Connections: Shall be as per IS 800 and applicable standards. i) Welds shall be in accordance with IS 822 and two sides welds in all members & joints. ii) Inspection of welds shall be done as per IS 822. iii) Dye penetration test shall be done at all shop welded and site welded joints. iv) Bolts – specifications of bolts are indicated in the material specifications.

C. ANALYSIS OF STRUCTURES

SI. No	Description
a)	The structural analysis shall be carried out by using Standard Engineering Software like STAAD Pro, ETABS, etc., 3D static and dynamic analysis shall be carried out in line with IS codes
b)	The structures shall be modeled as 3D – frames.

c)	The structures shall be analyzed for individual load cases as described above, using state of the art software packages as required. Suitable load combinations shall be performed and the performance of the structures in various states of collapse and serviceability is checked accordingly as per IS codal provisions. If functional/ structural/ Geotech requirements warrants advanced finite element analysis (or) non-linear analysis with soil-structure interaction, the same shall be carried out without any additional cost to Department

D. DESIGN OF STRUCTURES

Sl. No	Description
a)	The design of the concrete structures shall be based on the Limit State Method as per IS 456 and steel structures shall be based on the Limit State Method, conforming to IS 800. The overall design is based on all relevant codes / standards and sound engineering practice.
b)	The design of the various elements of the structures shall be made using software packages, and manual calculations.
c)	Note: Only latest version/ revision shall be followed for all the codes mentioned here
d)	Design of RCC structures and detailing shall satisfy the provisions in IS 13920 (latest).

1.6.12 FOUNDATIONS FOR COMPRESSORS, PUMPS, BLOWERS

1.6.12.1 CODES AND STANDARDS

All designs shall conform (latest revisions) to:

- IS 456 – Plain and Reinforced Concrete
- IS 3370 – Concrete Structures for Liquid Retaining Structures (if applicable)

- IS 1904, IS 2950 (Part I & II) – Design & Construction of Machine Foundations
- IS 2974 (Part 1 to 5) – Foundations for Rotary/Reciprocating Machines
- IS 800, IS 875 – Steel Design and Loads
- IS 1893 (Part 1 & 4) – Earthquake & Dynamic Load Considerations
- IS 10262 – Concrete Mix Design
- IS 2911 – Pile Foundations (if applicable)
- NBC 2016 – General Requirements for Structural Design

Where IS codes are not available, relevant international codes such as **ACI**, **DIN**, or **BS** may be referred to with prior approval of the Dept.

1.6.12.2 DESIGN BASIS

- The Contractor shall obtain **machine data sheets** (static & dynamic loads, speed, unbalanced forces, foundation layout) from the Equipment design.
- Perform **static and dynamic analyses** considering machine operating conditions, frequency separation (resonance check), and allowable amplitude limits as per IS 2974.
- Design drawings shall show foundation block dimensions, reinforcement, anchor bolt details, grout pockets, vibration isolation pads, inserts, and embedment's.

1.6.13 DESIGN OF RCC PAVED AREA FOR MOVEMENT AND PARKING OF FULLY LOADED TANKERS/TRAILERS (UP TO 40 MT AXLE LOAD EQUIVALENT). PIPE PEDESTALS FOUNDATIONS, RING WALLS, PILE CAPS, AND PEDESTALS FOR VERTICAL AND HORIZONTAL STORAGE TANKS.

The design shall comply with the **latest revisions** of the following codes (or equivalent international standards with prior approval):

Discipline	Code Reference
RCC Design	IS 456, IS 3370, IS 2950
Steel Design	IS 800, IS 875

Discipline	Code Reference
Machine/Tank Foundation	IS 2974, API 650/IS 803
Earthquake Resistance	IS 1893 (Part 1 & 4)
Soil & Foundation	IS 1904, IS 2911 (for piles)
Roads & Pavements	IRC 37, IRC 58, IS 456
Loads	IS 875 (Parts 1–5)
Concrete & Materials	IS 10262, IS 383, IS 9103, IS 516
General	NBC 2016, CPWD Specifications

GUIDELINES FOR DESIGN:

1. As a guideline, paved Area to be designed for repetitive loads of loaded tankers (axle load up to 16–20 tonnes) using rigid pavement design principles (IRC 58:2015).
2. Pipe Pedestals shall be designed to support the dead weight, thermal loads, and occasional loads (wind, earthquake, vibration) from the pressure pipelines.
3. Pedestal spacing and height shall suit pipeline profile and stress analysis furnished by designer
4. Foundations for Heavy Storage Tanks: Foundation type (ring wall, raft, or pile) to be selected based on soil strata and load.

1.6.14 GENERAL CONDITIONS

- (i) Maximum effort to be made to plan the service lines like water lines, rain water pipes, cable trays etc are not visible from outside to have aesthetic look of the building.
- (ii) The final plinth level shall be 600 mm above the nearest road level. The formation level in general is about 150 mm below nearest road level which may vary slightly as per the site condition and the contractors are advised to visit the site and confirm the same. Nothing extra will be paid to the contractors on account of variation in formation level.

- (iii) The floor height from finished floor level of one floor to finished floor level of successive floor and the minimum clear head room from top of floor finish to the bottom of beams shall be as per architectural drawings.
- (iv) The structural drawings shall be got proof checked from reputed IITs/ NITs/ institutions and subsequent approval from Department. If any modification in design/ drawing is needed as per site conditions, or subsequent to proof checking, the contractor shall do/ redo the design without any extra cost. The decision of the Department in this regard shall be final and binding. No claim whatsoever on this account will be entertained on this count.
- (v) The technical specifications, design considerations and Scope of work given in the tender document are for the general guidance of the Tenderer and shall not be considered as exhaustive.
- (vi) Structure shall be designed for the satisfactory performance of the functions for which the same is to be constructed.
- (vii) Details/ specifications not appearing in the list, but required to complete the work, shall be considered as part of the Scope and Tenderer's offer shall be considered to include the same.
- (viii) Any miscellaneous materials, which are found essential for technical completion of the contract but not mentioned explicitly in this specification, shall be deemed to be included in the specification. Accordingly, such materials shall be included by the vendor as part of the offer.
- (ix) All loading and unloading arrangements shall form part of the scope as required.
- (x) The contractor shall be responsible for handling and ensuring safe custody of the materials and accessories from the time of supply at site till installation, testing and commissioning and handing over the same to the department on satisfactory completion of work.
- (xi) The contractor shall co-ordinate with other agencies during the course of the installation as applicable and to ensure the safe commissioning.
- (xii) The works of installation, testing and commissioning shall be done by employing qualified competent engineers / supervisors and all instructions of

the department shall be strictly followed for the completion of work with good workmanship as required and regulations and other mandatory requirements.

- (xiii) Taking all precautionary measures to safeguard against any accident for the contractors' employees, general public, supervisory staff of Department by providing necessary safety equipment e.g. MS sheet barricading etc and personnel's protection equipment e.g. helmets, safety shoes etc. at work site, and contractor shall be responsible & liable for payment towards any such accidents but nothing shall be paid on this account.
- (xiv) The site has to be kept clean of all debris, rubbish and dirt & surplus/waste material all the time. It also includes maintenance, cleaning & de-silting the drains, pipe lines laid by the agency for all services etc. executed by the agency to the entire satisfaction of the Department during the construction period. Cleaning and de-silting will also be done by the agency before handing over the completed building to Department. All machines, equipment and labour for this purpose will be arranged by the contractor.
- (xv) Maintenance / defect liability period shall be as per contract clauses, from the date of handing over the building complete in all respects & fit for occupation. During this period, the defects noticed in the work carried out by the contractor shall be removed at his cost. In case he fails to do so after intimation to him in writing by the Department, the same shall be carried out at his cost. However, maintenance of other building activities such as cleaning, sweeping of building & desalting of sewer lines, S.W. Drain shall be done only once, at the time prior to handing over the building.
- (xvi) The scope of work includes cost of all materials, manpower, equipment, T&P, fixtures, accessories, royalties, taxes, watch & ward and all other essential elements for completion and maintenance of works as aforesaid whatsoever. Any changes, modifications, revisions etc. required to be done by Department, client, local bodies, proof consultants etc. in accordance with applicable standards will have to be done at contractor's cost and nothing extra shall be payable on these counts.

1.6.15 DETAILED SCOPE OF WORK

1.6.15.1 ARCHITECTURAL

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- (i) The layout plan/ sketch/ drawing provided in this Tender Document is for guidance only. Any changes necessitated for complying, functional need of as per Project/ Department requirement, Standard DOS guidelines, NBC & CPWD norms have to be carried out by the contractor. The necessary architectural consultancy services for preparing the detailed architectural drawing shall be within the scope of work.
- (ii) Architectural designing, planning, proof checking, making of drawings, 3D Modelling on any BIM applications with minimum LOD 350 and IFC format of the same shall be made available for interoperability of building information to all stake holders of the project. The 3D architectural BIM model information (s) shall be used for structural, MEP services and Horticulture design. The comprehensive BIM model with minimum LOD 350 of project shall have all the architectural, structural, horticulture and MEP services elements
- (iii) Schematic layout plan is attached with bidding documents. These are only indicative just to give idea regarding proposed works. The successful bidder shall appoint an architectural consultant, who in association with the Department shall prepare the detailed architectural drawings considering the requirement of a world class ASU in the TLP site at SDSC SHAR. Architectural Consultant shall incorporate all the suggestions and modification as directed by Department and also in consultation with ASU equipment and their functional requirements.
- (iv) Preparation of architectural construction drawings incorporating the structural design details. Design and prepare elevations as per contract specifications before start of the work.
- (v) Preparation of interior details including equipment layout, toilet layout, other finishing details and detailing including electrical fittings, fixtures, sockets, switches, etc. all complete.
- (vi) Preparation of opening details for doors, windows, ventilators, etc.
- (vii) Preparation of flooring layout as per contract specifications.
- (viii) Preparation of color scheme for internal and external finishes.
- (ix) Preparation of as built drawings.

- (x) Preparation of integrated Building plan incorporating all external services, roads, drains, street lighting, UG sump, rain water harvesting, levels, retaining structures, etc. all complete.
- (xi) Obtaining clearance of Architectural drawings from Department Architect is necessary.
- (xii) Any drawings or details as mentioned above shall be prepared and submitted in duplicate in suitable size of sheet so that all dimensions, features, notes etc are completely legible for approval.

1.6.15.2 STRUCTURAL DESIGN

- (i) Preparation of design basis report and carry out structural design, prepare working drawings for foundation, superstructure and all other related structures as per the Architectural Drawings.
- (ii) Preparation of Structural Design to meet the requirements of architectural, electrical, mechanical, piping and ASU equipment, to make the building functional.
- (iii) Preparation of structural design of the building complying to all latest modifications, corrigendum, addendum of the relevant BIS Codes in general i.e. IS:456-2000/ latest amendment, IS:800-2007, IS:875, IS:1343-2012, IS:1893-2016, IS: 10297, IS:13920-2016, IS:15916-2010 and other relevant BIS Codes with up-to-date revisions.
- (iv) Obtaining structural drawings proof checked by the reputed Government institutions like IIT/NIT/approved Departments. If any modification in design/ drawing is needed as per site conditions, or subsequent to proof checking, the contractor shall do/ redo the design without any extra cost. The decision of the Department in this regard shall be final and binding. No claim whatsoever on this account will be entertained on this count. The cost of proof-checking shall be borne by the contractor.
- (v) Obtaining go-ahead clearance for the structural drawings before execution.

1.6.15.3 PH WORK

- (i) Scope of plumbing work includes Internal PH work for Toilets of Male & Female Personnel based on Architectural drawings & minimum requirements as per NBC & other relevant IS standards, Internal water supply for domestic requirement & Internal sewerage works.
- (ii) Water requirement for the ASU plant shall be realized within the premises as part of Scope of Contract.
- (iii) Sewerage lines including disposal system shall be realized within the premises as part of Scope of Contract.
- (iv) The Plumbing/ Sanitary Design & Schematic/ Line drawings, detailed fabrication/ execution drawings & shop drawings, as required at site are to be prepared by the Contractor and submitted to Department for obtaining go-ahead clearance for drawings before proceeding with the work.
- (v) The preparation of Sanitary/ Plumbing drawings shall include, but not limited to:
 - a. Integration of detailed drawings with Civil/ Structural details prepared by contractor for each building and obtaining clearance of Department.
 - b. The Execution of Plumbing/ Sanitary work for buildings including hot water arrangement, provision and installation of Plumbing systems as per Scope of the work read with Technical Specifications and Drawings.

1.6.16 ADDITIONAL CONDITIONS

1. SPECIFICATIONS AND STANDARDS:

- All Materials, works and construction operations shall conform to the Specifications and Standards of Department. If any material or construction methodology mentioned in the drawing and if detailed specification not available in the tender document, the same shall be carried out as per the CED specifications (schedule I) /CPWD specifications and I.S. Codes etc.

2. COMPLIANCE WITH LOCAL BYE-LAWS, RULES & REGULATIONS:

- The work shall be carried out in the manner complying in all respects with the requirements of relevant bye-laws of the local body under the jurisdiction of which the work is to be executed or as directed by the Department and nothing

extra shall be paid on this account. The contractor shall give due notices to the Municipality, Police and /or other authorities as may be required under the law / rules under force and obtain all requisite licenses / permissions to carry out the work and pay all charges which may be levied on account of his execution of the work under the agreement. Nothing extra shall be payable on this account.

- In the event of any restrictions being imposed by security and traffic agencies or any other authority having jurisdiction in the area on the working or movement of labour /material, the contractor shall strictly follow such restrictions and nothing extra shall be payable to the contractor on this account. The loss of time on this account, if any, shall have to be made up by generating additional resources etc.

3. PROTECTION OF EXISTING STRUCTURES SERVICES AND INTERFERENCE WITH OTHER WORKS.

- Existing drains, pipes, cables, overhead wires, sewer lines, water lines and similar services encountered in the course of the execution of the work shall be protected and maintained against the damage by the Agency. The Agency shall identify all underground and overhead services and take necessary measures to protect the services before starting any excavation/ activity. All temporary supports and other measures required to protect and maintain the services during construction period as per direction of Department, shall be deemed to be included in the quoted rate / amount of the Agency and nothing extra shall be paid on this account.
- For shifting of any temporary or permanent services, the agency shall arrange to shift the services including liaising work with the concerned Govt. Agencies as and when required. Any construction cost of shifting of the above services shall be paid by the Department directly to the concerned Govt. Agency. In certain cases, it can also have paid by the agency to the concerned Govt. Department for which such actual cost paid shall be reimbursed to the agency by the Department on evidentiary document production.
- The contractor shall carry out his work so as not to interfere with or hinder the progress or completion of the work being performed by other contractor (s) or

by the Department and shall as far as possible arrange his work and shall place and dispose of the materials being used or removed, so as not to interfere with the operations of other contractors. He shall arrange his work with that of the others in an acceptable and coordinated manner and shall perform it in proper sequence to the complete satisfaction of Department.

4. RECESSES, HOLES, OPENINGS, ETC.

- The contractor shall leave such recesses, holes, openings, etc. as may be required for the electric, air-conditioning and other related works for which inserts, sleeves, brackets, conduits, base plates, clamps etc. shall fix the same at the time of casting of concrete, stone work and masonry work or at any similar location if required, and nothing extra shall be payable on this account. Alternatively, recesses in RCC/ Masonry shall be cut with specialized cutting tools as per requirement of work. All Recesses, holes and openings shall be sealed with appropriate epoxy chemicals after or during installation of inserts in the same. Nothing extra shall be payable for these operations to the contractor.

5. TENDER DRAWINGS.

- Only indicative layout is attached as a part of tender document.
- The Department shall not bear any responsibility for the lack of knowledge and also the consequences, thereof to the Contractor. The information and data shown in the drawings and mentioned in the tender documents have been furnished, in good faith, for general information and guidance only. The Department, in no case, shall be responsible for the accuracy thereof and/or interpretations or conclusions drawn there from by the Contractor and all consequences shall be borne by the Contractor. No claim, whatsoever, shall be entertained from the Contractor, if the data or information furnished in tender document is different or in-correct otherwise or actual working drawings are at variance with the drawings available for inspection or attached to the tender documents. It is presumed that the contractor shall satisfy himself for all possible contingencies, incidental charges, wastages, bottlenecks etc. likely during execution of work and acts of coordination, which may be required between different agencies. Nothing extra shall be payable on this account.

6. ORDER OF PREFERENCE

If there is any difference or discrepancy between the description of items as given in the item wise requirement and tender drawings, particular specifications for individual items of work, additional conditions, CED specifications /CPWD specifications and I.S. Codes etc., the following order of preference shall be observed.

- Description under working Drawings, Schedule of Finishes and minimum specification. In case of any discrepancies among above documents specified, the higher specifications shall be followed as per directions of Department.
 - Additional and special condition.
 - General conditions of contracts (GCC) DOS for EPC works
 - CPWD Specifications
 - Indian Standard Specifications of B.I.S. with correction slips up to last date of receipt of bid.
 - National Building codes 2016 with correction slips up to last date of receipt of bid.
 - ASTM, BS, or other foreign origin code mentioned in tender document.
 - Manufacturer's specifications.
 - Sound engineering practices or well-established local construction practices.
 - Decision of Department
7. This work is to be executed in region having harsh climatic conditions and within the strict time line without any fail, hence agencies shall mobilize all their resources to achieve that. Agency shall increase their efforts to compensate if any hindrance/s occurred during the execution of work. However, nothing extra shall be paid in this regard.
8. The works covered under the scope are to be carried out complete in all respect including services and rates quoted by the bidder shall be considered for entire scope of work which includes all activities and work starting from the given concept to completion till handing over of completed project in functional state

from all perspective. There can be changes in the scope of work as per requirement of local bodies. The drawing attached with this document is indicative only and the detailed drawings shall be developed by the agency after approval of competent authority. The agency shall submit all “Good for construction” drawings to the Department before starting execution.

9. General ground level inside the Plant shall be (+) 600mm from adjoining pavement level/ road level
10. The indicative drawings/layout plan of buildings is attached with this document.
11. The detailed Design Basis Report (DBR), Methodology & Drawings as per conditions & specifications given in this document for each component like Civil works as detailed in the tender document etc. shall be prepared by the agency and submitted to Department for getting clearance to go ahead with the execution.
12. All works shall be carried out as per relevant items of Specifications of CED DOS or CPWD and Schedule of rates 2023 of SDSC SHAR for new & innovative technologies and prevailing CED –DOS / CPWD Specifications (Corrected up to the last date of receipt of tenders), if not covered in these documents, IS codes / NBC 2016, ECBC 2018 shall also be followed.
13. The scope of work includes “Structural Design” also. This shall be carried out as per relevant BIS codes, NBC 2016 and other international codes with up-to-date corrections / amendments / errata.
14. The Contractor agency is required to connect all the external services like Water Supply, Sewerage, Drainage, Electric Supply, Telephone Lines etc. to the main lines of the authority’s/service providers and this shall be considered as integral part of Scope of work and deemed to be included in the quoted price of the agency.
15. Site shall be handed over to the Contract agency for planning, designing and execution of work. on “as is where is basis”.
16. The Agency shall hand over the assets after completion of work with as built drawings, services route plans, Maintenance manuals, Warrantees / Guarantees or any other document required by the Department for record and maintaining these establishments.

17. The Contractor shall construct/ provide one site office at his own cost on the construction site consisting of four rooms with necessary furniture like tables, chairs, conference table including 1 toilet with total built up area not less than 50 Sq. metres, Air Condition (AC)/Heating system for sub zero temperature of suitable size for rooms of Dept. staff. The location and plan shall be got approved from Department. Specification for the site office shall be portable type and or any other specification as per approval of Department. The Digital display arrangement (with projection system & sound system for conference room) shall be provided.
18. The final plinth level will be decided soon after actual start of work at site. **The formation level may vary slightly as per the site condition and the contractors are advised to visit the site and confirm the same.** Nothing extra will be paid to the contractors on account of variation in formation level in the item of schedule of quantity.
19. The floor height from finished floor level of one floor to finished floor level of successive floor and the minimum clear head room from top of floor finish to the bottom of beams shall be as per architectural drawings.
20. The structural drawings shall be got proof checked from reputed IITs, NITs/ other Departments approved by Department. If any modification in design/ drawing is needed as per site conditions, or subsequent to proof checking, the contractor shall do/ redo the design without any extra cost. The decision of the Department in this regard shall be final and binding. No claim whatsoever on this account will be entertained on this count
21. Taking all precautionary measures to safeguard against any accident for the contractors' employees, general public, supervisory staff of Department by providing necessary safety equipment e.g. MS sheet barricading etc and personnel's protection equipment e.g. helmets, safety shoes etc. at work site, and contractor shall be responsible & liable for payment towards any such accidents but nothing shall be paid on this account.
22. The site has to be kept clean of all debris, rubbish and dirt & surplus/waste material all the time. It also includes maintenance, cleaning & de-silting the drains, pipe lines laid by the agency for all services etc. executed by the agency to

the entire satisfaction of the Department during the construction period. Cleaning and de-silting will also be done by the agency before handing over the completed building to Department. All machines, equipment and labour for this purpose will be arranged by the contractor.

23. Maintenance / defect liability period would be uniformly one (1) year from the date of handing over the building complete in all respects & fit for occupation. During this period, the defects noticed in the work carried out by the contractor shall be removed at his cost. In case he fails to do so after intimation to him in writing by the Department, the same shall be carried out at his cost. However, maintenance of other building activities such as cleaning, sweeping of building & desilting of sewer lines, S.W. Drain shall be done only once, at the time prior to handing over the building.

24. The scope of work includes cost of all materials, manpower, equipment, T&P, fixtures, accessories, royalties, taxes, watch & ward and all other essential elements for completion and maintenance of works as aforesaid whatsoever. Any changes, modifications, revisions etc. required to be done by Department, client, local bodies, proof consultants etc. in accordance with applicable standards will have to be done at contractor's cost and nothing extra shall be payable on these counts.

25. ALL HEIGHTS, LIFTS, LEADS AND DEPTHS

Unless otherwise specified in tender document, the rates tendered by the contractor shall be all inclusive and shall apply to all depths, heights, lifts and leads of the building and nothing extra shall be payable on this account.

26. STACKING OF MATERIALS

The Contractor(s) shall take instructions from the Department regarding collection and stacking of materials at any place. No excavated earth or building rubbish shall be stacked on areas where other buildings, roads, services and compound walls are to be constructed. The stacking shall take place as per stacking plan however, if any change is required, the same shall be done with the approval of Engineer-in Charge.

27. INCIDENTAL WORKS

For execution of any items of work where incidental works such as bailing out water, providing shoring etc. are actually required but not specifically stated in the scope of item or tender document, contract amount quoted by the agency shall cover such charges towards such Incidental Works also and nothing extra on account of such incidental charges shall be payable.

28. SETTING OUT

- (i) It shall be responsibility of the contractor to ensure correct setting out of alignment. Real Time Kinematics / Total Station survey instruments only shall be used for layout, fixing boundaries, and centre lines, etc., Nothing extra shall be payable on this account.
- (ii) Though the site levels are indicated in the drawings the contractor shall ascertain and confirm the site levels with respect to benchmark from the concerned authorities. The contractor shall protect and maintain temporary/permanent benchmarks at the site of work throughout the execution of work. These benchmarks shall be got checked by the Department or his authorized representatives. The work at different stages shall be checked with reference to bench marks maintained for the said purpose. Nothing extra shall be payable on this account.
- (iii) The contractor shall be entirely and exclusively responsible for the horizontal, vertical and other alignments, the level and correctness of every part of the work and shall rectify effectively any errors or imperfections therein. Such rectifications shall be carried out by the Contractor at his own cost to the entire satisfaction of the Department.
- (iv) The proposed level of top surface of internal roads, pathway, lawns etc. is subjected to corrections as per original/existing ground level (OGL/EGL) with the approval of Department.
- (v) The contractor shall survey the whole plot/land of the campus to verify (OGL/EGL). The RL shall be taken with reference to permanent bench mark of the campus adopted by the department for detailed design of the campus infrastructure. Nothing extra shall be payable to the contractor for this survey.

- (vi) Provision for cross drainage for storm water below internal road using RCC(NP2) pipes of suitable diameter at suitable location shall be made by the contractor as per tendered drawings and as per direction of Department.

29. SCAFFOLDING/SHUTTERING

- Wherever required for the execution of work, all the scaffolding shall be provided and suitably fixed, by the Contractor. It shall be provided strictly with lock and cup steel double scaffolding system, suitably braced for stability, with all the accessories, gangways, etc. with adjustable suitable working platforms to access the areas with ease for working and inspection. It shall be designed to take all incidental loads. It should cater to the safety features for workmen. Nothing extra shall be payable on this account. It shall be ensured that no damage is caused to any structure due to the scaffolding.
- At the request of contractor, the use of Marine Ply/Doka/ Peri / Mivan shuttering for beams, slabs, walls and columns may be permitted by Department. Nothing extra shall be paid on this account. Foam Sheet/ jointing tape shall be used in the joints of shuttering to ensure no leakage of cement slurry. Nothing extra shall be paid on this account

30. CO-OPERATION WITH OTHER CONTRACTORS / SPECIALIZED AGENCIES / SUB CONTRACTOR

The Contractor shall take all precautions to abide by the environmental related restrictions imposed by any statutory body having jurisdiction in the State as well as prevent any pollution of streams, ravines, river bed and waterways. All waste or superfluous materials shall be transported by the Contractor, entirely to the satisfaction of the Department and disposed at designated places only. Utmost care shall be taken to keep the noise level to the barest minimum so that no disturbance as far as possible is caused to the occupants / users of adjoining buildings. No claim what so ever on account of site constraints mentioned above or any other site constraints, lack of public transport, inadequate availability of skilled, semi-skilled or unskilled workers in the near vicinity, non-availability of construction machinery spare parts and any other constraints not specifically stated here, shall be entertained from the Contractor. Therefore, the Tenderers are

advised to visit site and get first-hand information of site constraints. Accordingly, they should quote their tenders. Nothing extra shall be payable on this account.

The Contractor shall co-operate with and provide the facilities to the sub-Contractors and other agencies working at site for smooth execution of the work.

The Contractor shall:

- Allow use of steel scaffolding, toilets, sheds etc.
- Properly co-ordinate their work with the work of other Contractors.
- Provide control lines and benchmarks to his Sub-Contractors and the other Contractors.
- Provide electricity and water at mutually agreed rates.
- Provide hoist and crane facilities for lifting material at mutually agreed rates.
- Co-ordinate with other Contractors for leaving inserts, making chases, alignment of services etc. at site.
- Adjust work schedule and site activities in consultation with the Department and other Contractors to suit the overall schedule completion.
- Resolve the disputes with other Contractors / sub-contractors amicably and the Department shall not be made intermediary.

Other agencies will also simultaneously execute and install the works of substation generating sets, air-conditioning, lifts, etc. for the work and the contractor shall afford necessary facilities for the same.

The contractor shall conduct his work, so as not to interfere with or hinder the progress or completion of the work being performed by other contractor(s) or by the Department and shall as far as possible arrange his work and shall place and dispose-off the materials being used or removed so as not to interfere with the operations of other contractor or he shall arrange his work with that of the others contractors/ specialized agencies/ subcontractors in an acceptable and in a proper coordination manner and shall perform it in proper sequence to the complete satisfaction of Department.

For completing the work in time, the Contractor might be required to work in two or more shifts (including night shifts). No claim whatsoever shall be entertained on this account, notwithstanding the fact that the contractor may have to pay extra amounts for any reason, to the labourers and other staff engaged directly or indirectly on the work according to the provisions of the labour and other statutory bodies regulations and the agreement entered upon by the Contractor with them.

31. PRODUCT DELIVERY, STORAGE AND HANDLING OF CHEMICALS

- (i) The contractor shall construct storage space for Chemicals materials to ensure that the storage conditions are as recommended by the manufactures.
- (ii) All the materials shall be procured and delivered in sealed containers with labels legible and intact.
- (iii) All the chemicals {polymers, epoxy, water proofing compound, plasticizer, Polysulphide, SBR based elastomeric, APP (Atactic Polypropylene Polymer), all exterior and interior paints, polish etc.} shall be procured in convenient packs say 20 litres/kg} capacity packing or less as approved by the Department, and not in bigger capacity containers, say 200 litre (kg) drums unless otherwise specifically permitted by the Department. One sample from each lot of the chemical procured by the contractor shall be tested in a laboratory as approved by the Engineer in-Charge.
- (iv) All material required for the execution of the work shall be got approved, procured and deposited with the Departmental supervisory staff. The materials shall be kept in joint custody of the contractor and the Department. The watch and ward of such material shall, however, remain to be the responsibility of the contractor and no claim, whatsoever, on this account shall be entertained. Different containers of each chemical shall be serially numbered on packing and also consumed in that order. Day-to-day account of receipt, issue and balance shall be regulated by the Department and proper account shall be maintained at site of work in the prescribed form as per the standard practice.

- (v) The original copies of challan /cash memos towards the quantity of various chemicals procured shall be made available by the contractor at the request from the Engineer in- Charge and a copy of the same shall be kept in record.
- (vi) The Name of manufacturers, manufacturer's product identification, manufacturer's mixing instructions, warning for handling and toxicity and date of manufacturing and shelf life shall be clearly and legibly mentioned on the labels of each container.
- (vii) The contractor shall submit for the chemicals procured, manufacturer's and / or authorized dealer's certificate regarding supplying and verifying conformance to the material specifications, as specified.
- (viii) All filled containers shall be handled in safe manner and in a way to avoid breaking container seals.
- (ix) Empty containers of the chemicals should not be removed from site without the written approval of the Engineer-in- Charge or till the completion of work and shall be removed only with the written approval of the Department.
- (x) All arrangements for measuring, dosing and mixing of material / chemicals at site have to be made by the contractor.
- (xi) Contractor shall suitably advise his site Engineer and all the workers as regards safe handling of chemicals. Necessary protective and safety equipment in form of hand gloves, goggles etc. shall be provided by the contractor and be also used at site.
- (xii) All incidental charges of any kind including cartage, storage and wastage and safe custody of material etc. shall be borne by the contractor and no claim, whatsoever, shall be entertained on this account.
- (xiii) The chemicals shall be tested in an independent laboratory as approved by the Department at the frequency as specified. If required, more samples may have to be tested as per the directions of the Department. Nothing extra shall be pay.

32. SECURITY OF THE SITE

- The Agency shall be wholly responsible for security of site and works. The Agency shall be responsible for keeping unauthorised persons off the Site; and Authorized persons shall be limited to the Employees of the Agency, Sub Agency or persons as authorized by the Department.
- **Lighting:** The agency shall provide sufficient lighting at project site considering the safety and security of project. The Agency shall provide suitable numbers and suitable type of fittings to have sufficient illumination level with glare-free lighting for safety of workmen while performing their assigned job. Wiring for such installation shall be adequately protected to avoid any risk of electric shock. The agency shall ensure that luminaries should always be so placed that no person is required to work in their own shadow and that the local light for one person is not a source of glare for the others. Strongly made clamps should be available for attaching luminaries to poles and other convenient supports.
- **Luminaries** shall be robust, resistant to corrosion and rain proof especially at the point of the cable entry. Lamp holders not fitted with a lamp should be capped off and no open end shall be left. The agency shall take every effort to illuminate the worksite as per the direction of Department

33. DEFECT LIABILITY

The scope of the defect liability will be as under:

Sl No	Description	Defect Liability
1	Concrete	Rectification of structural /superficial/non-structural cracks. Rectification of dampness/leakages/seepage in roof slab/junctions & sunken portion, depressed portion, through RCC slab, vertical ties, bands, walls, base slab, junction of RCC walls with base slab and construction joints of RCC water tanks. Rectification of cracks in beam, slab, column, lintels, vertical ties, plinth bands, lintel bands etc.
2	Brick/ Block work	Rectification of cracks in confined masonry panel wall/partition wall in full length or in part portion.

SI No	Description	Defect Liability
		Cracks / settlement of main wall, partition wall or dwarf walls. Rectification of efflorescence, dampness.
3	Woodwork & Joinery	Replacement of warped / bent / weather affected joinery, termite & borer affected joinery of wooden door / window shutters and frames. Cracks in panels, bars / rails / styles of wooden door / window shutters etc.
4	Builders Hardware	Repairs / Replacement of loosened / premature failure of fittings including lever mechanics in door locks, hydraulic door closers, handles, tower bolts, cupboard locks etc. Tightening / Replacement of sag in mosquito proofing SS net.
5	Steel & iron Work	Rectification / Replacement of defective part of gate, shutter, etc. Redoing of defective portion in fabrication / welding including painting thereon. Structural steel work and MS railing. Windows, grills, gates etc. – Defects to be rectified.
6	Roof treatment	Rectification of leakage / seepage in roof slab, expansion / seismic joints, floor junctions, inadequate / faulty slope, drain outlets, including covering at junction till guarantee period.
7	Finishing	Rectification of structural / superficial cracks. Rectification of protruding / peeling off plaster. Rectification of efflorescence, dampness appeared. Undulation / unevenness in plaster. Paint & polishing
8	Flooring	Rectification of sunken / deflected / depressed portion of plinth protection, flooring in rooms, toilets, entrance foyer, staircase and other locations. Rectification / Replacement of settled floors. Settlement of foundation & floors and resultant undulation of door finishes.

SI No	Description	Defect Liability
		Rectification / Replacement of floor tiles which are sunken/ uneven / undulating at joints / different in colour, texture, etc.
9	Aluminium windows and doors	Rectification / Replacement of defective part of Aluminium door, window and ventilator frame & shutters
The above list is illustrative for civil work and not exhaustive. The rectification will include all Civil and Electro-Mechanical works including internal and external services without any exclusion		

1.6.17 CIVIL WORKS SPECIFICATIONS

GENERAL GUIDELINES / SPECIFICATIONS FOR CIVIL WORKS

- a) Below mentioned are brief general specifications for guidance purpose only. Detailed specifications have to be drafted as per the intended purpose of the construction requirements conforming to applicable local bye-laws, regulations, norms, codal provisions, work wise, building wise, room wise depending upon the functional, architectural, structural requirements of the client specific to the project and may be incorporated.

Item No	Description	Guide lines
1.0	General Specifications / Guidelines	1. CED-DOS Specifications as per Schedule/ CPWD Specifications 2019 Vol-I and Vol-II as amended from time to time shall be applicable for all the items to be executed as per Good for construction drawings. 2. Contractor shall carryout his own soil investigation from a soil investigating agency approved by the Department for the purpose of design of foundation and superstructure. 3. Type of cement to be used in the work shall be as per provisions of IS: 456 with regard to exposure conditions. PPC cement is recommended by the Department. 4. C&D waste products and recycled aggregates to the

Item No	Description	Guide lines
		extent provided in IS codes shall be used as per extant provisions of Green Building measures. 5. Only potable water shall be used in the work.
2.0	Earthwork, Foundation and Plinth	1. Scope of work includes all items of CED Technical Specifications (including shoring, bailing and pumping out water, strutting, rock cutting etc.) as may be applicable to the work as per design and drawings submitted by the contractor and as confirmed by the Department and are to be executed as per CED DOS/CPWD specifications. 2. Filling available earth or earth brought from outside shall be done as per requirement to level the ground as per approved drawings. 3. Plinth filling shall be done as per the recommendation of the soil investigation report or with earth suitable for plinth filling 4. Appropriate ground improvement or soil stabilization measures as per the soil investigation report and structural design, if any recommended shall be carried out. 5. Appropriate foundation system Including isolated footing/ combined footing/ Raft/ pile and possible combination of these as per the recommendations of the soil investigation report containing borehole data, seasonal variation of subsoil water table, and as per structural design conforming to relevant Indian Standard Codes shall be provided. Foundation system as per the detailed soil investigation. 6. Nothing extra shall be paid on account of soil investigation. 7. Anti-termite treatment as per the necessity of ground shall be carried out as per relevant Indian standard codes/ CPWD specifications. 8. Structural/Non- Structural Grade slab as per the necessity at site/design requirement and as per the functional requirement of supported flooring shall be designed & provided accordingly. 9. Damp proof course shall be provided wherever

Item No	Description	Guide lines
		required as per CED /CPWD specification. 10. Drainage and Plinth protection along the perimeter of the buildings shall be provided as per CED / CPWD specifications or as per specific functional requirement. 11. The hard rock if any obtained from the excavation shall be disposed-off in the low-lying area with in the campus identified by the SDSC SHAR for which nothing shall be extra paid. 12. Plinth height shall be +600mm above adjoining road level as per the Architectural scheme drawing. 13. Earth filling in plinth and sides of foundations shall be properly consolidated as per specification. Rubble/ Brick masonry wall below plinth level of the exterior plinth beam till 900 mm below
3.0	Superstructure	1. Structural design shall be carried out conforming to relevant Indian Standard codes. Building shall be designed based on latest IS codes and should have seismic resistant provisions as per IS codes. The materials like concrete, steel, centering and shuttering shall be as per the approved technology and as per CPWD specifications/ IS codes. 2. All the horizontal, vertical, inclined projections of the structure like porticos, slab projections, staircases, mumty, machine rooms, water tanks, any other architectural features like column, beams, shear walls & slabs shall be designed as integral part of the structure and provided. 3. Expansion joints/ seismic separation joints shall be provided as per the approved structural drawing and treated and covered as per CED / CPWD specifications / manufacturer specifications. The vertical & horizontal expansion joints shall be kept, keeping in consideration the seismic requirements as per the relevant BIS code, NBC- 2016 and CED / CPWD Specifications. 4. The Structural Steel shall be made at least 2 hours fire resistant by using Intumescent Fire Paint / Vermiculite coating as per manufacturer's specifications and by

Item No	Description	Guide lines
		applicators approved by them in case measures stipulated in NBC2016 are not possible to adopt. 5. The dimensions (Height, width, room size) given in the drawing are minimum required dimensions. Consequently if there is any increase in the overall dimensions of the building as per design requirement, it needs to be accounted in the quote.
4.0	Flooring	1. Flooring shall be provided as per s. no 1.6.19. 2. Skirting minimum 100mm high to be provided as per functional and architectural requirement. 3. Leveling course to be provided on the top of RCC slab before laying flooring as per site requirement, if required.
5.0	Doors, windows ventilators, fittings & fixtures	1. Doors, windows, ventilators including fittings fixtures and glazing shall be provided as per s. no 1.6.20. 2. Windows along with glazing shall be designed for wind loads applicable to the area/location as per relevant IS codes. 3. All windows shall have MS grills as per approved design 4. Curtain rods of Stainless steel/brass/PVC/Oxidized Mild steel shall be provided as per requirement at per s. no 1.6.20. 5. Blinds vertical / horizontal / roller of approved make and opacity shall be provided at windows at per s. no 1.6.20.
6.0	Internal finishing Painting, wall paneling, dado, false ceiling	Internal finishing like painting, wall paneling, dado, false ceiling shall be provided per s. no 1.6.21.
7.0	External finishing Painting, Cladding,	1. External finishing including painting, cladding, and structural glazing shall be provided per s. no 1.6.22. 2. Structural cladding system shall be designed for applicable wind loads, thermal expansions and seismic movements.
8.0	Internal Water	1. Plumbing system shall be designed and provided as per

Item No	Description	Guide lines
	Supply, Sanitary lines and fittings fixtures	the functional requirements of the buildings. 2. Double stack system shall be followed. All sewerage to be connected to one stack and all drainage to be connected to other stack. 3. Water supply and sanitary fittings shall be provided as per the functional and architectural requirements. 4. Exposed pipes shall be placed over saddle duly fixed to the wall by bracket. 5. All drainage through portico/ roof shall be connected to Rain Water Harvesting.
9.0	External Water Supply pipelines & sewage lines. Fittings & fixtures / chambers sewage pipe line fitting & fixtures / chamber	Inspection chambers/ manholes/ gullies chambers/ valves and other accessories of approved specifications and make shall be provided considering all the site conditions and reduced level as per design parameters. As far as possible green and recyclable materials shall be preferred, as per approved drawings. Note: 1) Necessary External sewage disposal system to be provided by the bidder and is part of scope of work. 2) Necessary External water line to be provided by the bidder and is part of scope of work.
10.0	Water Storage tanks	Bulk storage tanks including fire tank of required capacity either underground /overhead / ground shall be provided as per the design requirement. Refer to GLR.
11.0	Roads/ footpath s/ Kerb stones, Parking, Signage's (As per site requirement and as per approved drawing)	1. All round 5.5mtr RCC Main road as per design. 2. All Access paths /paved surfaces shall be provided as per requirement and design with 100mm thick M-30 grade Factory made Kerb stones of required sizes along the sides of roads and access paths. 3. Retro-reflective sign boards shall be made of aluminum/Stainless steel sheet supported on epoxy painted MS/SS frame work. Road markings shall be with thermoplastic reflective paint. (i) NP3 / HDPE pipe of required diameter including testing of joints as per specification shall be provided at road crossings. (ii) Manholes of required dia and depth shall be provided

Item No	Description	Guide lines
		with brick wall (with Sewer Bricks/CD-100 bricks) as per CPWD specifications or IS codes. In adverse sub soil conditions, manholes and sewer lines pipes shall be appropriately designed and provided. (iii) Storm water management to be taken care by providing proper grading and slope design to prevent the water accumulation near critical installations viz., cold box, cryogenic tanks area etc.,
12.0	Waterproofing Treatment	Water proofing treatment shall be done as applicable and as required on terraces, sunken slabs, toilet slabs, water tanks, OHT, GLR and any other liquid retaining structures per s. no 1.6.23.
13.0	Railings & Grills	Mild steel /GI railings and grills shall be provided as per architectural design in staircases, steps, ramps corridors and in other common circulation areas as indicated in drawings and in accordance with provisions of NBC 2016 as per s. no 1.6.24
14.0	Technology	The design life for the building shall be 75 years (Permanent Structure). The successful bidder has to submit the design and drawings along with the specifications for approval of the Department before starting the work.
15.0	Rainwater pipes	All the RWPs (Rain water pipes) including fittings shall be unplasticized Rigid PVC SWR Type-A rain water pipes of minimum 160 mm dia, conforming to IS: 13592 Type A.
16.0	Plinth Protection	Minimum 1000 mm wide CC Plinth protection to be provided all around the building as CPWD specification.
17.0	Signage Works	Signage utilities and Room Numbers: Stainless steel 316 having graphics & text in machine Etched for Building name sign to be in capital letters. CRCA (Cold rolled Close Annealed) sheet support structure having aluminium panels, powder coated with graphics and text for way finding, directional and statutory signage's, all as per NBC 2016. Indoor Signage: Rigid Photo luminescent based glow-in-the-dark rigid sheet with high intensity luminous properties enclosed in a transparent weatherproof UV

Item No	Description	Guide lines
		stabilized coated sheet with UV screen printing by imported inks. To be fixed on all rooms. Thickness 1 mm (plus/minus 10%), Service temp --20to+80deg, Application-Suitable for in door use, Surface colour-Greenish Yellow, Visibility- Glow upto 24 hrs in total darkness, Other properties –Fungi static, Non-radioactive, contains no lead or phosphorus, no health or environmental problem, Simple to install and easy to maintain, can be screw or just peel off to stick, Self-extinguishing. All signage's as per NBC 2016.
18.0	Building Accessibility	All the blocks, railings, ramp, especially abled toilet and rooms shall be accessible by specially abled persons as per GRIHA/GHAR, CPWD/NBC 2016 norms, whichever is higher. Toilets for differently abled persons as per GRIHA/GHAR, CPWD/NBC 2016 norms, whichever is higher shall be provided as per approved drawings and direction of Department.

1.6.18 SCHEDULE OF WALLS

S. No.	Location	Description of item /Brief Specifications
1	Auxiliary Building, Electrical switch room, Fire pump room, LOX & LIN filling pump room, WTP operator room	
(A) External Walls		
S. No.	Location	Description of item /Brief Specifications
1	Outer Walls as per Architectural drawings	- Wall with outer layer as 230 mm thick Red Brick of min. compressive strength 4.5N/sq.mm joined with Cement Mortar 1000 mm high Parapet wall shall of 100 to 150mm thick RCC Wall of M35 Grade concrete.
(B) Internal Walls		
S. No.	Location	Description of item / Brief Specifications

1	Internal/ Partition Walls	115mm thick partitions will be provided with Brick of min. compressive strength 4.5N/sq.mm wall joined with Brick joined with Cement Mortar in all areas with RCC band as per CED/ CPWD specification.
Note: Items / specifications to be provided at any location even though left out in the above provisions but is required as per functional requirements and as per approved drawings shall be provided as per direction of Department and the rates for same shall be deemed to be inclusive in quoted rates of contractor. Nothing extra on this account shall be payable.		

1.6.19 SCHEDULE OF FLOORING

S. No.	Location	Description of item /Brief Specifications
1	Auxiliary Building	
	Subbase to floor for all rooms in Auxillary building: - Filling in plinth with local sand to required level with proper consolidation, 100mm thick PCC 1:2:4 with 20mm nominal size aggregate, - RCC [M35 grade] Grade slab of minimum 100mm thick or as per design whichever is higher	
1.1	DCS room & LAB room	50mm thick IPS flooring over which Steel infilled false flooring (300mm to 600mm depth) with vitrified tile topping/ PVC laminate) to be provided over subbase as mentioned above
1.3	SPTA room, Maintenance room, AHU room, Electrical Panel room	50mm thick Hardonite flooring to be provided over subbase as mentioned above
1.4	Staff room, Documentation room, security office, corridor area	Double charged Vitrified Ceramic tile flooring of size 600mmx 600mm with 100mm skirting height over subbase as mentioned above
1.5	All washrooms	- Flooring: Anti-skid Premium quality Ceramic tile of 300x300mm size and make of Johnson/ Somany/ Kajaria/ NITCO or equivalent to be provided over subbase as mentioned above - Dado: Glazed Designer ceramic tiles 300mm x 600mm / 450mm tiles up to 2100mm height and

		make of Johnson/ Somany/ Kajaria/ NITCO or equivalent
2	Electrical switch room, Fire pump room, LOX & LIN filling pump room, WTP operator room, Compressor House area	50mm thick Hardonite flooring over subbase as mentioned above
3	Tanker parking yard area, Cold box area, Adsorber vessels area	Vaccum dewatered finish with grooves cut filled up with polysulphide sealant

Note: Items/ specifications to be provided at any location even though left out in the above provisions but is required as per functional requirements and as per approved drawings shall be provided as per direction of Department and the rates for same shall be deemed to be inclusive in quoted rates of contractor. Nothing extra on this account shall be payable.

1.6.20 SCHEDULE OF DOORS, WINDOWS, VENTILATORS INCLUDING FITTINGS, FIXTURES AND GLAZING DETAILS DOORS, WINDOW AND VENTILATORS

S. No.	Location	Description of item /Brief Specifications
1	All buildings / structures	• Powder coated, Fire rated, Factory finish Structural steel doors of size as per design in all rooms except wash rooms with necessary hold fast arrangement • WPC doors of size 750/900mm x 2100mm as per approved drawings for wash rooms • UPVC windows three track with 5mm thick glass panes with mesh shutter provision & MS safety grill with 12mm square rod in all rooms except wash rooms as per approved drawings / design • UPVC Ventilator with 5mm thick frosted glass lovers with mesh and exhaust fan provision & MS safety grill with 12mm square rod to be made in wash rooms as per approved drawings / design
(B)Fittings and Fixtures		
1	All Door fittings	As per door hardware schedule attached & as per approved drawings/CPWD specifications as directed by the Engineer-in- charge. Following door hardware items are indicative only: (i) Heavy-Duty Stainless-steel hinges 100mm- 4 per shutter (leaf) (ii) Stainless steel mortise lock (Godrej ultra tri bolt or equivalent) (on main Door etc.) -1 No. per door (iii) Stainlesssteelslidingdoorbolt300x16mm(all other doors)-1 per door. (iv) StainlesssteelHandlewithorwithoutplate150mmormore

		-2pershutter. (v) S.S Tower bolt 300 x 12 mm & 150x12mm - 2 per shutter (minimum 450mm size for door heights above - 2.4m) (vi) SS cum Rubber buffer 40mmx50mm-1per shutter. (vii) SS twin rubber Doorstopper-1per shutter. (viii) Door closer-hydraulic type wherever specified/required (ix) SS Door latch (x) SS Door lens (xi) Door stoppers
2	Window fittings	As per window hard ware schedule attached & as per Civil Specification/ manufacture's recommendations.
3	Curtain rod with required accessories	SS Drapery rods on all windows and doors in all rooms except toilets / baths/ WCs

1.6.21 SCHEDULE OF INTERNAL FINISHING INCLUDING PAINTING & FALSE CEILING

(A) Plastering		
1.	Plastering on walls(Internal)	(i) 15 mm thick smooth plaster over brick work on Masonry surfaces (ii) 12 mm thick smooth plaster over RCC Surfaces (iii) Necessary additional SS/ glass fibre mesh(120gsm) / GI chicken mesh shall be provided over dissimilar joints (RCC and Brick junctions) &over chases of electrical conduit and concealed pipe line and shall be neatly finished
(B)Painting &Finishing		
1	Internal finishing	(i) Exposed Ceiling-cement based wall putty, one coat of cement/ acrylic primer, two or more coats of premium plastic emulsion paint with low VOC. However, wherever false ceiling is provided, slabs shall be treated with one coat of cement/ acrylic primer and white cement-based putty of 1 mm thickness. (ii)Internal walls- Cement based/ acrylic wall putty, one coat of cement/ acrylic primer, two or more coats of premium plastic emulsion washable paint with low VOC
2	Steel work / Joinery	Synthetic Epoxy paint in 2 coats over ready mixed Yellow oxide zinc chromate primer to make smooth surface Architectural drawings and as directed by Engineer- in – Charge.
3	Primer	Asper CED/ CPWD Specifications for wood work and steel-work.
C)False Ceiling & Under deck Insulation		

1	Auxiliary Building: DCS room, LAB room, SPTA room, Staff room, Documentation room	False Ceiling: Providing and fixing Aluminum Metallic plain / perforated false ceiling tiles with grid of make Chanakya / Armstrong or equivalent
2	Auxiliary Building: AHU room	Under deck Insulation: 30mm thick Polyisocyanurate / Phenotherm under deck insulation

Note: Items / specifications to be provided at any location even though left out in the above provisions but is required as per functional requirements and as per approved drawings shall be provided as per direction of Department and the rates for same shall be deemed to be inclusive in quoted rates of contractor. Nothing extra on this account shall be payable.

1.6.22 SCHEDULE OF EXTERNAL FINISHING INCLUDING PAINTING

FINISHING / FACADE

1	Plastering on walls (External walls as per approved drawings)	i) Sand faced plaster 20mm thick plaster Cement Plaster
2	External Painting	1. Two or more coats of exterior grade acrylic emulsion paint of Ultima of Asian or equivalent over a coat of exterior primer 2. 20x6mm groove as per scheme elevation.

Note: Items /specifications to be provided at any location even though left out in the above provisions but is required as per functional requirements and as per approved drawings shall be provided as per direction of Department and the rates for same shall be deemed to be inclusive in quoted rates of contractor. Nothing extra on this account shall be payable.

1.6.23 SCHEDULE OF WATERPROOFING WORKS

1	Roof of all buildings with RCC roof	Supplying& Applying of Solvent Free, 100% solids, Two Component (ASTM D 16, Type V), Polyurea (0.5mm) + Polyurethane(0.7mm) + Aliphatic Coating (0.3mm) System, Non-Tar Extended, Total System Thickness of 1.5mm (excluding primer) of Poly Urethane based DRYTHANE of AMCHEM Products Pvt Ltd or equivalent Poly Urethane based membrane water proofing system of make FAB / Dr.Fixit / CIPY / CERA / FOSROC / SIKA / BASF /ALCHIMICA Building Chemicals/Sunanda or equivalent.
2	Misc.	Waterproofing treatment shall be done as applicable and as required on terraces, sunken slabs, toilet slabs, lift pits, basement rafts walls, water tanks, UG sumps, OHTs and any other liquid retaining structures Water stops shall be provided in construction joints of liquid retaining structures.

1.6.24 SCHEDULE OF RAILINGS, GRILLS, SIGNAGE'S RAILINGS

1	Stair case	Fabricating, Supplying and Fixing in GI handrail as per design
2	Window grills	MS Grill to be painted with Two or more coats of epoxy paint
3	Signage for building	Providing and fixing of the signage of retro reflective signage boards wherever applicable such as indication, directions, room names and emergency exits etc., with retro reflective signage. As per specification of CED/ DSR 16.60

Other miscellaneous items MENTIONED IN DRAWING

1	Cable trench	RCC wall cable trench with MS Chequered plates / precast RCC cover slabs as per design
2	Plinth protection and Storm water drains	Plinth protection of 1000mm wide to be provided around the buildings with necessary brick storm water drains in the layout.

1.6.25 DETAILED TECHNICAL SPECIFICATIONS

1. EARTH WORK

1.1	Earthwork in excavation for FOUNDATION TRENCHES in ALL KINDS OF SOILS including dressing of sides, ramming of bottom, disposing the surplus excavated materials within a distance of 500m lead and lift depth/ height as per the drawing complete as per specifications. (Disposed soil to be levelled by breaking clods if any and neatly dressed) in all Kinds of Soils/ Ordinary soil.

	Item shall be carried out as per the Specifications and or specified as in the tender document and No extra payment will be admissible towards this.
1.2	Earth work in excavation by MECHANICAL means (Hydraulic excavator) /manual means in Foundation trenches / over areas (exceeding 30cm in depth. 1.5 m in width aswell as 10 sqm on plan) including disposal of excavated earth of 500m lead and lift depth/ height as per the drawing complete as per specifications. (Disposed soil to be levelled by breaking clods if any and neatly dressed) in all Kinds of Soils/ Ordinary soil/ Item shall be carried out as per the Specifications and or specified as in the tender document and No extra payment will be admissible towards this.
1.3	Providing and injecting Chemical emulsion for PRE-CONSTRUCTIONAL Anti-termite treatment and creating a chemical barrier on top surface of plinth filling, junction of inside wall and floor, on top of damp proof course (DPC) or on masonry at the level of plinth filling as per IS 6313(part-II)- 2022 Latest edition using chemicals like CHLOROPYRIPOS 20ECemulsifiable (IS: 8944-1978) or Imidacloripid 30.5% . Chloropyripos 20EC mixed with water in 1:19 ratio (i.e., 1 litre of Chemical to 19 litres of water). The emulsion is spread at 5 lit/sqm on top surface of plinth filling, top of Damp proof course and at 1 lit/linear meter along the junction of wall and floor, all as per specifications and directions. (Plinth area of the building at Ground floor only to be considered). The work has to be executed by an agency having membership with Indian Pest Control Association (IPCA) and 10 years warranty has to be furnished.
	Note: The PRE-CONSTRUCTIONAL Anti-termite treatment shall be carried out as per the Specifications and or specified as in the tender document
1.4	Supplying and filling in plinth with approved good earth as per relevant IS code in layers not exceeding 15cms in depth consolidating each deposited layer by ramming thoroughly, watering and dressing etc; complete for all

	leads and lifts. Item shall be carried out as per the Specifications and or specified as in the tender document and No extra payment will be admissible towards this.
1.5	Construction of GRANULAR SUB-BASE by providing HBG material confirming to Grading Zone of Mort & H table 400-2 as specified below including cost, seigniorage charges and conveyance of all materials to work site and spreading in uniform layers with motor grader or by approved means, on prepared surface mixing by mix in place method with Rotavator/approved means at OMC and compacting with vibratory roller to achieve the desired density etc, complete for finished item of work as per MoRT& H specification 401(Latest revision), thickness as per the drawing and as directed by the Engineer -in -charge for Grading-III of MoRT& H table 400-2 Note: The Granular sub-base work shall be carried out for the building as well portico below plain cement concrete (PCC) subbase to floor as per the Specifications for Civil Engineering Division and or specified as in the tender document/ MoRT&H specifications.
1.6	Filling available excavated approved earth (excluding rock) in trenches, sides of foundations, plinth, etc; in layers not exceeding 15cms depth breaking clods, consolidating each deposited layer by ramming, watering and dressing, etc; complete for all leads and all lifts etc., complete as per specifications.
	Note for Earthwork: • Before earthwork site shall be leveled and cleared. Clearing grass/ Jungle clearance shall comprise uprooting of rank vegetation, grass, brushwood, shrubs, stumps, trees and saplings of all girths shall be carried out and is included in scope. Tenderer has to visit the site before quoting. • For the purpose of determining the Original Ground Level / Initial Ground Level (OGL/ EGL) at any particular location, the existing ground level (to be recorded at the start of the item of the work) before the start of execution of the item shall be the OGL / EGL and all lead/ lift/ depth /

height for all purposes shall be referred from this EGL only. Also, the lead includes all lifts/depth/height and nothing extra shall be paid for additional lift/depth/height (other than mentioned in the item) involved in lead

- The items of earth work and other item of "Detailed Schedule of Items" may be required to be executed in required gradient/slope as per drawings and direction of Engineer- in Charge. The rates are inclusive of all above and nothing extra shall be paid on this account.
- The rate for construction of Embankment and/or filling up the depressions, Carriage and disposal of surplus earth is included in the execution of item at all levels with all lift/depth/height, except those specified in the relevant item, and nothing extra shall be paid.
- Lead means distance from site location from where supply of earth is being done for the purpose of earth filling. Nothing extra shall be paid on account of lead inside or outside of campus.
- Earth obtained on account of excavation (as per drawings) is to be retained in the campus at dedicated locations for the purpose of backfilling only in landscape areas (excluding road work). If after/during back filling the earth obtained in excavation is found to be in excess of what is required for backfilling in landscape areas, the same excess earth, shall have to be disposed off by the contractor outside site location for all leads /lifts/depths/height. Nothing extra shall be payable on this account.
- Excavation shall be undertaken to the width of the Basement/Retaining wall footing including necessary margins for construction operation as per drawing or directed otherwise. Where the nature of soil or the depth of the trench and season of the year, do not permit vertical sides, the contractor at his own expense shall put up the necessary shoring, strutting and planking or cut slopes with or without steps, to a safer angle or both with due regard to the safety of personnel and works and to the satisfaction of the Engineer In charge.
- All the major excavation shall be carried out by mechanical excavator. No extra payment shall be made for that.

- The contractor shall make at his own cost all necessary arrangements for maintaining water level, in the area where works are under execution low enough so as not to cause any harm to the work shall be considered as inclusive of pumping out or bailing out water, if required, for which no extra payment shall be made. This will include water coming from any source, such as rains, accumulated rain water, floods, leakages from sewer and water mains subsoil water table being high or due to any other cause whatsoever.
- The contractor shall make necessary provision of pumping, dredging bailing out water coming from all above sources and excavation and other works shall be kept free of water by providing suitable system approved by the Engineer-in charge. In order to avoid possibility of basement floor of main building being getting uplifted/ damaged due to water pressure, the contractor shall lower the ground water table below the proposed foundation level by boring tube wells all around the proposed building using well point sinking method or any suitable method as approved by Department. Sub soil water table shall be maintained at least 75 cm. below the C.C. level during laying of C.C., water proofing treatment, laying of basement raft/ footings and beams including filling of earth/ sand/ flyash/ murum under the basement floor.
- The water table shall not be allowed to rise above base of raft/footing level until completion of outer retaining walls including water proofing of vertical surface of walls and back filling along the walls upto ground level and until the structure attains such height to counter balance the uplift pressure. However, the contractor should inspect the site and make his own assessment about sub-soil water level likely to be encountered at the time of execution and quote his rates accordingly. Rate of all items are inclusive of pumping out or bailing out water, if required. Nothing extra on this account whatsoever shall be paid to him. The sequence of construction shall be got approved by the Engineer-in- charge.
- The contractor shall take all necessary measures for the safety during construction and provide, erect and maintain such barricades including signs, markings, flags, lights and flagman, as necessary at either end of

the excavation/embankment and at such intermediate points as directed by the Department for the proper identification of construction area. He shall be responsible for all damages and accidents caused due to negligence on his part.

- All management (including watch and ward) of barricades shall be the full responsibility of the contractor. The barricades shall be removed only after completion of the work or part of the work. The contractor's rate shall include all above items of work and nothing extra shall be paid to the contractor over and above his quoted rates.

Note for Back filling

- For back filling under and around building, surplus soil received from excavation of foundation after removal of rocks, boulder, plant waste etc. shall only be used with approval of EIC. Additional good earth, for the filling work shall be procured by the contractor from outside of campus.
- The Sample of the soil which is proposed to be filled shall be got tested as per the direction of Department before taking up the filling work. In case the source of earth supply is changed, the same shall be again got tested as per the direction of the Department. If the Department so desires intermediate testing of soil shall be done from time to time to ensure the quality of filled up earth.
- In case disposal of Surplus earth shall have to be disposed off outside from construction site location at any dumping ground arranged by agency or to the location suggested by Engineer in Charge (The disposal and levelling at the dumping location directed by Department for all lead / lift / depth / height/ Gradient / Slope as per the direction/permission of Department and nothing extra shall be paid on this account.
- For Embankment work / Plinth filling work Quarry dust/stone dust/ fine aggregate as per relevant IS code brought from outside shall only be used. Filling up to required level as per approved GFC Drawing with Locally Available Earth (excluding Black Cotton Soil/ Highly Plastic Soil/ Expansive Soil) suitable for road embankment work

	brought from outside of campus& compacted earthwork in embankment under optimum moisture conditions as per Civil Engineering works specification. • Camber should be made during the preparation of the sub-grade as per drawings.
	Note for Anti Termite Treatment: IS 6313 (part-II)- 2022 Latest edition shall be followed scrupulously. Checks & Controls at Site: The Contractor shall take the following precautions at site. Chemical should be brought in sealed containers Concentration percentage shall be clearly indicated on the container. Date of expiry shall also be indicated on the containers. The material so brought shall be safely and securely stored (away from other materials) and shall be under the control of Department. The quantity required or particular day based on area shall be issued on written requisition, records of which shall be safety and securely kept. If any portion in original container remains unused the same duly sealed shall be returned to store and reissued against when used. The empty can should immediately be punctured and crushed so that the can cannot be used for any other purpose. Such destroyed can shall be returned to store for a counter check of inventory and the actual quantum of chemical used.

2. MASONRY WORKS

Technical Specification for Masonry works- Random Rubble Masonry, Brick Masonry, Half Brick Masonry, cement block Solid block masonry etc

2.1	Providing and constructing RANDOM RUBBLE MASONRY using hard granite stones obtained from approved quarry with bond stones at every 0.50 sqm of wall surface in cement mortar in mixes stipulated below without pinning on face, but including raking out joints and pointing flush in same mortar including curing, etc; complete as per specifications in FOUNDATION AND PLINTH. (Rate includes cost of bond stones wherever provided) at all

	depth/ height. Mix ratio specified is for (cement: Fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS 2116-1980,2002) In cement mortar 1:6.
	Note: • Random rubble masonry works shall be carried by using Portland Pozzolana Cement (PPC). • All Random rubble masonry works work shall be carried out as per the Specifications for Civil Engineering Division and or specified as in the tender document. • The width and height of external and internal RR masonry walls shall be as per the cross sections indicated in the structural drawing. • The width and height of RR masonry walls for ramp foundation and verandah shall be as per the cross sections indicated in the structural drawing.
2.2	Providing and constructing BRICK MASONRY in cement mortar as per mixes stipulated below using approved well burnt bricks of "CLASS DESIGNATION" (Classification as per I.S. 1077-1986) as specified below including raking out joints 10mm deep, scaffolding, curing, etc; complete as per specifications: In foundation & plinth at all depths a) USING BRICKS OF " CLASS DESIGNATION 3.5 (Minimum Average Compressive strength not less than 3.5N/sqmm) CM 1:6 (The mix ratio specified is for cement : Fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS 2116-1980,2002)) – 230mm thick
2.3	Providing and constructing BRICK MASONRY in cement mortar as per mixes stipulated below using approved well burnt bricks of "CLASS DESIGNATION" (Classification as per I.S. 1077-1986) as specified below including raking out joints 10mm deep, scaffolding, curing, etc; complete as per specifications IN SUPERSTRUCTURE at all heights USING BRICKS OF CLASS DESIGNATION "4.5" (Minimum Average Compressive strength not less than 3.5N/sqmm) In cement mortar 1:6 .(The mix ratio specified is for cement :Fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS 2116-1980,2002)) – 230mm thick

2.4	Providing and constructing HALF BRICK MASONRY walls/partitions in the following mixes using FIRST CLASS well burnt bricks of "CLASS DESIGNATION" (Classification as per I.S. 1077-1986) as specified below including scaffolding, raking out joints, curing, etc; complete with R.C.C 1:2:4 (1 cement:2 Fine aggregate Fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS 2116-1980,2002) :4 graded stone aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS383:2016 of 20mm nominal size) - <i>stiffeners of size 115mmx75mm at every 900mm centers</i> including formwork steel reinforcement consisting of 2 nos. of 8mm dia HYSD bars for main reinforcement with 8 mm dia HYSD at 230mm c/c for each R.C.C stiffener etc; complete as per specifications in SUPER STRUCTURE at all heights USING BRICKS OF "CLASS DESIGNATION 4.5"(Minimum Average Compressive strength not less than 3.5N/sqmm) In cement mortar 1:4 – 115mm thick
2.5	Providing and constructing HALF BRICK MASONRY walls/partitions in following mixes using approved well burnt bricks of "CLASS DESIGNATION" (Classification as per I.S. 1077-1986) as specified below, including scaffolding, raking out joints, curing, etc; all as directed by the Engineer -in- charge. In SUPERSTRUCTURE at all heights / Foundation at all depths. (The mix ratio specified is for cement : Fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS 2116-1980,2002)) USING BRICKS OF "CLASS DESIGNATION 3.50"(Minimum Average Compressive strength not less than 4.50 N/Sqmm) In cement mortar 1:4 – 115mm thick
2.6	Providing and constructing Solid Cement Concrete block masonry in cement mortar 1:6 (1 cement : 6 Fine aggregate)/ cement mortar 1:4 (1 cement :4 Fine aggregate) using factory made, load bearing, approved quality cement concrete blocks of specified size, Grade C (4.0) as per IS: 2185 (part-1) 2005, Density of blocks not less than 1800 kg/cum. Minimum average compressive strength of units is 4.5 N/sqmm and minimum strength of individual unit is 4.2 N/sqmm, setting in position, curing, raking out joints wherever required etc., complete all leads and all as per specifications and directions of Department. In

	foundation and plinth/ In Super structure with 200mm/150mm/100 thick walls using available size blocks
	Note: • Masonry works shall be carried by using Portland Pozzolana Cement (PPC). • All masonry works shall be carried out as per the Specifications for Civil Engineering Division and or specified as in the tender document. • The cut lintels shall be provided for masonry wall as per standard engineering practice. • RCC bands & mullions in the walls shall be provided in the masonry walls as per Structural requirements and as per standard engineering practice. • Circular /curved or any geometric shape Masonry shall also be provided if required as per standard engineering practice or drawing without any extra cost. • Cable trenches for the building as size indicated in the structural drawing shall be constructed with masonry if indicated. • The foundation details for 100mm/115mm thick wall shall be as indicated the Structural requirement and as per standard engineering practice. • Toe wall, Parapet wall, Duct covering wall etc., shall meet the structural requirement and also as per standard engineering practice

3. PLAIN CEMENT CONCRETE WORKS

Technical Specification for Plain Cement Concrete (PCC)- Foundation and Plinth, Sub base to floor, Plinth Protection, bed blocks, anchor blocks, window cills, coping blocks, Damp Proof Course (DPC) etc

3.1	Providing and laying cement concrete using 40mm nominal size graded hard granite stone coarse aggregate and fine aggregate as per IS 383: 2016 obtained from approved quarry including compaction, finishing top surface to level, curing but excluding cost of formwork, etc; complete as per specifications. Mix ratio specified is for (cement: Fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS383:2016): graded hard granite stone coarse aggregate) with P.C.C 1:5:10 (1 Cement: 5 fine aggregate: 10 graded stone aggregate 40 mm nominal size) at all depths for In foundation and plinth as indicated in the drawings
3.2	Providing and laying cement concrete using 20mm nominal size graded hard stone aggregate obtained from approved quarry including compaction, finishing top surface to level, curing, cost of formwork, etc; complete all as per specifications. Mix ratio specified is for (Cement: Fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS 383:2016): graded hard granite stone coarse aggregate). In foundation and plinth and sub base to floor with 1:3:6 (1 Cement: 3 fine aggregates: 6 graded stone aggregate 20mm nominal size) at all depths as indicated in the drawings
3.3	Providing and laying cement concrete in pavements and ramps in panels not exceeding 10sqm per panel and Plinth Protection in panels not exceeding <u>3sqm</u> per panel using graded hard granite stone aggregate including providing necessary formwork, making <u>10mm wide grooves</u> in panels for depth of 1/3 rd of thickness of pavement or 40mm whichever is more and filling the grooves with approved hot poured sealing compound confirming to grade A or B of IS-1834, consolidation, curing and treatment for the top with neat rough finish, etc; complete all as per specifications, Mix ratio specified is for (Cement: Fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS 383:2016)) Using 20mm

	nominal aggregate in CC 1:3:6 (1 Cement : 3 fine aggregate : 6 graded stone aggregate 20mm nominal size) . The item shall be carried out as per the detail (Length, width and &depth) shown in the drawings
3.4	Providing and laying cement concrete using graded hard granite stone aggregate of 20mm nominal size obtained from approved quarry including formwork, compaction, finishing, curing, etc; IN BED BLOCKS, ANCHOR BLOCKS, WINDOW CILLS, COPING BLOCKS, etc; at all heights and depths complete all as per specifications. Mix ratio specified is for (Cement: Fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS 383:2016). The work includes providing throating / drip mould wherever required as per standard engineering practice of size not less than 40mm X 15mm. The rate is inclusive for making drip mould & no extra cost will be paid for. Using 20mm nominal aggregate in CC 1:3:6 (1 Cement : 3 fine aggregate : 6 graded stone aggregate 20mm nominal size.
3.5	Providing Damp Proof Course (DPC) with cement concrete using graded hard granite stone aggregate of 20mm nominal size obtained from approved quarry, mixed with approved water proofing compound such as ROFFE HYPROOF manufactured by M/s Roffe Construction Chemicals Pvt. Ltd. at 140ml per bag of cement or CONPLAST X 421 IC of Fosroc Chemicals Ltd. at 130ml per bag of cement or equivalent as per manufacturer's specifications including formwork, compaction, finishing top surface to level, curing etc; complete all as per specifications. Mix ratio specified is for (Cement: Fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS 383:2016) Using 20mm nominal aggregate in CC 1:2:4 (1 Cement : 2 fine aggregate : 4 graded stone aggregate 20mm nominal size).
	PCC 1:2:4 specification
3.6	Providing and laying cement concrete using 20mm nominal size graded hard granite stone aggregate obtained from approved quarry including

	compaction, finishing top surface to level, curing but excluding cost of formwork, etc; complete all as per specifications. Mix ratio specified is for (cement: coarse sand: graded stone aggregate)
	In foundation and plinth /sub-base to floors P.C.C. 1:2:4
3.7	Providing and laying Gravel and fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS 383-2016) mix (1:1) of 150mm consolidated thickness including supplying approved graded gravel mixed with coarse sand and spreading under the plinth protection including sectioning, watering, consolidating with hand roller of minimum 1 tonne weight inclusive of water charges, hire charges of roller, etc; complete all as per specifications under plinth protection as shown in the drawings
3.8	Construction of GRANULAR SUB-BASE by providing HBG material confirming to Grading Zone of MoRT & H table 400-2 as specified below including cost, seigniorage charges and conveyance of all materials to work site and spreading in uniform layers with motor grader or by approved means, on prepared surface mixing by mix in place method with Rotavator /approved means at OMC and compacting with vibratory roller to achieve the desired density etc, complete for finished item of work as per MoRT& H specification 401(Latest revision), thickness as per the drawing and as directed by the Engineer -in -charge for Grading-III of MoRT& H table 400-2 Note: The Granular sub-base work shall be carried out for the building as well portico below plain cement concrete (PCC) subbase to floor as per the Specifications for Civil Engineering Division and or specified as in the tender document/ MoRT&H specifications. The thickness of the GRANULAR SUB-BASE shall fulfil the structural and functional requirement.
	Note: a) All Plain Cement Concrete (PCC) work shall be carried by using Portland Pozzolana Cement (PPC).

	b) All Plain Cement Concrete (PCC) work shall be carried out as per the Specifications for Civil Engineering Division and or specified as in the tender document Cill band, coping block etc., reinforcement shall be provided as per structural design or as per the standard engineering practice.

4. REINFORCED CEMENT CONCRETE WORKS

Technical Specification for Reinforced Cement Concrete (RCC), Integral liquid water proofing, Precast Reinforced cement concrete, Inhibiting admixture, Poly-sulphide sealant.	
4.1	Providing and laying in position ready mixed or site batched design mix cement concrete for reinforced cement concrete work; using fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS 383-2016) and coarse stone aggregate(graded hard granite stone aggregate of maximum 20mm nominal (downgraded) size as per IS 383: 2016 obtained from approved quarry, PPC Grade, admixtures in recommended proportions as per IS: 9103 (Latest revision) / IS 456 (latest revision) to accelerate / retard setting of concrete, to improve durability and workability without impairing strength; including pumping of concrete to site of laying, curing, finishing, carriage for all leads; but excluding the cost of centering, shuttering and reinforcement as per direction of the Department; for the following grades of concrete. All works up to Plinth level at all depths. Concrete of M35 grade with minimum cement content for the exposure conditions as per IS 456 (Latest Revision) –for all structural elements including RCC VDF flooring. All works above plinth level at all heights Concrete of M35 grade with minimum cement content for the exposure conditions as per IS 456 (Latest Revision) for all structural elements.
4.2	Supply and mixing integral liquid water proofing compound of approved quality and brand in R.C.C items with ROFFE HYPROOF

	manufactured by M/s Pidilite Industries Ltd. (Erstwhile M/s. ROFFE Construction Chemicals Pvt. Ltd.) at 140ml per 50KG of cement or CONPLAST X 421 IC of Fosroc Chemicals ltd. at 130ml per 50 KG of cement or equivalent approved make mixed with cement as per manufacturer's specifications etc., complete as directed by Engineer in charge. In M-35 grade concrete (Only for site batched design mix cement concrete) [For Roof slabs and elements which are directly exposed to sun and as directed by EIC
4.3	Providing and fixing M-35 grade Precast Reinforced cement concrete using graded hard stone aggregate of 20mm nominal size obtained from approved quarry including mechanical mixing, centering and shuttering, compaction, simultaneously finishing smooth with 6mm thick cement plaster 1:3 (1 cement: 3 Fine aggregate) on exposed surfaces and fixing in position with same C.M 1:3, curing etc., complete all as per specifications but including cost of steel reinforcement upto at all heights for String courses, bands, coping blocks, bed plates, anchor blocks, plain window sills
4.4	Mixing Corrosion inhibiting admixture of approved quality and brand in RCC items as per technology developed by Central Electro Chemical Research Institute (CECRI), Karaikudi, Tamilnadu & Licensed to CONCARE PLUS of M/s. Cleantech corrosion Chemicals Pvt. Ltd or CLEANFLO STEELCARE of M/s. Cleanflo India Pvt. Ltd or Equivalent approved make Licensed with CECRI or Bipolar Corrosion inhibiting admixture AURAMIX BCI of M/s. FOSROC Chemicals ltd. or equivalent approved make mixed with concrete as per manufacturer's specifications etc., complete all as per specifications (Rate to include the cost of corrosion inhibiting admixture and necessary labour required for the work). Note: Compatibility of corrosion inhibiting admixture shall be ensured with other mineral admixtures / chemical admixtures mixed in

	the concrete & should not adversely affect the physical / chemical / strength parameters of concrete. - The permissible limits for sulphates, chlorides & other elements as specified in IS 456 (latest revision) in concrete after mixing the corrosion inhibiting admixture, shall be ensured and dosage of corrosion inhibiting admixture for exposure condition shall be followed as per manufacturer's recommendations. - The specifications / tests stipulated in IS 456 (latest revision) shall be ensured. The mix design report as per relevant IS codes, shall be submitted for departmental approval before execution. Concrete of M35 grade for exposure conditions as per IS 456 (latest revision).
4.5	Providing Polysulphide sealant in Expansion Joints /RCC Slabs/ Beams etc. The joints shall be of size 50mm wide & 10mm deep using sealant of approved make. The work shall be executed strictly as per manufacturers' specifications etc., complete all as per directions of Engineer in Charge at all Heights. As per the drawing shown locations and construction joints as per CED specifications
4.6	Providing and fixing in position approved quality premoulded bitumen pads (expansion joints filler board confirming to IS 1838 part I 1983) of specified thickness in expansion joints of all R.C.C works at all heights, including applying necessary bitumen solution primer wherever required and finishing the exposed ends with shalikit/ Expandex or equivalent sealing compound confirming to IS 1834-1961, Grade A, to make the joints water tight, complete all as per approved drawings, specifications and directions of Department -Using 25 mm thick DURO BOARD "HD 100" Supreme at all Heights As per the drawing shown locations and construction joints as per CED specifications
4.7	Providing PRECAST CEMENT CONCRETE JALI in 1:2:4 (1 cement: 2 fine aggregates: 4 stone aggregate 6 mm nominal size) reinforced with 1.6mm dia mild steel wire including centering and shuttering,

	roughening, cleaning fixing & finishing in cement mortar 1:3(1 cement:3 fine aggregate) etc. complete excluding plastering of the jambs, sills and soffits of available size and as per standard engineering practice.
4.8	Providing and making Vacuum dewatered concrete (VDF) for pavements including proper lines, levels, alignment, finishing with power trowelling, and removing the excess water using vacuum dewatering process, so as to obtain the desired surface finish and complete all as directed by Department and as per standard engineering practice.
	Note for R.C.C. WORK: - - Design mix is to be carried out as per IS 10262, IS 456 and other relevant IS codes / CED Specifications. - The contractor shall use Design Mix Concrete for all RCC/ CC works prepared from fully automatic Batch Mix Plant at site / Ready mix concrete. The Contractor shall install fully automatic Batch Mix Plant at site or in nearby area wherever permissible. Under special circumstances, Contractor will arrange concrete from RMC (Ready Mix Concrete) producing plants (located within 60 km distance from the site of work) with prior approval from Department. Nothing extra shall be payable for sourcing concrete from RMC plant (For all purposes, the Contractor shall carry out fully, the responsibilities of the “placement Contractor” and the “manufacturer of concrete”.) - The RCC/CC work shall be done with Design Mix Concrete. Wherever letter M has been indicated, the same shall imply for the Design Mix Concrete. The Design Mix Concrete will be designated based on the principles given in IS: 456, 10262 & SP 23. The Conditions & Specifications stated herein shall have precedence over all conditions & specifications stated in relevant I.S. Codes/C.E.D. Specifications. The concrete mix shall be designed for the specified target mean compressive strength in

order to ensure that work test result do not fall below the acceptance criteria specified for the concrete mix. The Contractor shall design mixes for each class of concrete indicating that the concrete ingredients and proportions will result in concrete mix meeting the requirements specified.

(Note: LOX compatible concrete shall be provided for LOX area)

- The sources of coarse aggregate, fine aggregate, water, admixture & cement to be used in concrete work shall be identified by the contractor & he will satisfy himself regarding their conforming to the relevant specifications & their availability before getting the same approved from the Department.
1. **The Department reserves the right to exercise control over the: -**
 - Ingredients, water and admixtures purchased, stored and to be used in the concrete including conducting of tests for checking quality of materials, recording of test results and declaring the materials fit or unfit for use in production of mix.
 - Calibration check of the Fully Automatic Batching plant /RMC.
 - Weight and quantity check on the ingredients, water and admixtures added for batch mixing.
 - Time of mixing of concrete.
 - Testing of fresh concrete, recordings of results and declaring the mix fit or unfit for use. This will include continuous control on the workability during production and taking corrective action, if required.
 2. For exercising such control, the Department shall periodically depute his authorized representative at the Fully automatic batching plant/ RMC. It shall be responsibility of the Contractor to ensure that all necessary equipment, manpower & facilities are made available to Department and/or his authorized representative at Fully automatic batching plant/ RMC.
 3. All required relevant records of produced and used concrete shall be made available to the Department or his authorized

representative. Department shall, as required, specify guidelines & additional procedures for quality control & other parameters in respect of materials, production & transportation of concrete mix which shall be binding on the Contractor. Only concrete as approved in design mix by Department shall be produced and transported to the site.

4. The terms machine batched, machine mixed and machine vibrated concrete used elsewhere in agreement shall mean the concrete produced in concrete batching and mixing plant and if necessary, transported by transit concrete mixers, placed in position by the concrete pumps/ boom pump, tower crane and vibrated by surface vibrator /needle vibrator / plate vibrator, as the case may be to achieve required strength and durability.
5. The concrete mix design will be carried out by the Contractor, at his own cost, through one of the following laboratories/Test houses to be approved by Department: -
 - The contractor shall engage outside / independent laboratories of any Government Institutes, Indian Institutes of Technology, National Institutes of Technology, Central and State Research Centers, Centrally and State funded laboratories for design mix of batch concrete / self- compacting concrete and testing of materials connected therewith in accordance with relevant Specifications.
 - IITs, NITs or any Govt. Engineering College.
6. In the event of all the above laboratories being unable to carry out the requisite design/testing; the Contractor shall have to get the same done from any other reputed Govt. laboratory with prior approval of the Department. The various ingredients for mix design / laboratory tests shall be sent to the lab / test houses through the Department and the samples of such aggregates sent shall be preserved at site by the department.
The contractor shall submit the report on design mix from any of above approved laboratories for approval of Engineer in Charge

	within 30 days from the date of issue of letter of acceptance of the tender. No concreting shall be done until the design mix is approved. 7. In case of change of source or characteristic properties of the ingredients used in the concrete mix during the work, the contractor as per the directions of the Engineer-in charge shall <u>submit a revised laboratory mix design report</u> conducted at laboratory established at site. All cost of mix designing and testing, connected therewith, including charges payable to the laboratory shall be borne by the Contractor including redesigning of the concrete mix whenever required & as directed by Department. 8. All the required registers such as Master Test Register, Cement Register, Cube Register, M.A.S. Register, Drawings Register, Side Order Book, Steel Register, Paint Register & Inspection Register etc. shall be properly maintained by contractor's Engineer as per direction of Department. The record of outside tests shall be properly maintained. 9. All the test report, done from outside lab, shall be properly maintained in folder as well as in register. 10. Copies of all the materials bills shall be produced by contractor as per direction of Department. 11. The entire RMC batch mix plant slips shall be systematically maintained in folder and no slip should be missing.
	Ready Mixed Concrete (RMC) shall be carried out as per the CED specifications and relevant IS codes.

5. FORM WORK CENTERING & SHUTTERING WORKS

Technical Specification for Form work/ centering and shuttering	
5.1	Providing rigid and water tight centering and shuttering using best quality wood/ plywood/ steel forms and centering with steel props, cuplock systems acro tubes etc., including staging strutting, propping, bracing, etc., complete for all RCC items fixed in position as required to obtain plain exposed form finish/ ordinary form finish including labour for careful removal of form work, cost of de-shuttering and decentering for RCC elements etc., complete all as per specifications in Horizontal / Vertical/ slanting surfaces/curved/ circular surfaces or any geometrical shape and at all heights
	a) Foundations, Footings, plinth beams, Lift wall, Retaining wall, Bases of columns, pedestal Mass concreting, Floorings etc., at all depths
	b) Suspended floors, roofs, landings, cantilever, chejja, balconies and access platform etc at all heights. The rate should include providing centering, shuttering, strutting, propping, bracing, staging required from the height as per the drawing.
	c) Lintels, beams, RC band, girders, bressumer, Brackets, cantilevers etc at all heights. The rate should include providing centering, shuttering strutting, propping, bracing, staging required from the height as per the drawing.
	c) Columns, Pillars, Piers, Abutments, mullions, Posts and Struts etc at all heights.The rate should include providing centering, shuttering strutting, propping, bracing, staging required from the height as per the drawing.
	e) Walls (any thickness) including attached pilasters, buttresses, plinth and string courses parapet, etc at all heights. The rate should include providing centering, shuttering strutting, propping, bracing, staging required from the height as per the drawing.

	f) Stairs/ spiral-staircases at all heights. The rate should include providing centering, shuttering strutting, propping, bracing, staging required from the height as per the drawing.
	g) Vertical and Horizontal fins individually or forming box louvers, bends and facias at all heights. The rate should include providing centering, shuttering strutting, propping, bracing, staging required from the height as per the drawing.
	h) Shelves, Domes, Arches, Shafts, Chimneys, Edges of slabs, cornices, mounding etc. at all heights. The rate should include providing centering, shuttering strutting, propping, bracing, staging required from the height as per the drawing
	Note: Works shall be carried out up to plinth and also above plinth at all heights as per the drawings.

	Form Work : Form work shall include all temporary or permanent forms or moulds required for forming the concrete which is cast-in-situ, together with all temporary construction required for their support. Design & Tolerance in Construction Form work shall be designed and constructed to the shapes, lines and dimensions shown on the drawings with the tolerance given below.

Note- These tolerances apply to concrete dimensions only, and not to positioning of vertical steel or dowels).

General Requirement

- It shall be strong enough to withstand the dead and live loads and forces caused by ramming and vibrations of concrete and other

(a)	Deviation from specified dimension of cross section of columns and beams	+10 mm -5 mm
(b)	Deviation from dimensions of footings	
	(i) Dimension in Plan	(+ 50mm (-10mm
	(ii) Eccentricity in plan	0.02 times the width of the footing in the direction of deviation but not more than 50 mm.
	(iii) Thickness	+ 50mm Or ± 0.05 times the specified thickness. Whichever is less

incidental loads, imposed upon it during and after casting of concrete. It shall be made sufficiently rigid by using adequate number of ties and braces, screw jacks or hard board wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete.

- Form shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections, care shall be taken to see that no piece is keyed into the concrete.

Material for Form Work

- (a) Propping and Centering: All propping and centering should be either of steel tubes with extension pieces or built up sections of rolled steel.

Centering/Staging :

- Staging should be as designed with required extension pieces as approved by Department to ensure proper slopes, as per design for slabs/ beams etc. and as per levels as shown in drawing. All the staging to be either of Tubular steel structure with adequate bracings as approved or made of built up structural sections made from rolled structural steel sections.
- In case of structures with two or more floors, the weight of concrete, centering and shuttering of any upper floor being cast shall be suitably supported on one floor below the top most floor already cast.
- Form work and concreting of upper floor shall not be done until concrete of lower floor has set at least for 14 days.

Shuttering:

Shuttering used shall be of sufficient stiffness to avoid excessive deflection and joints shall be tightly butted to avoid leakage of slurry. If required, rubberized lining of material as approved by the Department shall be provided in the joints. Steel shuttering used for concreting should be sufficiently stiffened. The steel shuttering should also be properly repaired before use and properly cleaned to avoid stains, honey combing, seepage of slurry through joints etc.

- Runner Joists:** RSJ, MS Channel or any other suitable section of the required size shall be used as runners.
- Assembly of beam head over props. Beam head is an adopter that fits snugly on the head plates of props to provide wider support under beam bottoms.
- Only steel shuttering shall be used, except for **unavoidable portions** and very small works for which 12 mm thick water proofing ply of approved quality may be used.

Form work shall be properly designed for self weight, weight of reinforcement, weight of fresh concrete, and in addition, the various live loads likely to be imposed during the construction process (such as

workmen, materials and equipment). In case the height of centering exceeds 3.50 meters, the prop may be provided in multi-stages.

Camber: Suitable camber shall be provided in horizontal members of structure, especially in cantilever spans to counteract the effect of deflection. The form work shall be so assembled as to provide for camber. The camber for beams and slabs shall be 4 mm per meter (1 to 250) or as directed by the Engineer-in- Charge, so as to offset the subsequent deflection, For cantilevers the camber at free end shall be 1/50th of the projected length or as directed by the Department.

Walls: The form faces have to be kept at fixed distance apart and an arrangement of wall ties with spacer tubes or bolts is considered best. The two shutters of the wall are to be kept in place by appropriate ties, braces and studs.

Removal of Form work (Stripping Time): In normal circumstance and where various types of cements are used, forms may generally be removed after the expiry of the following periods:

Removal of Form work (Stripping Time): as per amendment 5 of IS 456 2000

Type of Form work	Minimum period Before Striking Form work for concrete made using OPC	Minimum period Before Striking Form work for Concrete made using cement other than OPC or using mineral admixtures like fly ash and slag
(a) Vertical form work to columns, walls, beams	16-24 h	16-24 h
(b) Soffit form work to slabs (Props to be re-fixed	3 days	7 days

	immediately after removal of formwork)		
	(c) Soffit form work to beams (Props to be re-fixed immediately after removal of formwork	7 days	10 days
	(d) Props to slabs:		
	• Spanning upto 4.5m	7 days	10 days
	• Spanning over 4.5m	14 days	14 days
	(e) Props to beams and arches:		
	• Spanning up to 6m	14 days	14 days
	• Spanning over 6m	21 days	21 days

Note 1: For other types of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. Generally, If Portland Pozzolana or low heat cement or OPC with direct addition of fly ash has been used for concrete, the stripping time will be 10/7 of the period stated for OPC with 43 grade cement above.

Note 2: The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slabs, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

	Note 3: For rapid hardening cement, 3/7 of above periods for OPC 33 grade will be sufficient in all cases except for vertical side of slabs, beams and columns which should be retained for at least 24 hours. Note 4: In case of cantilever slabs and beams, the centering shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength. Note 5: Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all types of cement in cold weather and accordingly stripping time shall be increased. Note 6: Work damaged through premature or careless removal of forms shall be reconstructed within 24 hrs.

6. STEEL REINFORCEMENT

Technical Specification for Steel Reinforcement-	
6.6.1	Providing steel reinforcement for all R.C.C items including decoiling, cutting, hooking, bending, cranking, fabricating to required shape, placing in position and tying the system with soft drawn annealed binding wire of diameter not less than 1.00mm with 2 strands etc; complete all as per specifications at all heights/ depths and as per the approved structural drawings. Note: Suitable care shall be taken to protect the reinforcement from exposure to saline atmosphere during storage, fabrication and use. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods as per IS. With Fe500D /Fe550D (HYSD bars conforming the specifications of IS 1786 latest revision)
6.6.2	Providing and fixing parallel treaded, Type 2 Mechanical Splicing with Couplers of approved make confirming to IS 16172-2023, BS-8110, ACI-318 for connection of reinforcement bar including threading, enlargement at connection by forging, protecting the prepared reinforcement bars and

related operations as required to complete the works per direction of Engineer- in- Charge. (Authorised Couplers specified in the drawings or as approved by the Department shall be used in the work.)

General Instructions for Reinforcing steel work:

- 1) For reinforced cement concrete, the reinforcement bars shall consist of the grades as specified in the GFC drawings conforming to IS 1786: 2008 (Indian Standard specification for high strength deformed steel bars and wires for concrete reinforcement) as per latest amendments.
- 2) The contractor shall obtain manufacturer's certificate stating the process of manufacture, chemical composition and test sheet giving result of each mechanical test applicable to the material purchased and submit it to the Department. Each test certificate shall indicate the number of the cast to which it applies, corresponding to the number or identification mark to be found on the material
- 3) Steel bars brought by the contractor for use in the work shall be got checked by the Department or his authorized representative of the work on receipt of the same at site before use. Samples of each confinement shall be taken and got tested by the Engineer- in-charge or his authorized representative for chemical composition and physical properties (including bend and re-bend test) as per the provisions in this regard in the relevant BIS codes from any Govt. or approved laboratory.
- 4) The steel reinforcement bars shall be stored by the contractor at site of work in such a way as to prevent distortion & corrosion, and nothing extra shall be paid on this account. Bars of different sizes and lengths shall be stored separately to facilitate easy counting and checking.
- 5) Records of actual sectional weight shall also be kept dia-wise & lot-wise. The average sectional weight for each diameter shall be arrived at from samples from each lot of steel received at site. The decision of the Department shall be final for the procedure to be followed for determining the average sectional weight of each lot.

General Notes:

- Works shall be carried out up to plinth and also above plinth at all height.
- Work shall be carried out as per the Civil Engineering Division specifications and or as specified in the Tender document and No extra payment will be admissible.
- At lap locations indicated threaded type mechanical couplers (Parallel threaded) shall be used for the reinforcement bars of diameter 25mm and above.
- Also, threaded type mechanical couplers (parallel threaded) may be used for 20mm dia bars to avoid congestion with approval of EIC.
- Mechanical couplers shall be provided away from the special confining zone, preferably at the middle of the floors.
- Mechanical coupler for beams shall comply IS 16172:2023 & IS 13920:2016 as indicated in the structural drawings or as per standard Engineering practice.
- At any point not more than 50 percent of column bars shall be coupled and centre to centre distance between the couplers shall be 750mm.
- The steel reinforcement work shall comply structural drawings for the Note, instructions, guidelines, IS codes, laps, development lengths, curtailment, dimensions etc.,
- For Storage-Suitable care shall be taken to protect the reinforcement from exposure to saline atmosphere during storage, fabrication and use wherever necessary. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods as per IS if required.
- Special confinement reinforcement shall be provided throughout the column length above the terrace level at grid indicated in the structural drawings.
- The ductile detailing for location of the special confining reinforcement in columns shall be as per the structural drawings.

- Chairs, spacer bars etc. shall be provided as per GFC drawings or as per standard engineering practice/ CED Specification and/or as per direction of Department for which nothing extra shall be paid.

Steel for Reinforcement:

The steel used for reinforcement shall be any of the following types

- 1]. Mild steel and medium tensile bars conforming to IS 432 (Part 1)
- 2]. High strength deformed steel bars conforming to IS 1786
- 3]. Hard drawn steel wire fabric conforming to IS 1566
- 4]. Structural steel conforming to Grade A of IS 2062
- 5]. Thermo-mechanically treated (TMT) bars.

Elongation percent on gauge length is 5.65 A where A is the cross-sectional area of test piece. Mild steel is not recommended for the use in structures located in earth quake zone subjected to severe damage and for structures subjected to dynamic loading (other than wind loading) such as railway and highway bridges. Welding of reinforcement bars covered in this specification shall be done in accordance with the requirements of IS 2751.

Nominal mass/weight: The tolerance on mass/weight for round & square bars percentage given in below Table of the mass/weight calculated on the basis that the masses of the bar/ wire of nominal diameter and of density 7850Kg/m³ or 0.00785 Kg/mm³

Tolerance on Nominal Mass

Nominal size in mm	Tolerance on the Nominal Mass per cent		
	Batch	Individual sample +	Individual sample for coil (x)
(a) Up to and including 10	±7	-8	±8
(b) Over 10, up to and including 16	±5	-6	±6
(c) Over 16	±3	-4	±4

(i) '+' for individual sample plus tolerance is not specified

(ii) 'x' For coil batch tolerance is not applicable

(iii) Tolerance shall be determined in accordance with method given in IS 1786.

High strength deformed bars & wires shall conform to IS 1786. The physical properties for all sizes of steel bars are mentioned below in Table

Sl. No	Property	Fe 500 D	Fe 550D
(i)	0.2 Per cent Proof stress/ yield stress, Min, N/mm ²	500.0	550.0
(ii)	Elongation, per cent, Min. on gauge length $5.65 \sqrt{A}$, where A is the Cross-sectional area of the test piece.	16.0	14.5
(iii)	Tensile strength, Min	10 Per cent more than the actual 0.2 per cent proof stress/ yield stress but not less than 565.0 N/mm ²	8 Per cent more than the actual 0.2 per cent proof stress/ yield stress but not less than 600.0 N/mm ²
(iv)	Total elongation at maximum force, percent, Min on gauge length $5.65 \sqrt{A}$, where A is the cross-sectional area of the test piece.	5	5

Chemical composition of reinforcement bars shall be as per Table as follows:

Constituent	Maximum Per cent	
	Fe 500 D	Fe 550 D
Carbon	0.25	0.25
Sulphur	0.040	0.040
Phosphorus	0.040	0.040
Sulphur and Phosphor	0.075	0.075

Thermo Mechanically treated reinforcement bars:

- The available code BIS 1786 pertains to HSD Bars. Therefore there should be no stipulation that TMT bars should conform to relevant BIS code.
- The TMT bars are being produced under valid license from either of the firms namely Tempcore, Thermex Evcon Turbo & Turbo Quench. These firms have acquired patents and are giving licenses to various producers to produce TMT Bars. The TMT bars shall conform to IS 1786 pertaining to Fe 500 D, Fe 550 D or Fe grade of steel as specified.

In design and construction of reinforced concrete building in **seismic zone III** and above, steel reinforcement of Grade Fe 415 D shall be used. However, high strength deformed steel bars, produced by thermo mechanical treatment process of grade Fe 415, Fe 500 and Fe 550 having elongation more than 14.5% and conform to other requirements of Fe 415 D, Fe 500 D and Fe 550 D respectively of IS 1786 may also be used for reinforcement. In future, latest provision of IS 456 and IS 13920 or any other relevant code as modified from time to time shall be applicable.

7. STRUCTURAL STEEL WORKS

Technical Specification for Structural steel:-	
7.1	Supplying, fabricating, assembling, hoisting/erecting and fixing in position at all heights from FFL and with all leads, structural steel works of welded built-up sections/bolted sections/ standard sections, all as per structural drawings and as per detailed specifications (for materials and workmanship) in the situations described hereinafter including a)cutting of components to required lengths/widths and shapes/profiles, b) smooth machining of edges/ faces, c) welding (electric arc welding) at joints of built-up sections/ single sections. for required weld lengths and sizes d) bolted connections of joints wherever required and e) painting all over with two coats of Epoxy paint of approved quality, make and colour/ shade <u>over one coat of yellow oxide zinc chromate primer</u> of Berger or equivalent approved make with surfaces duly prepared to receive painting etc., complete all as directed by the Department.
7.2	Structural steel works of welded built-up sections fabricated with plates of any thickness of grade as per Structural drawing.
7.3	The fabrication work shall start only after approval to the fabrication drawings. Any change required in the fabrication drawings shall be carried out at no extra cost over the quoted rates. Fabrication shall be in a perfectly workmanship like manner and as provided in Section V and VI of IS 800 and IS 7215. Welding shall be carried out by qualified welders. Electrodes for welding, the procedure, selection, test and inspection shall conform to provisions in IS 816, IS 818, IS 822, and IS 833. Erection/hoisting shall commence only after passing of fabricated parts by the Engineer -in- charge
7.4	NOTES FOR BOLTED CONNECTIONS: 1. The foundation bolts shall be as per IS 5624 (latest revision) & as per relevant IS codal provisions. Length of foundation bolts shall be as per detailed design drawings. Shear connections of primary & secondary

	structural members shall be of MS bolts as per IS 1363 & all relevant IS codes specified in IS 800:2007.
7.5	For all structural steel elements related to Doors/Ladder/ Stair case/ stair case roof/ Jali supporting elements/ Brackets/ Cable trench/ Working platform/ any embedment plate/ Shera board support/ Ramp angles etc., using With M S Channels, M S Angles, MS Tee sections, M S pipes of any diameter, Chequered M S plates. M S RHS sections M S bed plates & Base plates, MS chequered plate etc any thickness as per structural drawing.
7.6	Ladder railing, balcony railing and staircase railing etc., with: M.S tube (medium): 40 mm/ 20mm nominal bore as per structural drawing.
7.5	Structural steel work of factory-made MS Holding down foundation bolts including nuts and washer plates of any dia including necessary threading and machining wherever necessary.
7.6	Note: • Works shall be carried out up to plinth and also above plinth at all height. • All the structural steel sections shall conform to IS 2062 (Latest). • All structural steel shall be cleaned off rust & Milled scales. • All welds are 6mm thick continuous fillet weld or size of welds shall be as per detailed structural drawings and shall conform to IS 816. • All structural steel design, fabrication, erection shall be as per IS 800: 2007. 4. All structural steel shall conform to IS 2062 (weldable quality). • The contractor is entirely responsible for the stability of the structure during erection and shall use sufficient bolts, braces or guy ropes to ensure that member / structure will remain rigid until final connection is completed • The structural steel members grade of steel for RHS, SHS & CHS shall be FY 310N/sqmm, Handrails (Circular tubes) shall be FY 240N/sqmm,

	MS plates & Rolled steel sections shall be FY 250 N/sqmm, HYSSD lugs shall be FY 500N/sqmm. • The epoxy paint for the structural steel of shade old oak 8A 2584 of Berger or equivalent. • All the structural work shall be carried out as per Architectural drawings for pattern, locations and shade and Technical parameters/ triats/ guidelines/ notes/ instructions shall be complied as per structural drawing.

8. FLOORING WORKS

<i>Technical Specification for Flooring works</i>	
8.1	Providing and laying vitrified ceramic tile flooring / skirting (thickness to be specified by the manufacturer) with water absorption's less than 0.08% using approved quality vitrified ceramic tiles conforming to IS:15622-2006, group B-Ia manufactured by Somany/ Simpolo /M/s. Kajaria/ or equivalent make and having straight cut edges for paper joints of approved size and thickness in all colours, shades and approved make, laying the tiles over a bed of 20mm thick cement mortar 1:4 with cement slurry @ 3.3 kg / sqm., including grouting the joints with white cement and matching pigments etc., finishing to required level, curing etc. as per manufacturer's specifications, drawings etc. at all heights & in all floors
	a) Flooring- Vitrified tile, Polished Double charged of size 600mm x 600mm /800mm x 1200mm and thickness as per manufactured specification
	b) Skirting 125mm high- Vitrified tile and thickness as per manufactured specification laid over a bed of 12 mm thick cement mortar 1:4 with cement slurry @ 3.3 kg / sqm., including grouting the joints with white cement and matching pigments etc.,
8.2	Providing and laying (carborundum based) 50mm thick Hardonite non-metallic monolithic flooring for heavy traffic using Nitoflor Hardtop of M/s. FOSROC Chemicals or equivalent consisting of 50mm thick base of cement concrete 1:2:4 laid to level in bays not exceeding 3sqm per panel including providing 3mm thick aluminium dividing strips to the full

	depth of flooring including applying a layer of Nitoflor Hardtop Powder at 5kg / sqm on the surface immediately when the surface is green and finishing by power trowel to the required finish and level etc., and after 24 hours a lithium based liquid floor hardener "Nitoflor LH" of M/s. Fosroc Chemicals or equivalent shall be spread at the rate of 100 ml per sqm on the surface and allowed to saturate and dry for 2 hours. The buffing shall be carried out after 24 hours of providing the nitoflor-LH to get the required shining etc., complete all as per manufacturers specifications and directions of Engineer in charge.
8.3	Providing and laying Ceramic tile flooring/dadding of approved quality, size, colour and thickness according to the dimensions of tiles and having scratch hardness and other parameter conforming to IS 15622 (Somany/ Simpolo /Kajaria or equivalent make) laid over a bed/backing as specified below, with cement slurry at 3.30kg/sqm, close jointed and pointed with matching white cement slurry mixed with approved pigment and finishing to required level, curing etc., complete all as per specification and as directed by Department at all floors
	a) In flooring with approved colour floor tiles (Antiskid) matt finish size 300mm x 300mm as per IS 15622 over bed/backing of 20mm thick in CM 1:4.
	b) In dado with approved colour wall tiles all sizes upto 300mm X 450/600 mm as per IS 15622 over a bed/backing of 12mm thick in CM 1:3. Height shall be comply with as indicated in the drawing.
8.4	Providing and fixing Steel Infill Access floor (false floor) systems of M/s. DG False flooring & Technologies Pvt. Ltd. Or M/s. United Access floor Pvt., Ltd., or FLEXI Brand of M/s AET Building products (WI) Pvt Ltd or equivalent all as per following specifications: S Y S T E M : The access floor system to be installed shall provide a minimum finished floor height of 300mm to 600mm from the existing floor level. The system shall provide suitable pedestal and under-structure designed to withstand various static loads and rolling loads subjected to it in an office/ server/ DCS/ panel/ rack area/ clean rooms/ control rooms, etc,. The entire access floor system shall provide for adequate fire resistance, acoustic barrier and air leakage. P A N E L: Unitile USF-1200 Access Floor panel of size

	604 x 604 mm or Flexi USF-1200 Access floor panel of size 600X600 mm shall be all steel welded construction, with an enclosed bottom pan of 64 hemispherical cones and a top plain sheet which are fuse welded at 124 locations to form a panel of an overall depth of 36 mm. The inner empty core of the panel is injected with a light weight fire retardant, noncombustible cementitious compound at high pressure to fill in all the crevices of the panel and ensures support of not less than 85% of the top surface area of the panel. The panel after cleaning, degreasing, phosphating by 7 tank process is coated with 40-micron epoxy coat and is heated to achieve maximum adhesion and surface resistance. L A M I N A T I O N: The panel is then laminated with 1.5 mm thick fire-retardant floor grade antistatic laminate on a semi -automated lamination line to ensure maximum bonding to the steel surface. The edges of the laminated/pvc is protected with black pvc edge trim 5mm wide on all sides. This edge trim is mechanically lo, P A N E L L O A D I N G: Concentrated Point Load - 560 kgs on a 25 x 25 mm square indenter on the centre of the panel with a maximum permissible deflecting of not more than 2.5mm. Uniformly Distributed Load (UDL) - 1680 kg/ Sqm with a maximum permissible deflecting of not more than 2.0 mm., F I R E R A T I N G: The Panels shall confirm to Class O & Class 1 Fire Ratings tested as per BS 476 Part 6 & 7 SUB STRUCTURE - PEDESTAL ASSEMBLY:
8.5	Sub structure installed to support the panel shall be suitable to achieve a minimum finished floor height of 65mm to a maximum of 600 mm from the existing floor level. Pedestal design shall confirm speedy assembly and removal for relocation and maintenance. The assembly shall provide easy adjustment of leveling and accurately align panels for a maximum 30 mm up and down in the vertical direction. Pedestals shall support an axial load of 2200kgs. without permanent deflection and an ultimate load of 3500 kgs. The Pedestal head assembly shall consist of an 80X80 mm aluminum die cast proprietary designed head which shall have an inbuilt stringer snap locator, panel locator for side wall and the bottom base locator pin which enables the panel to be in position independently with or without stringer. The aluminium head is positioned in the pedestal pipe with a 18 mm rolled form threads and with 2 check nuts for level

	adjustment and arresting vertical movement. The Pedestal Base assembly shall consist of 22mm OD pipe of thickness 1.6mm projection welded to a base plate of 100 x 100 x 2mm thick with stiffening folds. The sub structure assembly shall be suitably anchored to the floor with suitable adhesive or fastener as recommended by the manufacturer All steel components shall be electro galvanized. STRINGERS: The stringer is electro galvanized steel cold rolled construction specially designed for lateral stability, rolling loads and to support the panels on all four sides for alignment. The stringer to have a counter sunk holes at both ends to accommodate bolting of the same to the pedestal head assembly. The stringers shall be 20 x 25 x 1 x 575 mm. For Flexi brand the stringers shall be 20 x 32 x 1.2 x 565 mm NOTE: 1. One no. of panel lifting device has to be supplied freely to Department for day to day maintenance. The quoted rate shall be inclusive of lifting device. 2. Contractor shall provide a guarantee certificate for a period of 5 years for any manufacturing defects from manufacturers. 3. The work shall be executed as per the manufacturer's specifications at all floors and at all heights.
8.6	Providing and laying Indian Patent Stone Flooring with cement concrete 1:2:4 (cement: fine aggregate: graded stone aggregate) using graded granite stone fine aggregate obtained from approved quarry laid to level or slope in bays not exceeding 3sqm per panel including providing 3mm thick aluminium dividing strips to the full depth of the flooring and finished smooth with float coat of cement at 4.4kg/sqm, curing, etc., complete all as per specifications - 50mm thick (using 20mm nominal size stone aggregate) for Electrical panel room as indicated in the drawing.
8.7	Providing plain cement mortar skirting 20mm thick in a mix of 1:3 including a base layer and finished smooth to required level and plumb at corners and at face in cement slurry mixed at the rate of 10KG per 10sqm inclusive of curing etc; complete all as per specifications. (Rate to include cost of chasing of walls wherever required & providing 6 x 10mm neat groove on top i.e. at junctions of plaster & skirting) -125mm high for Vacuum dewatering flooring area and Electrical panel room area as per drawing.

8.8	Extra for making chequres of approved pattern on cement concrete floors, steps, landings, pavements, ramps etc., complete all as per specifications and direction of Engineer In Charge for ramps as indicated in the drawing.
8.9	Vacuum Dewatering from concrete (grade M35) for flooring including hire charges & transportation charges for equipment, finishing the concrete with machine power trowel, finishing the surface neatly all as directed by Engineer in charge and as per specification The rate includes all the labour and materials, equipment involved for the work for Car parking/ Stilt floor as per drawing.
8.10	Providing and fixing carpet tile size of 600mmx600mm with tufted level loop pile of universal fibres with 100mm solution dyed nylon/millitron with machine gauge of 1/10 (47.2/10cm, tufts 1704/100 sq. cm with the thickness of 6.5mm +/-0.5mm and pile weight of 18 to 20Oz per Sq.yard, with warranty of 10 years includes -face fiber wear, delamination of backing, antistatic, edge ravel, color fastness and lifetime staining/ soiling. Brand: Milliken or equivalent.
8.11	Carpet Flooring Roll: Providing and fixing of Broadloom Carpet with tufted level loop pile of universal fibers with 100% solution dyed nylon/millitron with machine gauge of 1/10(47.2/10cm), tufts 1704/100 sq.cm with the thickness of 6.5mm +/-0.5mm with the broadloom width of 13'6" (4.11m) and pile weight of 18 to 20 OZ per sq.yard, with the warranty of 10 years includes – face fiber wear, delamination of backing, antistatic, edge ravel, colorfastness and lifetime staining/soiling. Brand-Milliken or equivalent.
8.12	Note for Flooring
	The newly laid granite stone/Vitrified/Ceramic flooring shall be protected with a suitable protective layer with POP layer/ EPE laminated foam shall be laid on all finished floors for protection from damage during execution of other items of work in that area which shall be removed and cleaned just before handing over of the premises for which nothing extra shall be paid or by covering the entire finished surface as directed till the finished items like painting/ polishing, etc., completed inside the building. This

shall be done irrespective of whether mention has been made in the individual flooring items or not at no extra cost.

9. JOINERY WORKS

Technical Specification for Joinery works(Steel, wood, Steel, GRP, Aluminium etc)

9.1	Providing and fixing M.S flat iron door frame as per design jointed and welded together to make angles/ tees. The frame will be made by intermittent welding of two flats 30/35/ 38/ 40mm X 6mm and 30 X 6mm at right angles, on the outside welds being 2.5cms long 30cms apart c/c., including providing and fixing with standard M.S hold fasts 6 nos. of size 30/35/ 38/ 40mm x 3mm x 400mm long welded to the door frame and embedded in cement concrete blocks of size 345/230/115 x 230 x 150mm in c.c 1:3:6 using 20mm nominal size hard granite stone aggregate for wall locations. Further if frames are butting to the RCC/ PCC columns/ mullions, 8mm diameter anchor fasteners shall be provided instead of red oxide zinc chromate primer, and two coats of synthetic enamel paint of approved shade and quality, drilling holes and making arrangements for fixing tower bolts, threading for screws, bolts for fixing mortice lock/ latch including supplying 3nos. of 12.5cms copper oxidised mild steel butt hinges for each leaf, 12mm square M.S rods as a spacer which is to be embedded below floor permanently shall be welded to the door frame. (only weight of flat iron door frames will be calculated for payment).
9.2	Providing and fixing steel doors made out of standard MS medium class hollow tube sections. The shutters shall be of MS tubes for styles, rails and intermediate members and fixed with MS sheets (single / double skin) including providing and fixing approved pivots as required and hinges transom coupling member etc., including cleaning the surface thoroughly free from rust scales and painted with two coats of synthetic enamel paint over a coat of red oxide zinc chromate primer conforming to IS

	specifications including providing and fixing MS aldrops, MS tower bolts and MS handles etc., complete all as per specifications and drawings.
9.3	Fully openable shutter (single / double shutter)
9.4	Providing First class teak wood in frames of doors, windows, ventilators and other frames like partition etc; wrought, framed and fixed in position with 40mmx3mm and 400mm long MS holdfasts embedded in cement concrete blocks of size 345/ 230/ 115mm x 230mm x 150mm in PCC 1:3:6 mix for wall locations. Further if the frames are butting to the RCC/PCC columns/ mullions, 8mm dia anchor fastener shall be provided instead of hold fasts or with M.S bolts/T.W plugs and G.I. screws as required including tarring back of the frames, etc; complete all as per specifications.
	a) For Door frames with double rebate suitable for 30 mm, 35 mm, 38 mm, 40 mm thick shutters. (Cross section 150mm x 100mm) – SD1 b) For Door frames with Single rebate suitable for 30 mm, 35 mm, 38 mm, 40 mm thick shutters.(Cross section 125mm x 65mm) –D1 & D2
9.5	Supplying and fixing solid hard core non decorative type(BN) interior grade commercial BLOCK BOARD FLUSH DOOR SHUTTERS of approved make (Shakti/ Kutti/ Kailash/ Merino or equivalent) conforming to IS-2202 (part-I) - 1991 with teak wood internal lipping on all sides and solid teak wood inserts for mounting locks, etc; having well matched commercial ply veneering with cross bands and face veneers on both faces, including cost of providing and fixing builders hardware like hinges, knobs, handles, locks, tower bolts,etc.; complete all as per specifications. Single/Double shutters 40mm thick as per the drawing–D1 & D2 The details/ size/ location shall be as per Architectural drawing. Samples as stipulated in IS code should be furnished for tests free of cost by the contractor as the tested samples are destroyed during testing Door shall be Painting Wood work with TWO or more coats of SYNTHETIC ENAMEL PAINT of I quality and approved colour to give

	an even shade over a coat of zinc chromate primer including cleaning the surfaces, applying a coat of approved putty on whole surface and rubbing the surface to achieve desired smooth surface, scaffolding, etc.; complete all as per specifications (Rate to include cost of zinc chromate primer, putty also).
9.6	Providing and fixing SINTEX INDIANA series UPVC openable windows/ Doors with MS safety bars (Flats) made OUT of hollow multi Chambered extruded UPVC sections reinforced with steel tube wherever required. The corners shall be mitre cut and welded. The outer frame made of Sintex DWUF 401 having overall dimension of 40x90mm and maximum wall thickness of 1.5mm +/- 0.3mm with concealed steel reinforcement of MS tube of size 27 x 20mm of wall thickness of 1mm +/- 0.2mm. Mild Steel safety square bars of 12 mmx 12mm is to be fixed in the frame/ mullion . The shutter frame made out of Sintex section DWUF 405 having over all dimensions 40 x 48mm and maximum wall thickness of 1.9 +/- 0.3mm with steel reinforcement of 22 x 18mm x 1mm +/- 0.2 mm. Suitable snap-fit glazing bead with sintex code GL-19 of size 19 x 19.5 mm x 1.7mm +/- mm +/- 0.3mm will be provided to fix the glass with necessary EPDM gasket.
9.7	Outer frame sintex code DWUF 401 along with snap fit mullion bead with SIntex code DWUF 403 od size 50x12.5x1.5mm +/- 0.3 mm is used as fix mullion for the window. Inner shutter frame made of sintex section DWUF 421 of size 40 x 33 x 1.8mm +/- 0.3mm fixed with Stainless Steel Fly proof mesh (SS 316) with suitable rubber rod. Hardware fittings such as powder coated hinges, EBCO/HATTICH make powder coated window handles, powder coated tower bolts and EBCO/HATTICH make friction stays are to be provided. The work has to be carried out as per Manufacturers specifications and through authorised agency of manufacturer for: Note: Rate shall include providing MS safety bars (20X5mm MS FLAT at 100mm c/c horizontally, 250mm c/c vertically) painted with two coats of

	epoxy paint over a coat of yellow oxide Zinc chromate primer of approved brand.
	a) Single/Double shutter fully openable UPVC window/ Doors having outer shutter with 5mm thick plain glass and inner shutter fixed with SS 316 fly / mosquito proof 26G x 1/16 " wire mesh – Windows - W1
	b) Single shutter fully openable UPVC window/ Doors having outer shutter with 4mm thick Translucent glass and inner shutter fixed with SS 316 fly / mosquito proof 26G x 1/16 " wire mesh – Ventilators - V1
9.8	Supplying & Fixing of factory-made composite door shutter with frame and single shutter manufactured by M/s. Fimen Fibre Products Pvt. Ltd., or equivalent with door frame of size 90x60mm. The door shutter shall be of rigid G.R.P sandwich composite structure of 26mm thick (minimum) laminated on all sides with G.R.P skin fabricated using U.V. stabilized Isophthalic gel coat and one layer of 450 GSM E glass chopped strand mat (CSM) impregnated with polyster resin.
	The thickness of skins shall not be less than 1.5mm. Expanded polysterene structural foam panel of density 20kg/cum shall be used as core material for the whole areas of door except the wooden frame structure. The wooden reinforcements made of seasoned salwood block of minimum cross section of 70x26 for lock side 40x26 all-round forming the framework for shutter and minimum of 75mm wide intermediate strip for the width of the door for fixing locks and fixture and shall confirm to IS:4020-1998. The finish of the shutter be without grains and of approved colour etc., complete all as per manufacturers specifications at all heights. For GD1, GD2 & GD3
	Providing, supplying & fixing of Fixed Louvered Ventilator made out of multi chambered uPVC sections with TPV gaskets having isolated drainage and reinforced with Galvanized Iron of 120 GSM profiles through out the window. The outer frame having a overall size of 60 x 55 mm with reinforcement of 1 mm thickness and Mullion with overall size of 74 x 60 mm with reinforcement of 1 mm thickness. Composition of

	profile shall consists a minimum of 6 PHR of Tio2 for every 100 parts of PVC resin. Ventilator shall be provided with 4.5 mm Pin Head glass, standard hardware. Wall thickness of frame & Mullion shall be 2.2 - 2.4 mm.
9.9	Supplying & fixing of factory made 30mm thick single shutter manufactured by M/s. Fimen Fibre Products Pvt. Ltd., or equivalent as per the following specifications. The single leaf shutter shall be of rigid GRP sandwich composite structure of 30mm thick (minimum) laminated on all sides with GRP skin fabricated using UV stabilized isophthalic gel coat and one layer of 450 GSM E class chopped strand mat (CSM) impregnated with polyester resin. The thickness of the skins shall not be less than 1.5mm thick. Expanded polystyrene structural foam panel of density 20kg/cum shall be used as core material for the whole area of door except the wooden frame structure including providing and fixing 6 nos. of 260mm x 25mm x 5mm size MS holdfast 3 nos. of 100mm long Brass hinges with brass screws, 2 nos. 100mm long aluminium powder coated tower bolts, 2 nos. 125mm aluminium powder coated handles to each shutter and the shutter shall be fixed to frame and sent to the site keeping 50mm gap between shutter and frame at the bottom. The rate shall include fixing of door frames in opening with shutter.
9.10	Providing and fixing Stainless Steel fly proof mesh (grade 316) of size 1/16" 26g including fixing with aluminium beading of size 10mm x 20mm etc.; complete all as per specifications (for External Main & Utility steel door)
	Note: MD1, D1& D3- The details/ size/ location shall be as per Architectural drawing.
9.11	Supplying all the below mentioned Aluminium joineries of suitable approved brand / make with necessary screws of suitable material. Complete all as per specifications at all heights & floors and as directed by Engineer In-charge. (Aluminium joineries shall be fixed as per

	standard engineering practice for functional requirement of the doors/ windows/ventilators/cupboards/shelves etc)
	Tower bolt 200mm long - Anodised aluminium tower bolt as per IS 204-1974 Barrel dia 16mm and bolt dia 15mm (Ruby/ Jindal make or equivalent):- (2 nos per flush door)
	Tower bolt 250mm long - Anodised aluminium tower bolt as per IS 204-1974 Barrel dia 16mm and bolt dia 15mm (Ruby/ Jindal make or equivalent):- (1 no per flush door)
	D' type handle(125mm x19mm with 75mm grip size)(Ruby/ Jindal make or equivalent):- (1 no per flush door)
	D' type handle(150mmx19mmwith 100mm grip size)(Ruby/ Jindal make or equivalent):- (1 no per flush door)
	SS/ Brass single rubber Door stopper round (1 no per flush door)
	Aldrop - Anodised aluminium sliding door bolt with 4 clamps (Ruby/ Jindal make or equivalent) (300x19.05mm) (1 no per door)
	Providing padlock Godrej-Navtal 6 levers (Model no 3279) with 3 keys (1 no per door)
	Providing Godrej make - URO mortice lock for ordinary doors 146mm size 2C with brass handle set/ satin handle set/ décor satin handle set/ crystal satin handle set with necessary screws.
	Providing and fixing magic eye (door view) for entrance door etc., all as per the directions of Engineer in charge.
	Providing Godrej make - Steel door lock for steel ordinary doors with 3 keys. Handle set with necessary screws/ Fasteners/welding etc as per the direction of EIC.
	Providing rubber bush for door of 50mm dia and 75mm long for doors (1 no per door)
	Heavy type PVC door buffer 75mm (1 no per door)

	SS306 grade four ball bearing (For flush door)
	For Toughened glass doors H type handle 300x25mm = 02 nos pair. Floor spring with locking system Locking arrangement
	Note: - All UPVC window/ ventilator includes all hardware items/ MS safety bars/ joineries as per manufacturer's specifications and nothing will be paid extra. - All steel doors, rates shall include all necessary fixing arrangement, joineries etc., as per standard Engineering practice. - All steel joineries shall be painted with two coats of Epoxy paint over a coat of suitable primer. - UPVC Windows/ Ventilators shade is as per the direction of Engineer Incharge.
	Any variation from above as per site requirement or as per norms, shall be provided without cost adjustment.

10. ROOFING WORKS

Technical Specification for Roofing works, Water proof Layer roof treatment, Screed concrete, Rain water pipe system, Khurras, Angular Fillet, Polycarbonate sheet

10.1	Supplying& Applying of Solvent Free, 100% solids,Two Component (ASTM D 16, Type V), Polyurea (0.5mm) + Polyurethane(0.7mm) + Aliphatic Coating (0.3mm) System, Non-Tar Extended, Total System Thickness of 1.5mm (excluding primer) of PolyUrethane based DRYTHANE of AMCHEM Products Pvt Ltd or equivalent PolyUrethane based membrane water proofing system of make FAB / Dr.Fixit / CIPY / CERA / FOSROC / SIKA / BASF /ALCHIMICA Building Chemicals/ Sunanda or equivalent. The treatment system has to form a tough durable film, highly resistant to mechanical damage and totally impervious to water immersion.

Product shall not emit any Volatile Organic Compounds (VOC) or odour and will be totally environment friendly.

i) System Composition:

- a) Damp Tolerant, Solvent Free Penetrating Primer: 0.15 mm Nominal WFT
- b) Solvent Free Polyurea(0.5mm)+Polyurethane(0.7mm)+Aliphatic Coating(0.3mm)= 1.5 mm Nominal DFT (Total system thickness) excluding primer
- c) Stripe coat of 1mm thick of make Drythane plus or equivalent shall be applied in parapet to floor joint portions only.

ii) Supply:

Liquid coating materials will be supplied with original manufacturer's Material Test Certificate (MTC) showing residual shelf life. Material will be in original airtight, sealed drums without any damage or leak. Only approved makes shall be purchased.

iii) Performance Properties:

- a) Adhesion (ASTM D 4541) > 380PSI, Tensile Strength of the Concrete with 90% or more break within the concrete matrix.
- b) Tensile Strength (ASTM D 412) > 29/20 MPa
- c) Elongation @ Break (ASTM D 412) > 700%/>125% d) Crack Bridging 10/2.54 mm
- d) Hardness (ASTM D 2240) > 42/>64 Shore D
- e) Water Absorption (ASTM D 570, Para 7.4, Long Term Immersion) < 1.50 %
- f) Chemical Resistance to 30% NaOH (ASTM D 543, 30-day immersion), Weight Gain < 1.5%
- g) Certified Potable Water Safe as per US FDA 175.300 by CFTRI (Only for water tank, swimming pool applications)

iv) Application Procedure:

Strictly follow manufacturer's application instructions and provide a copy in advance to Engineer-In-charge to ensure compliance. Application will involve cleaning surface thoroughly with high pressure waterjet, drying and application of primer and topcoat by paint rollers. Ratio of the two components (Resin: Activator) must be strictly ensured as per design. Use pre-measured packaging as far as possible. Cracks will be treated with elastomeric polyurethane stripe coat prior to coating application.

v) Covering:

This type of product has very high mechanical resistance to mechanical damage as well as UV and Sunlight and protection by Screed, Tiles, etc., is not necessary. However, the coated surface may be covered with tile/ stone, etc., for aesthetic purposes and drain board/ geotextile/ soil/ grass.

Note: Ensure Substrate is strong enough to receive PU coating.

TOP COAT:

Supply & apply of 100% solids, two component, colour fast & HEAT REFLECTIVE coating system having tensile strength of 17.6Mpa, Hardness of 60 shore D, SRI Index (ASTM C 1459-16) of Topcoat 110& reduce rooftop surface temperature by as much as 13 °C, after sufficient surface preparation, Drythane or equivalent make's Aliphatic is applied at 300microns & No need for reinforcement or protection.

Important Notes:

- 1) The Contractor / Agency has to submit warranty for water proofing for 7years period from the date of completion of work on a non-judicial stamp paper.
- 2) Polyurea + Polyurethane + Aliphatic Coating System of PolyUrethane based water proofing system shall be used after the approval of Engineer in Charge after making a mock up at site.
- 3) During defect liability period / warranty period, any rectifications shall be attended by the agency within a week time, failing which the

	work will be done with agency and incurred amount will be recovered from security deposit without any notice. 4) The work should be executed through specialized / authorised agencies of reputed water proofing chemical companies.
10.2	Providing and laying protection screed in cement concrete 1:2:4 (1 cement: 2 Fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS383:2016): 4 hard granite stone aggregate 20mm nominal size graded hard granite stone coarse aggregate as per IS 383:2016), mixed in-situ with integral water proofing compound as per manufacturers, laid to slope as slope mentioned in the drawing finished smooth without honeycombing and receive Five layer WPC etc, complete all as per the directions of Engineer in charge at all heights
10.3	Providing and making khurras of size specified below with 12mm thick CM 1:3 plaster finish over PCC 1:2:4 using 10mm nominal size stone aggregate (1 cement: 2 Fine aggregate: 4 stone aggregate) of 600mm x 600mm of varying thickness of 40mm at WPC side to 30mm at pipe end, laid to slope, compacted over PVC sheet of 1000 x 1000mm x 400 micron laid over top of slab after cleaning the surface of concrete slab. The top surface of CM 1:3 plaster shall be finished smooth with cement punning, rounding of edges etc., complete all as per specifications and directions of Engineer in charge. Note: The RWP shall be fixed during construction of parapet to ensure filling the joints and around pipe properly of size) 600mmx600mm size
10.4	Providing and laying angular fillet 7.5cm x7.5cm cement concrete 1:2:4 (cement : fine aggregate : graded stone aggregate) 20mm nominal size, including compaction, finishing, curing, etc; complete all as per specifications at all heights In fillet 7.5cmx7.5cm.
10.5	Providing and fixing rigid PVC SWR (Soil, waste & Rainwater) pipes & specials make of PRINCE, SUPREME, FINOLEX, ASHIRVAD or equivalent & conforming to Type-A IS 13592-1992, including accessories like bends and fixing with MS clamp at not more than 1.20 mtr c/c fabricated using MS flat of 30mm x 6 mm and 30mm x 3mm fixed to masonry or RCC member using anchor fasteners etc. as per the design and manufacturer's specifications complete all as per specifications and

	directions of Department. Rate to include cost of providing a shoe at the lower end of each RWP and painting of pipes and clamps with two coats of synthetic enamel paint of approved make and colour 160mm dia OD pipes with minimum wall thickness of 3.20 mm
10.6	Providing plaster drip/ moulding of size as specified below in cement mortar 1:3 (1 cement : 3 fine aggregate) including scaffolding ,curing etc, complete all as per specifications ,drawings and direction of Engineer -in -charge (Size: 45mm x15mm size)
10.7	Providing, fabricating and fixing of polycarbonate sheet roofings/weather sheds of any shape over MS tubular frame work as per detailed drawing and specifications as detailed below a)The weather shed shall be mentioned below of "M/s.Sabic GE plastic/Markralon" or "Lexan" make manufactured by M/s.GE Plastic India Ltd. or equivalent make and of approved shade and colours. Sheet fixing shall be done with aluminium profile as per detailed section drawings. The clamping profiles shall be consisting of base section and a compatible top section. All aluminium sections shall be powder coated as per detailed schedule of finishes. All the edges of polycarbonate sheets shall be closed with suitable side tape and suitable aluminium sections.
	The clamping shall have provision for EPDM rubber gasketing for water sealing however silicon sealant shall be used for sealing intersectional joints if any and other vulnerable joints wherever required etc. for all heights and at all levels complete all as directed by Department. Rate to include supply and fixing necessary self tapping screws, weather cap, filling joints with silicon sealant, aluminium section for joining sheets, EPDM gasket scaffolding etc. With 4mm thick compact poly carbonate sheet of with a UV protections on both sides approved size & shape Location: Ducts/ Light wells in the terrace/roof as indicted in the drawings
	Note: Rate shall include, the cost of MS frame Work, polycarbonate sheet, labor, scaffolding above Ground level. In all shades, colours and all shapes including curved/architectural design.
10.8	Water proof cement plastering of thickness as specified below in cement mortar 1:3 (1 cement : 3 fine aggregate mixed with approved water

	proofing compound such as CICO or ACCOPROOF or equivalent as per manufacturers specifications including scaffolding, curing, etc; complete for INTERNAL/EXTERNAL SURFACES all as per specifications at all heights - For roof slab & cable trench/ Water tank slab etc)- 15mm thick

11. PLASTERING WORKS

Technical Specification for Finishing works- External Plastering and Internal plastering	
	Cement Mortar mix ratio is cement: Fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS 1542-1992,2003))
	Internal Plastering
11.1	Plastering 12mm/15mm thick with cement mortar specified below, finished smooth including scaffolding, curing, etc.; complete for INTERNAL SURFACES of walls, beam, ribs, sills, jambs, ceiling, etc; complete all as per specifications at all heights Mix specified is for cement : Fine aggregate)
	a)12 mm cement plaster of mix : 1:5 (1 cement : 5. fine aggregate) at all heights for wall surfaces
	b) 12 mm cement plaster of mix : 1:4(1 cement : 4. fine aggregate) at all heights for RCC surfaces
	c) 15 mm cement plaster of mix: 1:5 (1 cement : 5 . fine aggregate) at all heights for wall surfaces
11.2	External Plastering
	Sand faced cement plastering 20mm thick FOR EXTERNAL SURFACES comprising of a base layer of 13mm thick in cement mortar 1:5 (1 cement : 5 Fine aggregate) and a top layer of 7mm thick in cement mortar 1:3 (1 cement : 3 Fine aggregate) finished rough with proper rounder grains by using sponge including scaffolding, curing, etc; complete all as per specifications at all heights and all Depths Mix specified is for cement : Fine aggregate)

11.3	Plastering 12mm thick with cement mortar specified below finished rough including scaffolding, curing, etc; complete for EXTERNAL SURFACES of walls, inclusive of sills, jambs, soffits, etc; complete all as per specifications at all heights and all Depths Mix specified is for cement : Fine aggregate)
	a) 12 mm cement plaster of mix : 1:4 (1 cement : 4 . fine aggregate)

12. PAINTING WORKS

Technical Specification for Finishing works- External Painting and Internal Painting	
	Internal Painting
12.1	Painting internal plastered surfaces with two or more coats of Premium quality 100% acrylic emulsion paint of approved brand and colour as specified below (Berger/ Dulux/ Asian or equivalent) to give an even shade with required finish over a coat of interior acrylic primer and a layer of putty (of approved make) for smooth finish including cleaning the surfaces filling the crevices with approved filler, putty for whole surface for unevenness, sand papering, scaffolding, curing, etc., complete all as per specifications at all heights. The paint series shall be of premium quality (Velvet Touch series of Dulux or Silk Luxury of Berger/ or Royale shine of Asian or equivalent)
12.2	Painting Wood work with TWO or more coats of SYNTHETIC ENAMEL PAINT of I quality and approved colour to give an even shade over a coat of zinc chromate primer including cleaning the surfaces, applying a coat of approved putty on whole surface and rubbing the surface to achieve desired smooth surface, scaffolding, etc.; complete all as per specifications (Rate to include cost of zinc chromate primer, putty also).
12.3	French spirit polishing TWO or more coats including a coat of wood filler and Shellac at 0.245kg/10sqm on new work etc.; complete all as per specifications. (Rate to include cost of wood filler, pigment, woollen cloth, putty, sand paper, linseed oil, cotton, etc.).

	External painting
12.4	Providing and applying WATERPROOFING COATING for external walls as a part of painting system of approved make and colour of Berger/ Asian/ DULUX WEATHERSHIELD WATERPROOF or equivalent having protection against water ingress, caress cracks etc., to receive top coat of emulsion paint all as directed by EIC at all heights. The waterproof coating shall have water absorption value < 200 ml/sqm/24 hrs and elongation at break: 350%. Procedure for application: • Apply one coat of Alkali Bloc primer (dilution 1:1) • Apply one coat of weathershield waterproof coating by roller or by brush (No dilution) • Apply 2 coats of weathershield Max exterior emulsion (20% dilution max) Alkali bloc primer and 2 coats weathershield max exterior emulsion is included in the same item.
	All Shade/ colour/ Locations shall be followed as per the Architectural drawings.
12.5	Painting external plastered surfaces with two or more coats of TEXTURED EXTERIOR paint Berger paint Ruf &Tuf Decora Dholpur stone finish or its equivalent make of approved colour and shade over a coat of exterior cement primer including cleaning the surfaces, filling the crevices with approved filler/ exterior wall putty, necessary scaffolding etc., complete all as per specifications. (Minimum quantity of paint for new works - cement primer 2.20 ltr/10sqm and textured emulsion paint 3.28 ltr/10sqm for two or more coats at all heights- Rate shall include providing texture pattern& painting
	Note: All Shade/ colour/ Pattern/ Locations shall be followed as per the Architectural elevation drawings.

12.6	Forming Horizontal /vertical/slating groove of uniform size from 20X6 mm in plastered surface as per approved pattern using wooden battens, nailed to the under layer including removal of wooden battens, repairs to the edges of plaster panel and finishing the groove complete as per specifications at all heights and direction of the Engineer-in Charge. • Work shall be carried out as per detailed specification indicated in the Tender document. • Pattern/ Locations/ Length shall be followed as per the Architectural Elevation drawings.
	Note: All the painting works shall be carried out as per the Specifications for Civil Engineering works and Architectural drawings. No Extra payment will be admissible for change of shade/ pattern.

13. FENCING WORKS

	Technical Specification for fencing work
13.1	a) Supplying and fixing chain link fencing to RCC posts using G.I chain link fencing tied to the post with 6mm MS rod using GI binding wire including providing 10G. GI wire horizontally at top and bottom, cost of all materials required for the work, etc; all as directed by the Engineer-in-charge.
	b) Using G.I CHAIN LINK FENCING of size 50x50x10gx10g.

14. SPECIAL ITEMS

Technical Specification for Special items and other miscellaneous works.	
14.1	Providing and Fixing 15mm thick densified regular edged eco-friendly light weight CALCIUM SILICATE FALSE CEILING tiles of approved texture Spintone / Cosmos / Hexa or equivalent of size 595 x 595mm in

true horizontal level, suspended on inter locking metal grid of hot dipped galvanized steel sections (galvanizing @ 120 grams per sqm including both side) consisting of main 'T' runner suitably spaced at joints to get required length and of size 24x38mm made from 0.33mm thick (minimum) sheet, spaced 1200mm centre to centre, and cross 'T' of size 24x28mm made out of 0.33mm (minimum) sheet, 1200mm long spaced between main 'T' at 600mm centre to centre to form a grid of 1200x600mm and secondary cross 'T' of length 600mm and size 24 x28mm made of 0.33mm thick (minimum) sheet to be inter locked at middle of the 1200x600mm panel to form grid of size 600x600mm, resting on periphery walls / partitions on a perimeter wall angle pre-coated steel of size (24x24x3000mm) made of 0.40mm thick (minimum) sheet with the help of rawl plugs at 450mm centre to centre with 25mm long dry wall screws @ 230mm interval and laying 15mm thick densified edges calcium silicate ceiling tiles of approved texture (Spintone / Cosmos / Hexa or equivalent) in the grid, including, cutting/ making opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc., wherever required Main 'T' runners to be suspended from ceiling using G.I. slotted cleats of size 25x35x1.6mm fixed to ceiling with 12.5mm dia and 50mm long dash fasteners, 4mm G.I. adjustable rods with galvanised steel level clips of size 85 x 30 x 0.8mm, spaced at 1200mm centre to centre along main 'T', bottom exposed with 24mm of all T-sections shall be pre-painted with polyester baked paint, for all heights, as per specifications, drawings and as directed by Department. NOTE: Only calcium silicate false ceiling area will be measured from wall to wall. No deduction shall be made for exposed frames/opening (cut outs) having area less than 0.30sqm. The calcium silicate ceiling tile shall have NRC value of 0.50 (Minimum), light reflection > 85%, non - combustible as per B.S. 476 part IV, 100% humidity resistance and also having thermal conductivity <0.043W/m °KC. (Rate to include cost of all materials, including frame work and calcium silicate boards.)

Note: Work shall be carried out as per specifications for Civil Engineering Division and or specified in the Tender document. Rate shall include

	painting of False ceiling for the exposed area. Work shall be carried out as per the Architectural drawing or pattern indicated.
14.2	Providing and fixing False ceiling manufactured by M/S DG False flooring & Technologies Pvt Ltd or Chanakya Technologies or equivalent with false ceiling grid of 600mmx 600mm ceiling tiles mentioned below, Grid made of Aluminum Commercial anodized bulb T section of main T 38mm x 25mm x 1.1mm and suspended with 6mm GI Rod with J hook level adjuster, with Cross T to be placed at 1200mm Centre to centre. The crossT 1200mm length of size 25mm x 25mm x 1.1mm shall be reverted into main T at every 1200mm centre to centre. The sub cross T of 600mm length of size 25mm x 25mm x 1.1mm shall be reverted into cross T at 600mm centre to centre. All joints will be reverted with Aluminum cleat of 25mm x 25mm x 1.1mm and wall angle will be of 25mm x 25mm x 1.1mm Aluminum L angle duly commercial anodized. Detailed Specification: 1. The wall angles will be fixed to wall by means of screws and rowel plug. 2. The entire work shall be executed to true line and level in professional way / good workmanship. "Frame work and tiles shall be cut and modified to accommodate light fittings air conditioning diffusers / grills whenever required without any extra cost. 3. The ceiling grid work system shall be suspended from the soffit of RCC ceiling using 6mm GI hanger rods to be fixed to the RCC slab using anchor fasteners of 8mm dia of approved type and make at 1.2 m c/c or closer spacing in both directions as per site condition. 4. The Perimeter channels are to be leveled at the required position of the finished ceiling line and fixed to the wall at 610 mm c/ c with the screws and nylon plugs. 5. The line and level of the grid work has to be checked for perfection, proper fixing arrangement between grid work and RCC slab and prior clearance of the grid work has to be obtained from the Engineer-in-charge before the placement of false ceiling tiles. 6. The rate shall include providing all materials, erecting, suspending, grid work, jointing, providing required cutouts and openable doors and all other activities related to the completion of the above job. 7. Measurements will be made on flat plan area basis in Sq.m

	and No deduction shall be made for cutouts made for A.C. grills, diffusers, electrical fittings, smoke detectors etc. DG COM CEIL 595 x 595 x 7.5mm thick with SQM 1,180.65 galvanised steel with white pre coated plain tile with exposed grid
14.3	Providing and fixing GI hexagonal chicken wire mesh of size 12mm x22g at the junction of dissimilar surfaces of brick masonry wall and R C C column by beams and the like including necessary nails for fixing etc, complete all as per specification and direction of Engineer - in -charge for all floor at all heights Note: Chicken mesh shall be provided for a width not less than 150mm for the junctions of dissimilar materials. Item shall be got approved from Engineer in charge before usage in the work. Theoretical consumptions of chicken mesh materials shall be procured and kept at site office. Clearance of Engineer In charge / Site Engineer shall be obtained before covering or concealing.
14.4	Providing and fixing of Armstrong Prima Adria Microlook Edge Mineral Fibre Ceiling Tile in true horizontal level false ceiling grid manufactured by M/s. Armstrong World Industries or equivalent using hot dipped galvanized steel section exposed surface chemically cleaned capping prefinished in baked polyester paint, Armstrong main tee size 30x15mm every 1200mm c/c maximum and rotary stitched 1200mm Armstrong cross tee at every 600mm c/c and 600mm Armstrong cross tee at every 1200mm c/c maximum and Armstrong wall angle around the wall to form grid size of 600x600mm and suspending the grid using 2mm pre straightened GI rod / wire and 8mm dia anchor fasteners at every 1200mm intervals at the main tee and laying Armstrong Prima Adria Microlook Edge Mineral Fibre Ceiling Tiles of size 600mm x 600mm x 15mm over the formed grid, including providing necessary openings and additional framework required for light fittings, etc., manufactured by Armstrong World Industries having fire rating of 60 minutes as per BS 476/23 of 1987, light reflection of >85%, Noice

	Reduction Co-efficient (NRC) of 0.50, Sound attenuation of 32db, $k=0.052 - 0.067 \text{ W/m K}$, weight of 4.0kg/sqm and Humidity Resistance of 95%. The work shall be executed as per the manufacturer's specifications and direction of
14.5	Supply, fabrication and fixing of 1.05m high SS-316 grade handrail for staircase using 30mmx30mm stainless steel hollow square box for vertical balusters 50mm outer dia of stainless steel hollow tube for top handrail fixed over 20mm dia SS Hollow tube including providing 25 mm dia hollow tube stainless steel on either side of balusters at mid height of balusters parallel to handrail and fixing 40mmx6mm SS plate at the side of step including cutting the section to required length, welding, grinding etc., all as per specification, drawings and directions of Engineer in charge. at all heights of SS Handrail. (SS 316L : Material specification shall meet AISI SS 316L; Test reference: ASTM E1086-08)- Stair case & Balconies(Hand rails) The work shall be carried out as per the specification indicated above. The height, fixing arrangement, pattern and location shall be as per the structural & Architectural drawings.
14.6	Providing and laying light duty Non-pressure NP-2 Class R.C.C Hume pipes with collars jointed with stiff mixture of C.M. 1:2 (1 cement:2 fine aggregate) including joints, etc; complete: For 300mm dia, Locations at Electrical panel rooms/ lift & as indicated in the Architectural/ Structural drawings.
	Note: For all wardrobes, cupboards, showcase shutters, kitchen shutters etc., rates shall include all necessary fixing arrangement, hinges, handles, tower bolts, locking arrangements, painting, joineries etc., as per Standard Engineering practice.
	Any variation from above as per site requirement or as per norms, shall be provided without cost adjustment.
14.7	Providing & fixing of Luxalon ® Metal Tile Ceiling system manufactured by M/s.Hunter Douglas India Pvt. Ltd. or equivalent, comprising of Tile

	of size as specified below manufactured out of 0.7mm thick Aluminum Alloy 3105. The Tile will be manufactured on advanced equipment that includes several levelling stages in the manufacturing process. Tile ends will be raised with pips and stops to ensure positive engagement into the spring to enable for demounting of individual panels. The Tile sides will be sufficiently high to ensure a minimum deflection across the length of Tile.
	All Tiles will be level edged. The Tile shall be Polyester based, powder coated in white colour. The Tile shall be clipped into clip in profile of 0.5mm thick G.I. The clip in profile shall be supported from slab by means of rigid suspension of 4mm G.I. Rod, Hold on clamp with clip. The work includes providing necessary openings and additional framework required for light and AC fittings including Provision for upturn as pelmet at ends along walls for return air in the .false ceiling complete all as per the manufacturers specifications at all heights a) Tile size of 600mm x 600mm / 600mmx1200mm
14.8	Extra for openable side / top hung VISION GLASS PANELS (IGUs) including providing and supplying at site all accessories and hardwares for the openable panels as specified and of the approved make such as heavy duty stainless steel friction hinges, min 4 - point cremone locking sets with stainless steel plates, handles, buffers etc. including necessary stainless steel screws/ fasteners, nuts, bolts, washers etc. all complete as per the Architectural drawings, as per the approved shop drawings, as specified and as directed by the Department.
14.9	Supply and installation of under deck thermal insulation with Polyisocynurate foam fine aggregate (Crushed stone sand produced by crushed hard stone/rock as per IS 383-2016) wiced between Alumium foil/kraft paper of thickness as mentioned below. The insulation material shall have thermal conductivity of 0.018-0.021W/m.K at mean temperature of 20 deg. C and density 45 ± 3 Kg/m ³ . The fire propogation property shall confirm to calss O, according to BS 476 part 6 & part 7 and shall be free from CFC and HCFC. Panel shall have a width of 1200 ± 10

	mm and length as required as per site conditions. Installation of the panels shall be carried out using reinforced GI washer of length 65mm used 1100mm at intermediate intervals and 300mm at corners from edges to fix to the ceiling with screw of self thread type anti corrosive and finishing the edges of the boards with joint paper complete with all the accessories and finishing as per site conditions Complete all as per direction of EIC and at all heights a) 30mm thick (minimum) panel with 80micron Aluminium foil embossed on both sides
14.10	Providing and fixing GRC (Glass fibre Reinforced Cement Concrete) Jali/Screens in approved size, pattern, design shade and thickness of 30 to 35 mm and having minimum of 50% voids. The GRC jali shall be made from '53 grade' White Portland Cement manufactured by 'JK Cement' or equivalent, Fine graded Quartz & Silica Sand, Alkali Resistant Glass Fiber manufactured by 'N.E.G JAPAN' or equivalent, Super Plasticizers manufactured by 'ZPXRC' or equivalent, Polymers manufactured by 'Dow Chemicals' or equivalent and U.V resistant Synthetic inorganic pigments should be used for pigmentation manufactured by Lanxess / 'BAYFERROX (Germany)' or equivalent. The material casting should take place in FRP Molds. The GRC Jali flexural strength average L.O.P shall be above or equivalent to 6 N/mm² & M.O.P should be above or equivalent to 15 N/mm² for tests done on 28 days cured samples. The dry density, water absorption, Compressive strength and tensile strength of GRC jali/Screens shall be 1800 to 2000 kg/Cum, less than 8% of dry weight by immersion over a period of 24 hours, M - 40 Grade concrete mix design With compressive strength of 400 kg/cm² (in 28 days cube testing) and 4-7 MPa respectively. The rate shall include labour charges for fixing the GRC jali to M S frame work by using M.S Galvanized Clamps, fixtures and fasteners of Hilti / Fischer or self - tapping screws or as per approved shop drawings approved by site engineer in charge.

etc., cleaning and making the surface good for painting, complete all as directed by Engineer- In-Charge. Cost include M S frame work to which the Jali/Screens fixed also.

1.6.26 GUIDELINES FOR QUALITY ASSURANCE OF CIVIL WORKS

A. CONDITIONS FOR CEMENT TO BE PROCURED AND SUPPLIED IN THE WORK BY THE CONTRACTOR

Note: Portland Pozzolana Cement confirming to IS:1489 shall be used for this work unless otherwise specially mentioned.

Note: The entire quantity of Cement required for the work shall be procured by the Contractor.

CONDITION FOR CEMENT:

1. The contractor shall procure only **Portland Pozzolana Cement** conforming to **IS : 1489 (Part 1 & 2)** from reputed manufacturer's of cement such as Zuari, ACC, L&T, Priya, Rajashree, Grasim, J.P.Rew Vikram, Shree Cement, DALMIA, PENNA Birla Jute & Cement Corporation of India as approved by Ministry of Industry, Government of India and holding licence to use ISI certification mark for their product whose name shall be got approved from Engineer-In-Charge. Supply of cement shall be taken in 50 Kg bags bearing manufacturer's name and ISI marking. Samples of cement arranged by the contractor shall be taken by the Engineer-In-Charge and got tested in accordance with provisions of relevant BIS codes. In case test results indicate that the cement arranged by contractor does not conform to the relevant BIS codes, the same shall stand rejected and shall be removed from the site by the contractor at his own cost within a week's time of written order from the Engineer-In-Charge to do so. As far as possible only one brand of cement shall be allowed for procurement especially in case of exposed form finish work.
2. The cement shall be brought at site in bulk supply of approximately 50 tonnes or as decided by the Engineer-In-Charge.
3. The cement godown of the capacity to store a minimum of 2000 bags of cement shall be constructed by the contractor at site of work for which no extra payment

shall be made. Double lock provision shall be made to the door of the cement godown. The keys of one lock shall remain with the Engineer-In-Charge or his authorized representative and the key of the other lock shall remain with the contractor. The contractor shall be responsible for the watch and ward and safety of the cement godown. The contractor shall facilitate the inspection of the cement godown by the Engineer-In-Charge at any time.

4. The contractor shall supply free of charge the cement required for testing. The cost of tests shall be borne by the Department / contractor in the manner indicated below.
 - i) By the contractor if the results show that the cement does not conform to relevant BIS codes.
 - ii) By the Department, if the results show that the cement conforms to relevant BIS codes.

However, the charges for initial test done along with each consignment shall be borne by the contractor.

5. The actual issue and consumption of cement on work shall be regulated and proper accounts maintained. The theoretical consumption of cement shall be worked out as per procedure prescribed in clause 41 of the conditions of the contract.
6. Cement brought to site and cement remaining unused after completion of work shall not be removed from site without permission of the Engineer-In-Charge.

7. CONTROL REGISTER

As and when the consignments of cement are brought to site by the contractor, they shall inform the Engineer-In-Charge or his authorized representative to verify the quantities received and maintain a Control Register showing the lorry receipt no. in which the consignment is received and the date of receipt to enable the Engineer-In-Charge to verify the consumption as per contract conditions. The register shall be signed by the Contractor and the Engineer-In-Charge.

Bidder shall confirm that the above conditions are gone through in detail and agreed.

B. CONDITIONS FOR STEEL TO BE PROCURED AND SUPPLIED IN THE WORK BY THE CONTRACTOR

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Note: The entire quantity of Steel required for the work shall be procured by the Contractor.

CONDITION FOR STEEL:

1. The contractor shall procure steel reinforcement bars (HYSD bars Fe 500D) conforming to relevant BIS codes from main producers/manufacturers such as SAIL, RINL-VIZAG, TATA, JSW STEEL, Kamachi Industries Ltd, TMT Bars or equivalent. Samples from each consignment shall be taken and got tested by the Engineer in charge as per the provisions in this regard in relevant BIS codes. In case the test results indicate that the steel arranged by the contractor does not conform to BIS codes, the same stand rejected and shall be removed from the site of work by the contractor at his cost within a week's time from written orders of the Engineer-in-charge to do so.
2. The steel reinforcement shall be brought to the site as required for the work. The contractor shall procure steel bars in full length. They shall not bring old, rusted/corroded steel bars to site. As regards stacking of MS rounds, HYSD bars etc., the relevant BIS codes should be invariably followed.
3. The steel reinforcement shall be stored by the contractor at site of work in such a way so as to prevent distortion and corrosion. No extra shall be paid on this account. Bars of different sizes & lengths shall be stored separately to facilitate easy counting & checking.
4. For checking nominal mass. Testing for tensile strength, bend test, re-bend test etc, specimen of sufficient length shall be cut from each size of the bar at random at frequency as mentioned below from each consignment for all diameters separately.

Size of bar	For consignment below 100 tonnes	For consignment over 100 tonnes
Below 10 mm dia	One sample for each 25 tonnes or part thereof	One sample for each 40 tonnes or part thereof
10 mm to 16 mm dia	One sample for each 35 tonnes or part thereof	One sample for each 45 tonnes or part thereof
Over 16 mm dia	One sample for each 45 tonnes or part thereof	One sample for each 50 tonnes or part thereof

5. The contractor shall supply free of charge the steel required for testing. The cost of tests shall be borne by the contractor/Department in the manner indicated below:-

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- i) By the contractor, if the results show that the steel does not conform to relevant BIS codes.
- ii) By the Department, if the results show that the steel conforms to relevant BIS codes.

However the charges for initial test of each diameter of bar under every consignment shall be borne by the contractor.

6. The actual issue & consumption of steel on work shall be regulated & proper accounts maintained by. The theoretical consumption of steel shall be worked out as per procedure prescribed in clause 41 of the conditions of the contractor.
7. Steel brought to site and steel remaining unused shall not be removed from site without the written permission of the Engineer in charge.
8. **CONTROL REGISTER**

As and when the consignments of steel are brought to site by the contractor, they shall inform the Engineer in charge or his authorized representative to verify the quantities received and maintain a Control Register showing the lorry receipt no in which the consignment is received and the date of receipt to enable the Engineer in charge to verify the consumption as per contract conditions. The register shall be signed by the contractor and the Engineer in charge.

Bidder shall confirm that the above conditions are gone through in detail and agreed.

C. USAGE OF PPC / BLENDED CEMENTS – GUIDELINES

- (1) The quantity of Cement used on the work shall be as per theoretical requirement. If the consumption of cement is less than the theoretical requirement the difference in quantity of cement will be recovered at double the market rate.
- (2) Deshuttering /stripping of form work shall be observed as follows based on the type of cement used.

No	Structural Member	PPC
a)	Vertical form work to columns, walls, beams.	16-24 h
b)	Soffit form work to slabs (props to be refixed immediately after removal of form work)	7 days
c)	Soffit form work to beams (props to be refixed immediately after removal of form work)	10 days

d)	Props to slabs 1) Spanning upto 4.5m 2) Spanning over 4.5m	10 days 14 days
e)	Props to be beams and Arches 1) Spanning upto 6m 2) Spanning over 6m	14 days 21 days

(3) Curing shall be observed for a minimum period of 14 days.

D. QUALITY ASSURANCE

- To ensure quality of construction, the bidder shall ensure inspection and testing of all materials and works at his own cost conforming to specifications.
- All certificates and guarantees obtained by the bidder from different suppliers of materials, sub-bidders doing part job, manufacturers of doors, windows etc. shall be passed on to the purchaser.
- All defective materials / works which do not conform to the specifications shall be rejected / dismantled and removed from site by the Bidder at his own cost.
- The Bidder shall provide a **SITE LABORATORY** with equipment all as directed by EIC and shall maintain and engage qualified technical personnel at site to run the laboratory at his own cost. All routine tests of cement, aggregates, sand, bricks, concrete cubes, etc. shall be conducted at site, and equipment required for accelerated concrete cube test should also be provided in the laboratory for predicting the strength of concrete early.
- For those tests which are not possible to be carried out at site laboratory, Bidder shall arrange to send requisite samples to ISRO approved laboratory outside the site and get those tested as required entirely at his cost.
- Before starting any concreting or erection work at site, the stage passing certificates have to be obtained from the engineer in the formats prepared after mutual discussion and agreement.
- As-built survey details marking location of all bolts and inserts shall be submitted by the Bidder so as to enable further structural/equipment erection without any loss of time.
- Before covering up any work within excavated pits, clearance has to be taken from engineer in respect of completion of said works as per drawing and specification.

E. GENERAL

Material and work specifications shall conform to contract specification, CED specification, relevant IS Codes, CPWD specification and other relevant standard codes of practice.

F. DUTIES AND RESPONSIBILITIES OF QUALITY ASSURANCE

The broad responsibilities as part of Quality Assurance Activities shall be :-

- Receiving and studying of all the documents/ drawings related to the Project and quality matters.
- Forwarding the necessary documents/ reports to the Department as per Contract.
- Communicating with all concerned about quality requirement of the Project.
- Taking necessary action for material testing, maintaining quality records, calibration of test equipment etc.
- Arranging for inspection both on-site and off-site by the Department wherever required.
- Analyzing the progress and adopting suitable corrective measures, if needed.
- Co-ordination with other Contractors at sites as well as various offices.
- To maintain records.
- To organize procurement of materials as per the sequence of works/ as per direction of Engineer-in-charge.
- Adhering of statutory provision and safety aspects.

G. QUALITY PLANNING

To assure the desired quality of output, planning and control points have meticulously been formulated in this document keeping in mind the following objectives :-

- To establish quality control laboratory at site.
- To identify and acquisition of Plant and Equipment to facilitate quality construction smoothly.
- To devise formats to be followed on routine basis for stage checking of materials, erection of reinforcement, inserts, bolts, dimensions, and locations etc., before starting of any construction work.
- To identify the item/ material and conduct test at on-site as well as off-site approved laboratories for its acceptability as per specification.
- To establish procedures for control of all drawings, specifications and tender documents to ensure the usability of right and latest drawings/ documents by the concerned.
- To maintain all records pertaining to quality for all the work performed.

- To maintain records of all site changes.

H. DOCUMENT AND DATA CONTROL

All the documents, drawings and specification will be maintained at site. All these documents will be summarized and organized in a manner so that the record is maintained accurately and all the changes are taken note of during the construction.

The issuance of documents such as drawings, specifications and instruction procedure including changes to such documents will refer to the following documents: -

- Project drawings listed in the drawing list.
- Construction Specifications.
- Engineering Standards.

Drawings list will be maintained at site and shall be updated on receipt of revised and / or additional drawings. Superseded copies of drawings and specifications will be clearly marked and stored separately.

I. MATERIAL:

Materials shall be procured as per specification given in the contract documents. Tests shall be carried out for the materials as per frequency given in Technical specifications, CED specification, relevant IS codes, CPWD specification & other relevant code of practice and/or as summarized in this document.

Test record shall be maintained as per formats given in the contract documents. Record shall be maintained for Manufacturer test certificate with quantity of procurement in each lot date wise.

J. STORAGE:

Storage of all materials shall be as per relevant CED specification, IS codes, CPWD specification and other relevant standard codes of practice.

Cement, wooden material, fitting and fixtures shall be kept in store as per standard practice and store record shall be maintained for arrival & consumption of store material. Various bulk material like brick, sand, stone chips, reinforcement, pipes & pipe fittings etc. shall be kept in stacks.

K. APPROVAL AND INSPECTION:

Approval of Engineer-in-charge shall be obtained before procurement of any material.

L. CONTROL OF QUALITY RECORDS

The following quality records will be maintained at project office, under different file head.

- Master list of all construction drawings/ documents.
- Minutes of meeting on site activities, progress of work, changes / modification etc.
- Test records/ certificates for all construction materials, and approvals from the Client.
- Calibration records for inspection, measuring and test equipment.
- Reporting of Progress.
- Logging of non-conformities.
- Accident reports.
- Extra work at site.
- Work Completion Certification.
- Sketches for modifications carried out at site.

1.6.27 SPECIFICATION FOR SOME SPECIALISED ITEMS/WORKS:

READY MIXED CONCRETE (as per IS 4926)

MATERIALS

Selection and Approval of Materials : Materials used should satisfy the requirements for the safety, structural performance durability and appearance of the finished structure, taking full account of the environment to which it will be subjected. The selection and use of materials shall be in accordance with IS 456. Materials used shall conform to the relevant Indian Standards applicable. Where materials are used which are not covered by the provisions of the relevant Indian Standard, there should be satisfactory data on their suitability and assurance of quality control. Records and details of performance of such materials should be maintained. Account should be taken of possible interactions and compatibility between IS 4926 and materials used. Also, prior permission of the purchaser shall be obtained before use of such materials.

Cement: Cement used for concrete shall be in accordance with the requirements of IS 456.

Mineral Admixtures: Use of mineral admixtures shall be permitted in accordance with the provisions of IS 456.

Aggregates: Aggregates used for concrete shall be in accordance with the requirement of IS 456. Unless otherwise agreed testing frequencies for aggregates in plant shall be as given IS 4926.

CHEMICAL ADMIXTURES

- Use of chemical admixtures shall be permitted in accordance, with the provisions of IS 456 and IS 9103.
- It shall be the responsibility of the producer to establish compatibility and suitability of any admixture with the other ingredients of the mix and the determine the dosage required to give the desired effect.
- Admixtures should be stored in a manner that prevents degradation of the product and consumed within the time period indicated by the admixture supplier. Any vessel containing an admixture in the plant or taken to site by the producer shall be clearly marked as to its content.
- When offering or delivering a mix to a purchaser it should be indicated if such a mix contains an admixture or combination of admixtures or not. The admixtures may be identified generically and should be declared on the delivery ticket.
- The amount of admixture added to mix shall be recorded in the production record. In special circumstances, if necessary, additional dose of admixture may be added at project site to regain the workability of concrete with the mutual agreement between the producer and the purchaser.

WATER:

- Water used shall be in accordance with the requirement of IS 456. Unless otherwise agreed, the testing frequencies for water shall be as given in Annex A.
- The use of re-cycled water is encouraged as long as concrete of satisfactory performance can be produced and steps are taken to monitor the build up of chlorides in any recirculated water and that any subsequent adjustments to the mix design are made to ensure that any overall limit on chloride contents

is satisfied. The addition of any recycled water shall be monitored and controlled to meet these requirements.

- The total amount of water added to the mix shall be recorded in the production record. The water content of concrete shall be regulated by controlling its workability or by measuring and adjusting the moisture contents of its constituent materials. The producer's production staff and truck-mixer, drivers shall be made aware of the appropriate responses to variations in concrete consistency of a particular mix caused by normal variations in aggregate moisture content or grading.

GENERAL REQUIREMENTS

Basis of Supply: Ready-mixed concrete shall be supplied having the quality and the quantity in accordance with the requirement agreed with the purchaser or his agent. Notwithstanding this, the concrete supplied shall generally comply with requirements of IS 456.

All concrete will be supplied and invoiced in terms of cubic metres (full or part) of compacted fresh concrete. All proportioning is to be carried out by mass except water and admixture, which may be measured by volume.

Transport of Concrete: Ready-mixed concrete shall be transported from the mixer to the point of placing as rapidly as practicable by methods that will maintain the required workability and will prevent segregation, loss of any constituents or ingress of foreign matter or water. The concrete shall be placed as soon as possible after delivery, as close as is practicable to its final position to avoid re-handling or moving the concrete horizontally by vibration. If required by the purchaser the producer can utilize admixtures to slow down the rate of workability loss, however this does not remove the need for the purchaser to place the concrete as rapidly as possible. The purchaser should plan his arrangements so as to enable a full load of concrete to be discharged within 30 minutes of arrival on site.

Concrete shall be transported in a truck-mixer unless the purchaser agrees to the use of no agitating vehicles. When non-agitating vehicles are used, the mixed concrete shall be protected from gain or loss of water.

Time in Transport: The general requirement is that concrete shall be discharged from the truck-mixer within 2 h of the time of loading. However, a longer period may be permitted if retarding admixtures are used or in cool humid weather or when chilled concrete is produced. The time of loading shall start from adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the wet aggregate whichever is applicable.

Ready-mixed concrete plant shall have test facilities at its premises to carry out routine tests as per the requirement of the standard.

Sampling and Testing of Ready-Mixed Concrete

Point and Time of Sampling: For the assessment of compliance of ready-mixed concrete, the point and time of sampling shall be at discharge from the producer's delivery vehicle or from the mixer to the site or when delivered into the purchaser's vehicle. It is critical that the sampling procedure and equipment used enables as representative a sample as possible to be taken of the quantity of concrete delivered (see Annex A).

The sampling may be carried out jointly by the purchaser and the supplier with its frequency mutually agreed upon. However, it will not absolve the supplier of his responsibility from supplying in concrete as per the requirement given in this standard or otherwise agreed to where so permitted in the standard.

Workability: The test for acceptance is to be performed upon the producer's delivery vehicle discharge on site or upon discharge into the purchaser's vehicle. If discharge from the producers' vehicle is delayed on site due to lack of preparedness on behalf of the purchaser then the responsibility passes to the purchaser after a delay of more than 30 min.

The workability shall be within the following limits on the specified value as appropriate:

Slump ± 25 mm or $1/3$ of the specified value, whichever is less.

Compacting factor : ± 0.03 , where the specified value is 0.90 or greater,
 ± 0.04 , where the specified value is less than 0.90 but more than 0.80,

± 0.05 , where the specified value is 0.80 or less.

Flow table test may be specified for concrete, for very high workability (see IS 9103) Acceptance criteria for spread (flow) are to be established between the supplier and the purchaser.

Specified Strength

- Compliance shall be assessed against the requirements of IS 456 or other agreed Indian Standard. The purchaser may perform his sampling and testing or may enter into an arrangement with the producer to provide his testing requirements.
- Unless otherwise agreed between the parties involved, the minimum testing frequency to be applied by the producer in the absence of a recognized ready- mixed concrete industry method of production control should be one sample for every 50 m³ of production or every 50 batches, whichever is the greater frequency. Three test specimens shall be made up for each sample for testing at 28 days (see also IS 456).
- In order to get a relatively quicker idea of the quality of concrete, optional test on beams for modulus of rupture at 72 ± 2 h or at 7 days or compressive strength test at 7 days may be carried out in addition to 28 days compressive strength test. For this purpose, the value should be arrived at based on actual testing. In all cases 28 days compressive strength shall alone be the criteria for acceptance or rejection of the concrete.
- The purchaser shall inform the producer if his requirements for sampling and testing are higher than one sample every 50 m³ or 50 batches, whichever is the greater frequency.

Additional Compliance Criteria: Any additional compliance criteria shall be declared to the producer by the purchaser prior to supply and shall be mutually agreed upon in terms of definition, tolerance frequency of assessment, method of test and significance result.

Non-Compliance: The action to be taken in case of non-compliance shall be declared and mutually agreed upon.

INFORMATION TO BE SUPPLIED BY THE PURCHASER

The purchaser shall provide to the producer the details of the concrete mix or mixes required by him and all pertinent information on the use of the concrete and the specified requirements. Prior to supply taking place, it is recommended that a meeting is held between the purchaser and the producer. Its objective to clarify operational matters such as notice to be given prior to delivery, delivery rate, the name of the purchasers authorized representative who will coordinate deliveries, any requirements for additional services such as pumping, on site testing or training, etc.

Designed Mixes: Where the purchaser specifies a designed mix to be supplied it is essential that all relevant information is conveyed to the producer. In order to assist in this, the format given in Annex B may be completed and forwarded to the producer at the time of enquiry.

Prescribed Mixes: The concrete mix shall be specified by its constituent materials and the properties or quantities of those constituents to produce a concrete with the required performance. The assessment of the mix proportions shall form an essential part of the compliance requirements. The purchaser shall provide the producer with all pertinent information on the use of the concrete and the specified requirements. In order to assist in this, the format given in Annex B may be followed with suitable modifications as applicable to prescribed mixes.

INFORMATION TO BE SUPPLIED BY THE PRODUCER

When requested, the producer shall provide the purchaser with the following information before any concretes is supplied:

- (a) Nature and source of each constituent material,
- (b) Source of supply of cement,
- (c) Proposed proportions or quantity of each constituent/ m
- (d) Generic type(s) of the main active constituent(s) in the admixture; 3 of fresh concrete.

- (e) Whether or not the admixture contains chlorides and if so, the chloride content of the admixture expressed as a percentage of chloride ion by mass of admixture;
- (f) Where more than one admixture is used, confirmation of their compatibility and
- (g) Initial and final setting time of concrete when admixture is used at adopted dosage (tested as per IS 8142).

PRODUCTION AND DELIVERY

MATERIALS STORAGE AND HANDLING

- (i) **Cement:** Separate storage for Different types and grades of cement shall be provided. Containers may be used to store cement of different types provided these are emptied before loading new cement. Bins or silos shall be weatherproof and permit free flow and efficient discharge of the cement. Each silo or compartment of a silo shall be completely separate and fitted with a filter or alternative method of dust control. Each filter or dust control system shall be of sufficient size to allow delivery of cement to be maintained at a specified pressure, and shall be properly maintained and prevent undue emission of cement dust and prevent interference with weighing accuracy by build up of pressure. Cement shall be stored and stacked in bags and shall be kept free from the possibility of any dampness or moisture coming in contact with them and where cement can be stored and retrieved without undue damage to the bags. The bags are to be protected from becoming damp either from the ground or the weather. The cement is to be used in the order it is delivered (see also IS 4082). In case, the cement remains in storage for more than 3 months, the cement shall be retested before use and shall be rejected, if it fails to conform to any of the requirements given in the relevant Indian Standard.
- (ii) **Dry Pulverized Fuel Ash and Other Mineral Admixtures:** Suitable separate arrangement for storage of pulverized fuel ash, silica fume, metakeolin, rice husk ash, ground granulated blast furnace slag such as for cement, shall be provided, in the plants utilizing these materials.

(iii) **Aggregates (Coarse and Fine):** Stockpiles shall be free draining and arranged to avoid contamination and to prevent intermingling with adjustment material. Handling procedures for loading and unloading aggregates shall be such as to reduce segregation to a minimum. Provision shall be made for separate storage for each nominal size and type of aggregate and the method of loading of storage bins shall be such as to prevent intermingling of different sizes and types. Fine aggregates shall be stacked in a place where loss due to the effect of wind is minimum (see also IS 4082 and IS 456).

(iv) **Water:** An adequate supply shall be provided and when stored on the plant such storage facilities shall be designed to minimize the risk of contamination.

(v) **Chemical Admixtures:** Tanks or drums containing liquid admixtures shall be clearly labeled for identification purposes and stored in such a way to avoid damage, contamination or the effects of prolonged exposure to sunlight (if applicable). Agitation shall be provided for liquid admixture, which are not stable solutions.

Batching Plants and Batching Equipment: Hoppers for weighing cement, mineral admixtures, aggregates and water and chemical admixture (if measured by mass) shall consist of suitable container freely suspended from a scale or other suitable load-measuring device and equipped with a suitable discharging mechanism. The method of control of the loading mechanism shall be such that, as the quantity required in the weighing hopper is approached the material may be added at controllable rate and shut off precisely within the weighing tolerances. The weighing hoppers for cement, mineral admixtures aggregate shall be capable of receiving their rated load, without the weighed material coming into contact with the loading mechanism. Where the rated capacity of a batching plant mixing cycle is less than 2.0 m^3 , additional precautions shall be taken to ensure that the correct number of batches are loaded into the truck mixer. The weighing hoppers shall be constructed so as to discharge efficiently

and prevent the build up of materials. A tare adjustment, up to 10 percent of the nominal capacity of the weigh scale, shall be provided on the weighing mechanism so that the scale can be adjusted to zero at least once each day. Dust seals shall be provided on cement hoppers between the loading mechanism and the weigh hopper, and shall be fitted so as to prevent the emission of cement dust and not affect weighing accuracy. The hopper shall be vented to permit escape of air without emission of cement dust. Vibrator or other attachment, where fitted, shall not affect the accuracy of weighing. There shall be sufficient protection to cement and aggregate weigh hoppers and weighing mechanisms to prevent interference with weighing accuracy by weather conditions or external build-up of materials.

Where chemical admixture dispensers are used, they shall be capable of measurement within the allowable tolerances and calibrated container or weigh scales shall be provided to check the accuracy of measurement at least once a month.

Where a continuous mixer with ribbon loading is used the batching procedure specified by the manufacture of the plant shall be followed. Each control on the batching console and weigh-dial or display shall be clearly labeled with its function and where concerned with the batching of materials, the materials type.

When more than one type or grade of cement is being used, the weighing device and discharge screw or other parts of the transfer system shall be empty before changing from one type of cement to another.

When more than one type or grade of cement is being used, the weighing device and discharge screw or other parts of the transfer system shall be empty before changing from one type of cement to another.

When pulverized fuel ash and other mineral admixtures are batched through the cement weigh system, the weighing device and discharge screw or other parts of the transfer system shall be empty when the weighing system has returned to zero reading or completed the batch.

Where a back weigh system is utilized to weigh materials a system shall be in place so as to prevent materials being loaded during the process of weighing.

Measurement of Materials: Cement and mineral admixture materials shall be measured by mass in a hopper or compartment separate from those used for other materials and on a scale of appropriate sensitivity, measurement being taken from a zero reading. Aggregates shall be measured by mass, allowance being made for the free moisture content of the aggregates. The added water shall be measured by volume or by mass. Any liquid chemical admixture (or paste) shall be measured by volume or by mass and any solid admixture by mass. When weighing materials any build up in the hopper during the day must be tared out or allowed for in the batch weights. After measurement all materials shall be discharged into the mixer without loss. The accuracy of the measuring equipment shall be within + 2 percent of the quantity of cement and mineral admixtures being measured and within + 3 percent of the quantity of aggregate, chemical admixture and water being measured. The plant operator shall be provided with a clear display of the quantities of materials to be batched for each mix and batch size with information identifying the display to be selected for each designed and prescribed mix to be produced. Analogue scale displays for the weighing of cement, mineral admixtures, aggregates and water shall be readily discernable from the operating position. For digital readouts the numerals shall be readily discernable from the operating position. Fully automatic production systems shall be fitted with control equipment to allow the correct operation of the plant to be monitored during weighing and batching. Automatic control systems on batching plants shall not commence batching until all hoppers have been emptied and /or tared and the scales zeroed unless such systems are designed to take account of build up in their programming.

All scales shall be tested and calibrated.

Mixing

- (i) *Washing Out Water:* Before loading concrete materials or mixed concrete into either a stationary mixer or truck mixer any water retained in the mixing drum for washing out purposes shall be completely discharged.
- (ii) *Stationary or Central Mixers :* Stationary mixers shall not be loaded in excess of the manufacturer's rated capacity. The mixing time shall be measured from the time all the materials required for the batch, including water, are in the drum of the mixer. The mixing time shall not be less than that recommended by the manufacturer. Where a continuous mixing plant is used, the complete mixing time shall be sufficient to ensure that the concrete is of the required uniformity.
- (iii) *Truck Mixers:* When a truck mixer is used for the partial or complete mixing of concrete, mixing shall be considered to commence from the moment when all the materials required for the batch, including water, are in the rotating drum of the mixer.

Truck or agitators shall not be loaded in excess of the manufacturer's rated capacity. In order to produce a satisfactory mix, and where there is no data available to establish different period and speed of revolutions, mixing shall continue for not less than 60 revolutions of the truck mixer drum at a rate of not less than 7 revolutions/min. All completely truck mixed concrete shall be visually inspected for uniformity prior to leaving the plant.

When a truck mixer or agitator is used for transporting concrete which has been mixed before leaving the plant, the concrete shall be agitated during transit and remixed at the site for at least 2 min so that the concrete is of the required uniformity.

Where water is added to the concrete in the truck mixer through the truck mixer water meter and when such water is being accounted for in the total water within the mix, it shall be ensured that the truck mixer water meter is in operational condition and properly calibrated. Where a water meter is not available, water must be measured in a suitable container before being added to the truck mixer.

- (iv) *Condition of Mixer:* Stationary and truck mixers shall be maintained in an efficient and clean condition with no appreciable build up of hardened concrete or cement in the mixing drum, on the mixing blades, or on the loading hopper or discharge chutes.

Delivery Ticket: Immediately before discharging the concrete at the point of delivery, the producer or his representative shall provide the purchaser with a preprinted delivery ticket for each delivery of concrete on which is printed, stamped or written the minimum information detailed invoicing.

Quality Control

Quality control of ready-mixed concrete may be divided into three components, forward control, immediate control and retrospective control.

Forward control: Forward control and consequent corrective action are essential aspects of quality control. Forward control includes the following.

- (i) Control of purchased material Quality
- (ii) Control of Materials storage
- (iii) Mix design and mix design modification
- (iv) *Transfer and Weighing Equipment:* The producer shall be able to demonstrate that a documented calibration procedure is in place. The use of elector-mechanical weighing and metering systems, that is, load cells, flow meters, magmeters, etc, is preferable over purely mechanical system, that is, knife edge and lever systems.
- (v) Plant mixers where present and truck mixers used shall be in an operational condition.

Immediate Control: Immediate control is concerned with instant action to control the quality of the concrete being produced or that of deliveries closely following. It includes the production control and product control.

- (i) *Production Control:* The production of concrete at each plant shall be systematically controlled. This is to ensure that all the concrete supplied shall be in accordance with these requirements and with the specifications that has formed the basis of the agreement between the producer and purchaser.

Each load of mixed concrete shall be inspected before dispatch and prior to discharge.

The workability of the concrete shall be controlled on a continuous basis during production and any corrective action necessary taken.

For each load, written, printed or graphical records shall be made of the mass of the materials batched, the estimated slump, the total amount of water added to the load, the delivery ticket number for that load, and the time the concrete was loaded into the truck.

Regular routine inspections shall be carried out on the condition of plant and equipment including delivery vehicles.

- (ii) *Product Control:* Concrete mixes shall be randomly sampled and tested for workability and where appropriate, plastic density, temperature and air content. Where significant variations from target values are detected, corrective action shall be taken.

It is important to maintain the water cement ratio constant at its correct value. The amount of added water shall be adjusted to compensate for any observed variations in the moisture contents in the aggregates. Suitable adjustments should also be made in masses of the aggregates due to this variation (see IS 456). Any change in water content due to change in aggregate grading shall be taken care of by forward control by suitable modifications to mix design.

Retrospective Control: Retrospective control is concerned with those factors that influence the control of production. Retrospective control may cover any property of materials or concrete, such as aggregate grading, slump, or air content, but is particularly associated with 28-day cube strength because by its very nature it is not property which can be measured ahead of, or at the time of, manufacture.

Mix Performance: The producer shall be responsible for ensuring that suitable control procedures are in place ensure the following.

- (i) *Design Mixes:* A quality control system shall be operated to control the strength of design mixes to the levels required as per IS 456 and shall be based on random tests of mixes which form the major proportion of production. The system shall include continuous analysis of results from cube tests to compare actual with target values together with procedures for modifying mix proportions to correct for observed differences. Compressive strength testing shall be carried out using a machine that meets the requirements of IS 14858.
- (ii) *Prescribed Mixes:* Periodic and systematic checks shall be made to ensure that the cementitious material contents of prescribed mixes comply with their mix descriptions.

Stock Control of Materials: The producer shall operate a materials stock control procedure to enable verification of total quantities used and to confirm that only approved materials have been received.

Complaints: The producer shall have a procedure in place to enable the diagnosis and correction of faults identified from complaints.

ORDER PROCESSING

A competent person to interpret the specified requirements and relate these to mix design criteria shall systematically review specification and orders supplied by the purchaser. These shall be formally recorded together with any modification to the specification resulting from subsequent agreed documentation to ensure that the plant operator is given the correct instructions for batching and mixing. When mixes or materials are offered as alternatives to requested mixes or where there is no specification supplied by the purchaser, orders whether received verbally or in writing, shall be agreed with the purchaser and the fact recorded. Alternatives to the mix description or compliance requirements in the purchaser's specification shall be clearly identified in the quotation.

RECORDS

Records shall be maintained by the producer to provide confirmation of the quality and quantity and quantity of concrete produced. The records shall be retained for the purposes of these requirements for a period of at least one year. They shall cover the following aspect:

- (a) Production and delivery:
 - (i) Batching instruction
 - (ii) Batching Records,
 - (iii) Delivery tickets, and
 - (iv) Equipment calibration and plant maintenance.
- (b) Materials and production control:
 - (i) Concrete production and materials purchase, usage and stocks, and
 - (ii) Certificates or test results for materials.
- (c) Production quality Control: Control test results.

GENERAL GUIDELINES FOR DESIGN MIX CONCRETE

1. Wherever DESIGN MIX concrete has been specified in the tender, the contractor will have to submit in advance to the Engineer-in-charge, the details of such concrete mix design (which shall be got carried out by contractor at his own expense from a Government Recognized Local Material Testing Laboratory in accordance with methods of Concrete Mix Design laid down by BIS). The theoretical cement consumption co-efficient for concrete of a particular grade shall be the consumption as indicated in the details of the mix design as approved by the Engineer-in-charge the relevant quantity of concrete as certified by the Engineer-in-charge which has actually been laid using the concerned approved proportions. The coefficient shall be revised as and when there is a change in the approved concrete mix proportion.
2. The proportions as per the design mix shall be allowed to be used only after written approval to the same by the Engineer-in-charge. The contractor shall ensure the mix proportions as per the approval accorded at site diligently and

scrupulously. No change in the concrete proportioning shall be made by contractor without written approval of EIC.

3. The contractor shall submit sample (consisting of quantity of material as directed by EIC) of the material(s) (like fine and coarse aggregates, water, admixtures etc) along with the details of concrete mix design. Contractor shall also submit along with mix design, the results of the tests conducted to ascertain the basic properties of materials on which the mix design is based.
4. Coarse clean sand (from approved source) confirming to relevant grading zone and clean, appropriate size well-graded, hard stone coarse aggregates from approved quarry shall be used for all concrete works. In case of non-availability of river sand, M-sand from approved quarry confirming to the relevant standards can be used.
5. During the course of execution of the work also the contractor shall abide by the IS guidelines in all respect for monitoring and testing of the properties of component materials like coarse & fine aggregates, water, cement & admixtures etc and also the concrete including for method of sampling, frequency of sampling method of testing and maintenance of test records etc. The acceptance criteria for design mix concrete as laid at site shall be that given in para16 of IS-456 (latest Edition).
6. Wherever there is any change in the basic properties of materials (including due to change in the source etc) adopted in the approved mix design, the contractor shall re-submit the mix design details as per the revised data for design. Revised design details shall be adopted only after approval from the Engineer-in-charge.
7. The contractor shall establish and maintain this expense, a System to the satisfaction of the EIC, for monitoring and testing of the properties of concrete and it's component materials. The contractor shall also maintain and up-date all necessary records in connection with monitoring and testing of the concrete and it's constituent materials as per the direction of the EIC. Values of the Standard Deviation of concrete test results shall be calculated and brought up to date after every change in the mix design and at least once a month. Records in connection with monitoring and testing of quality of concrete and it's

component materials shall be kept open for inspection by the EIC or his authorized representatives anytime.

8. In all cases the contractor shall be bound to use the minimum quantity of cement as per IS code(s) including IS-456 (latest Edition) for Exposure Conditions mentioned under various RCC items of Price Bid from durability point of view. The contractor shall also not exceed the maximum water cement ration as per IS-456-2000 for Durability Criteria for relevant Exposure conditions.
9. All design mix concrete shall be mechanically batched, mixed and vibrated unless otherwise specified. Guidelines for extreme weather concreting as given in the IS codes shall be followed by contractor and no extra cost, over & above the quoted rate of contractor for design mix concrete will be payable for extra precautions to be taken/extra efforts in this regard.

PLACING CONCRETE BY PUMPING

GENERAL

Concrete conveyed by pressure through either rigid pipes or flexible hoses and discharged directly into the desired area is termed as pumped concrete.

Method of applying pressure to concrete is by pumps. Pumps to be used shall be either of the two types as mentioned below:-

- (A) Piston type pumps
- (B) Squeeze pressure type pumps.

Compressed air pressure pumps shall not be used in the works.

Pumping Equipment

Piston Pumps: Piston pump to be used in the works shall consist of a receiving hopper for mixed concrete, an inlet valve, an outlet valve, and the pump shall be a twin-piston pump.

The two pistons shall be so arranged that one piston retracts when the other is moving forward and pushing concrete into the pipe line to maintain a reasonably steady flow of concrete. Single piston pumps shall not be acceptable.

Inlet and outlet valve shall be any one of the following types :-

- Rotating plug type
- Sliding plate type
- Guided plunger type
- Swing type
- Flapper type
- Or any combination of the above.

The pistons shall be mechanically driven using a crank or chain or hydraulically driven using oil or water.

The receiving hopper shall have a minimum capacity of 1.0 cum and the hopper shall be fitted with remixing rotating blades capable of maintaining consistency and uniformity of concrete.

The primary power for pumps may be supplied by gasoline, diesel, or electric motors.

The primary power unit and the pump unit may be truck, trailer or skid mounted.

Squeeze Pressure Pumps: Squeeze pressure pumps shall consist of a receiving hopper fitted with re-mixing blades. Re-mixing blades shall be such that these can push the concrete into the flexible hose connected at the bottom of the hopper.

The flexible hose shall pass through a metal drum around the inside periphery of the drum and come out through the top part of the drum

The drum shall be maintained under a very high degree of a vacuum during operation. The drum shall be so fitted with hydraulically operation metal rollers., which when rotating, create a squeeze pressure on the flexible hose carrying concrete and forces the concrete out into the pipe line.

Effective Range and Discharge of Pumps: Effective range of pumps to be used in the work shall be decided after studying the site conditions. However, the minimum horizontal range shall not be less than 150 metres and minimum vertical range shall not be less than 50 metres.

Selection of pumps bases on discharge capacity shall be decided after studying the requirements for the project. Discharge capacity shall be worked out by the contractors and approval obtained from the Engineer-in-Charge. As a guide line figure the contractor may assume a discharge capacity of 15 cubic metre/hour/pump.

Pipe Lines: All concrete carrying pipe lines shall generally be rigid pipe lines. Flexible pipe lines may only be used at bend curves in lines or at discharge ends if required. Placements of flexible units shall be done judiciously and connected to the pipe lines only when it meets the approval of the Engineer-in-Charge.

- (i) **Rigid Line/ Hard Line/ Slick line:** Such lines shall be made either of steel or plastic. Aluminum alloy pipes shall not be used.

Minimum pipeline diameter shall be 100 millimeters and shall have normal maximum length of 3 metre in each section connected through couplers.

(ii) **Flexible Pipe Line:** Flexible lines shall be made out of rubber or spiral wound flexible metal or plastic. The pipe shall again be such that they are in sections of 3 metre length each and connected through couplers. These pipes shall be such that they are interchangeable with rigid lines. While installing flexible units, care shall be taken that there are no links in the pipeline, which is a normal tendency with these pipes having diameter 100 mm and above.

Couplers: Couplers to be used for connecting pipe line sections (either hard or flexible) shall have adequate strength to withstand stresses due to handling, misalignments, poor support to pipe lines etc.

For horizontal runs of pipes and for vertical run upto 30 metre height the couplers shall be rated for a minimum pressure of 35 kg/ cm square. Couplers used for rising runs between 30 metre and 50 metre heights shall have a minimum pressure rating of 50 kg/cm square. Couplers shall be designed to allow for replacement of any pipe section without displacing other sections. These shall provide for the full internal cross section. These shall provide for the full internal cross section with no constructions or service. Which may disrupt the smooth flow of concrete. For pipelines of size 150mm and above, double toggled type coupler with a thick rubber gasket and secondary wedge-take-up is recommended. Types of couplers that may be used shall be any of the following:-

- Grooved end coupler
- One piece extended lever swing type couplers
- And full flow oil line type couplers.

Other Accessories: Other accessories which shall be catered for, are as under:-

- (a) Back up pump of rigid and flexible pipes of varying lengths of similar rating/specifications
- (b) Curved sections of rigid pipes
- (c) Swivel joints and rotary distributors
- (d) Pin and gate valves to prevent back flow in pipe lines
- (e) Switch valves to direct the flow into another pipe line
- (f) Connection devices to fill forms from the bottom up
- (g) Splints, rollers, and other devices for protection of conduit over rock concrete Reinforcing steel and form and to provide lifting and lashing points in the pipe line.

- (h) Transitions for connecting different sizes of pipe sections
- (i) Air vents for downward pumping.
- (j) Clean out equipment.

For concreting of columns, walls and scattered small placement, recommendation is made for special cranes or power controlled booms carrying pipe lines with a pendant type concrete delivery hose.

Lubricating of Pipe Line

Before pumping concrete into the pipeline, the line shall be lubricated with a properly designed mortar/grout lubricant. This shall be ensured by starting the pumping operation with a properly designed mortar, or with a batch of regular concrete with the coarse aggregate omitted. The quantity of mortar required as lubricant is dependent on the smoothness and cleanliness of the pipelines. As a guide line, for a 100 mm diameter pipe line of 100 metre length, 0.08 cum to 0.10 cum of mortar should normally be adequate, but this shall not be taken as specified, and the contractor shall establish his requirements. The quantity of mortar that comes out of the delivery end of the pipeline shall not be used in place of the concrete work. However, with the approval of Engineer-in-Charge, this mortar may be used as bedding mortar against construction joints. The rest of the mortar shall be wasted.

Lubrication shall be maintained as long as the pumping of concrete continues.

GUIDELINES FOR FIELD PRACTICE

General Precautions

- (i) Proper planning of concrete supply, pump locations, line layout, placing sequence and the entire pumping operation will result in savings of time and expense.
- (ii) The pump shall be placed as near the placement area as practicable. The surrounding area of the pump shall be free of obstructions to allow for movement of concrete delivery trucks. The surface must be strong enough to withstand the loaded trucks operating on it. If the surface is a suspended slab, the truck route shall be adequately supported in consultation with the Engineer-in-Charge.

- (iii) Pipe lines from the pump to the placing area shall be laid with minimum number of bend. For large placement areas, alternate lines shall be installed for rapid connection when required. A flexible pipe at the discharge end will permit placing over a large area directly without re-handling of pipelines. The pipeline shall be firmly supported.
- (iv) If more than one size of pipe must be used, the smaller diameter pipe shall be placed at the pump end and the larger diameter at the discharge end.
- (v) When pumping downwards, an air release valve shall be provided at the middle of the top bend to prevent vacuum or air buildup. Similarly, while pumping upwards, a no-return valve shall be provided near the pump to prevent the reverse flow of concrete.
- (vi) It is essential that direct radio/telecommunication be maintained between the pump operator and the concrete placing crew. Good communication between the pump operator and the batching plant is also essential. The placing rate shall be estimated by the pump operator so that concrete can be ordered at an appropriate delivery rate.
- (vii) The pump shall be started for a check run and operated without concrete to ensure that all moving parts are in operation properly. Before placing concrete, the pump shall be run with some grout/mortar for lubricating the line.
- (viii) When concrete is received in the hopper, the pump shall be run slowly until the lines are completely full and the concrete is steadily moving. A continuous pumping must be ensured, because, if the pump is stopped, concrete in the line may be difficult to move again.
- (ix) When a delay occurs because of concrete delivery or some form repair works or for any other reason, the pump shall be slowed down to maintain some movement of concrete in the pipe line. For longer delays, concrete in the receiving hopper shall be made to last as long as possible by moving the concrete in the lines occasionally with intermittent strokes of the pump. It is sometimes essential to run a return line back to the pump so that concrete can be re-circulated during long delays.
- (x) If after a long delay, concrete cannot be moved in the line, it may be necessary to clean out the entire line. However, quite often only a small section of pipe line may be plugged and requires cleaning. The pump operator who know such

details as the length of line, age of concrete in the line etc., should be depended upon to aid in deciding the appropriate section to be cleaned.

- (xi) When the form is nearly full, and there is enough concrete in the line to complete the placement, the pump shall be stopped and a “go devil” inserted at the appropriate time so that concrete ahead of the go-devil shall be forced completion of the work. The go-devil shall be forced through the pipeline to clean it out. Use of water pressure is a safer method. The go-devil shall be stopped at the discharge end to ensure that water does not spill on the placement area, if air pressure is used, extreme care shall be taken and the pressure must be carefully regulated. A trap shall be installed at the end of the line to prevent the go-devil being ejected as a dangerous projectile. An air release valve shall also be installed in the line to prevent air pressure build up.
- (xii) It is essential to clean the line after concrete placing operation is complete. Cleaning shall be done in the reverse direction from the form work end to the pump-end where the concrete in the line can be dumped in bucket. After removal of all concrete, all pipe lines and other equipment shall be cleaned thoroughly and made ready for the next use.

SUBMITTALS

Along with their bid the contractors shall be required to submit the following information regarding the equipments proposed to be used by them:-

- (i) Type, number, capacity, range, mounting, nature of primary power used and the operating weight of pump and mounting.
- (ii) Manufacturer’s specifications for pipe lines giving pressure ratings, sizes and material for straight and curved sections.
- (iii) Manufacturer’s certificates.

TECHNICAL SPECIFICATION FOR WELL SINKING:

- 1. The first lift of steining shall be cast only after sinking the curb at least partially for stability.
- 2. As far as possible reinforcement bars shall not be lapped at the location of construction joints in the vertical steining.

3. Normally dewatering of RCC pit should not be permitted for sinking the well. Dewatering also shall never be resorted to if there is any danger of sand blowing under the well.
4. Water jetting may be employed for well sinking wherever necessary. Sinking or loading with kentledges shall be commenced only after steining has been cured for atleast 48 hours.
5. Well sinking shall be uniform with each drop not more than 300 to 500mm at any instance.
6. Sand blowing in wells can often be minimized by keeping the level of water inside the well higher than the water table and also by adding suitable kentledges.
7. In case the well sinks suddenly with a jerk the steining of the well shall be examined to the satisfaction of engineer-in-charge to see that no damage has occurred to it.
8. Unless otherwise specified, the tilt of the well shall not exceed 1 (horizontal) in 80 (vertical), and the shift at the well base shall not be more than 150mm in any resultant direction. Whenever any tilt is noticed, adequate preventive measures like placing eccentric kentledges, pulling anchoring or dredging unvelly and depositing dredge materials unequally, putting obstacles to cutting edge, water jetting etc shall be adopted before any further sinking. After correction, the dredged material shall be spread out uniformly. The dredgeing shall be done in a spiral fashion starting from the centre of the well and working towards outer edge. The dredged materials shall not be allowed to be accumulated in side the pit. It shall be dumped and spread as for away as possible and then continuously and simultaneously removed as per engineer-in-charge's directions.
9. For bottom plug, the concrete mix shall be designed (in dry condition) to attain the concrete strength as mentioned in the drawing and shall contain 10 per cent more cement than that required for same mix placed dry. To cater for underwater concreting. However, the total cement content shall not be less than 360 kg/cu.m. Of concrete with a slump in the range of 150mm to 200mm.

10. Tremie concrete when started shall be continued without interruption for full concreting in the bottom plug. The concrete production equipment and placement equipment should be sufficient to enable under water concreting within stipulated time. Necessary standby equipment should be available for emergency.
 11. Concreteing shall be done in one continuous operation till the dredge hole i.e. RCC pit of 10.5m dia is filled upto the required height and thereafter sounding shall be taken to ensure that the concrete has been laid to the required height.
 12. Concrete shall not be disturbed in any way for at least 14 days.
 13. In order to check any rise in the level of the bottom plug soundings should be taken at the close of concreteing and once every day for the subsequent 3 days.
 14. The permissible allowances for well steining and curb shall be as follows:
 - A) Variation in dimension: +50mm to -10mm.
 - B) Misplacement from specified position in plan : 115mm.
 - C) Surface irregularities measured with 3 m, straight edge: 5mm.
 - D) Variation of levels at the top : ± 25 mm.
- If any deviations from the above, the same shall be brought back within the permissible limits by the contractor at his own cost.
15. For details refer to the specifications by Ministry of Road Transport And Highways.
 16. Contractor can formulate well sinking specifications and methods including dewatering system and got approved by competent authority before execution of the work.
 17. The formwork on the interface of curb and well steining shall be removed only after 72 hours.
 18. To reduce the heat of hydration chilled water shall be used with the pre-cooled aggregates for mixing if required.
 19. The contents of circular no. Ced/d/gen dated 1.7.98 with respect to hot weather concreting shall be followed if required.
 20. Safety

- a) Necessary safety precautions shall be taken while sinking like equipment and men working inside the well shall be brought out of the well as soon as there are indications of sand blow.
 - b) Well trained and competent personnel shall only be engaged for well sinking.
 - c) The supply of fresh air shall all times be sufficient to permit work to be done without any danger and excessive discomfort for personnel during well sinking.
21. Users clearance with regard to diameter, depth, location of bracket, and other dimensions for lid movement etc shall be obtained before execution.
22. Necessary embedment in the pit shall be fixed with the concurrence of the users and obtained.

OTHER SPECIALISED ITEMS:

Other specialised items like Bi-polar admixture, Elastomeric water proofing of roof, Anti corrosive slurry coating for reinforcement bars shall be strictly as per respective MANUFACTURER'S SPECIFICATION.

ROAD WORKS

The road work Items like Sub-grade preparation, Embankment construction, Granular Sub-Base (GSB), Wet Mix Macadam (WMM), Dense Bituminous Macadam (DBM), Bituminous concrete (BC), Road marking, Signage, Cross drainage works, etc road related works shall be carried out strictly as per Technical specification of CPWD- VOL-II (SUB HEAD: 16.0:: ROAD WORK) along with "Specification for Road and Bridge Work" by Government of India, MORTH 5th revision and various relevant IRC Standards.

1.6.28 LIST OF IS CODES REFERRED

List of IS codes referred in this document were indicated below. However latest revisions of codes in use shall be followed.

IS 383 – 1970	:	Specification for coarse & fine aggregates from natural sources for concrete.
IS 2386 (Part 1 to 8) – 1963	:	Method of Test for aggregates for concrete
IS 456 – 2000	:	Code of practice for plain and reinforced concrete.

IS 712 - 1984	:	Specification for building limes.
IS 3182 – 1986	:	Specification for broken brick (burnt clay) fine aggregate for use in lime mortar.
IS 269 – 1989	:	Specification for 33 grade ordinary Portland Cement.
IS 455 – 1989	:	Code of practice for Portland Slag Cement.
IS 1489 – 1991	:	Specification for Portland Pozzolana Cement.
IS 8041 – 1990	:	Specification for rapid hardening Portland Cement.
IS 8112 – 1989	:	Specification for 43 grade ordinary Portland Cement.
IS 12269 – 1987	:	Specification for 53 grade ordinary Portland Cement.
IS 8043 – 1991.	:	Specification for Hydrophobic Portland Cement
IS 12330 – 1988	:	Specification for Sulphate resisting Portland Cement.
IS 6452 – 1989	:	Specification for high alumina cement for structural use.
IS 8042 – 1989	:	Specification for White Portland Cement.
IS 3535 – 1986	:	Methods of sampling Hydraulic Cement.
IS 4031 (Part 1 to 15) - 1988 to 1991	:	Methods of test for Hydraulic Cement.
IS 4032 – 1985	:	Method of Chemical Analysis of Hydraulic Cement.
IS 2645 – 1975	:	Specification for Integral Cement Waterproofing Compounds.
IS 1599 – 1985	:	Method of Bend Test.
IS 1608 – 1972	:	Method of Tensile Testing of Steel Products.
IS 6925 – 1973	:	Method of test for determination of Water Soluble Chlorides in concrete admixtures.
IS 432 – 1982	:	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
IS 1786 – 1985	:	Specification for high strength deformed steel bars and wires for concrete reinforcement.

IS 1566 – 1982	:	Specification for hard drawn steel wire fabric for concrete reinforcement.
IS 280 – 1978	:	Mild steel wire for general engineering purposes.
IS 2062 – 1992	:	Structural steel (Standard Quality).
IS 1161 – 1979	:	Steel Tubes for Structural purposes.
IS 5624 – 1970	:	Foundation bolts.
IS 1363 - (Part 1 to 3) - 1992	:	Hexagon Head bolts, screws, nuts.
IS 2016 – 1967	:	Plain washers.
IS 3063 – 1972	:	Single coil rectangular section spring washers.
IS 1239 (Part 1&2)-1990	:	Mild Steel Tubes and other wrought steel pipe fittings.
IS 1367 – 1980	:	Technical supply conditions for threaded steel fasteners.
IS 1030 – 1989	:	Carbon steel castings.
IS 3480 – 1966	:	Flexible steel conduit for electrical wiring.
IS 2667 – 1988	:	Fittings for rigid steel conduits for electrical wiring.
IS 9537 (Part 3) – 1983	:	Conduit for electrical installations - Rigid Plain conduits of insulating material.
IS 6946 – 1973	:	Flexible non-metallic conduits for electrical installations.
IS 3419 – 1989	:	Fittings for rigid non-metallic conduits.
IS 5913 – 1989	:	Methods of tests for Asbestos Cement Products.
IS 2098 – 1964	:	Specification for asbestos cement building boards.
IS 2096 – 1992	:	Specification for asbestos cement flat sheets.
IS 9537 (Part 2) – 1981	:	Conduit for electrical installations - Rigid steel conduits.
IS 2614 – 1969	:	Method for sampling of fasteners.
IS 1592 – 1989	:	Specification for asbestos cement pressure pipes.
IS 9627 – 1980	:	Specification for asbestos cement pressure pipe (Light duty).
IS 6908 – 1991	:	Specification for asbestos cement pipes and fittings for sewerage and drainage.

IS 1626 (Part 1 to 3) - 1980 to 1991	:	Specification for asbestos cement building pipes & pipe fittings and roofing fittings
IS 459 – 1992	:	Specification for unreinforced corrugated and semi corrugated asbestos cement sheets
IS 1077 – 1992	:	Specification for common burnt clay building bricks.
IS 3495 (Part 1 to 4) -1992	:	Method of Test for burnt clay building bricks.
IS 3620 – 1979	:	Specification for laterite stone block for masonry.
IS 1121- 1974	:	Method of test for determination of strength properties of natural building stone.
IS 1124 – 1974	:	Method of test for determination of water absorption Sp. Gr. etc. of building stones
IS 1125 – 1974	:	Method of test for determination of weathering of natural building stones.
IS 1126 – 1974	:	Method of test for determination of durability of building stone.
IS 1127 – 1970	:	Recommendation for dimensions and workmanship of natural building stones for masonry work.
IS 2185 (Part-1)-1979	:	Specification for concrete masonry unit Hollow and solid concrete blocks.
IS 2116 – 1980	:	Specification for sand for masonry mortar
IS 1542 – 1992	:	Specification for sand for plaster.
IS 2185 (Part-2)-1983	:	Specification for concrete masonry unit-Hollow and solid light weight concrete blocks.
IS 2185 (Part-3)-1984	:	Specification for concrete masonry unit - Auto claved Cellular Aerated concrete blocks.
IS 6041 – 1985	:	Code of practice for construction of Auto claved Cellular concrete block masonry.
IS 6441 (Part 1 to 9) - 1972 & 1973	:	Method of Test for Auto claved Concrete Products.
IS 3068 – 1986	:	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete.
IS 2114 – 1984	:	Code of practice for laying in-situ terrazzo floor finish.

IS 460 (Part 1 to 3)-1985	:	Specification for Test Sieves.
IS 1237 – 1980	:	Specification for cement concrete flooring tiles.
IS 777 – 1988	:	Specification for glazed earthen ware wall tiles.
IS 1129 – 1972	:	Recommendation for dressing of natural building stone.
IS 1130 – 1969	:	Specification for Marble (blocks, slabs and tiles).
IS 809 – 1992	:	Specification for rubber flooring materials for general purposes.
IS 3462 – 1986	:	Specification for unbacked flexible PVC flooring.
IS 3461 – 1980	:	Specification for PVC asbestos floor tiles
IS 2818 – 1990	:	Indian Hessians.
IS 653 – 1992	:	Linoleum sheets and tiles.
IS 5389 – 1969	:	Code of practice for laying hard wood parquet and wood block flooring.
IS 210 – 1978	:	Grey Iron Castings.
IS 2114 – 1984	:	Code of practice for laying in-situ terrazzo finish.
IS 1198 – 1982	:	Code of practice for laying of linoleum flooring.
IS 1003 (Part-2)-1983	:	Specification for timber panelled & glazed shutters, windows and ventilator shutters.
IS 1141 – 1973	:	Code of practice for seasoning of timber.
IS 1003 (Part-1) - 1983 & 1991	:	Specification for timber panelled & glazed shutters - Door shutters.
IS 287 – 1973	:	Recommendation for maximum permissible moisture content of timber used for different purposes.
IS 2202 (Part-1) - 1983 & 1991	:	Specification for wooden flush door shutters (Solid core type).
IS 2191 (Part-1&2)-1983	:	Specification for wooden flush door shutters (cellular and hollow core type).
IS 3087 – 1985	:	Specification for wood particle boards (Medium density) for general purposes.
IS 3478 – 1966	:	Specification for high density wood particle boards.
IS 3097 – 1980	:	Specification for veneered particle boards

IS 303 – 1989	:	Specification for plywood for general purposes.
IS 1328 – 1982	:	Specification for veneered decorative plywood.
IS 205 – 1992	:	Specification for non-ferrous metal butt hinges.
IS 1341 – 1992	:	Specification for steel butt hinges.
IS 362 – 1991	:	Specification for parliament hinges.
IS 453 – 1973	:	Specification for double acting spring hinges.
IS 3818 – 1992	:	Specification for continuous (Piano) hinges.
IS 206 – 1992	:	Specification for Tee and Strap hinges.
IS 281 – 1991	:	Specification for mild steel sliding door bolts for use with padlocks.
IS 1019 – 1974	:	Specification for rim latches.
IS 2681 – 1979	:	Specification for non-ferrous metal sliding door bolts for use with padlocks.
IS 204 (Part 1&2)-1991&92	:	Specification for tower bolts - Ferrous and Non-ferrous metals.
IS 208 – 1987	:	Specification for door handles.
IS 2209 – 1976	:	Specification for mortice locks (vertical type).
IS 6607 – 1972	:	Specification for rebated mortice locks (vertical type).
IS 1823 – 1980	:	Specification for floor door stoppers.
IS 1837 – 1966	:	Specification for fan light pivots.
IS 207 – 1964	:	Gate and shutter hooks and eyes.
IS 6343 – 1982	:	Specification of door closers (pneumatically regulated) for light door weighing upto 40 Kg.
IS 8756 – 1978	:	Specification for ball catches for use in wooden Almirah.
IS 6315 – 1992	:	Specification for floor springs (hydraulically regulated) for heavy doors.
IS 7197 – 1974	:	Specification for Double action floor spring (without oil check) for heavy doors
IS 364 – 1993	:	Specification for fan light catch.
IS 3828 – 1966	:	Specification for ventilator chains.
IS 363 – 1976	:	Specification for hasp and staples.
IS 9899 – 1981	:	Specification for hat, coat and wardrobe hooks.
IS 729 – 1979	:	Specification for drawer locks, cup-board locks and box locks.

IS 3564 – 1986	:	Specification for door closers (Hydraulically regulated).
IS 4351 – 1976	:	Specification for steel door frames.
IS 419 – 1967	:	Putty for use on window frames.
IS 5187 – 1972	:	Specification for flush bolts.
IS 3847 – 1992	:	Specification for mortice night latches.
IS 4621 – 1975	:	Specification for indicating bolts.
IS 1038 – 1983	:	Specification for steel doors, windows and ventilators.
IS 1977 – 1975	:	Structural steel (ordinary quality).
IS 1361 – 1978	:	Specification for steel windows for industrial buildings.
IS 7452 – 1990	:	Hot rolled steel sections for doors, windows and ventilators.
IS 1948 – 1961	:	Specification for aluminium doors, windows and ventilators.
IS 1148 – 1982	:	Specification for hot rolled rivet bars for structural purposes.
IS 1949 – 1961	:	Specification for aluminium windows for industrial buildings.
IS 204 (Part 1) – 1992	:	Specification for tower bolts-non-ferrous metal.
IS 733 – 1983	:	Wrought aluminium and aluminium alloy bars, rods and sections (for general engineering purposes).
IS 6248 – 1979	:	Specification for metal rolling shutters and rolling grills.
IS 1081 – 1960	:	Code of practice for fixing and glazing of metal doors, windows and ventilators.
IS 2339 – 1963	:	Specification for Aluminium Paint for general purpose in dual containers.
IS 2835 – 1987	:	Flat Transparent sheet glass.
IS 5437 – 1969	:	Wired and figured glass.
IS 101 (Part 1 to 8) - 1964 to 1993	:	Method of sampling and test for paints, varnishes and related products.
IS 2074 – 1992	:	Ready mixed paint, air drying, red oxide zink chrome, priming.

IS 5410 – 1992	:	Cement paint, colour as required.
IS 427 – 1965	:	Distemper, dry, colour as required.
IS 428 – 1969	:	Distemper, oil emulsion, colour as required.
IS 348 – 1968	:	French polish.
IS 5411 (Part 1&2) - 1972 to 1974	:	Plastic emulsion paint.
IS 702 – 1988	:	Industrial Bitumen.
IS 73 – 1992	:	Paving Bitumen.
IS 217 – 1988	:	Cut Back Bitumen.
IS 454 – 1961	:	Specification for Digboi type cutback bitumen.
IS 5467 – 1986	:	Specification for shellac Wax.
IS 3384 – 1986	:	Specification for Bitumen primer for use in water proofing and damp proofing.
IS 290 – 1961	:	Specification for Coal Tar Black Paint.
IS 341 – 1973	:	Specification for Black Japan, Type A, B & C.
IS 1322 – 1982	:	Specification for bitumen felts for water proofing and damp proofing.
IS 218 – 1983	:	Specification for creosote oil for use as wood preservative.
IS 3037 – 1986	:	Specification for Bitumen mastic for use in water proofing of roofs.
IS 1580 – 1991	:	Specification for Bituminous compound for water proofing and caulking purposes.
IS 8542 – 1977	:	Specification for polish for wooden furniture paste.
IS 9862 – 1981	:	Ready mixed paint, brushing etc.
IS 782 – 1978	:	Specification for caulking lead.
IS 405 (Part 1&2) – 1992	:	Lead sheet and strips.
IS 5134 – 1977	:	Bitumen impregnated paper.
IS 2849 – 1983	:	Specification for non load bearing gypsum partition blocks.
IS 8591 – 1977	:	Specification for floor polish paste.
IS 2095 – 1982	:	Specification for gypsum plaster boards.
IS 77 – 1976	:	Specification for linseed oil, boiled for paints.
IS 533 – 1973	:	Gum Spirit of turpentine (oil of Turpentine).
IS 1504 – 1974	:	Bees Wax.

IS 3536 – 1966	:	Ready mixed paint, brushing, wood primer pink.
IS 8273 – 1984	:	Specification for gypsum plaster for use in the manufacture of fibrous plaster board.
IS 5871 – 1987	:	Specification for bitumen mastic for tanking and damp proofing.
IS 651 – 1992	:	Specification for salt glazed stoneware pipe and fittings.
IS 1729 – 1979	:	Sand cast iron spigot and socket soil pipe.
IS 771 (Part 1 to 7) - 1979 to 1985	:	Specification for glazed fire clay appliances.
IS 1230 – 1979	:	Cast iron rain water pipes and fittings.
IS 774 – 1984	:	Flushing cisterns for water closets and urinals.
IS 2548 (Part 1&2) – 1983	:	Specification for plastic seats and cover for water closet.
IS 1726 – 1991	:	Specification for cast iron manhole cover and frames.
IS 1239 (Part 1&2)-1990 to 1992	:	Mild steel Tubes and fittings.
IS 4984 – 1987	:	Specification for high density polyethylene pipes for potable water supplies: Sewerage and industrial effluents.
IS 2556 (Part 1 to 15) - 1972 to 1985	:	Specification for vitreous sanitary appliances (vitreous china).
IS 7328 – 1992	:	High density polyethylene materials.
IS 4985 – 1988	:	Specification for unplasticised PVC pipes for potable water supplies.
IS 3076 – 1985	:	Specification for low density polyethylene pipe for potable water supplies.
IS 9762 – 1981	:	Specification for polyethylene floats for ball valve.
IS 3395 – 1984	:	Code of practice for fire safety of industrial buildings.
IS 7834 (Part 1 to 8) – 1987	:	Specification for injection moulded PVC fittings with solvent cement joint for water supplies.
IS 8008 (Part 1 to 7) – 1976	:	Specification for injection moulded HDPE fittings for potable water supplies.

IS 8360 (Part 1 to 3) - 1977	:	Specification for fabricated high density polyethylene fittings for potable water.
IS 784 – 1978	:	Specification for prestressed concrete pipe.
IS 1703 – 1989	:	Specification for copper alloy float valves (horizontal plunger type) for water supply fittings.
IS 12234- 1988	:	Specification for plastic equilibrium float valve for cold water services.
IS 778 – 1984	:	Specification for copper alloy gate, globe and check valves for water works purposes.
IS 1536 – 1989	:	Centrifugally cast (spun) iron pressure pipes.
IS 1537 – 1976	:	Vertically cast iron pressure pipes for water, gas and sewage.
IS 1538 (Part 1 to 23) – 1976	:	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS 3589 – 1991	:	Electrically welded steel pipes for water, gas and sewage.
IS 781 – 1984	:	Specification for cast copper alloy screw down bib taps and stop valves for water services.
IS 1239 (Part 1&2) - 1990 to 1992	:	Mild steel tubes and fittings.
IS 779 – 1978	:	Specification for water meters.
IS 1795 – 1982	:	Specification for pillar taps for water supply purposes.
IS 1363 (Part 1 to 3) - 1992	:	Dimensions for screw thread run-outs and undercuts.
IS 2016 – 1967	:	Plain washers.
IS 638 – 1979	:	Sheet rubber jointing and rubber insertion jointing.
IS 4127 – 1983	:	Code of practice for laying of glazed stoneware pipes.
IS 458 – 1988	:	Specification for precast concrete pipes.
IRC 19 – 1981	:	Standard specification and code of practice for water Bound macadam.

IRC 29 – 1988	:	Tentative specification for 4 cm Asphaltic concrete surface course.
IRC 15 – 1981	:	Standard specification and code of practice for construction of concrete roads.
IS 6313 – 1981	:	Code of practice for antitermite measures in building.
IS 1054 – 1962	:	Dieldrin emulsifiable concentrates.
IS 1308 – 1984	:	Aldrin dusting powders.
IS 6439 – 1978	:	Hepta chlor emulsifiable concentrates.
IS 2632 – 1964	:	Crotonaldehyde.
IS 1791 – 1985	:	Specification for batch type concrete mixers.
IS 10262- 1982	:	Recommended guidelines for concrete mix design.
IS 7861 (Part 1) – 1975	:	Code of practice for extreme weather concreting - Recommended practice for hot weather concreting.
IS 1199 – 1959	:	Methods of sampling and analysis for concrete.
IS 516 – 1959	:	Method of test for strength of concrete.
IS 7861 (Part 2) – 1981	:	Code of practice for extreme weather concreting. Recommended practice for cold weather concreting.
IS 2502 – 1963	:	Code of practice for bending and fixing of bars for concrete reinforcement.
IS 2751 – 1979	:	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
IS 800 – 1984	:	Code of practice for general construction in steel and deformed bars.
IS 816 – 1969	:	Code of practice for use of metal arc welding.
IS 814 – 1991	:	Covered electrodes for manual metal arc.
IS 3370 (Part 1&2)-1965	:	Code of practice for concrete structures for the storage of liquids.
IS 2911 (Part 1 to 4) – 1979 to 1985	:	Code of practice for design and construction of pile foundations.
IS 1343 – 1980	:	Code of practice for prestressed concrete.

IS 1785 (Part 1&2)-1983	:	Specification for plane hard drawn steel wires for prestressed concrete.
IS 2250 – 1981	:	Code of practice for preparation and use of masonry mortars.
IS 1635 – 1992:	:	Code of practice for field slaking of building lime.
IS 2212 – 1991	:	Code of practice for brick work.
IS 1597 (Part 1&2)-1992	:	Code of practice for construction of stone masonry.
IS 4101 (Part 1 to 3) - 1967 to 1985	:	Code of practice for external facing and veneer.
IS 737 – 1986	:	Wrought aluminium and aluminium alloys, sheet and strips (for general engineering purposes).
IS 2572 – 1963	:	Code of practice for construction of hollow connect block masonry.
IS 1661 – 1972	:	Code of practice for application of cement finishes.
IS 5766 – 1970	:	Code of practice for laying of burnt clay brick flooring.
IS 5491 – 1969	:	Code of practice for laying of in-situ granolithic concrete flooring topping.
IS 3316 – 1974	:	Specification for structural granite.
IS 1196 – 1978	:	Code of practice for laying bitumen mastic flooring.
IS 1195 – 1978	:	Specification for bitumen mastic for flooring.
IS 3462 – 1986	:	Specification for unbacked flexible PVC flooring.
IS 1198 – 1982	:	Code of practice for laying fixing and maintenance of linoleum floor.
IS 848 – 1974	:	Specification for synthetic resin adhesive for plywood.
IS 4457 – 1982	:	Specification for ceramic unglazed vitreous acid resisting tiles.
IS 851 – 1978	:	Specification for synthetic resin adhesive for construction work (non structural) for wood.

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IS 2202 (Part 1&2) - 1981 to 1991	:	Specification for wooden flush door shutters.
IS 102 – 1962	:	Ready mixed paint.
IS 1081 – 1960	:	Code of practice for fixing and glazing of metal doors.
IS 6248 – 1979	:	Specification for metal rolling shutters and rolling grills.
IS 1868 – 1982	:	Anodic coatings on aluminium and its alloys.
IS 2065 – 1983	:	Code of practice for water supply in buildings.
IS 2064 – 1993	:	Code of practice for selection, installation and maintenance of sanitary appliances.
IS 7634 (Part 1 to 3) – 1975	:	Code of practice for plastic pipes.
IS 1742 – 1983	:	Code of practice for building drainage.
IS 5330 – 1984	:	Criteria for design of anchor blocks for penstocks with expansion joints.
IS 3114 – 1985	:	Code of practice for laying of cast iron pipes.
IS 783 – 1985	:	Code of practice for laying of concrete pipes.
IRC-SP11- 1977	:	Hand book of quality control for construction of roads and run-ways.
IRC-63 – 1976	:	Tentative guidelines for use of low grade aggregates and soil aggregate mixtures in road pavement construction.
IRC-60 – 1976	:	Tentative guidelines for use of Lime Fly Ash Concrete as pavement base or sub-base.
IRC-74 – 1979	:	Tentative guidelines for use of Lean Cement Concrete and lean concrete Fly Ash Concrete as pavement base or sub-base.
IS 6509 – 1985	:	Code of practice for installation of joints in concrete pavement.
IS 1838 (Part 1) – 1983	:	Specification for performed filler for expansion joint in concrete pavements and structures.
IRC-43 – 1972	:	Recommended practice for Tools, Equipment and appliances for concrete pavement construction.
IRC-15 – 1970	:	Standard specifications and code of practice for construction of concrete road.

IS 3036 – 1992	:	Code of practice for laying lime concrete for a water proofed roof finish.
IS 1346 – 1991	:	Code of practice for water proofing of roofs with bitumen felts.
IS 1609 – 1991	:	Code of practice for laying damp proofing treatment using bitumen felt.
IS 4365 – 1967	:	Code of practice for application of bitumen mastic for waterproofing of roofs.
IS 9103 – 1979	:	Specification for admixtures for concrete.
IS 2645 – 1975	:	Specification for integral cement water proofing compounds.
IS 1834 – 1984	:	Specification for hot applied sealing compound for joint in concrete.
IS 278 – 1978	:	Specification for Galvanized barbed wire for fencing.
IS 2721 – 1979	:	Specification for Galvanized steel chain link fabric.
IS 280 – 1978	:	Specification for Mild steel wire.
IS 4826 – 1979:	:	Specification for hot dipped galvanized coating on round steel wires.
IS 1200 (Part 1 to 28) - 1971 to 1993	:	Method of measurement of building and Civil Engineering Works.
IS 4081 – 1986	:	Safety code for blasting.
IS 5916 – 1970	:	Specification for cast iron gratings for drainage purposes.
IS 4130 – 1991	:	Safety Code for demolition of building.
IS 3764 – 1992	:	Safety code for excavation work.
IS 5121 – 1969	:	Safety code for piling.
IS 4014 (Part 2) – 1967	:	Code of practice for steel tubular scaffolding.
IS 3696 (Part 1&2) - 1987 to 1991	:	Safety code of scaffolds and ladders.
IS 6922 – 1973	:	Criteria for safety and design of structures subject to underground blast.
IS 5499 – 1969	:	Code of practice for construction of underground raid shelter.

IS 4138 – 1977	:	Safety code for working in compressed air.
IS 7293 – 1974	:	Safety code for working with construction machinery.
IS 8989 – 1978	:	Safety code for erection of concrete framed structures.
IS 4756 – 1978	:	Safety code for Tunneling work.
IS 7205 – 1974	:	Safety code for erection of structural steel works.

1.6.28	SPECIFICATIONS FOR PACKAGED AIR CONDITIONING UNITS
1.0	Supply, installation, testing and commissioning of self-contained air cooled of nominal cooling capacity Packaged air conditioning units as indicated below comprising hermetic scroll compressor of danfoss or equivalent make, air cooled condenser, evaporator cooling coil with minimum 3 rows of copper coil with bluefin/goldfin coating over aluminium fins, blower and motor, thermostat, starters for motors of compressors, condenser and blower with over load relay and single phase preventor , 20 Microns HDPE filters, return air slots and associated refrigerant piping all (except condenser unit) housed in a powder coated sheet metal cabinet and duly painted.
2.0	The indoor units comprising of compressor and evaporators shall be installed in the packaged unit room and these units shall be required to operate for minimum 16 hrs per day throughout the year. The condenser unit shall be of large face area with minimum three rows of copper coil with blue fin/cold fin coated aluminium fins, integral sub cooling circuit, suitable fan and motor, refrigerant pipe connection, metallic frame work etc. prewired in a single cabinet and duly painted. And the outdoor unit shall be suitable for operation throughout the year.
3.0	The unit shall be designed to operate for ambient conditions of SRIHARIKOTA. The unit shall be designed to operate on 400 V/415 V,50 Hz, AC supply. Each unit should be capable of delivering air quantities as mentioned below. Unit should include controls like Pressure control, overload relays, pressure gauges etc. The noise level of indoor and outdoor units shall not exceed 70 db within 1 metre of the units. MS parts including structural members of outdoor condenser units shall be hot dip galvanised with a coating thickness of 75-100 microns Or painted with one coat of Epoxy primer and two or more coats of approved Epoxy paint. Hydrophilic coating (blue fin/gold fin) shall be provided to the evaporator cooling coil and condenser coil to prevent against corrosion.
4.0	Each package unit shall be provided with microprocessor-based control system and shall be fully automatic in operation. Auto restart after resumption of power supply in case of power failures shall be an inbuilt feature of package unit. Display of parameters like room temperature, RH, status of package unit, Fault/ Trip indication shall be provided with packaged unit. Packaged units shall have provision for interconnection to future DDC / BMS system. Ambient Conditions at Sriharikota to be considered for operation Package air conditioning unit
5.0	Summer: DBT-42.2°C & WBT : 28.3°C Monsoon : DBT-28.3°C & WBT : 26.7°C Winter : DBT-18.3°C & WBT : 13.9°C Note: 1. Refrigerant shall be R-410a/R407c/Eco friendly refrigerants. 2. Capacity of Package AC unit shall be AHRI conditions. 3. Canvas connection shall have zip for checking the temperature at outlet of Each package Air conditioning unit

PART 2
OPERATION & MAINTENANCE OF
AIR SEPARATION PLANT

2.1 INTRODUCTION

The objective of the proposed O & M contract is to ensure the uninterrupted operation of the 50 TPD Cryogenic Air Separation Plant on a 24x7 basis in three shifts, producing LOX & LIN products, by engaging skilled human resources and using state-of-the-art automation technology in the plant.

The Quality Assurance of the LOX & LIN products shall meet the specifications defined by the Department in the document. The LOX & LIN products stored in the storage tanks at ASU Plant shall be transferred and transported to the Storage facilities located within the SDSC SHAR, using the Department transportation tankers.

Technical and Non-technical services related to Plant Operation & Maintenance are covered in this section, including Transportation of LOX & LN2. Contractor shall execute the Plant O &M using his own resources or by subcontracting after successful realisation & commissioning of the plant, as per RFP terms.

As the Plant is established within the premises of SDSC SHAR and is a Government of India property, all the requisite Safety & Security protocols laid by the SDSC SHAR shall be adhered by the contract agency.

2.2 PERIOD OF CONTRACT

1. Operation & Maintenance of the plant shall be for the period of three (3) years after the successful performance testing & acceptance of the Air Separation Plant by the Department. PO will be placed initially for plant realisation and operations support for the one-year (i.e, during warranty period). A Separate PO will be placed subsequently for operational support (O&M), including supply of spares and consumables for 2nd & 3rd year production (post-warranty period).
2. The O & M contract shall commence based on the closure of the realisation contract and clearance by the Department.
3. For smooth running of the Plant in 24 X 7 in 3 shift mode, the contractor shall prepare the Operation plan, Maintenance plan, Quality Assurance plan & Safety plan, etc, based on the details provided in Annexures 7F to 7K in the tender

document. The O & M plan shall be finalised in consultation with the Department and agreed upon by both the Department and Contractor, before the commencement of production of LOX & LIN.

4. The contract is deemed to be closed on expiry of the contract period unless it is extended as per the terms and conditions.

2.3 MOBILIZATION PERIOD

1. The Contractor shall mobilize the required manpower, tools & tackles, applicable machinery, if any, etc, for O & M, within the mobilization period.
2. Contractor shall commence Operation and Maintenance services within fifteen (15) days after receiving communication from the Department.
3. List of technical / non-technical personnel in different categories with experience certificates shall be furnished for the Department Review & clearance.
4. All expenses towards mobilization to the site, de-mobilization of machinery, workforce, material, and clearing the site, etc, shall be deemed included in the price quoted by the contractor, and no extra payment on such expenses shall be entertained.
5. No mobilization advance is payable to the contractor for O & M.
6. The contractor shall make their own arrangement for the removal of old as well as unused material from the Plant to the Department Stores / identified place, after completion of contract, without any additional cost.

2.4 HANDING OVER OF THE PLANT

1. At the time of handing over the plant for O & M, the inventory of the plant, including all allied facilities, shall be checked jointly by the Department and the Contractor. The operating condition and technical details shall be recorded and signed by the authorized representatives of the Department and the Contractor.

2. Any inventory added to the plant by the Contractor/ the Department during the Contract period shall also be recorded separately. These records shall be the document to check the inventory at the time of either completion or termination of the contract.
3. The Contractor shall make good all the damages caused to the system or part of the plant due to faulty and negligent operation. At the end of the contract period, the Contractor shall hand over the plant and all equipment in the contract scope in good working condition.
4. Any material required for making the plant in working condition shall be brought by the Contractor at his own cost and risk, and such material shall be of the original brand and of good quality as approved by the Department. In case the damages cannot be rectified or the material quality is not acceptable, the Department will recover the cost of the damaged system or part of it of the plant from the Contractor. The basis of recovery shall be at the actual cost incurred by the department.

2.5 DETAILS OF SERVICES / SUPPLY

S. No.	Description	Annexure
1	Operation of the Air Separation Unit and auxiliary units for producing LOX and LIN in 3 shift mode daily against the plant operating parameters.	7D
2	Analysis and Quality Assurance of LOX & LIN products, to meet the Department specifications.	7E
3	Maintenance of Process & Mechanical equipment, Systems, piping, Flow components, valve actuators, etc.	7F
4	Maintenance of Electrical equipment, Systems, Substation, etc.	7G

5	Maintenance of Automation (Control) and Instrumentation systems.	7H
6	Approvals & Statutory clearances to be renewed by the contractor for operating the plant during the Contract period.	-
7	Transportation of LOX and LIN from the Air Separation Plant to the SDSC SHAR Storage facilities, using Department transportation tankers.	-
8	Deployment of human resources for Operations & Maintenance of Air Separation Plant, Analysis of Products, and transportation of LOX & LIN to Storage facilities of SDSC SHAR.	7I

2.6 SCOPE OF CONTRACTOR

1. The Contractor shall be responsible for the operation and maintenance, safety, productivity, and reliability of the Air Separation Plant for the specified period by mobilization of his team of engineers, technicians, and supervisors, chemicals, consumables, etc.
2. Production Planning and Management: Manage the plant production in accordance with the requirements of the Department.
3. Planning and execution of preventive and predictive maintenance activities as per the annual plan jointly developed in consultation with the Department.
4. The Contractor shall undertake the entire responsibility for rectification and repairs of Plant, including utility units and transport tankers with prime movers on round the clock basis as and when required.
5. Analysis of inter streams, product, and other samples, Effluent treatment if required, and disposal at identified areas.

6. Procurement of plant spares kits / maintenance kits, arranging AMCs for equipment, maintenance services, transportation, and delivery of cryogenic fluid to the Department's sites.
7. The Contractor shall carry out the operation of the Electrical Substation along with the DG sets and carry out the maintenance. The supply of spares and consumables for the facilities at the plant, including DG sets and substation, shall be the responsibility of the Contractor.
8. All equipment within the fenced area of the Plant shall be managed by the contractor. The Contractor shall be responsible for providing the general tools necessary for the maintenance of plant equipment.
9. Approvals & Statutory clearances to be renewed annually by the contractor, during the Contract period. All statutory payments shall be borne by the Department. However, liaison for the same shall be done by the contractor. Any changes/additions required to be made to meet the requirements of statutory authorities shall be carried out by the contractor with the approval of the Department, within the contract price, and at no additional cost to the Department. Tentative list includes:
 - ✓ PESO license for LOX / LIN storage tanks.
 - ✓ PESO license for LOX / LIN transportation tankers.
 - ✓ Taxes & Permits and F.C. for transport tankers.
 - ✓ Andhra Pradesh Pollution Control Board
 - ✓ Electricity Department & Electrical Inspectorate, etc
10. Transportation of Products:
 - Contractor is responsible for transportation of LOX / LN2 from the Air Separation Plant site to SDSC storage facilities located at FLP / SLP /TLP (The average distance between the Air Separation plant site to the Storage facility is around 10 km).
 - Contractor shall plan transportation of LOX / LN2, in consultation with the department.

- Necessary inspection/test report, release note, etc., of the Contractor shall accompany each lot of LOX or LIN.
 - LOX / LIN tanker will be analysed each time for every receipt for compliance with chemical content specifications, and in case if there is a discrepancy/ deviation is noticed in the specifications during quality checks, the same shall be mutually discussed and necessary action shall be taken up.
 - In case the Contractor has failed to deploy Department tankers for transportation due to any breakdown / non-renewal of license, the Contractor shall hire third-party road transportation tankers at his own expense and transport the products as per the requirement.
11. Good Housekeeping services shall be in the scope of the Contractor.
12. Equipment overhaul, tube bundle cleaning, software/ hardware upgrade, if any
13. Transformer oil filtration & testing, etc
14. Maintenance of ASU plant internal security and safety is also the responsibility of the Contractor.
15. Maintenance of the Fire protection system, Fire hydrant, and incipient firefighting shall also form part of the scope.
16. The Contractor shall provide an exclusive standby light vehicle of a category like Tata Sumo, Mahindra Bolero, etc, at the plant on round the clock basis for internal transportation of men and material and it is a mandatory safety requirement. The drivers included in human resources to be deployed shall be utilized for operation of the exclusive light vehicle and movement of tankers on round the clock basis.
17. The Contractor shall be responsible to provide administrative support like transport for their men and materials, Staff Welfare measures, Communication Expenses including telephone charges & postage/courier charges, Office Maintenance including office furniture, Desktop PC & Printer, Printer cartridges, computer maintenance, paper & stationeries for submitting the

reports, General Administration etc....Department will not provide food, transport, accommodation (except office space at plant) and STD Telephone for the Contractor & his team in connection with O & M of the plant.

18. The Contractor shall be responsible for the Insurance of their staff working at the site and all the Equipment in the scope of the Contractor. Department shall not be responsible in any manner in case of any accident/disputes amongst the employees of Contractor.
19. The list of items shall be in the scope of the Contractor for carrying out day-to-day O & M works.
- a) Regulators for oxygen and LPG with torch and hoses in proper working conditions, complying with all prevailing norms.
 - b) Welding machines to carry out the job with the required welding cable, Welding holder, screen, and other welding accessories.
 - c) All required tools and tackles, Vacuum pumps, portable measuring instruments like thermo meter, portable Oxygen meters, psychrometer, anemometer, Digital temperature gun, Vibration measuring Instrument, multimeters, tong testers, Lux meters, and HT & LT Insulation Resistance testers (Meggar) for maintenance, cleaning, and housekeeping.
 - d) Sufficient no. of hand and flexible grinding machines, grinding wheels, and hand drilling machines for various jobs.
 - e) Wire rope, slings, max pull, cutting torch, hoses, and special tools like hydraulic jacks, dial indicators, micrometer (0-25), vernier calipers, torque wrenches, chain pulley blocks, lifting tackles, scraping and cleaning hand tools, gas regulators, jigs, and fixtures for removal & fitting of parts like coupling and impeller.
 - f) All Personal protective equipment (PPEs) to the workmen.
 - g) Material handling equipment, Hydra/ Pick n carry crane/trailer for regular maintenance jobs as and when necessary

h) Any other tools/instruments required in the course of work are also in the scope of the party

20. The following activities shall also be in the scope of the Contractor and hence, shall depute OEM personnel for OEM resource and deputation for the Plant wherever deemed necessary.

- a) Major / Minor Overhaul of Air Compressors.
- b) Inspection involving gear casing removal, bearing maintenance, and rotors in Air Compressors.
- c) Chemical circulation in Gas coolers for Descaling.
- d) Overhaul of cooling tower cells.
- e) Civil jobs.
- f) Maintenance of HT Panels and Breakers
- g) Removal, dismantling, and re-commissioning of HT motors, including the jobs of Cable termination / de-termination, TB-related jobs like cover removal/fixing.
- h) Water treatment of the cooling water system
- i) Complete replacement of adsorbents of Driers, etc.

21. Following consumables, but not be limited to, and required for maintenance/breakdown jobs shall be the scope of the Contractor. They shall be from the approved vendor's list.

- a) All consumables like cotton waste, gland ropes, lube oil, grease, Diesel/ Kerosene for cleaning purposes, TCE, etc
- b) Spare / repair kits / maintenance kits
- c) Seals
- d) Suitable gaskets of different thickness
- e) Chemicals
- f) oils, lubricants

- g) desiccants
- h) refrigerants
- i) The filled-in LPG, Nitrogen, Argon, and oxygen cylinders
- j) Different types and sizes of Electrodes for welding and other jobs
- k) Compressed Air, Water, Nitrogen, and Argon for maintenance purposes
- l) Calibration gases.
- m) Slagwool, Perlite, etc.

22. Supply of diesel for running DG sets and transportation tankers is in the scope of the contractor.

23. The Contractor will be responsible for the Scope of Work mentioned in Section 2.5.

2.7 SCOPE OF THE DEPARTMENT

1. The Department shall provide Plant, Equipment/machinery, and Analytical Laboratory Equipment, and other infrastructural facilities required for the plant operation and maintenance.
2. **The Department shall provide Electricity for the plant operations at free of cost. The Department shall put its best effort to ensure an uninterrupted power supply to ASU Plant. The Department shall take care of the incoming HT feeder for power supply.**
3. The Department shall arrange necessary security of the plant.
4. The Contractor shall assist the Department for the renewals of the licenses/clearances that may be required for operating the plant, including transportation tankers.
5. The Department shall inspect the product and conduct quality control checks as and when required.
6. Receipt of the products from the Air Separation Plant and unloading of LOX & LIN to the Department Storage tanks located at FLP / SLP /TLP.

7. Department shall be entitled from time to time to shut down the Air Separation Plant due to storage constraints at its premises.

2.8 PRICE

1. Plant O & M cost shall constitute two cost elements, namely 1. Fixed operating cost & 2. Cost for production consumables.
2. The fixed operating cost elements like salaries for operating manpower/labour (list of technical / non-technical personnel in different categories with qualification, experience shall be mentioned for 3 shifts plant operation & maintenance), canteen, accommodation, conveyance of contractor's staff, maintenance cost with spare parts, administrative expenses, insurance, etc., shall be worked out in detail. Fixed Operating cost once mutually agreed to, the price shall be Firm & Fixed and no change shall be allowed during the O & M period.
3. Cost of production consumables consists of Chemicals, Desiccants, Oils, Spare kits, repair kits & Lubricants, Diesel, etc.,.
4. The Contractor shall produce a break-up and documentary proof for arriving at the fixed operating cost & Cost of production consumables to the Department.
5. O & M cost shall be paid quarterly. The fixed cost component is fixed and firm, whereas the Cost of production consumables shall be paid based on the monthly production.
6. Production consumables for manufacturing one ton of LOX and one ton of LN2 shall be submitted for department review.
7. The following are the major factors to be considered for estimating the cost of fixed operating costs:
 - a. Workforce to be deployed
 - b. Operational shifts: General shift, 1st, 2nd, and 3rd shifts.
 - c. Transportation of operating personnel
 - d. Administrative expenses

- e. Statutory expenses
 - f. PPE viz, Safety shoes, industrial safety helmet, and safety belts, etc.
 - g. ESI, EPF, Bonus, Paid holidays, and minimum wages hike as per Andhra Pradesh /Central Govt. labour act, whichever is higher.
 - h. Canteen & accommodation expenditure.
 - i. Uniforms
 - j. First aid medical kits
 - k. Registration charges towards labour license, ESI, EPF, and other statutory requirements.
 - l. Bio-metric instruments, etc
8. **Liquid Oxygen: No Cost is payable for production.**
9. **Liquid Nitrogen: No Cost is payable for production.**

2.9 PRICE BASIS

- The agency should take care of GST (if applicable) while quoting rates and should separately indicate the rate of GST to be charged.
- The rate quoted by the Agency shall be all-inclusive for provisions of all incidental expenses necessary for proper execution and completion of work in full in accordance with the Terms & Conditions of RFP.
- Any other materials & activities not mentioned/covered, but otherwise required for satisfactory completion/safety of work as defined in RFP, have to be supplied /done by the contractor within the specified schedule at no extra cost to the Department.
- The quoted rates are deemed to be inclusive of all materials, consumables, Labour, supervision, tools & tackles, cost of various tests, inspections, as well as preparatory, incidental, intermediate /auxiliary/ancillary or enabling works.
- In case the Contractor could not perform the activities as per the scope, the same shall be executed by any of the agencies at the risk & cost of the non-performing

contractor, and the expenses towards these shall be recovered, including 15% of over heads.

- Bonus for production targets: Bonus for achieving the production targets shall not be applicable in this Contract.
- During the contract period, any component replaced/repaired shall be carried out at no additional cost to the Department. The Contractor shall ensure that necessary spares/components are kept ready for trouble-free operation and maintenance of the plant.

2.10 PAYMENT TERMS

- The payment shall be made on a quarterly basis based on satisfactory performance, duly certified by the Department's focal point. Contractor has to pay wages to his employees before 7th of every month through the bank.
- The department will release the payment within 30 days of submission of a valid invoice.
- In case of disputes for non-payment of wages to the deployed manpower or any other disputes, the payment due to the Contractor shall be withheld by the Department till settlement of the disputes or on the orders of the court of law.

2.11 SPECIFIC TERMS AND CONDITIONS:

Specific Terms & Conditions shall be read in conjunction with the General Terms & Conditions, Scope of Work, Job Specification, Technical Specifications, and any other document forming part of this tender document, wherever the context so requires.

2.11.1 STATUTORY RULES AND REGULATIONS

- The Contractor shall comply with all the statutory rules and regulations, like provisions of the Minimum Wages Act, Electricity Act, and the Regulations, Contract Labour Act, and rules framed there under and other laws, including labour laws affecting contract labour that may be brought into force from time to time.

- The Contractor must ensure the payment of prevailing State Government monthly minimum rates of wages promulgated by the Labour Commissioner, Andhra Pradesh /Central Govt., to the persons employed under this Contract
- The Contractor shall employ qualified/trained persons for operation & maintenance of the equipment and shall be fully responsible to obtain such licenses, if any for taking up the above work as prescribed by the state / local bodies/electricity boards / Pollution control board/other statutory regulations for operation & maintenance and will be responsible for the same from time to time during the term of the contract. Contractor shall be responsible for any periodic statutory inspection to be carried out on the equipment, the necessary test report and certificate, rectification of defects pointed out during such inspection, etc. A failure to comply with this clause by the Contractor will render him liable for payment of all penalties imposed by the Department / local bodies, and the inspection and/or subsequent rectification will be carried out at their risk and cost.

2.11.2 GROUP INSURANCE/ ALL RISK INSURANCE

Contractor shall mandatorily (where ever ESI not applicable/drawing the more than Rs.21, 000/- Gross salary per month/as per eligible) provide the insurance to their work forces comprehensively against and risks during the course of work undertaken by them in purchasers work place through a comprehensive All Risk Insurance (ARI) policy obtained from any of the insurance companies as approved by the Insurance Regulatory & Development Authority of India (IRDA). The contractor shall have to furnish originals of the ARI policy along with premium receipts and other papers thereto should submit to the department with a minimum coverage of Rs. 10 Lakhs per person (in the name of contract workforce) for entire contract period

2.11.3 WORK SPECIFICATIONS AND STANDARDS

- The plant operations shall comply with the Indian Electricity Rules-1956, Indian Electricity (Supply Act) calculations for the Electrical Buildings-1959 of the Insurance Association, Indian Electricity Act, relevant Indian Standard Specifications, and Codes of Practice, as modified till date, & CPWD Specifications,

Petroleum & Explosives Safety Organization (PESO) Nagpur, Chief Fire Officer (CFO), and any other statutory authorities from time to time at the Plant as applicable. Any other Standard not mentioned above, but considered necessary for the satisfactory performance of the job, shall also be applicable.

- In the absence of any Specifications covering any material, design of works the same shall be performed / supplies / executed in accordance with Standard Engineering Practice as per the instructions/directions of the Department, which will be binding on the Contractor.
- Whenever it is mentioned in the specification that the contractor shall perform and execute certain work or provide certain facilities, it is understood that the contractor shall do so at his own cost, and the Contract price shall be deemed to have included the cost of such performances and provisions, so mentioned.

2.11.4 OWNERSHIP

- The site, equipment, and machinery belong to and are owned by the Department. The facilities, buildings, and other inventory, including utilities assigned to the Contractor, are meant for the discharge of the scope of the Contract by the Contractor. The Contractor shall have no right whatsoever to sell or transfer any of the listed inventories to any of their companies or to third parties or to put them to use for any other purpose. But at no time shall the title or ownership of these facilities rest with the Contractor either legally or contractually, implied or otherwise.
- The Contractor is not allowed to make any changes or modifications without prior concurrence and written permission of the Department. Any changes necessitated by changes in laws, regulations, codes, and standards shall be deemed as changes requested by the Department and shall be carried out after detailed discussions and mutual Agreement.
- Upon completion of the contract period, the contractor shall vacate the ASU Plant premises within 30 days from the date of completion of the contract.

2.11.5 LIMITATION OF LIABILITY

- The contractor shall take complete responsibility for the operations and maintenance of the plant, including all the manpower required for this purpose. The Department has neither any commitment nor any liability whatsoever towards these requirements, except those identified specifically under section 2.7.
- The contractor expressly indemnifies the Department from any type of claims from the contractor's personnel or any of his subcontractors, deployed/employed for the plant activities.
- Due to the negligence on the part of the contractor in not following the documents, Safety rules, & Standards, etc., the contractor shall be liable. In addition to the liabilities mentioned in this contract, the liabilities of Contractor shall include the following:
 - a) The contractor is legally bound and liable for all the liabilities and is legally responsible for the discharge of the responsibilities connected with the scope of the operation of this contract.
 - b) Any litigation, either directly or indirectly connected with the discharge of the scope by the contractor during the contract period or after termination, incidental to plant operation during the validity period of the contract, shall continue to rest with the contractor.

2.11.6 WORKING HOURS

- Plant Operation activities shall be carried out in a shift mode (three shifts), including holidays, unless a plant shutdown is declared by the Department.
- The works may have to continue beyond normal working hours to the extent of round-the-clock, including holidays, towards completing the scheduled maintenance activities/breakdown repair activities time schedule / drawn up programs, if any. No extra claim shall be entertained.

2.11.7 COORDINATION WITH OTHER AGENCIES

Work shall be carried out in such a manner that the work of other agencies operating at the site is not hampered due to any action of the Contractor. Proper coordination with other agencies will be the Contractor's responsibility. In case of any dispute, the decision of the Department shall be final and binding on the Contractor.

2.11.8 SHUTDOWNS

- Necessary shutdowns will be arranged by the Contractor in consultation with the Department for carrying out the maintenance works based on requirements. No claims on account of delayed / prolonged shutdown will be entertained.
- The breakdown works shall be completed within the schedule fixed by the Department & Contractor in a case-by-case basis, within the approved shutdown period.
- No compensations for idle time: The Contractor shall make every reasonable effort to have the materials and working front available so as not to delay operational & maintenance activities. No idle time claim shall be entertained under any circumstances.

2.11.9 SUBCONTRACTING

- The Contractor, in no case, shall lease, transfer, sub-let, appoint a caretaker, or assign scope for services and the personnel to be deployed for carrying out Plant Operation & Maintenance, Quality Assurance, and Transportation of the products to another company or its subsidiary, without the written consent of the Department.
- The Contractor shall take prior approval from the Department for awarding a subcontract for full/partial works in the contract, if any, at its own cost. In such a case, the contractor shall be responsible for the proper execution of any subcontract placed by him in connection with this contract, and the payment for the subcontractor shall be the responsibility of the Contractor.

- Written permission, if given, shall not relieve Contractor from his obligations under the Contract, and he shall take full responsibility for all work done by Sub-Contractors. Contractor shall be responsible for transmitting pertinent data of all Contract terms and conditions to Sub-contractors. Contractor shall furnish to the Department three (3) copies of all such subcontracts placed, in connection with this contract.
- The Department reserves the right to pay the subcontractor directly, in case the contractor fails to pay his subcontractor, in the interest of completion of work.

2.11.10 RECONCILIATION OF MATERIALS

- Spare / repair kits, Seals, Chemicals, oils, lubricants, desiccants, refrigerants, and consumables, etc, belong to the Department, shall be used only for Plant operations & Maintenance, and the same shall be taken into account for materials reconciliation.
- The contractor shall bear all other costs, including lifting, carting, custody, and handling, etc., and return of surplus / serviceable scrap materials to Department Stores/storage points etc. No separate payment for such expenditure will be made.
- No material shall be allowed to be taken outside the Air Separation Plant without a valid gate pass.
- The contractor shall be responsible for proper storage, preservation, and watch & ward of the materials belonging to the Department.
- Every month, the contractor shall submit an account for all materials proposed to be utilised for the O & M, in the proforma prescribed by the Department. On completion of the work, the contractor shall submit a "Material Appropriation Statement" for all materials utilized in the proforma prescribed by the Department.
- Waste materials and other partly used items are the property of the Department and must be returned to the store with the appropriate documentation so that they can be considered as part of the material reconciliation.

- Unaccountable wastage/ scrap shall be at actual as per site assessment, subject to a maximum as stated above.
- The percentage allowance shall be accounted for based on the final measurement book.
- All unused, scrap materials, and salvageable materials shall be the property of the Department and shall be returned by the Contractor category-wise at his cost to the Department-designated store yard(s).
- In case the Contractor fails to do so or exceeds the limits of allowances specified above for scrap / serviceable materials, then recovery for such quantities not returned as well as returned in excess of permitted limit by the Contractor will be done at the penal rate i.e., 125% of landed cost at the time of final bill/closing of contract by the Department, shall be affected from the Contractor's bill(s) or from any other dues of the Contractor to the Owner.
- Contractor shall be responsible for the adjustment/ weighment/ measurement of the surplus materials to be returned to the store. Contractor shall also be responsible for suitable segregation of returned materials into separate stacks of serviceable and scrap materials.

2.11.11 JOINT COORDINATION COMMITTEE

The department will identify a Focal Point at the Air Separation Plant for ensuring smooth operation, monitoring, and maintenance of the systems.

Further, A Joint Coordination Committee (JCC) comprising Department and Contractor representatives is also proposed to be formed for overseeing the plant operations towards the smooth running of the Plant. JCC is only a recommending body, and decisions /recommendations shall be implemented with the approval of the Director, SDSC, if it is applicable as per the contract, and with the approval of the Department, in case of amendments.

This Co-ordination Committee shall:

- Monitor plant operation, production schedule, ISRO's off-take, to third party and manpower utilization.

- Review of maintenance schedules
- Breakdown and root cause analysis of all items/components/equipment, etc, if any
- Review of safety incidents that occurred in the plant
- Resolve any issues arising out of the administration, security, insurance, operation, and maintenance of the Plant.
- Any deviation/modifications/changes, etc, called for towards operation & maintenance of the plant, shall be first projected to the Joint Coordination Committee, before implementation.
- Any augmentation to the plant / existing establishment, etc., shall be discussed in the JCC meeting before proceeding with such proposals.

2.11.12 MANPOWER DEPLOYMENT

- List of technical / non-technical personnel in different categories with experience certificates shall be furnished for Department Review & clearance, before the commencement of plant operations.
- Police verification of the character and antecedents of the workforce:
 1. The Character and Antecedents of the workforce shall be verified by the Service Provider / Bidder from the concerned Police authorities, and the Original Police Report (within 12 months' validity, received from the nearest police station of their Aadhaar contact address) shall be submitted to this office on the first day of the contract.
 2. The Contractor shall verify/certify the conduct of the workforce at frequent intervals. If any of the workforce misbehaves or commits any misconduct, the Department reserves the right to refuse permission to such persons to enter the premises, and such workforce shall be withdrawn by the Contractor immediately.
- The Contractor shall not engage or remove, or change any person without the knowledge and concurrence of the Department. SDSC SHAR shall have the

right to advise the Contractor to terminate the services of any employee for any violation of security provisions and/or indiscipline / violent behaviour, agitation, affecting other peaceful works. In case of such advice, Contractor shall comply with the same with immediate effect, with or without assigning any reason.

- Resignation of contract employees shall be informed to the department in advance, and also a copy of the relieving order shall be sent to the Department focal point.
- Contractor has to arrange to provide smart cards to their employees and install biometric attendance recording machines, based on the Purchaser's clearance.

2.11.13 TRANSPORTATION AND CANTEEN FACILITY

The Contractor shall make their own arrangements for total transportation and canteen facility for the persons engaged in the works. Any mode of transportation will not be provided by the department. The vehicles arranged by the Contractor should be Passenger travel worthy and shall be certified by the RTO. A copy of the relevant documents has to be submitted by the Contractor to the Department. Entry permits for vehicles will be issued through thorough security checks.

2.11.14 SECURITY RESTRICTIONS

- The contractor shall abide by and also observe all security regulations promulgated from time to time by the Department.
- Department will issue an 'entry permit' for the Contractor's working personnel after submission of police antecedent verification, without which entry will not be permitted. The photo identity card is a smart card that needs to be swiped at the time of entry/exit, for security reasons.
- The attendance and their access will be controlled by the information logged in the computerized access control system. The swiping data will also be used to check the veracity of the bills. In case of any variation in the data logged by the

system, the Department focal point's opinion is final and binding on the Contractor.

- The Contractor shall submit the list of personnel along with their address proof. It is the responsibility of the Contractor to return/surrender the passes after expiry, and in case of non-compliance in this regard, the Department reserves its right to withhold the payment till such time the passes are returned.
- In case of a smart card misplaced / untraceable, a duplicate smart card will be issued on a payment basis only when the non-traceable report from the Police is submitted. The smart ID card, on damage/mutilation, will not respond to the Access control system. Hence, the smart card needs to be protected very carefully, and in case of replacement, it will be changed on a payment basis.
- The Contractor shall maintain IN time and OUT time punching of all operational and maintenance staff at the plant entrance. The data shall be provided by the Contractor to the Department at the end of each month and also as & when desired by the Department.
- The Contractor shall not allow any visitor on the works or premises of the sites without the approval of the Department.

2.11.15 QUALITY ASSURANCES AND INSPECTION OF THE PRODUCTS

1. Quality assurance of the product shall be performed by the Contractor in accordance with the Quality assurance system given in the Quality assurance manual and related procedures, and shall be carried out by the Department for its off-take.
2. The indicators provided in the Department tankers shall be used for measuring the quantity. The measurement shall be carried out at the plant immediately after filling and before the tankers leave the premises.
3. Each tanker load meant for the Department shall leave the plant premises only after the acceptance certificate is issued by the Department.

2.11.16 SAFETY NORMS

- The Contractor is responsible for the safety of the plant and their personnel. The Contractor shall ensure process safety. The Contractor shall identify one safety focal point with PG Diploma in safety well well-versed in the Operation & Maintenance safety of the plant. The Contractor shall strictly follow the safety instructions of the Department and maintain the safety register.
- Contractor shall coordinate with the Department's safety division for safety audit & safety review and implement their suggestions for improving the safety of the plant.
- The Contractor shall train their operational personnel/workers on safety-related aspects. Implementation of safety precautions/procedures at the work site is the responsibility of the Contractor.
- All the safety appliances required for safe working, as decided by the Department, shall be provided by the contractor to his workmen.
- The Contractor and his workers shall abide by all the safety regulations and shall wear the necessary safety equipment during the work.
- Contractor's personnel shall wear uniform, Safety shoes & Helmets (Make confirm to IS 2925), inside the plant. No Workmen shall be engaged on the work without proper safety induction and without using the required PPE.
- Contractor is solely responsible for any accident/injury/death of the workforce.
- Contravention of any safety regulation of the Department in vogue from time to time will result in work stoppage, levying penalties, and ultimately in contract termination.
- The contractor shall also ensure that his employees observe the statutory safety rules and regulations, and also those laid down by the Department from time to time, and promptly submit a report of the accident and state the measures taken by him to prevent their recurrence, and also keep the employer indemnified of all claims arising out of such accidents.

2.11.17 SALE OF PRODUCTS TO A THIRD PARTY

- Sale of LOX and LIN products to Third parties shall be done by Department only.
- In case if Department desires to do the same at a later date, Contractor shall extend full cooperation to the Department by way of exploring the market potential and in fixing the price, taking into account the prevailing market price and the production cost.
- Contractor shall extend full support for assuring the quality of the product and loading to the Third-party agency road tankers at ASU premises, towards delivery.

2.11.18 PENALTIES

The Contractor shall be responsible for round-the-clock operational, availability, and maintenance of the plant. Department shall be entitled to recover Liquidated Damages/penalties from the Contractor for non-performance, from their bill, based on conditions outlined in the table below:



S. No.	Parameter	Baseline	Tolerance	Penalty
1	Shutdown	Due to the account/default of the Contractor	None	1% on Quarterly O&M Charges shall be deducted from the bills for every 1-day downtime till the resumption of the product with the specified purity.
2	Manpower Attendance	Not maintaining the minimum manpower deployment on the 1 st & 3 rd Shift for round-the-clock operation assistance, and Shift maintenance	Shortfall in the manpower shall be managed with standby staff, at no additional cost.	Human resources are essential for continuous running of the Plant for production without any break a specified and envisaged in Annexure 7I of the RFP document. In case of the any shortfall of the human resources, Rs 300 per day per person (identified crew) shall be deducted from the bills on an average.

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S. No.	Parameter	Baseline	Tolerance	Penalty
3	Completion of Preventive maintenance, Condition-based maintenance, Testing and Calibration, etc., as per the mutually approved list and scheduled for the month	Default / Delay in completion	Shall be included in the next month's activities schedule at no additional cost. However, no recovery shall be done for the reasons that are not attributable to the contractor.	Rs 5000 per month on any slipover of the monthly planned activity scheduled for that month. It is on the account of the activity compromised in the previous month and then compensated in the next month.
4	Specific Power consumption as per the plant design conditions.	Based on the actual performance guarantee test procedure & data at the plant design conditions specified in the RFP document.	+ 5%	1% on Quarterly O&M Charges shall be deducted from the bills for every 0.5% increase in specific power consumption beyond tolerances + 5%.

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Penalty may be waived by the Department on the request of the contractor for valid and sufficient reasons. However, the waiver will not be admissible as a matter of right of the contractor.

Non-availability of ASU for Production due to a breakdown.

The contractor shall have to provide standby equipment during the breakdown period and ensure uninterrupted services.

For calculation purposes down downtime on an hourly basis shall be considered. However, recovery is not applicable for the following reasons:

- a) Down time within the schedule for all maintenance jobs.
- b) Reasons which are not attributable to the agency
- c) If the downtime is within the repair/ maintenance allowable days

2.11.19 MAINTENANCE OF RECORDS

- Contractor shall maintain operational records and submit daily production reports to the Department.
- All the Documents shall be written in the English language, and the metric system of measurements shall be used exclusively in this Contract.
- The Contractor shall maintain the data acquired by the Distributed Control System in Electronic form, printed log sheets duly approved by the Department for recording hourly readings of operational parameters of entire plant with different equipment/panels etc., and maintenance documents in compliance with ISO requirements. The detailed operation & maintenance log sheet & data shall be provided by the Contractor to the Department at the end of each month and also as & when desired by the Department.
- The Contractor shall maintain data of plant Operation & Maintenance, list of deviations, log books, shift register, safety register, etc., as per the format approved by the Department. The inventory of spares, chemicals and consumables, oil & diesel, products shall be maintained on a daily basis with details of receipts and consumption.
- The contractor has to maintain facility-wise activity log books and muster rolls of his employees.
- It is the responsibility of the Contractor to store all the plant-related documents till completion of the contract period. All such documents shall be handed over to the Department upon expiry of this period.
- Quality Audit of the plant shall be carried out jointly by the Contractor and the Department, once a year, to ensure proper and safe operations of the plant.
- It is the responsibility of the Contractor to store all the plant-related documents till completion of the contract period. All such documents shall be handed over to the Department upon expiry of this period.

2.11.20 PRODUCTION CONSUMABLES PROCUREMENT

- Contractor shall ensure that the procurement cycle for Consumables & Spares shall not cause interruption in the continuous operation of the Plant.
- Production planning shall be planned at least 1 month in advance and greater than 1 month for long lead items. Weekly report shall be submitted to the Department on stock.
- No Source change for product consumables is allowed unless it is warranted. The decision of the Department shall be final.

2.11.21 DAMAGE OF EXISTING SYSTEM

Plant activities must be carried out with utmost safety, and ASU should not be disturbed/affected due to the execution of jobs by the Contractor. Care should be taken for the existing system. In case of damage to any existing system or equipment resulting from the execution of the jobs under this contract, the contractor would be held responsible, and the affected equipment/system must be restored to normalcy by the contractor at his own expense. Department reserves the right to get the job done by other agencies at the risk and cost of the contractor if he fails to take corrective actions for the damaged /affected systems, and shall deduct the necessary amount from the contractor's bills for such rectification jobs.

2.11.22 INCOME TAX

Statutory deductions on account of Income Tax at the prevailing rate as applicable from time to time shall be deducted from the contractor's bill as per the Income Tax Act, 1961, and the rules thereunder or any re-enactment or Modifications thereof. Tax deducted-at-source certificate will be issued to the Contractor.

2.11.23 GOODS & SERVICE TAX

- Responsibility for the payment of GST lies with the Contractor only.

- The bidder shall furnish a copy of the GST registration along with the offer wherever applicable. Alternatively, the bidder shall furnish the same within one month from the date of issue of the Letter of Award or along with the first Invoice. In case GST is applicable for the tendered work, the Agency shall claim the GST, indicating the rate of abatement/deduction allowed as per the GST Act in the first invoice itself.
- In case of statutory variation in GST/statutory variation in GST, it should be raised in subsequent months from the date of issue by the Government. Notification for payment of the differential GST amount. In case such a claim is not raised within the specified period of two months, the claim shall not be entertained for payment of arrears.

2.11.24 FORCE MAJEURE

A Force Majeure (FM) means extraordinary events or circumstance beyond human control such as an event described as an act of God (like a natural calamity) or events such as a war, strike, riots, crimes (but not including negligence or wrong-doing, predictable/seasonal rain and any other events specifically excluded in the clause). An FM clause in the contract frees both parties from contractual liability or obligation when prevented by such events from fulfilling their obligations under the contract. An FM clause does not excuse a party's non-performance entirely, but only suspends it for the duration of the FM. The firm has to give notice of FM as soon as it occurs (say, not later than 14 days after its occurrence), and it cannot be claimed ex-post facto. There may be a FM situation affecting the purchase organization only. In such a situation, the purchase organization is to communicate with the supplier along similar lines as above for further necessary action. If the performance in whole or in part or any obligation under this contract is prevented or delayed by any reason of FM for a period exceeding 90 (Ninety) days, either party may at its option terminate the contract without any financial repercussion on either side. Notwithstanding the punitive provisions contained in the contract for delay or breach of contract, the supplier would not be liable for imposition of any such

sanction so long as the delay and/ or failure of the supplier in fulfilling its obligations under the contract is the result of an event covered in the FM clause.

2.11.25 APPLICABLE LAW, JURISDICTION & DISPUTE RESOLUTION

a) Applicable Law & Jurisdiction

The contract shall be interpreted and governed in accordance with the laws of the Union of India. Any legal issue, dispute, or claim arising out of or relating to this contract shall be subject to the exclusive jurisdiction of the courts located in Tirupati district, Andhra Pradesh, India only.

b) Dispute Resolution

Amicable Settlement: In case of any dispute or difference arising out of or in connection with this contract, the parties shall first attempt to resolve the matter amicably through mutual discussions within thirty (30) days from the date the dispute arises.

Conciliation / Mediation: If amicable resolution fails, the parties may refer the dispute to conciliation or mediation by a mutually agreed third party before proceeding to arbitration.

Arbitration

In the event of any dispute(s) and/or difference(s) arising out of or relating to the interpretation and application of the Work Order, such dispute(s) and/or difference(s) shall be settled amicably by mutual consultations of the good Office of the respective Parties and recognizing their mutual interests attempt to reach a solution satisfactory to both the parties. If such a resolution is not possible within 30 days from the date of receipt of written notice of the existence of such dispute(s) and/or difference(s), the unsolved dispute(s) and/or difference(s) shall be referred to the Arbitrators appointed by the Parties by mutual consent in accordance with the rules and procedures of Arbitration and Conciliation Amendment Act, 2015 as amended from time to time. The arbitration shall be conducted Satish Dhawan Space Centre SHAR, Sriharikota. The expenses for the Arbitration shall be shared equally or as may be determined by the Arbitrator. The

considered and written decision of the Arbitrator shall be final and binding between the Parties. The applicable language for Arbitration shall be “English” only.

Services under the Work Order shall be continued by Party during the pendency of arbitration proceedings, without prejudice to a final adjustment in accordance with the decision of the Arbitrator unless otherwise directed in writing by the Centre (SDSC SHAR) or unless the matter is such the Work Order cannot be possible continued until the decision (whether final or interim) of the Arbitrator is obtained.

In case order is concluded on the Public Sector Undertakings, the following Arbitration Clause will be applicable:

In the event of any dispute(s) or difference(s) relating to the interpretation and application of the provisions of the commercial contracts between ISRO/SDSC SHAR & Central Public Sector Enterprises (CPSEs)/Port Trusts inter se and also between ISRO/SDSC SHAR & CPSEs and Government Departments/Organizations (excluding disputes concerning Railways, Income Tax, Customs & Excise Departments), such dispute(s) or difference(s) shall be taken by either party for resolution through the “Administrative Mechanism for Resolution of CPSEs Disputes (AMRCD)”, as mentioned in the Office Memorandum F No. 4(1)/2013-DPE(GM)/FTS-1835 dated 22nd May, 2018 issued by the Director of the Department of Public Enterprises (DPE) under the Ministry of Heavy Industries and Public Enterprises, Government of India.

2.11.26 TERMINATION OF CONTRACT

Under normal circumstances, termination of the agreement is not foreseen. However, in the case of non-compliance with or non-performance of the terms and conditions of the contract set out in this contract by either the Contractor or the Department, both parties shall have the right to terminate this contract, wholly or partly, by giving a notice of 3 months’ in writing to the other party.

The termination of this contract for any other reason shall be by mutual consent.

2.11.27 INSOLVENCY AND BREACH OF CONTRACT

The department may at any time terminate the contract by notice in writing, terminate the contract with immediate effect in any of the following cases:

- a) In the event of the Contractor going into liquidation or winding up his business, or making arrangements with his creditors.
- b) It is found that the contract has been procured by submitting incorrect or incomplete statements by the contractor or by making any misrepresentation, including the submission of forged documents.
- c) In the event of any breach of the terms and conditions of the contract by Contractor or if Contractor is found to be indulging in activity subversive to the Department's interest or activity prejudicial to the interests of the Department, and for any other good or sufficient reasons.

Upon such termination of the contract, the Security Deposit is liable to be forfeited and the Bank guarantee to be invoked.

Contractor, upon receipt of such notice, shall discontinue the work. In the event of such termination, Contractor shall be paid for the actual time performed and service provided till the date specified in the notice.

2.11.28 APPLICABLE LAW AND INDEMNITY CLAUSE

The contract shall be governed by and interpreted in accordance with the laws of India. The Contractor shall indemnify the Department and be solely responsible for infringement of any law of the states in force during the tenure of the contract by the Contractor.

2.11.29 SECURITY DEPOSIT

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The Contractor shall furnish a security deposit for an amount equivalent to 3% of the total annual contract cost, valid during the period of the contract, towards the performance of the contract by providing a bank guarantee from any nationalized/scheduled bank approved by the RBI in favour of the Department. The bank guarantee shall be submitted by the Contractor within fifteen days from the date of acceptance of satisfactory commissioning of the Plant by the Department. The format for the bank guarantee is given in Annexure-3. In case of non-performance of the Contractor or irreparable damages caused to the plant on the part of the Contractor, the security deposit shall be revoked by the Department.

2.11.30 RECOVERY OF SUMS DUE

Whenever any claim for payment of any sum of money arises out of or under the contract against the contractor, the Department shall be entitled to recover such sum by appropriation in part or in whole of the performance Security Deposit by the contractor. In case the sum is not sufficient to cover the full amount recoverable, the contractor should pay on demand the remaining balance due.

2.11.31 CLOSURE OF CONTRACT

Final payment shall be released only after satisfactory completion of the work/services. For final payment of the bill and release of the Security deposit, the contract agency shall be required to submit an Indemnity Bond on Rs. 100/- stamp paper, duly notarized by a notary, indemnifying the Department from all liabilities w.r.t. the persons engaged by the Agency regarding Payment of Wages, Provident Fund, Insurance, and other payments. Proforma of Indemnity Bond.

PART 3:

COMMERCIAL TERMS AND CONDITIONS

3.0 COMMERCIAL TERMS AND CONDITIONS

3.1. BIDDING DOCUMENTS

The bidder is expected to examine the bidding documents, including all instructions, Pre- Qualification Criteria, Forms, Annexures, terms and conditions of Contract, specifications, drawings and other documents and to fully familiarize itself with the requirements of the bidding documents. Failure to furnish all the information required by the Bidding Documents or the submission of a bid not substantially responsive to the Bidding Documents in every respect may result in the rejection of the Bid.

3.2. AMENDMENT OF BIDDING DOCUMENTS

- Bidders shall examine the Bidding documents thoroughly and inform the Department of any apparent conflict, discrepancy or error.
- At any time prior to the deadline for submission of bids, the Department may, for any reason whether at its own initiative or in response to a clarification or modification requested by any prospective Bidder(s), modify the Bidding documents, if required.
- Any Amendment to the bidding document (Corrigenda / Addenda / Amendment / extension in bid due date / Clarifications etc) if any, shall be hosted on eprocurement portal.
- Bidders are therefore advised to visit the Portal regularly for downloading the details of amendment to bidding document. The Bidders will be required to acknowledge notification of any such amendment to the Bidding documents. Bidders shall confirm the inclusion of Addendum/Corrigendum in their bid and shall follow the instructions issued along with addendum/corrigendum

3.3. LANGUAGE OF THE BID

The bid prepared by the bidders and all correspondence and documents relating to the Bid exchanged by the Bidder and the Company shall be written in the English language and all units shall be in Metric system. In case a document, certificate, printed literature, etc furnished by the bidder is in a language other than English, the same should be accompanied by an English

Translation, duly authorized by the Chamber of Commerce of the Bidders' country, in which case, for the purpose of interpretation of the bid, the English translation shall govern.

3.4. COST OF BID / BIDDING

All direct and indirect costs associated with the preparation, submission of bid shall be in to Bidder's account, and SDSC SHAR will in no case be responsible or liable for those costs, regardless of the conduct or outcome of the bid process.

3.5. SIGNATURE ON BIDS

- The Bid must contain the name, designation and place of business of the person or persons making the Bid and must be signed and sealed, on each page, by the Bidder with his usual signature. The names of all persons signing should also be typed or printed below the signature. The Bidder shall submit authority letter / Power of Attorney/ Board Resolution in favour of the authorized signatory(s) of the Bid. The Bidder's name stated on the proposal shall be the exact legal name of the Bidder
- Bids by bodies corporate/ limited Companies must be signed with the legal name of the Corporation/Limited Company by the President, Managing Director or by the Company Secretary or any other person or persons holding Power of Attorney for signing their Bid.
- In case of a Single Bidder, Power of Attorney issued by the Board of Directors/ CEO / CHAIRMAN/ MD / C&MD /Company Secretary of the Bidder/ all partners in case of Partnership firm/Proprietor in favour of the authorised employee(s) of the Bidder, in respect of the particular tender for signing the Bid and all subsequent communications, agreements, documents etc. pertaining to the tender and to act and take any and all decision on behalf of the Bidder, is to be submitted.
- The authorized employee(s) of the Bidder shall be signing the Bid and any consequence resulting due to such signing shall be binding on the Bidder.
- Power of Attorney shall be as per law of land;
- Bid shall contain no cuttings, erasures or overwriting except as necessary to correct errors made by the Bidder in which case each such corrections or

other changes in the Bid documents shall carry the initials of the person(s) signing the Bid.

3.6. MODIFICATION AND WITHDRAWAL OF BIDS

- In case any clarifications are sought by the Department after opening of tenders, then the replies of the bidder should be restricted to the clarification sought. Any bidder who modifies his bid (including a modification which has the effect of altering the value of his offer) after opening of Technical and Commercial bids without specific reference by the Department shall render the bid liable to be rejected without notice and without further reference to the Bidder.
- No bid may be withdrawn in the interval between the deadline for the submission of bids and the expiration during the validity or agreed extension validity period duly agreed by the bidder.

3.7. INFORMATION REQUIRED WITH THE BID

- Any bid not containing sufficient descriptive material to describe accurately the process details, functioning of various sections of the Plants, equipment proposed and other necessary details may be treated as incomplete and hence rejected. Such descriptive material and drawings submitted by the Bidder will be retained by the Department. Any major deviation from these drawings and descriptive material submitted will not be permitted during the execution of the Contract without specific written permission of the Department.
- Standard catalogue pages and other documents of the Bidder may be used in the bid to provide additional information and data as deemed necessary by the bidder.

3.8. LOCAL CONDITIONS

- It will be imperative on each Bidder to fully inform himself of all local conditions and factors which may have any effect on the execution of the works covered under these specifications and documents. Bidder shall inspect the site, examine and obtain at its cost and responsibility, all information required and satisfy himself regarding all matters and things

such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials and their rates, local working conditions, weather, flood levels, sub-soil conditions, natural drainage, and all information that may be necessary for preparing its Bid, performance of work and other obligations and related matters. By submitting the Bid the Bidder shall be deemed to have acknowledged and agreed that ignorance of the site and other said conditions shall not be basis for any claim for compensation or extension of time or loss of profits etc. and the Department shall not be liable on account thereof in any manner whatsoever to the Bidder or any person claiming through or under the Bidder.

- Bidders must before submission of their Bids, acquaint themselves with all applicable regulatory and other legal requirements pertaining to insurance and health, safety and environment requirement in INDIA and rules related to work permit and visa requirements in INDIA or in any way or manner affecting the performance of Scope of Work, the Contractor and the Plant operation and performance including social security, safety, pollution control, permits, licenses, and the other statutory requirements and regulations. The submission of a Bid by the Bidder will be construed as evidence that such an examination was made and the Bidder shall not raise at any time later any claims/disputes against the Department and the Department shall not be liable for the same in any manner whatsoever.
- The Department shall not entertain any request for clarification from the bidder, regarding such local conditions.
- The Bidder shall be deemed to have prepared the Bid on the basis of its independent judgment and to have made all necessary allowances and provisions to ensure that the Air Separation Plant will meet all technical specification prescribed hereunder including the specified performance requirements and guarantees and be entirely suitable for the purpose for which it is intended. Accordingly, at the time of submission the Bid Price will, without extra price and/or extension of time, be held to include everything implicitly or otherwise required or necessary for the proper and timely completion of the work including Acceptance of Plant in accordance

with the Contract. Further, in case of any contract awarded under these specifications and documents, neither any change in the time schedule of the Contract nor any financial adjustments arising thereof shall be permitted by the Department, which are based on the lack of such clear information or its effect on the cost of the works to the Bidder.

- Visit to site is optional and at Bidders cost and expense.

3.9. BID PRICE & CURRENCY OF BIDS

- The Bidders shall quote in their price for the entire scope of work as per Form 13 to Form 15, Form 16 A & 16B in the price schedule format and the price break-up Format.
- The price of materials shall be quoted in INR only.
- Bidders shall quote the price for supply items and services to be procured from India and for expenses to be incurred in India only in Indian Rupees.
- It shall be the duty of the Bidder to duly observe and perform all laws, rules, regulations, orders and formalities applicable under GST, Customs Duty, manufacture, sale and/or supply of any material to the Department and performance of the works under the contract. The Supplier shall keep the Department indemnified from and against any and all claims, demands, prosecutions, actions, proceedings, penalties, damages, demurrages and/or other levies whatsoever made or levied by any Court, Tribunal or the Customs or other Authorities with respect to any alleged breach, evasion or infraction of such duties, taxes, charges or levies or any breach or infraction of any applicable laws, rules, regulations, orders or formalities concerning the same and from the consequence thereof attributable to the Supplier.

3.10. BIDDING DOCUMENTS AND DEVIATION

- Bidders shall confirm compliance to Bidding Documents.
- It is expected that bidders will submit bids based strictly on the terms and conditions and specifications contained in the bidding documents and will not stipulate any deviations. Department reserves the right to reject as non-responsive any bid containing deviation(s).

- Bidder's authorized representative(s) shall attend the pre bid clarification meeting on the prescribed day. During the pre-bid clarification meeting, all the technical and commercial issues shall be discussed and concluded to ensure that the bid received subsequent to pre bid meeting shall be without any deviations to terms and conditions. Hence, bidders shall treat the pre bid clarification meeting as utmost important and depute competent & senior person capable of taking on the spot decision to sort out all the technical and commercial issues.
- However, in case any bidder does not attend the pre bid clarification meeting, it shall be understood that the bidder has a clear understanding of the scope, terms & conditions of the bidding document and does not have any comments/ deviations to the requirements of the bidding document.
- In order to ensure fruitful discussions during pre-bid clarification meeting, the bidder is requested to submit any queries/clarification/information pertaining to Bidding document in writing delivered by e-mail in the format provided in Bidding Forms so as to reach two days prior to pre bid clarification meeting. These queries shall be replied during pre-bid clarification meeting. The editable soft copies of the queries shall also be e-mailed to concerned persons specified in tender, to enable Purchaser to prepare replies to the queries in the same format expeditiously.
- The bidders are required to participate in the pre-bid clarification meeting after going through the entire bidding document. Bidder shall come with all technical and commercial points on which they need clarifications and also to ensure that they possess all the supporting documentation for meeting the Qualification Criteria. In case of any doubt, they may discuss the same during the meeting to avoid any techno-commercial clarifications/ discussions post bid.
- Any modification of the Bidding Document, which may become necessary as a result of the pre-bid discussion, shall be intimated to all bidders through the issue of an Addendum/Amendment at the Portal.
- Technical/ Commercial queries (TQ/CQ) shall not be issued once the bids have been opened. However, wherever CQ/ TQ are unavoidable, the same

may be raised and the cut-off date given for CQ/ TQ replies shall be adhered to.

- Offers shall be evaluated based on the information available up to cut-off date for CQ/ TQ replies. Bidder shall not submit any Price against TQ/ CQ raised.
- Bidder is advised to visit and examine the Project Site and its surroundings and obtain for itself on its own responsibility all information that may be necessary for preparing the bid and entering into a contract for execution of the Works. All costs towards the same including the cost of visiting the Site shall be at the bidder's own expense.
- Bidder and any of its personnel will be granted permission by Department to enter upon its premises and lands/ Project Site for the purpose of such visit, but only upon the express condition that the bidder and its personnel will relieve and indemnify Owner and its personnel from and against all liability in respect thereof, and will be responsible for death or personal injury, loss of or damage to property, and any other loss, damage, costs, and expenses incurred as a result of the inspection.

3.11. PRICE BASIS

Prices quoted should be on the basis of F.O.R. SDSC, SHAR, Sriharikota, 524124. The Bidder shall submit the cost proposal as per price bid format. Unit price includes charges for Third Party Inspection works involved, during realisation of Air Separation Plant. The rates shall be valid until handing over the systems to purchaser and Bidder shall also supply additional items / quantities, if required for the completion and successful commissioning of the systems without any additional cost. Items not featuring in the RFP document but required for completion of the systems shall be borne by Bidder and shall be deemed to be included in the bidder's offer. No extra claim for such items shall be entertained after placement of order

3.12. TAXES & DUTIES

- a) **GST:** Bidders must provide applicable GST rate/s as well as HSN/SAC Code for the item/service/s quoted, for evaluation of the offer.

b) CUSTOMS DUTY:

- As per notification No.45/2025 Customs dated 24.10.2025, ISRO is eligible for NIL Customs Duty.
- The necessary Custom Duty Exemption Certificate (CDEC) shall be provided by ISRO on to those Bidders who claim purchase preference under Make in India Policy and full fill all requirements of Tender document applicable for Indigenous Manufacture i.e. CLASS I / CLASS II Local supplier. Such CLASS I / CLASS II Local supplier have to take note of this aspect and submit their offer clearly mentioning the Quoted price arrived by considering the NIL Custom Duty as per above notification.
- While requesting for issue of CDEC for the imported content, the Tenderers should mention the item description, quantity for which CDEC is to be provided for the bought out imported items. The necessary documentary proof like P.O on their supplier, Invoice, AWB shall be produced will requesting for issue of CDEC from ISRO.
- However, CDEC will be issued only to those successful CLASS I / CLASS II Local supplier, not exceeding the limit of Foreign Content declared in their quote. Also a declaration of the supplier in their letter head that imported items in the invoice are used for realisation of ordered items.
- Supplier may note that ISRO is not responsible for any incidental charges incurred towards late / non submission of CDEC.

- c) INCOME TAX:** Income tax at TDS at the prevailing rate as applicable and if applicable from time to time shall be deducted from the supplier's bills as per Income Tax Act and a certificate issued (TDS Certificate).

3.13. DELIVERY PERIOD

Delivery is the essence of this PO/ Contract and hence, scope of the works as listed in RFP shall be completed within Twenty-Four months (24) from date of Purchase Order release. In this duration, plant shall be completed in all respects including commissioning and Performance Guarantee Test.

The delivery of all equipment / items / components / services etc, shall be so scheduled that it shall be possible to commission within due date from the date of award of PO in order to match with the overall commissioning schedule of Project.

3.14. DELIVERY SCHEDULE

The following delivery scheduled may be adhered strictly towards completion the realization of Air Separation Plant within 24 Months.

Milestone	Deliverable	Timeline
T0	PO release	
T1	Submission of Detail Design & Engineering Reports	T0 + 2 Months
T2	• Mobilisation of site construction equipments • Building construction works & Structural shed • Equipment Foundations & Piping Pedestals • Electrical & Air conditioning	T0 + 12 Months
T3	• Review and approval Design and Detailed Engineering • Department Clearance for bought out items	T1+ 15 days
T4	Supply of Equipments	T3 + 10 Months
T5	Supply of Instrumentation related items	T3 + 10 Months
T6	Supply of Automation / Control System related items	T3 + 10 Months

T7	Supply of Auxiliary systems	T3 + 10 Months
T8	Supply of 250 KL storage tanks, Transportation tankers along with Prime movers	T3 + 10 Months
T9	Department Clearance for Equipment Erection / Installation	T2 + 15 days
T10	Erection / Installation of Air Separation Plant equipment's	T9 + 6 months
T11	Installation & Interfacing of Instrumentation System, Control System and Auxiliary systems	T9 + 6 Months
T12	Department Clearance for Subsystem testing / pre-commissioning	T11 + 1 Month
T13	Subsystem testing / pre-commissioning of individual systems and Departmental clearance	T12 + 2 months
T14	Department Clearance for Final Commissioning	T13 + 15 days
T15	Commissioning of the Plant & Performance Guarantee Testing	T14 +2 Months

- Schedules and Milestones: The contractor shall submit the schedules and milestones in the standard bar chart format within the 10 days of the contract.
- Progress reviews and corrective actions: These reviews shall be conducted regularly at least once in a month. This review shall be based on the schedule chart / PERT chart submitted by the Contractor. Slippages during the period shall plan to correct it in due course without further slippages. The entire work shall be completed within the specified period.

3.15. PAYMENT TERMS

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3.15.1 PAYMENT MILESTONES

The payment terms applicable are as follows, however an indicative break-up of items under the scope of work along with the values (in the form of a billing schedule) will be finalized by supplier and Department for effecting the pro-rata payments.

S. No.	Milestone for Payment	% of Payment on Contract Value	Remarks
1	Advance payment	10	Advance payment against submission of bank guarantee for an equal amount from a nationalized / scheduled bank and shall be valid till Contract completion period plus 60 days. Format of Bank guarantee shall be obtained from Department after award of contract.
2	Detail Engineering documents & Purchase order copies	10	After completion & submission of Detail Engineering documents & also Placement of Purchase order for Major Equipment / Raw materials / Bought out items against BG.
3	Civil Works & Auxiliary Systems	10	Completion of Civil works, Buildings, Structural Shed, Equipment Foundations, Paved areas, Approach Roads, Fencing, Rain water harvesting, Trenches, Humes, Pedestals, Fire Fighting Systems, Softening plant, Effluent / Waste water treatment plant, Process water distribution, Drinking water & Etc., All the works related to civil and auxiliary systems towards plant operation.

4	Supply and Acceptance of Plant Equipments	40	Receipt of Process Equipments including Instrument, Automation/Control & Electrical systems along with Commissioning /start-up spares and Acceptance at Department site along with relevant documents
5	Plant Erection and Commissioning	15	Systems / equipment erection, installation, sub-system testing & Commissioning at Department site along with TPI certification
6	Performance Guarantee Testing and Acceptance	15	Plant Production Performance Guarantee testing as per design and Acceptance by Department and submission of Performance bank guarantee for the equal amount, valid till warranty period plus 60 days.

3.15.2 MODE OF PAYMENT

- Bidders can submit the banker details and payments can be made through NEFT/RTGS through PFMS.
- Bank Guarantee from any Nationalized Bank / Scheduled Bank should be furnished. If the contractor / supplier is not realizing the plant within the delivery schedule, the advance amount will be recovered and interest will be levied as per the Marginal Cost of Lending Rate (MCLR) of RBI for the delay period.
- If the contractor/ supplier is realizing the plant beyond reasonable delay, then the advance will be recovered and the interest will be levied as per the Marginal Cost of Lending Rate (MCLR) of RBI at 2 % Penal Interest.

3.16. SECURITY CUM PERFORMANCE BANK GUARANTEE (SD cum PBG)

- 3% value of the order shall be deposited with SDSC within 10 days from the date of the Purchase Order towards security deposit in the form of Bank

Guarantee towards performance of the Contract valid till completion of the contract period plus sixty days towards claim period.

- The Security Deposit (bearing no interest) shall be held by the Department as Security till satisfactory completion, testing and handing over of all the systems and for the due performance of all the Contractor's obligations under the Contract as per delivery period or extension granted thereof by the Department.
- In case of breach of Contract, the Security Deposit shall stand forfeited in addition to other reliefs available to the Department under this Contract.

3.17. VALIDITY OF OFFER

Bid shall remain valid for acceptance for a period of 180 days from the due date of submission of the bid. The bidder shall not be entitled during the said period to revoke or revise his bid or to vary the bid except and to the extent required by SDSC SHAR in writing. Bid shall be revalidated for extended period as required by SDSC SHAR in writing. In such cases, unless otherwise specified, it is understood that validity is sought and provided without varying either the quoted price or any other terms and conditions of bid finalized till that time.

3.18. LIQUIDATED DAMAGES (LD)

Since delivery is the essence of this order, LD @ 0.5% per week or part thereof subject to a maximum of 10% of the order value of the undelivered portion for the delayed period of supply/ scope of work.

3.19. WORKMANSHIP GUARANTEE

The Supplier shall guarantee the Department that the entire plant inclusive of all equipment, component and items (Mechanical, Electrical, Instrumentation etc.) shall be free from faulty design, poor workmanship and improper material of construction and that the plant is of sufficient size and capacity, using the most energy efficient state-of-the-art technology to fulfill the operating conditions satisfactorily as specified in the bid package. Should any defect in design, material, workmanship or operating characteristics develop within the guarantee period, The Supplier shall make all necessary alterations,

modifications, repairs and replacement free of charge within one month of notification/detection without any commercial implication to the Department.

3.20. PERFORMANCE GUARANTEE

- The Supplier shall guarantee the performance parameters of the plant as a whole to meet the plant performance parameters as specified in the RFP document.
- The Supplier shall be solely responsible for proving the performance guarantee parameters after Commissioning at Site.

3.21. WARRANTY / DEFECTS LIABILITY PERIOD

The Contractor shall guarantee the design, engineering, workmanship, materials, and performance of the complete system and equipment for a period of 12 months from the date of commissioning and handing over the plant to Department.

- a) During this period, the Contractor shall, at its own expense, repair or replace defective components within 30 days of intimation from the department.
- b) The warranty shall cover all supplied equipment and materials, installation workmanship, Control and protection systems, Civil buildings, mechanical items and etc.

3.22. REPLACEMENT OF DEFECTIVE PARTS AND MATERIALS

If during the progress of the Work, Department shall decide and inform in writing to the Bidder, that the Bidder has manufactured any plant or part of the plant found to be unsound or imperfect or has furnished plant inferior to the quality specified, the Bidder on receiving details of such defects or deficiencies shall be at his own expenses within 07 (Seven) days of his receiving the notice, or otherwise within such time as may be reasonably necessary for making it good, proceed to alter, reconstruct or remove such work and furnish fresh equipment's up to the standards of the specifications. In case the Bidder fails to do so, Department may on giving the Bidder 07 (Seven) day notice in writing of his intentions to do so, proceed to remove the portion of the Work so complained of and at the cost of Bidder's, perform all such works or furnish all such equipment's provided that nothing in the clause shall be deemed to

deprive the Department of or affect any rights under the Contract, the Department may otherwise have in respect of such defects and deficiencies.

3.23. REPAIR / RECTIFICATION / MODIFICATION

In case the Air Separation Unit fails to meet the guaranteed parameters, the Supplier shall carryout, necessary repair, rectification and modification within the time frame defined in the contract or a mutually agreed with the Department, at his own risk and cost to establish the guaranteed parameters in the final performance test. All costs involved for above activities i.e. supply of manpower, materials, consumables and machines etc. shall be to Suppliers account.

3.24. MAKE IN INDIA

For this procurement, provisions contained in Government Public Procurement Order No. P-45021/2/2017-PP(BE-II)-Part(4) Vol.II dated 19.07.2024 its latest directives/amendments there of shall be followed. Accordingly, you are requested to indicate the percentage of local content in the material, clearly mentioning the details of location(s) at which value addition is made in line with clause 9 to O.M dated 19.07.2024 referred above. It may be noted that Local Content shall not include services such as Transportation, Insurance, Installation, Commissioning, Training and after sales service support like AMC/CMC etc. In case the bid value is more than Rs 10 Crore, the declaration relating to percentage of local content shall be certified by the statutory auditor or cost auditor, if the OEM is a company and by a practicing cost accountant or a chartered accountant for OEMs other than companies as per the Public Procurement (preference to Make-in -India) order.

Bidders shall ensure that for tenders involving supply of multiple items, weighted average of all items to be taken while calculating the local content.

The Bidder shall give self-certification for local content in the quoted item (goods/works/services) at the time of tendering. However, at the time of execution of the project, for all contracts above INR 10 Crore, the contractor/supplier shall be required to give local content certification duly certified by cost/ chartered accountant in practice. For cases where it is not possible to provide certification by Cost/ Chartered Accountant at the time of execution of

project, the supplier shall be permitted to provide the certificate for local content from Cost/Chartered Accountant after completion of the contract, within time limit acceptable to the procuring entity. In case the contractor/supplier does not meet the stipulated local content requirement and the category of the supplier changes from Class-I to Class-I or from Class-II to Non-local, a penalty upto 10% of the contract value shall be imposed.

"Purchase preference to MSE/MII-Class-I local suppliers will be as per notification No.F.1/4/2021-PPD dated 18-05-2023 and its directives/amendments thereof issued by Ministry of Finance, Department of Expenditure, Public Procurement Division".

3.25. MSME

Purchase preference will be given to MSEs having valid Udyam Registration and whose credentials are validated online through Udyam Registration portal as defined in Public Procurement Policy for Micro and Small Enterprises (MSEs) Order, 2012 dated 23.03.2012 issued by Ministry of Micro, Small and Medium Enterprises and its subsequent orders/ Notifications issued by concerned Ministry. If the bidder wants to avail themselves of the Purchase preference, the bidder must be the manufacturer / OEM of the offered product on GeM. Traders are excluded from the purview of Public Procurement Policy for Micro and Small Enterprises and hence resellers offering products manufactured by some other OEM are not eligible for any purchase preference. In respect of bid for Services, the bidder must be the Service provider of the offered Service. Relevant documentary evidence in this regard shall be uploaded along with the bid in respect of the offered product or service and Buyer will decide eligibility for purchase preference based on documentary evidence submitted, while evaluating the bid. If L-1 is not an MSE and MSE Seller (s) has / have quoted price within L-1+ 15% (Selected by Buyer) of margin of purchase preference /price band defined in relevant policy, such MSE Seller shall be given opportunity to match L-1 price and contract will be awarded for 100% (selected by Buyer) percentage of total quantity. The buyers are advised to refer the OM No. F.1/4/2021-PPD dated 18.05.2023. OM_No.1_4_2021_PPD_dated_18.05.2023 for compliance of Concurrent application of Public Procurement Policy for Micro and Small Enterprises Order, 2012 and Public Procurement (Preference

to Make in India) Order, 2017. Benefits of MSE will be allowed only if seller is validated on-line in GeM profile as well as validated and approved by Buyer after evaluation of documents submitted.

Relaxation for Minimum Qualification Criteria i.e. Financial Soundness, Technical Eligibility & Previous experience shall not be applicable for this Tender to MSME vendors.

3.26. **AMBIGUITY**

Should there be any ambiguity or doubt as to the meaning of any of the tender clause/condition or if any further information is required, the matter shall be immediately brought to the notice of Sr. Head, Purchase & Stores of SDSC SHAR in writing

3.27. **FORCE MAJEURE**

A Force Majeure (FM) means extraordinary events or circumstance beyond human control such as an event described as an act of God (like a natural calamity) or events such as a war, strike, riots, crimes (but not including negligence or wrong-doing, predictable/seasonal rain and any other events specifically excluded in the clause). An FM clause in the contract frees both parties from contractual liability or obligation when prevented by such events from fulfilling their obligations under the contract. An FM clause does not excuse a party's non-performance entirely, but only suspends it for the duration of the FM. The firm has to give notice of FM as soon as it occurs (say, not later than 14 days after its occurrence), and it cannot be claimed ex-post facto. There may be a FM situation affecting the purchase organization only. In such a situation, the purchase organization is to communicate with the supplier along similar lines as above for further necessary action. If the performance in whole or in part or any obligation under this contract is prevented or delayed by any reason of FM for a period exceeding 90 (Ninety) days, either party may at its option terminate the contract without any financial repercussion on either side. Notwithstanding the punitive provisions contained in the contract for delay or breach of contract, the supplier would not be liable for imposition of any such sanction so long as the delay and/ or failure of the supplier in fulfilling its obligations under the contract is the result of an event covered in the FM clause.

3.28. PROCUREMENT FROM A BIDDER SHARING LAND BORDER WITH INDIA

Bidder has to comply with the provisions regarding Procurement from a Country sharing Land Border with India. Suppliers / OEM shall not be allowed to sub-contract works or Purchase from any of the Firm / Manufacturer from a country which shares a land border with India unless such Firm / Manufacturer is registered with the competent authority. DoE order on public procurement dated 23.02.2023 shall be referred from Gov. Portal. Latest Guidelines/ Circulars/ Notifications issued by competent authorities shall be applicable.

3.29. SCOPE CHANGE

Scope change, in the RFP document. i.e. All the equipment / quantities mentioned are indicative and the exact quantity may vary based on the site conditions and process requirements. Supply of any other items which is not explicitly mentioned in the document but required for meeting the complete functional requirement of the system has to be provided by the supplier without any additional cost.

3.30. SUB-CONTRACTS AND ASSIGNMENT

- a. The Contractor shall not assign, sub-contract or sublet the whole or any part of the work in any manner. However, the Contractor may, with the prior written approval of Department, Sub-Contract any particular work or part of the work to any Sub-contractor approved by the Department.
- b. Each Sub-Contractor shall be covered by the Contract on the same basis as the Contractor including maintenance of records and diversification by the Department, provided, however, that notwithstanding approval of the Sub-Contract as aforesaid and notwithstanding that the Department shall have received a copy of the Contract, between Contractor and Sub-Contractor, the Contractor shall be and shall remain exclusively responsible to the Department for due and proper performance of the Contract, and Sub-Contractor shall for all purposes deemed to be servant/agent of Contractor employed for the performance of the particular work with full responsibility on Contractor for all acts, omissions and defaults of the Sub-

Contractor and any rights that Department may separately have or reserve against Sub-Contractor under the Contract shall be without prejudice to the foregoing.

- c. Subject to as hereinabove in this behalf specifically permitted and provided, the Contractor shall not sub-contract any work under the Contract, and any sub-contract in breach thereof shall be deemed to be an assignment of the Contract or part of portion thereof sub-contracted, as the case may be and shall be an event of default.
- d. Department shall have a legal relationship with the Contractor only. It shall be the responsibility of the Contractor to supervise and control the work carried out by the Sub-Contractors and to be answerable for any defect, default or deviation, etc., by them.
- e. If any Sub-Contractor engaged upon the work at the Site executes any work which in the opinion of the Contract Manager is not as per the requisite standard (the opinion of the Contract Manager being final in this behalf), the Contract Manager may give written notice to the Contractor, require the Contractor to terminate such sub-contracts, and Contractor shall upon the receipt of such notice terminate such sub-contract at the risk and cost of Contractor and shall keep Department indemnified against the consequences.
- f. All the works carried out by the Sub-Contractors shall also be scrutinized, inspected and approved by the Department. However, the responsibility for the performance of such sub-contracted system shall lie with the Contractor. Any delay in carrying out the work by the Sub-Contractor, which affects the overall schedule of the work, does not absolve the Contractor from payment of compensation for the delays.
- g. Nothing provided hereinbefore shall in any way detract the access of the Department to any of the Sub-Contractors whether under this Contract or any other Contracts of the Department with the Sub-Contractors.

3.31. APPLICABLE LAW, JURISDICTION & DISPUTE RESOLUTION

a) Applicable Law & Jurisdiction

The contract shall be interpreted and governed in accordance with the laws

of the Union of India. Any legal issue, dispute, or claim arising out of or relating to this contract shall be subject to the exclusive jurisdiction of the courts located in Tirupati district, Andhra Pradesh, India only.

b) Dispute Resolution

Amicable Settlement: In case of any dispute or difference arising out of or in connection with this contract, the parties shall first attempt to resolve the matter amicably through mutual discussions within thirty (30) days from the date the dispute arises.

Conciliation / Mediation: If amicable resolution fails, the parties may refer the dispute to conciliation or mediation by a mutually agreed third party before proceeding to arbitration.

Arbitration

In the event of any dispute(s) and/or difference(s) arising out of or relating to the interpretation and application of the Work Order, such dispute(s) and/or difference(s) shall be settled amicably by mutual consultations of the good Office of the respective Parties and recognizing their mutual interests attempt to reach a solution satisfactory to both the parties. If such a resolution is not possible within 30 days from the date of receipt of written notice of the existence of such dispute(s) and/or difference(s), the unsolved dispute(s) and/or difference(s) shall be referred to the Arbitrators appointed by the Parties by mutual consent in accordance with the rules and procedures of Arbitration and Conciliation Amendment Act, 2015 as amended from time to time. The arbitration shall be conducted Satish Dhawan Space Centre SHAR, Sriharikota. The expenses for the Arbitration shall be shared equally or as may be determined by the Arbitrator. The considered and written decision of the Arbitrator shall be final and binding between the Parties. The applicable language for Arbitration shall be "English" only.

Services under the Work Order shall be continued by Party during the pendency of arbitration proceedings, without prejudice to a final adjustment in accordance with the decision of the Arbitrator unless otherwise directed in writing by the Centre (SDSC SHAR) or unless the matter is such the Work Order cannot be possible continued until the decision (whether final or interim) of the Arbitrator is obtained.

In case order is concluded on the Public Sector Undertakings, the following Arbitration Clause will be applicable:

In the event of any dispute(s) or difference(s) relating to the interpretation and application of the provisions of the commercial contracts between ISRO/SDSC SHAR & Central Public Sector Enterprises (CPSEs)/Port Trusts inter se and also between ISRO/SDSC SHAR & CPSEs and Government Departments/Organizations (excluding disputes concerning Railways, Income Tax, Customs & Excise Departments), such dispute(s) or difference(s) shall be taken by either party for resolution through the “Administrative Mechanism for Resolution of CPSEs Disputes (AMRCD)”, as mentioned in the Office Memorandum F No. 4(1)/2013-DPE(GM)/FTS-1835 dated 22nd May, 2018 issued by the Director of the Department of Public Enterprises (DPE) under the Ministry of Heavy Industries and Public Enterprises, Government of India.

3.32. DISCLOSURES AND USE OF INFORMATION BY THE CONTRACTOR

The technical information, drawings, specifications, operation manual and other related documents forming part of proposal or Contract or prepared during execution of the Contract are the property of the Department and shall not be used for any purposes other than performance of the Contract. All rights, including rights in the event of grant of a patent and registration of designs are reserved. The technical information, drawings, specifications, records, operation manual and other documents shall not be copied, transcribed, traced or reproduced in any other form or otherwise in whole and/or duplicated, modified, divulged and/or disclosed by the Contractor, Sub-Contractor, if any, or any person working under or for the Contractor or such Sub-Contractor to a third party nor be misused in any other form whatsoever without the Department's consent in writing except to the extent required for the performance of this Contract. The Contractor will obtain necessary undertakings/bonds from the Sub-Contractors and his/their workmen and ensure the compliance by them. These technical information, drawings, specifications, operation manual and other related documents shall be returned to the Department with all approved copies and duplicates, if any, immediately after they have been used for the agreed purpose. Required numbering and

codification method need to be implemented by the Contractor to trace such documentation.

3.33. COMPLIANCE WITH SECURITY REQUIREMENTS

The party shall strictly comply with the security rules & regulations of the purchaser. The party shall complete the required formalities including verification of character & antecedents, of the persons engaged or deployed by him, through police or any other authority.

3.34. INFRINGEMENTS OF THE LAW

The Department shall not be responsible in any way for the consequences, direct or indirect, of an infringement by the Contractor or its Sub-Contractors and their employees, of the law or statutes of the country, including, but not limited to laws relating to recruitment, employment, conditions of service and public contracts insofar as applicable. The Contractor shall keep the Department, its officers, employees, consultants, agents or assignees indemnified from and against any claims or action there for.

3.35. INFRINGEMENT OF LABOUR LAWS

- The Contractor shall be responsible for strict compliance of and shall ensure strict compliance by its Sub-contractors, servants and agents of all labour and other laws, rules or regulations having the force of law affecting the relationship of employer and employee between the Contractor and the Sub-Contractor and their respective employees.
- Contractor shall indemnify the Department against any action, claim or proceedings relating to infringement of all or any of the prevailing labour laws like Workmen's Compensation Act 1923, Contract Labour (Regulation and Abolition) Act 1970, and Contract Labour (Regulation and Abolition) central Rules 1971, Employees Liability Act 1938, Industrial Disputes Act 1947, Employees State Insurance Act 1948, Employees Provident Funds and Miscellaneous Act 1952, Minimum Wages Act during the period of Contract.

3.36. INFRINGEMENT OF THIRD-PARTY RIGHTS

- Notwithstanding the passing of title to Department of any of the deliverable equipment and items under this Contract, the Contractor agrees (a) to resist

or defend at its own expense any claims for royalty payments or for equitable relief or damages against Department based on an allegation that the manufacture of any item under this Contract or the use, lease or sale thereof by the Contractor and/or its Sub-Contractors or use by the Department, infringes any Patent or intellectual property right of third parties, (b) to pay any royalties and other costs and expenses related to settlement of such request and (c) to pay the cost and damages, including legal charges and expenses, finally awarded as a result of any suit based on such a claim, provided that the Contractor is given prompt written notice of such request or claim by Department and given authority and such assistance and information as is afforded by applicable laws, rules or regulations or is available to Department for resisting such request or for the defence of such claim. Any such assistance or information which is furnished by the Department is to be at the Contractor's expense.

- In the event of such a request or claim or a suit based on such a demand, (a) prior to delivery, the manufacture of any item is enjoined, or (b) after delivery, the use, lease or sale thereof, is enjoined, the Contractor agrees to utilize its best effort either (i) to negotiate a license or other agreement with claimant so that such item no longer infringes upon any Patent or intellectual property rights of third parties, or (ii) to modify such item suitably or substitute a suitable item therefore (subject to the technical approval of Department, which shall not be unreasonably withheld), which modified or substituted item is not subject to such injunction, and to extend the provisions of this Article 15.2 thereto. In the event none of the foregoing alternatives are suitably and promptly accomplished by the Contractor, the Contractor shall be liable to Department for the additional costs and damages to Department arising as a result of such injunction, provided, however that the Contractor's financial liability with respect to such additional costs or damage to Department shall be limited to the actuals as per documentary evidence which shall include repayment of sums paid to the Contractor by Department prior to the injunction, actual additional cost of procuring a non-infringing hardware or other item and cost of any penalties or additional costs provided further such limitation shall not

apply to any amount paid or payable by the Contractor to Department as a result of any other provisions of this Contract or by application of law.

- The Contractor shall fully indemnify the Department against any action, claim or proceedings relating to any action, claim or proceedings relating to infringement or use of any patent or design or any alleged patent or design rights and shall pay any royalties which may be payable in respect of any claims made under or any action brought against the Department, in respect of such matters as aforesaid the Contractor shall be set at liberty, at his own expense, to settle any dispute or to conduct any litigation that may arise there from. The Contractor shall not be liable to indemnify the Department the infringement of the patent or design or any alleged patent or design right which is the direct result of an order passed by the Department in this behalf.
- Department neither represents nor warrants that performance of any work or the manufacture of any item called for under this Contract is free from third party claims or infringement of any Letters Patent or other proprietary rights.

3.37. PROPRIETARY RIGHT PROTECTION

The party shall be obliged to preserve the confidentiality of the proprietary information received, exchanged between each other during the period of the Contract. Technical documentation published and/or claimed for a patent shall be effected by both the parties only on mutual decisions and approval of both the parties, during the existence of this agreement.

3.38. LIABILITY CLAUSE

The Contractor shall be fully responsible for any damages, accidents, misuse, or losses arising from the use of temporary power, water, facilities, or site arrangements. Any penalties, claims, or legal issues resulting from such incidents shall be borne entirely by the Contractor, with no liability accruing to the Department.

3.39. INDEMNITY CLAUSE

If any action is brought before a Court, Tribunal or any other Authority against the Department or an officer of the Department / Owner, for the failure, omission or neglect on the part of the Bidder to perform any acts, matters, covenants or things under the Contract, or damage or injury or death caused by the alleged omission or negligence on the part of the Bidder, his agents, representatives or his Sub-Contractors', or in connection with any claim based on lawful demands of Sub-Contractors' workmen suppliers or employees, the Bidder, shall in such cases indemnify and keep the Department and/ or their representatives harmless from all losses, damages, expenses or decrees arising out of such action.

3.40. CONSTRUCTION AIDS, EQUIPMENT, TOOLS & TACKLES

Bidder shall be solely responsible for making available for executing the Work, all requisite Construction Equipments, Special Aids, Barges, Cranes and the like, all Tools, Tackles and Testing Equipment and Appliances, including imports & insurance of such equipment etc. as required.

3.41. BIDDER'S EQUIPMENT

All equipment brought by the Bidder onto the Site shall be deemed to be intended to be used exclusively for the execution of the Contract. The Bidder shall not remove the same from the Site without the Department consent that such Bidder's Equipment is no longer required for the execution of the Contract. All the necessary approvals with due taxes, insurance and license, as required for the use of equipment at site, are to be taken by the Bidder. The equipment should be in a good operating condition for safe use at site. The operator shall be competent to operate. It is advised to keep adequate spares, consumables, etc to reduce the breakdown time. Unless otherwise specified in the Contract, upon completion of the Facilities, the Bidder shall remove from the Site all Equipment brought by the Bidder onto the Site.

3.42. MATERIAL HANDLING, STORAGE & INSURANCE

- The Contractor shall be fully responsible for unloading, safe handling, shifting, stacking, and preservation of all materials at site. Adequate manpower, cranes, trailers, forklifts, jacks, rollers, pulleys, and other equipment shall be deployed by the Contractor without any extra cost to the

Department.

- The Contractor shall construct and maintain suitable storage sheds, fenced areas, and weather-protected facilities at his own cost for safe custody of all materials until installation. Proper identification tags, registers, and preservation methods (such as silica gel, oil drum sealing, wooden packing, etc.) shall be adopted as per manufacturer's recommendations.
- All materials shall be insured at the Contractor's cost from the time of dispatch, during transit, handling, storage, till final commissioning and handing over. Any loss, damage, theft, or deterioration of materials during handling or storage shall be promptly rectified/replaced by the Contractor at his own cost.
- All intra-site material shifting (e.g., from stores to erection location or between work fronts) shall be under the Contractor's scope, including labour, equipment, and safety arrangements.

3.43. HUMAN, SAFETY & ENVIRONMENT (HSE) REQUIREMENTS AT SITE

The Contractor shall develop, implement, and strictly adhere to a comprehensive Health, Safety, and Environmental (HSE) Plan throughout the project lifecycle. This plan shall comply with, but not be limited to, all applicable Indian statutory safety regulations, international standards, and best industry practices.

3.44. SITE CLEARANCE

- Site Clearance during execution

In the course of carrying out the Contract, the Bidder shall keep the Site reasonably free from all unnecessary obstruction, store or remove any surplus materials, clear away any wreckage, packaging material, rubbish & debris and temporary installations from the Site, and remove any Equipment no longer required for execution of the Contract with due approval of the Department.

- Site Clearance after Completion

After Completion of all parts of the Facilities, the Bidder shall clear away and remove all wreckage, packaging material, rubbish & debris and temporary works & installations of any kind from the Site with due

approval of the Department and shall handover the Site and Facilities to the Department clean and safe.

3.45. DISPOSAL OF SCRAP

The term 'Scrap' shall refer to scrap/ waste/ remnants arising out of the unpacking of equipment, construction debris, breakage of modules, fabrication of structural steel work and piping work at the project site in the course of execution of the contract and shall also include any wastage of cables during the termination process while installing the cables. The Bidder shall with the agreement of the Department promptly remove from the site any 'Scrap' generated during Performance of any activities at site in pursuance of the Contract. The disposal of such Scrap shall vest with the Bidder for the items supplied by the Bidder and issued by Department under this contract for installation and construction without any additional cost to the Department. The removal of scrap shall be subject to the due approval of Department & Bidder producing the necessary clearance from the relevant authorities, if required by the law, in respect of disposal of the scrap. The liability for the payment of the applicable GST shall be that of the Bidder. The Bidder shall also indemnify to keep the Department harmless from any act of omission or negligence on the part of the Bidder in following the statutory requirements with regard to removal/disposal of scrap.

3.46. COVERAGE

The contractor shall arrange comprehensive risk coverage at his own cost covering the value of equipment including transportation to the site from manufacturer's works, storage at site, fabrication, erection, testing and commissioning at site. The period of such coverage shall be up to contractual completion period or any extension granted by Department thereof.

During onsite activities at the Department's premise, the Contractor shall provide the following insurances:

- (a) Workmen compensation policy (Personnel insurance) for the Contractor's/ Sub-contractor's personnel under all categories covering death & accident.

- (b) Third-party business liability insurance to cover damage caused by fault of the Contractor to the Department and/ or third parties. The liability shall be Rs 20 Lakhs for bodily injury applicable to each person and Rs 1 Crore for tangible assets. The Department shall indemnify the Contractor against any further claims.
- (c) Notwithstanding the aforesaid insurance, the Contractor shall be responsible for all the materials/ services including all losses & uninsured losses until final acceptance of Air Separation Plant, by the Department.

3.47. CONTRACTOR'S ALL RISK INSURANCE POLICY

1. The Contractor shall be responsible at his own cost in and relative to performance of the work and Contract to observe and to ensure observance, by his Sub-Contractors, agents and servants of the provisions, of the safety code and all fire, safety and security regulations as may be prescribed by the Department from time to time and such other precautions and measures as shall be necessary and shall employ/deploy all equipment, necessary to protect all personnel, works, materials properties, structures, equipments, installations, communication systems and facilities whatsoever from damage, loss or other hazard whatsoever (including but not limited to fire and explosion) and shall during operations minimize the disturbance and inconvenience to the Department, other Contractors, the public and the adjoining land and property of the Department and occupiers, crops, trees, vegetation and shall indemnify and keep indemnified the Department from and against all losses and damages and costs, charges and expenses and penalties, actions, claims, demands and proceedings whatsoever suffered or incurred by or against the Department, as the case may be by virtue of any loss, alteration, displacement, disturbance or destruction or accident to any works, materials, properties, structures, equipments, installations, communication system and facilities and land and vegetations as aforesaid, with the intent that the Contractor shall be exclusively responsible for any accident, loss, damage, alteration, displacement, disturbance or destruction as aforesaid resultant directly or indirectly

from any breach by the Contractor, his Sub-Contractor(s) or agent(s) or servant(s).

2. To meet the above, the Contractor in consultation with the Department and Insurance Company enter into a Contractor's All Risk Insurance Policy (CAR) valid for the period from commencement of the work till handing over of the system/site to the satisfaction of the Department.
3. The Contractor's liabilities under s.no. 1 above in this clause and otherwise under the Contract shall remain indemnified notwithstanding the existence of any storage-cum-erection or other insurance covering any risk, damage, loss or liability for which the Contractor is liable to the Department in terms of the foregoing Sub-Clause or otherwise and/or in respect of which the Contractor has indemnified the Department, with the intent that notwithstanding the existence of such insurance, the Contractor shall be and remain fully liable for all liabilities and obligations under the Contract and indemnifies to the Department, and Department shall not be obliged to seek recourse under such policy(ies) in preference to the remedies available to it under the Contract. Provided that any monies received by the Department under any such insurance policy would go to reduce the liability of the Contractor.

3.48. TERMINATION FOR ANY FAULT OF THE CONTRACTOR

1. Notwithstanding anything elsewhere herein provided and in addition to any other right or remedy of the Department under the conditions the Contract or otherwise (including the right of the Department to claim compensation for delay in completion of the works), the Department shall be entitled to terminate the Contract by written notice at any time during its currency on or after the occurrence of anyone or more of the following events/contingencies, namely:
2. If the Contractor fails to rectify, reconstruct or replace any defective system / sub-system / equipment within a period of 60 days after the Contract Manager having given a notice to the Contractor to rectify, reconstruct or replace the said defective system / sub-system / equipment or the Contractor

delays, suspends work or is unable to complete the system / sub-system / equipment by the date mutually agreed upon.

3. If the Contractor commits breach of any of the terms and conditions of the Contract including clause regarding Sub-Contractor and assignment.
4. When the Contractor had made himself liable for action under the circumstances mentioned above, the Department shall have power to forfeit the Security Deposit of the Contractor and the Contractor will have no claim for damages whatsoever on such forfeiture.
5. The work remaining to be completed at the time of termination of the Contract, shall be got executed through any other Contractor in which case the expenses which may be incurred in excess of sums which would have been paid to the Contractor had the whole work been executed by him in terms of this agreement, shall be borne by the Contractor and shall be recovered from him.
6. If the Contract is terminated as provided in S. No 1 to 3 in this, the Department in addition to any other rights provided in this article may require the Contractor to transfer title and deliver to the Department in the manner and as directed by the Department (a) any completed system / sub-system / equipment, (b) such partially completed system / sub-system / equipment, drawings, information which the Contractor specifically produced / acquired for the performance of the contract. The Department shall pay to the Contractor as per the quoted rates in the contract for completed system / sub-system / equipment delivered to and accepted by the Department and for manufacturing materials delivered and accepted. For the partially completed system/ sub-systems / equipment accepted by the Department, payment will be made at mutually agreed rates.

3.49. CANCELLATION IN SPECIAL CASES

Department may at any time cancel this contract by giving written notice with immediate effect in either of the following cases:

- If the contractor is adjudged insolvent or if its financial position is such that within the framework of its national law, legal action leading towards bankruptcy may be taken against it by its creditors or its Govt., or
- If Department has sufficient reason to believe and it is determined through arbitration or through court proceedings, that the contractors has resorted to fraudulent or corrupt practices in connection with its securing or implementation of this contract.

3.50. RIGHT TO ACCEPT OR REJECT

The Department reserves the right to accept or reject any bid, or annul the bidding process, without assigning any reason and without incurring any liability towards affected bidders.

3.51. MEDICAL ASSISTANCE

While executing this scope of contract work at SDSC SHAR, if any of the workers engaged by contract agency is injured, contract agency has to take care of medical treatment

3.52. PUBLICITY

News releases, articles, brochures, advertisements, prepared speeches and other information releases concerning the work performed hereunder, by the Contractor, a Sub-Contractor or an employee or a consultant of either, the Contractor shall obtain the written approval of Department concerning the content and timing of such releases.

Under no circumstances shall the Contractor release information on matters related to the performance of work under this Contract without prior written approval of the Department.

3.53. FRAUDULENT PRACTICES, BRIBERY AND CORRUPTION OF GOVERNMENT SERVANTS

The Contractor represents and undertakes that he has not given, offered or promised to give, directly or indirectly any amount, gift, consideration, reward, commission, fees, brokerage or inducement to any person in service of the Department or otherwise in procuring the Contracts or forbearing to do

or for having done or forborne to do any act in relation to the obtaining or execution of the Contract or any other Contract with the Government for obtaining a Contract or showing or forbearing to show favour or disfavour to any person in relation to the Contract or any other Contract with the Government. Any breach of the aforesaid undertaking by the Contractor or any one employed by him or acting on his behalf or for his benefit (whether with or without the knowledge of the Contractor) or the commission of any offence by Contractor or anyone employed by him or acting on his behalf, as defined in Chapter IX of the Indian Penal Code, 1860 or the Prevention of Corruption Act, 1947 or any other Act enacted for the prevention of corruption shall, without prejudice to any other legal action, entitle the Department to cancel the Contract either wholly or in part, and all or any other contracts with the Contractor and recover from the Contractor such amount or the monetary value thereof and the amount of any loss arising from such cancellation without any entitlement or compensation to the Contractor. The Department will also have the right to recover any such amount from any contracts concluded earlier between the Contractor and the Government of India. The Contractor will also be liable to be debarred from entering into any Contract with the Government of India for a minimum period of five years. A decision of the Department to the effect that a breach of the undertaking had been committed shall be final and binding on the Contractor.

3.54. INSTRUCTIONS TO THE BIDDER

1. In case of any conflict / contradiction, the documents shall prevail over one another in the following order:
 - a) For all commercial, contractual and general conditions, Notice Inviting Tender (NIT).
 - b) Any contradiction either between various parts of document or in the content of the document itself shall be a matter of clarification to be obtained by the bidder from the purchaser. The purchaser's decision shall be final and binding.

2. Successful Bidder shall obtain approval from Department for selecting sub-suppliers / sub-contractors and makes for any of the equipment/ parts.
3. The purchaser reserves the right of selecting the make / model of equipment, wherever necessary and the supplier shall agree to supply equipment of particular make / model without any cost implication to purchaser.
4. This specification is issued for procurement from indigenous sources only. However, no foreign exchange or import license for importing equipment, components, raw materials or spares will be arranged for or provided by the purchaser. In case the equipment offered involves expenditure in foreign exchange, same shall be arranged and borne by the Bidder.
5. Any equipment / material which in any way fails to meet the requirements of the specification will be rejected by the purchaser and such equipment / material shall not be used under the contract. The successful Bidder will be required to promptly furnish new material at his cost without hampering the overall schedule of commissioning of the project.
6. Any changes or difficulties which might be encountered during the execution of the project or any other problems due to local conditions which are not anticipated / included in the tender document shall fall under full obligations of the successful Bidder. No claim on account of the same and for any ambiguity in any respect will be entertained after placement of order by Purchaser.
7. Bidder shall clearly indicate the deviations taken from the Tender documents/specifications separately in his offer.
8. Deviations, if any, w.r.t technical and commercial terms & conditions shall be clearly brought out and deviation list to be added. If deviations are not listed separately, it will be presumed that the bidder is adhering to all the technical specifications and commercial terms & conditions given in this document.
9. Transportation & Transit Insurance are fully in the scope of Contractor / Supplier and the same shall be borne by the party.

10. Bids will be evaluated as per the PART 4.
11. Bids meeting minimum qualification criteria as per the PART 4 only will be considered for evaluation.
12. Supplier shall submit all the formats of PART 4 duly filled & signed along with the offer.

3.55. EXCLUSION OF TENDERS

The following tenders shall be summarily rejected from the procurement process: Unsolicited tenders from Supplier.

- (a) The tenders who materially depart from the requirements specified in the tender document or which contain false information.
- (b) The tenders of Supplier who have not agreed to furnish Performance Bank Guarantee.
- (c) The validity of the tenders is shorter than the period specified in the tender enquiry.
- (d) The tenders received from Supplier or their agents or anyone acting on their behalf, which have promised or given to any official of the Centre/Unit/Department, a gratification in any form, or anything of value, so as to unduly influence the procurement process.
- (e) The tenders received from Supplier, who, in the opinion of the Centre/Unit, have a conflict of interest materially affecting fair competition.
- (f) The tenders received from Indian agents on behalf of their foreign Principals/OEMs (in cases where the Principals/OEMs also submit their tenders simultaneously for the same item/product in the same tender).
- (g) In case two or more tenders are received from an Indian agent on behalf of more than one foreign Principal/OEM, in the same tender for the same item/product.
- (h) If a firm quote 'NIL' charges / consideration, the bid shall be treated as unresponsive and will not be considered.

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PART 4
BIDDER QUALIFICATION AND EVALUATION CRITERIA

4.0 BIDDER QUALIFICATION & EVALUATION CRITERIA

4.1 BID SUBMISSION

1. The tenders submitted through E-procurement Portal on or before the tender due date and time will only be considered as valid tenders.
2. Mode of tendering: It is recommended to award the entire scope of work on turnkey basis to a single Bidder who will be responsible for performing the entire scope of work given in the document including the interfaces between civil, mechanical, electrical and structural systems etc. Splitting of the order is not envisaged due to nature of the works are interrelated.
3. Detailed project execution plan along with proposed subcontractors for executing different scope of works viz., civil, mechanical, instrumentation & automation systems, electrical and structural systems etc. shall be submitted along with the Bid.
4. Prices shall be mentioned in the space/column provided in the E-procurement Portal only for such purpose.
5. All risk in transit shall be exclusively borne by the contractor and shall pay only for such items as are actually received in good condition in accordance with the purchase order
6. Bids duly filled in by the bidder should invariably be submitted as stipulated in the E-procurement Portal.
7. Department may open Part – A of the bids on the due date of opening at stipulated time. Price bid (Part-B) of the technically and commercially acceptable bids shall be opened at a later date.
8. Department reserves the right to reject any or all the bids without assigning any reasons thereof.
9. Compliance to proposal requirement: Department expects bidder's compliance to requirement of proposal document without any deviation. Deviation on clauses, if felt absolutely necessary should be furnished in the Techno commercial part (and not in proposal document or Price part). Department shall not take cognizance of any deviation stipulated elsewhere in the bid. Any willful attempt by the bidders to camouflage the deviations by giving them in the covering letter or in any other documents that are enclosed may render the bid itself non-responsive.

10. Bids duly filled in by the bidder should invariably be submitted as stipulated in the Letter inviting bid. Bids shall be submitted in two parts as given below

4.2 PART – A: TECHNICAL AND UNPRICED COMMERCIAL PART

1. Complete techno-commercial part of the bid shall be filled in E-procurement Portal. Any documents related to technical literature, warranty certificates and any other document as per the tender shall be scanned and uploaded in the E-procurement Portal.
2. Part- A shall comprise the following attachments, specifying attachment number arranged in the order as follows:
 - a) Submission of bid along with one set of this tender document duly signed and stamped as token of acceptance.
 - b) Technical details, catalogues, etc. as applicable and any other document as mentioned in the proposal.
 - c) Compliance enclosed in proposal duly filled, signed, stamped, scanned and uploaded
 - d) All the annexures enclosed in proposal duly filled, signed, stamped, scanned and uploaded.
 - e) Unpriced copy of schedule of prices with all other commercial terms, taxes, duties and duly filled (prices to be kept blank), signed and stamped.
 - f) Any other relevant document, bidder desires to submit.
3. Any bids/offers with price details in techno-commercial offer (Part – A) shall be rejected.

4.3 PART – B: PRICED COMMERCIAL PART

1. Priced commercial part shall contain “Schedule of Price” marked “PRICE - BID” duly filled in E-procurement Portal. No stipulation, deviation, terms and conditions, presumption basis etc. shall be stipulated in price part of bid. Department shall not take cognizance of any such statement and may at their discretion reject such bids.
2. Unit rate for each of the item shall be indicated separately as mentioned in the guidelines for bidder to quote.

3. If the offers submitted by the tenderers are silent on taxes, it will be presumed that quoted rates are inclusive of taxes & duties and no claim in this regard will be entertained later.
4. Bidder has to consider entire BOM required for realisation and commissioning of Air Separation Plant as per the approved drawings / schematics / RFP.
5. Total amount shall be spelt out in terms of figures and words also.
6. Currency of evaluation shall be INR.

4.4 MINIMUM QUALIFICATION CRITERIA

Prospective Bidder shall fill details in the formats mentioned in S. No 4.7 and submit along with credentials/documentary proof.

The “Minimum Qualification criteria” mentioned below in respect of Financial turn over, Technical eligibility and Past experience of similar class of works completed, will be first scrutinized by Department.

4.4.1 FINANCIAL SOUNDNESS:

Average of annual financial turnover of last 3 financial years shall be more than **Rs.50 crores.**

&

Should have a Solvency certificate from a National / Schedule Bank of the amount equal to **Rs. 30 Crore**. The Banker’s Certificate should not have been issued earlier than Three (03) Months of last date of submission of tender.

The required details shall be provided in FORM -7: Financial Capacity of Bidder & FORM-8: Solvency Certificate format provided in PART 5 of this RFP.

4.4.2 TECHNICAL ELIGIBILITY:

- A. The Prospective Bidder shall be an Original Equipment Manufacturer (OEM) of Air Separation Unit and an organisation with at least 7 years’ experience possessing proven technology in Design & Supply of Air Separation Plants.

OR

The Prospective Bidder shall be a System Integrator and an organisation with at least 7 years’ experience. He should have realised Cryogenic Air Separation

Plant involving Erection, Testing & Commissioning in the last 7 years. The bidder shall submit the relevant certificate & work order copies in this regard.

- B. The Prospective Bidder, who happens to be OEM, should have realised Cryogenic Air Separation Plant with capacity of minimum 50 TPD producing Liquid Oxygen / Liquid Nitrogen and running satisfactorily for a duration of atleast 2 years. In case the Prospective Bidder is a System Integrator, the bidder shall submit the authorization letter from OEM selected by him for the present tender and the selected OEM should have supplied the plant of minimum 50 TPD producing Liquid Oxygen / Liquid Nitrogen and running satisfactorily for a duration of atleast 2 years.
- C. The Prospective Bidder, who happens to be OEM, should have realised Cryogenic Air Separation Plant for producing Liquid Oxygen with purity $\geq 99.8\%$ & Liquid Nitrogen with purity $\geq 99.995\%$. In case the Prospective Bidder is a System Integrator, the bidder shall submit the authorization letter from OEM selected by him for the present tender and the selected OEM should have supplied the plant producing Liquid Oxygen with purity $\geq 99.8\%$ & Liquid Nitrogen with purity $\geq 99.995\%$.
- D. Power Consumption of core plant equipment selected for the proposed plant for continuous production of 50 MTPD LOX (1458 Nm³/hr) as per the submitted make / model / specification of the equipment, shall not exceed 1900 kW.

NOTE:

- a) *Original Equipment Manufacturer (OEM) shall mean Air Separation Unit Cold Box Manufacturer / Supplier and Technology Provider.*
- b) *Bidder shall submit power consumption details for the all core equipment's along with make & model in ASU as listed in RFP document (Refer FORM-19). The Make & Model of the equipment catalogues / Technical Datasheets/ Performance Curves from the respective equipment OEMs shall be basis of reference for arriving Power Consumption.*

4.4.3 PREVIOUS EXPERIENCE:

The Bidder must have executed “similar works” in any Central or State Govt. Organizations / PSUs / Industries etc. through supply orders as mentioned below during the last Seven years ending previous day of last date of submission of bids.

“One similar work costing not less than 50 Crore”

(or)

“Two similar works costing not less than 30 Crore each”

Copies of relevant purchase orders /work contracts/ contract agreements along with corresponding completion / performance certificates issued by competent authority of end user or tax invoices with delivery challan on the similar works produced by bidder shall be submitted in this regard.

“Similar Works” means as per the Technical Eligibility requirements mentioned in S. No 4.4.2 towards realisation of the Air Separation Plant under Minimum Qualification Criteria, for this tender.

4.5 BIDDER EVALUATION CRITERIA

4.5.1 The bidders qualifying the “Minimum Qualification Criteria in S. No 4.4” will be evaluated based on the least cost method, where bidders must meet technical qualification before their financial bid is considered.

4.5.2 The consideration towards P.O placement is for the realisation of ASU plant at SDSC SHAR as per the following:

- A. Cost for Design, Engineering, Manufacturing, Inspection, Supply, Erection, Testing & Commissioning of 50 MTPD Cryogenic Air Separation Plant consisting of Air Separation Unit, Electrical Power distribution systems, Instrumentation & Control systems, Fire Fighting Systems, Water Treatment plant, Effluent Treatment plant, Cryogenic Storage tanks, Pumps & Road Transportation tankers, associated necessary subsystems along with Civil Buildings including Plant Commissioning spares, TPIA charges, Packing & Forwarding charges, Plant Warranty for 1 Year and Taxes as applicable as per

the scope of works, specifications, services etc., mentioned in the tender document.

PLUS (+)

- B. Plant Operation and Maintenance (O & M) for 24 X 7 trouble free operation required Resources, Production consumables and Product Transportation for one year during Warranty Period as per the scope of works, specifications, services etc., mentioned in the tender document (O & M for First year during Warranty period)

PLUS (+)

- C. Cost for Plant Operation and Maintenance (O & M) for 24 X 7 trouble free operation including required Resources, Production consumables, Operational spares & OEM spares and Product Transportation for Second year (after First Year O & M) as per the scope of works, specifications, services etc., mentioned in the tender document.

PLUS (+)

- D. Cost for Plant Operation and Maintenance (O & M) for 24 X 7 trouble free operation including required Resources, Production consumables, Operational spares & OEM spares and Product Transportation for Third year (after Second Year O & M) as per the scope of works, specifications, services etc., mentioned in the tender document.

4.5.3 Total cost to be considered for comparison, is Sum of A + B + C + D under 4.5.2 and shall be the basis for evaluation of L1 offer. **P.O. will be placed for value A & B (Section 4.5.2) only on the successful Bidder. A separate P.O. will be placed for the scope of work C & D (Section 4.5.2) subsequently.**

4.5.4 **Splitting of the order is not envisaged.**

4.5.5 Department may Negotiate with the successful bidder, if not meeting budget / estimated cost. Department may re-float the opened tender, if L1 Price is not acceptable to Department.

4.6 COMPLIANCE STATEMENT

- a. All required documents / certificates submitted by the bidder must pertain to completed projects / works with completion date within the last 7 years, ending on the day prior to the bid submission deadline, unless otherwise specified.
- b. Documents submitted such as specifications/client acceptance reports/approved drawings etc shall be correlating with PO/WO etc.
- c. For establishing completion of contract, proof shall be submitted correlating with the scope defined in contract.
- d. Even though a bidder may satisfy the above requirements, they would be liable to disqualification if they have made misleading or false representation or deliberately suppressed the information in the forms, statements and enclosures required in the prequalification document.
- e. All the compliance statements as per the relevant annexures are to be filled and submitted along with technical offer and covering letter.
- f. Relevant catalogue and datasheets to be submitted wherever need to be supported for compliance.

4.7 FORMATS TO BE FILLED BY THE BIDDER

- (a) FORM-1 : Main covering letter
- (b) FORM-2 : Bidder / Respondent Profile
- (c) FORM-3 : Compliance statement on eligibility criteria
- (d) FORM- 4 : Declaration regarding clean track
- (e) FORM-5 : Exceptions and deviations
- (f) FORM-6 : Acceptance of terms and conditions by the Supplier
- (g) FORM-7 : Financial Capacity of Bidder
- (h) FORM-8 : Form of bankers certificate from a nationalized bank
- (i) FORM-9 : Details of all works completed
- (j) FORM-10 : Details of all works in execution
- (k) FORM-11 : Performance report of works referred to in for "FORM- 9 & 10"
- (l) FORM-12 : Details of software & equipment available with the agency
- (m) FORM-13 : Price bid format
- (n) FORM-14 : Cost break-up for Realization of ASU Plant

- (o) FORM-15 : Cost break-up for quarterly payment of O & M during Warranty Period
- (p) FORM-16A : Cost break-up for quarterly payment of O & M during Second year
- (q) FORM-16B : Cost break-up for quarterly payment of O & M during Third Year
- (r) FORM-17 : Technical Details (to be filled / confirmed by supplier)
- (s) FORM-18 : List of Spare Parts
- (t) FORM-19 : Power Budgeting for the Air Separation Plant Core Equipment in Continuous operation.
- (u) FORM-20 : Unpriced bid format
- (v) FORM-21 : Unpriced break-up for Realization of Air Separation Plant
- (w) FORM-22 : Unpriced break-up for quarterly payment of O & M during Warranty Period
- (x) FORM-23 : Unpriced break-up for quarterly payment of O & M during Second Year
- (y) FORM-24 : Unpriced break-up for quarterly payment of O & M during Third Year

PART 5

FORMATS TO BE FILLED BY THE BIDDER

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FORM-1

Main Covering Letter

(To be printed on Company letter head)

[Date]

To,

Sr. Head, Purchase & Stores

SDSC SHAR,

Sriharikota 524124, Andhra Pradesh

Dear Sir,

Ref: Request for Proposal for "Establishment of Air Separation Unit Plant at SDSC SHAR Sriharikota"- Reg.

Having examined the Request For Proposal, the receipt of which is hereby duly acknowledged, we, the undersigned, intend to submit a proposal in response to the Request For Proposal (RFP).

We attach hereto the response as required by the RFP, which constitutes our proposal. Primary and Secondary contacts for our company are:

	Primary Contact	Alternate Contact
Name		
Designation		
Company Name		
Address		
Phone		
Mobile		

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E – mail		

We confirm that the information contained in this response or any part thereof, including its exhibits, and other documents and instruments delivered or to be delivered to SDSC SHAR is true, accurate, verifiable and complete. This response includes all information necessary to ensure that the statements therein do not in whole or in part mislead SDSC in Tendering process.

We fully understand and agree to comply that on verification, if any of the information provided here is found to be misleading the Tendering process, we are liable to be dismissed from the selection process or termination of the contract during the execution of the contract.

We agree for unconditional acceptance of all the terms and conditions set out in the RFP document.

It is hereby confirmed that I/We are entitled to act on behalf of our company/ corporation/ firm/ organization and empowered to sign this document as well as such other documents, which may be required in this connection.

(Signature)

(Name)

(In the capacity of)

(Name and Address of Company) Seal / Stamp of Contractor

CERTIFICATE AS TO AUTHORIZED SIGNATORIES

I, ...the Company Secretary of certify that Who signed the above response to RFP is authorized to do so and bind the company by authority of its board / governing body.

Date:

Signature: (Company Seal)

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FORM-2

RESPONDENT's PROFILE

(to be filled by Bidder)

S. No	Details	Response
1.	Name of the Company	
2.	Head office location and address with contact number & email id:	
3.	Type of company (whether Government or Public sector or Private sector)	
4.	Year of Establishment	
5.	Manpower Strength (Engineering/Manufacturing/Erection)	
6.	Addresses of Manufacturing facilities owned	
7.	Core capabilities (Specify brief profile, Standard products/services, etc.)	
8.	Company Website URL	

(Signed by Authorized Representative of Bidder)

Note: Do not leave any cell blank; Fill up as "Not applicable" if necessary.

FORM-3

Compliance statement on eligibility criteria

Contractor shall fill details in the following format and submit along with credentials specified in [PART 4](#).

Financial soundness:

With respect to Eligibility Criteria requirement in [PART 4](#):

Detail Value in INR crores	Financial year 2022-2023	Financial year 2023-2024	Financial year 2024-2025
Net revenue			
Profit/Loss after tax			

Previous Experience:

Detail	Order -1	Order -2	Order -3
Order ref. Number			
Client			
Details of ASU established (in brief)			
Date of completion			
Order value in INR			
Completion certificate ref. number			

(Signed by Authorized Representative of Bidder)

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FORM-4

DECLARATION REGARDING CLEAN TRACK

(To be submitted on letterhead of the Bidder)

Dated ----- 2025

To,

Sr.Head,
Purchase & Stores,
Satish Dhawan Space Centre SHAR
Sriharikota -524 124
Andhra Pradesh

Ref: "Request for Proposal for Establishment of Air Separation Plant at SDSC SHAR"

Dear Sir,

I have carefully gone through the Terms & Conditions contained in the RFP Document regarding the Establishment of Air Separation Plant at SDSC SHAR for TLP Facilities"

- i) I/ We have carefully read and understood all the terms and conditions of the RFP and agree to abide by the terms and conditions.
- ii) I/ We further undertake that none of the Proprietor/ Partners/ Directors of the firm/consortium is or was blacklisted/ banned/ suspended in business dealing with the Government. I/ we further undertake to report to the SDSC immediately after we are informed but, in any case,, not later than 15 days, if any firm in which Proprietor / Partners/ Directors are Proprietor or Partner or Director of such a firm which is blacklisted / banned / suspended in future during the currency of the contract with you. We have no objection, if enquiries are made about the work listed by us.
- iii) I further certify that I am competent authority in my company to make this declaration.
- iv) In accordance with the above we would like to declare that:
 - a) We are not involved in any litigation that may have an impact of affecting or compromising the delivery of services as required under this assignment.
 - b) We are not blacklisted by any Central/State Government/Public Sector Undertaking/Private Organizations in India and outside the India.
 - c) The information provided in the RFP document is true and no false representation has been made.

Yours faithfully,
(Signature of the Bidder)

Printed Name:

Designation Seal

Date

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FORM-5

TO BE SUBMITTED ALONGWITH TECHNICAL BID

NAME OF THE WORK : _____

NAME OF BIDDER : _____

EXCEPTIONS AND DEVIATIONS

In line with Proposal Document, Bidder may stipulate Exceptions and deviations to the Proposal conditions if considered unavoidable.

S.No	Reference in Specification	RFP. Spécification	Offered Spécification	Justification for Déviation
1	Page no. / Clause No.			

NOTE :

- ✓ Any deviations taken by the Bidder to the stipulations of the Proposal document shall be brought out strictly as per this format and enclosed along with the bid.
- ✓ Any deviations not brought out as per this Proforma and written elsewhere in the Proposal document shall not be recognized and the same is treated as null and void.
- ✓ Any will full attempt by the Bidders to camouflage the deviations by giving them in the covering letter or in any other documents that are enclosed may render the Bid itself non-responsive.

(SIGNATURE OF BIDDER)

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FORM-6

TO BE SUBMITTED ALONGWITH TECHNICAL BID

TECHNICAL COMPLIANCE STATEMENT

**(TO BE SIGNED BY BIDDER'S PRINCIPAL CORPORATE LEVEL SIGNATORY ON
COMPANY LETTERHEAD)**

I / We on behalf of confirm that the proposal of
50 TPD Capacity Cryogenic ASU plant against Tender Notice No.
.....dated..... quoted by
is in total compliance to the scope as well as all the technical Specification and no
deviation, variation or reservation Whatsoever has been mentioned in the technical
offer. It is further agreed that the technical details furnished in our offer will be reviewed
by Department during detailed engineering stage after order and any change required
to meet the requirements of RFP specification including amendment(s) (if any) will be
Incorporated by us without any price and time implication.

Company Seal

(Authorised Signatory of Company)

Place : _____

Date : _____

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FORM-7

Financial Capacity of Bidder

TURNOVER AND EXPERIENCE CERTIFICATE

(On the letter head of Statutory Auditor/ Chartered Accountant)

We have examined the records of _____ (Name of company/ firm) having CIN No./LLPIN/PAN No. _____).

On the basis of the records and information submitted to us, we certify the following:

- 1) The company / firm has experience of ____ years in similar nature of works as per Request For Proposal (RFP) in India / abroad.
- 2) The company / firm has completed ____ numbers of similar nature of works as per Request For Proposal (RFP) in last 3 Financial Years. The details in respect of value of similar works received is as follows:

S.No	Name of Work	Period of Contract From – To	Value of Work(s) in Rs.Cr

- 3) We have examined the books of accounts and other records of _____ (Name of company/ firm) for the Financial Years ending March 31, 2023, 2024 and 2025. On the basis of the information submitted to us, we certify the following:

Financial Year	Annual Turnover (in INR Crores)
2024-2025	
2023-2024	
2022-2023	

This certificate has been issued to authenticate the above.

(Signature and Stamp of the Statutory Auditor / Chartered Accountant)

Date : _____

Place : _____

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FORM-8

FORM OF BANKERS CERTIFICATE FROM A NATIONALIZED / SCHEDULED BANK

(Solvency certificate from a Nationalized Bank / Scheduled Bank)

This is to certify that to the best of our knowledge and information, M / s / Sh.

.....

(having marginally noted address), a customer of our bank are / is respectable and can be treated as good for any engagements up to a limit of INR _____(INR)

(Signature) For the Bank

NOTE:

1. Banker's certificates should be on letter head of the Bank, sealed in cover addressed to SDSC.
2. In case of partnership firm, certificate should include names of all partners as recorded with the Bank.



FORM-9

Details of all works completed during the last Seven years ending last day of the previous month in which RFP was published

SI. No.	Name of work / Project & Location	Owner or sponsoring Organization	Cost of works in crores	Date of commencement as per contract	Stipulated date of completion	Actual date of completion	Litigation / arbitration pending / in progress with details	Name of address / telephone of officer to whom reference may be made	Remarks
1	2	3	4	5	6	7	8	9	10

Signature of the Bidder

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FORM-10

DETAILS OF ALL WORKS IN EXECUTION LAST DAY OF THE PREVIOUS MONTH IN WHICH RFP WAS PUBLISHED

S.No.	Name of work/ Project & Location	Owner or sponsoring Organization	Cost of works in crores	Date of commencem ent as per contract	Stipul ated date of comp letion	Up to date amount of the work execute d (INR)	Slow progress if any & reason thereof	Name of address / telephone of officer to whom reference may be made	Remarks
1	2	3	4	5	6	7	8	9	10

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

Signature of the Bidder

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FORM-11

PERFORMANCE REPORT OF WORKS REFERRED TO IN FOR "FORM – 9 & 10"

(separate sheet to be provided for each work)

1. S.No.
2. Name of work / Projects and Location
3. Nature of work:
4. Agreement No.
5. Client name:
6. Amount of Work:
7. Date of Starting of project:
8. Stipulated date of completion:
9. Actual date of completion:
10. Completion cost:
11. Justification for Delay, if any:
12. Amount of compensation
 - a. Levied for delayed completion, if any
 - b. Amount of reduced rate items, if any
13. Litigation tendency:
14. Feedback from client:
 - i. Quality of work Very good Good Fair Poor
 - ii. Finance Soundness Very good Good Fair Poor
 - iii. Technical Proficiency Very good Good Fair Poor
 - iv. Resourcefulness Very good Good Fair Poor
 - v. General behavior Very good Good Fair Poor

Third party feedback, if any:

Signature of Bidder

Signature & Stamp of client

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FORM-12

DETAILS OF SOFTWARE & EQUIPMENT AVAILABLE WITH THE AGENCY

S. No.	Description	Nos	Capacity of type.	Age	Conditio n	Ownership status			Remarks
						Presently owned	Leased	To be purchased	
1	2	3	4	5	6	7	8	9	10
1.									
2									
3									

Signature of Bidder

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FORM-13

Price bid format (To be filled by the Bidder)

S. No	Description	Basic Cost ₹ (in Lakhs) A	GST rates as applicable B	Total Cost ₹ (in Lakhs) = A + B
1	Cost for Design, Engineering, Manufacturing, Inspection, Supply, Erection, Testing & Commissioning of 50 MTPD Cryogenic Air Separation Plant consisting of Air Separation Unit, Electrical Power distribution systems, Instrumentation & Control systems, Fire Fighting Systems, Water Treatment plant, Effluent Treatment plant, Cryogenic Storage tanks, Pumps & Road Transportation tankers, associated necessary subsystems along with Civil Buildings including Plant Commissioning spares, TPIA charges, Packing & Forwarding charges, Plant Warranty for 1 Year and Taxes as applicable as per RFP document [Refer FORM-14].			
2	Plant Operation and Maintenance (O & M) for 24 X 7 trouble free operation including required Resources, Production consumables and Product Transportation for one year during Warranty Period as per RFP document. (O & M for			

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S. No	Description	Basic Cost ₹ (in Lakhs) A	GST rates as applicable B	Total Cost ₹ (in Lakhs) = A + B
	First year during Warranty period) [Refer FORM-15].			
Quote for O&M of Plant Operation (Refer FORM-16A & FORM-16B))				
3	Cost for Plant Operation and Maintenance (O & M) for 24 X 7 trouble free operation including required Resources, Production consumables, Operational spares & OEM spares and Product Transportation for Second year (after First Year O & M) as per RFP document [Refer FORM-16A].			
4	Cost for Plant Operation and Maintenance (O & M) for 24 X 7 trouble free operation including required Resources, Production consumables, Operational spares & OEM spares and Product Transportation for Third year (after Second Year O & M) as per RFP document [Refer FORM-16B].			

Signature of Bidder

FORM-14

Cost break-up for Realization of Air Separation Plant

S. No.	Item Description	Quantity Nos (n)	Cost (Including Transportation & TPIA charges) (A)	GST as applicable ₹ (B)	Total cost ₹ (C= n x A + B)
1.	Design and Engineering of the plant	1 Lot			
2.	Supply of 50 TPD ASU equipments & components including TPIA charges	1 Lot			
3.	Storage Tanks (250kL for LOX & LN2)	2 Nos.			
4.	Civil construction Cost including RCC Civil / Structural Shelters, Auxiliary buildings, Treatment plant, Approach Roads etc.	1 Lot			
5.	Sub Station & Electrical distribution system	1 Lot			
6.	Instrumentation & Plant Automation	1 Lot			
7.	LOX & LIN loading pumps	4 Nos.			
8.	Road Transportation tankers, along with prime movers (LOX	2 Nos.			

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S. No.	Item Description	Quantity Nos (n)	Cost (Including Transportation & TPIA charges) (A)	GST as applicable ₹ (B)	Total cost ₹ (C= n x A + B)
	& LN2) with unloading pumps and Flexible hoses				
9.	Packaged Air conditioning system for Control Room	1 Lot			
10.	Fire Fighting Systems	1 Lot			
11.	Packing and Forwarding	1 Lot			
12.	Erection / Installation	1 Lot			
13.	Sub systems commissioning	1 Lot			
14.	Plant Integrated Commissioning along with commissioning & start-up spares and Plant Trial Operation for production	1 Lot			
15.	Performance Guarantee Test as per the plant design	1 Lot			

Signature of Bidder

FORM-15

Cost break-up for Operation & Maintenance (O & M)

For First Year during Warranty Period (S. No: 2 of FORM 14)

S. No	Description	During Warranty Period of 1 year ₹ Cost (in Lakhs)			
		Quantity n	Cost A	GST rates as applicable B	Total Cost = n * A + B
1	Fixed Cost for O & M of plant with adequate manpower resources for 24 X 7 trouble free operation of plant, for production of LIN & LOX as per plant design conditions and administrative expenses	1 lot			
2	Production cost on prorata basis, which includes production consumables, diesel & Product transportation	Per ton*			
Total cost for one year					
Payment will be made on Quarterly basis					
*Note: Annual Production Qty (LOX / LIN) of 15000 tonnes shall be considered for arriving the cost.					

Signature of Bidder

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FORM-16 A

Cost break-up for Operation & Maintenance (O & M) for Second Year

(S. No: 3 of FORM 14)

S. No	Description	During Warranty Period of 1 year ₹ Cost (in Lakhs)			
		Quantity n	Cost A	GST rates as applicable B	Total Cost = n * A + B
1	Fixed Cost for O & M of plant with adequate manpower resources for 24 X 7 trouble free operation of plant, for production of LIN & LOX as per plant design conditions and administrative expenses	1 lot			
2	Production cost on prorata basis, which includes production consumables, spares, diesel & Product transportation	Per ton*			
Total cost for one year					
Payment will be made on Quarterly basis					
*Note: Annual Production Qty (LOX / LIN) of 15000 tonnes shall be considered for arriving the cost.					

Signature of Bidder

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FORM-16 B

Cost break-up for Operation & Maintenance (O & M) for Third Year

(S. No: 4 of FORM 14)

S. No	Description	During Warranty Period of 1 year ₹ Cost (in Lakhs)			
		Quantity n	Cost A	GST rates as applicable B	Total Cost = n * A + B
1	Fixed Cost for O & M of plant with adequate manpower resources for 24 X 7 trouble free operation of plant, for production of LIN & LOX as per plant design conditions and administrative expenses	1 lot			
2	Production cost on prorata basis, which includes production consumables, spares, diesel & Product transportation	Per ton*			
Total cost for one year					
Payment will be made on Quarterly basis					
*Note: Annual Production Qty (LOX / LIN) of 15000 tonnes shall be considered for arriving the cost.					

Signature of Bidder

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FORM-17

TECHNICAL DETAILS (To be filled / Confirmed by supplier)

1. PRODUCT GUARANTEE PARAMETERS

Product		Quantity (in TPD)	Quantity (in Nm ³ /hr)	Purity required	Pressure (in bar (g))	Confirmation
Liquid Oxygen	Normal			≥ 99.8		
	Design					
Liquid Nitrogen	Normal			≥ 99.995		
	Design					

2. PLOT AREA REQUIREMENT

Total area requirement to be specified. Plant, control room and storage area to be indicated separately along with open and covered area requirement

Description	Area (in m X m)	
	Open	Covered
Plant		
Auxiliary Building		
Storage Area		
Transportation tanker parking		
Electrical Sub Station		
GLR		
Other areas		

3. POWER SUPPLY REQUIREMENT

Supplier to indicate the power requirement mentioning the required infrastructure.

Design Basis	HT Power	LT Power	Emergency/UPS (LT Power), If required
Power reqd (MW)			

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4. UTILITY CONSUMPTION (details to be furnished)

S. No.	Utility	Quantity
1	Electricity HT, in kWh	
2	Electricity LT (including emergency), in kWh	
3	Cooling Water in Cubic Meter	
4	Makeup Cooling Water in Cubic Meter	
5	Fire Water in Cubic Meter	
6	Potable Water in Cubic Meter	
7	Process Water in Cubic Meter	

5. POWER CONSUMPTION FOR THE CORE PLANT (details to be furnished)

Power consumption for core operating plant to deliver the products with required production capacity and specification

<i>Power Consumption details of Core plant equipment running 24X7</i>		
S. No	Equipment	kW
1	Main Air Compressor	
2	Product Compressor (if provided)	
3	Precooling System	
4	Regeneration gas Heater	
5	Process Pumps	
6	Break generator for Expansion Turbines	
7	Lube oil systems	
8	Cooling water system	
9	Instrumentation & Control system	
10	Control room AC and Essential plant lighting	
11	Any other equipment considered for the core plant running as per the plant design	
12		
	Total power in kW	

6. PROCESS REQUIREMENT (Guaranteed values to be indicated)

Utility	Flow (in m ³ /hr)	Supply Pressure (in bar (g))	Supply Temperature (in °C)	Remarks
Cooling Water				10°C temp rise is permitted
GN2 LP Stream for Cooling Water Tower				
GN2 LP Stream for Heater				
GN2 LP Stream for Instrument air				For Start-up and Shutdown
GN2 LP stream for Seal gas purging for LOX pumps				
Other				Any other utility requirement to be indicated

Signature of Bidder

LIST OF SPARE PARTS

[illegible]

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FORM – 19

**POWER BUDGETING FOR CORE EQUIPMENTS OF AIR SEPARATION
PLANT DURING CONTINUOUS OPERATION**

Data from this Format will be used for Bidder Evaluation in S. No 4.4.2 of PART 4. Bidder should have selected the Air Separation Unit for 50 MTPD LOX production (1458 Nm³/hr) with optimum design and least power consumption of the Core plant equipment's during continuous operation at the Plant design conditions as per Technical specifications.

Bidder shall submit power consumption details for the all core plant equipment's along with the selected make / model /specification as listed below along with the offer. The selected make / model /specification of the equipment catalogues / Technical Datasheets/ Performance Curves from the respective equipment OEM shall be the basis of reference for arriving Power Consumption.

All electrical motors / heaters / equipment shall be selected with 10% margin on its rated power for smooth running of the plant operation. Highly efficient electrical motors/equipment shall be selected for optimal electrical power consumption.

<i>Power Consumption details of Core plant equipment</i>		
S. No	Equipment	kW
1	Main Air Compressor	
2	Product Compressor (if provided)	
3	Precooling System	
4	Regeneration gas Heater	
5	Process Pumps	
6	Break generator for Expansion Turbines	
7	Lube oil systems	
8	Cooling water system	
9	Instrumentation & Control system	
10	Control room AC and Essential plant lighting	
11	Any other equipment considered for the core plant running as per the plant design	
12		
	Total power in kW	

Signature of Bidder

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FORM-20

Unpriced bid format (To be filled by the Bidder)

S. No	Description	GST rates as applicable	Separate Cost mentioned in price bid (YES/NO)
1	Cost for Design, Engineering, Manufacturing, Inspection, Supply, Erection, Testing & Commissioning of 50 MTPD Cryogenic Air Separation Plant consisting of Air Separation Unit, Electrical Power distribution systems, Instrumentation & Control systems, Fire Fighting Systems, Water Treatment plant, Effluent Treatment plant, Cryogenic Storage tanks, Pumps & Road Transportation tankers, associated necessary subsystems along with Civil Buildings including Plant Commissioning spares, TPIA charges, Packing & Forwarding charges, Plant Warranty for 1 Year and Taxes as applicable as per RFP document [Refer FORM-21].	UNPRICED BID	
2	Plant Operation and Maintenance (O & M) for 24 X 7 trouble free operation including required Resources, Production consumables and Product Transportation for one year during Warranty Period as per RFP document. (O & M for First year during Warranty period) [Refer FORM-22].	UNPRICED BID	

S. No	Description	GST rates as applicable	Separate Cost mentioned in price bid (YES/NO)
3	Cost for Plant Operation and Maintenance (O & M) for 24 X 7 trouble free operation including required Resources, Production consumables, Operational spares & OEM spares and Product Transportation for Second year (after First Year O & M) as per RFP document [Refer FORM-23].	UNPRICED BID	
4	Cost for Plant Operation and Maintenance (O & M) for 24 X 7 trouble free operation including required Resources, Production consumables, Operational spares & OEM spares and Product Transportation for Third year (after Second Year O & M) as per RFP document [Refer FORM-24].	UNPRICED BID	

Note:

1. The tender is on two-part bid basis. In this regard, in the technical bid the above format shall be filled and uploaded with mentioning "QUOTED".
2. **If prices are disclosed in the technical bid, their bids will not be considered for evaluation.**
3. In the price bid only, the prices shall be mentioned and uploaded.

Signature of Bidder

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FORM-21

Unpriced break-up for Realization of Air Separation Plant

S. No.	Item Description	Quantity Nos	GST as applicable ₹	Separate Cost mentioned in price bid (YES/NO)
1.	Design and Engineering of the plant	1 Lot	UNPRICED BID	
2.	Supply of 50 TPD ASU equipments & components including TPIA charges	1 Lot	UNPRICED BID	
3.	Storage Tanks (250kL for LOX & LN2)	2 Nos.	UNPRICED BID	
4.	Civil construction Cost including RCC Civil / Structural Shelters, Auxiliary buildings, Treatment plant, Approach Roads etc.	1 Lot	UNPRICED BID	
5.	Sub Station & Electrical distribution system	1 Lot	UNPRICED BID	
6.	Instrumentation & Plant Automation	1 Lot	UNPRICED BID	
7.	LOX & LIN loading pumps	2 Nos.	UNPRICED BID	
8.	Road Transportation tankers, along with prime movers (LOX	1 Lot	UNPRICED BID	

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S. No.	Item Description	Quantity Nos	GST as applicable ₹	Separate Cost mentioned in price bid (YES/NO)
	& LN2) with unloading pumps and Flexible hoses			
9.	Packaged Air conditioning system for Control Room	1 Lot	UNPRICED BID	
10.	Fire Fighting Systems	1 Lot	UNPRICED BID	
11.	Packing and Forwarding	1 Lot	UNPRICED BID	
12.	Erection / Installation	1 Lot	UNPRICED BID	
13.	Sub systems commissioning	1 Lot	UNPRICED BID	
14.	Erection / Installation	1 Lot	UNPRICED BID	
15.	Sub systems commissioning	1 Lot	UNPRICED BID	
16.	Plant Integrated Commissioning along with commissioning & start-up spares and Plant Trial Operation for production	1 Lot	UNPRICED BID	
17.	Performance Guarantee Test as per the plant design	1 Lot	UNPRICED BID	

Note:

1. The tender is on two-part bid basis. In this regard, in the technical bid the above format shall be filled and uploaded with mentioning "QUOTED".
2. **If prices are disclosed in the technical bid, their bids will not be considered for evaluation.**
3. In the price bid only, the prices shall be mentioned and uploaded.

Signature of Bidder

FORM-22

**Unpriced break-up for Operation & Maintenance (O & M)
for First year during Warranty Period (S. No: 2 of FORM 20)**

S. No	Description	During Warranty Period of 1 year ₹ Cost (in Lakhs)		
		Quantity	GST as applicable ₹	Separate Cost mentioned in price bid (YES/NO)
1	Fixed Cost for O & M of plant with adequate manpower resources for 24 X 7 trouble free operation of plant, for production of LIN & LOX as per plant design conditions and administrative expenses	1 lot	UNPRICED BID	
2	Production cost on prorata basis, which includes production consumables, diesel & Product transportation	Per ton*	UNPRICED BID	
Total cost for one year				
Payment will be made on Quarterly basis				
*Note: Annual Production Qty (LOX / LIN) of 15000 tonnes shall be considered for arriving the cost.				

Note:

1. The tender is on two-part bid basis. In this regard, in the technical bid the above format shall be filled and uploaded with mentioning "QUOTED".
2. If prices are disclosed in the technical bid, their bids will not be considered for evaluation.
3. In the price bid only, the prices shall be mentioned and uploaded.

Signature of Bidder

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FORM-23

**Unpriced break-up for Operation & Maintenance (O & M) for Second Year
(S. No: 3 of FORM 20)**

S. No	Description	During Warranty Period of 1 year ₹ Cost (in Lakhs)		
		Quantity	GST as applicable ₹	Separate Cost mentioned in price bid (YES/NO)
1	Fixed Cost for O & M of plant with adequate manpower resources for 24 X 7 trouble free operation of plant, for production of LIN & LOX as per plant design conditions and administrative expenses	1 lot	UNPRICED BID	
2	Production cost on prorata basis, which includes production consumables, spares, diesel & Product transportation	Per ton*	UNPRICED BID	
Total cost for one year				
Payment will be made on Quarterly basis				
*Note: Annual Production Qty (LOX / LIN) of 15000 tonnes shall be considered for arriving the cost.				

Note:

1. The tender is on two-part bid basis. In this regard, in the technical bid the above format shall be filled and uploaded with mentioning "QUOTED".
2. **If prices are disclosed in the technical bid, their bids will not be considered for evaluation.**
3. In the price bid only, the prices shall be mentioned and uploaded.

Signature of Bidder

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FORM-24

Unpriced break-up for Operation & Maintenance (O & M) for Third Year
(S. No: 4 of FORM 20)

S. No	Description	During Warranty Period of 1 year ₹ Cost (in Lakhs)		
		Quantity	GST as applicable ₹	Separate Cost mentioned in price bid (YES/NO)
1	Fixed Cost for O & M of plant with adequate manpower resources for 24 X 7 trouble free operation of plant, for production of LIN & LOX as per plant design conditions and administrative expenses	1 lot	UNPRICED BID	
2	Production cost on prorata basis, which includes production consumables, spares, diesel & Product transportation	Per ton*	UNPRICED BID	
Total cost for one year				
Payment will be made on Quarterly basis				
*Note: Annual Production Qty (LOX / LIN) of 15000 tonnes shall be considered for arriving the cost.				

Note:

1. The tender is on two-part bid basis. In this regard, in the technical bid the above format shall be filled and uploaded with mentioning "QUOTED".
2. If prices are disclosed in the technical bid, their bids will not be considered for evaluation.
3. In the price bid only, the prices shall be mentioned and uploaded.

Signature of Bidder

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PART 6

CHECKLISTS

CHECKLIST 01

LIST OF MANDATORY DOCUMENTS TO BE SUBMITTED FOR EVALUATION OF TECHNICAL BIDS

S No	Document	Bidder's Compliance
1.	Submission of proposed equipment layout for the plant (Refer Section 1.6)	Submitted / Not submitted
2.	Submission of technical proposal documents along with the offer as mentioned in PART 1 of Section 1.2, 1.3, 1.4, 1.5 & 1.6	Submitted / Not submitted
3.	Documents relevant to technical eligibility criteria as per PART 4	Submitted / Not submitted
4.	Documents relevant to previous experience criteria as per PART 4	Submitted / Not submitted
5.	Documents relevant to Financial Soundness like Annual Financial Turnover & CA certificate as per the PART 4	Submitted / Not submitted
6.	Solvency Certificate obtained recently within 3 months	Submitted / Not submitted
7.	Declaration on compliance to all Techno Commercial Terms & Conditions of the tender and the FORM -6	Submitted / Not submitted
8.	Declaration on Technical Compliance to specifications of various equipment & other items relevant to this RFP.	Submitted / Not submitted
9.	Declaration on Compliance to Bill of Quantity of various equipment & other items relevant to this RFP.	Submitted / Not submitted
10.	Declaration on Compliance to the delivery schedule of this RFP.	Submitted / Not submitted
11.	Declaration that the quoted prices are inclusive of GST only.	Submitted / Not submitted
12.	Submission of Un-Priced price bid format s	Submitted / Not submitted

13.	Declaration on Local Content of 50 % in document MII clause as applicable.	Submitted / Not submitted
14.	Table of Equipments / items makes offered as per the format furnished in the RFP.	Submitted / Not submitted
15.	Submission of all Annexures / Checklists as mentioned in the RFP	Submitted / Not submitted
16.	Submission of signed and stamped RFP document as acceptance of RFP specifications and Terns & Conditions.	Submitted / Not submitted
17.	<i>Note: All of the above-mentioned documents have to be signed and authenticated with the official seal of the bidder and submitted for evaluation of technical bids failing which, the bids shall be treated as non-responsive and hence rejected.</i>	

Signature of Bidder

CHECKLIST 02

CHECKLIST FOR AIR SEPERATION PLANT

(Compliance for the tender terms & conditions)

Bidder to note that bidder's quotation shall be evaluated (technically) based on bidder's reply / confirmation provided against Technical checklist/ RFP only. Bidder's offer shall be considered incomplete and may not be considered for technical evaluation by purchaser if duly filled-in, signed & stamped check list is not submitted along with bid. Bidder is required to give categorical reply to each point of this technical checklist, so that bidder's offer can be properly evaluated.

Bidder's reply "Not Confirmed" is not warranted and may lead to technical rejection of their bid.

However, Bidder may provide certain clarification, incase absolutely necessary, without deviating to bid requirement. Written confirmation shall have precedence over any clarification whatsoever.

S. No.	Description	Response by the Bidder	Clarification, if any
1.	Confirm that the bidder has quoted for the total scope of supply & services as per tender specification and attachments. Any deviation to this requirement may lead to the bid being considered as incomplete and liable for rejection		
2.	Bidder shall have single point responsibility for complete scope of work/services covered under this requisition.		
3.	Bidder to confirm categorical compliance to all clauses of Specifications, terms & conditions and other requirements of the RFP		
4.	Acceptance to end product requirements including turn down		

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S. No.	Description	Response by the Bidder	Clarification, if any
	requirements at no additional cost as per PART 1, Section 1.2		
5.	Acceptance to scope of supply / services as per PART 1, Section 1.2		
6.	Acceptance to detail engineering as per PART 1, Section 1.2		
7.	Acceptance to Safety & Fire Fighting Systems works as per PART 1 Section 1.5		
8.	Acceptance to Civil Construction works as per PART 1 Section 1.6		
9.	Acceptance to Packaged Air Conditioning units as per PART 1 Section 1.6		
10.	Acceptance to System realisation works as per PART 1, Section 1.2		
11.	Acceptance to Testing & commissioning works as per PART 1, Section 1.2		
12.	Acceptance to Operation & Maintenance of the plant for period of three years from the date of commissioning of the Plant as per PART 2.		
13.	Acceptance to supply of Liquid storage tanks, Liquid transfer systems and transportation tankers as per PART 1, Section 1.2		
14.	Submission of technical documents along with the offer as as per PART 1, Section 1.2		

S. No.	Description	Response by the Bidder	Clarification, if any
15.	Bidder to note that data sheets, drawings and other technical details submitted with the bid shall be retained for information only. However, Vendor's documents / drawings shall be reviewed during Detail engineering (Post order stage) for checking / ensuring compliance with tender specification / contract requirement.		
16.	Bidder to note that, if any comment arises during detail engineering from Department (to ensure compliance with tender specification / contract requirement), same shall be incorporated by contractor without any time and price implication.		
17.	Bidder to highlight plot area required for realisation of Air Separation Plant.		
18.	Bidder to confirm that price for carrying out HAZOP study for complete "cryogenic Air Separation Plant with 50 TPD capacity" has been included in their lump sum price of the offered package.		
19.	Bidder to confirm that their offered package shall be designed and		

S. No.	Description	Response by the Bidder	Clarification, if any
	supplied in modules to minimize the work at site		
20.	Bidder to confirm that all equipments / items shall be sourced from approved vendor list attached with this requisition. Any Vendors if proposed by the bidder for any item where no list is provided in the requisition, the makes of same shall have adequate Proven Track Record (PTR) in similar application and shall be subject to Department approval during detail engineering without any time and cost implication to Department.		
21.	Bidder to confirm that the supply of all consumables viz. first fill of oils & lubricants, desiccants, chemicals etc. and replenishment of any loss of these during commissioning have been included in their scope.		
22.	Confirm that price for 3-D modelling as per tender specification has been included in the lump sum price of the package.		
23.	Confirm that the Inspection & Testing requirements as specified in the tender specifications shall be complied.		
24.	Bidder to confirm that special tools and tackles as required for normal		

S. No.	Description	Response by the Bidder	Clarification, if any
	operation and maintenance have been included by the bidder in the base price of package. Or else bidder to confirm that special tools & tackles are not required		
25.	Bidder to confirm that commissioning spares have been quoted and price of the same is included in the base price of package.		
26.	Bidder to confirm that in case during commissioning, additional spares are required over and above the quoted commissioning spares, then the same shall be supplied by bidder without any commercial implication.		
27.	Confirm that Consumption rate of Utilities (such as electric power, cooling water, diesel etc.) required for the plant operations, has been furnished in the bid.		
28.	Bidder has to confirm that bid is submitted with the guaranteed power consumption for the core plant equipments in continuous operation mode for producing 50 MTPD liquid oxygen		
29.	Confirm that all Drawings / Data other details as sought in the RFP		

S. No.	Description	Response by the Bidder	Clarification, if any
	have been submitted along with bid		
30.	Confirm that cost for erection, testing, commissioning and performance guarantee, testing and training to Department personnel at site is included in the cost proposal		
31.	The detailed scope of work & technical specifications is understood and price was quoted accordingly for all the items.		
32.	All documents related to minimum Qualification criteria mentioned in PART-4 have been submitted, in technical Bid.		
33.	Third Party inspection charges are included in the quoted price.		
34.	Confirmation that the quoted prices are firm and fixed till the completion of scope of work.		
35.	Validity of Offer is 180 days (minimum). Refer Part 3.		
36.	Acceptance to the Department Payment Terms. Refer Part 3.		
37.	Advance payment is required or not		
38.	Are General terms and Conditions mentioned in RFP, is acceptable?		

S. No.	Description	Response by the Bidder	Clarification, if any
39.	Are there any deviations from RFP technical specifications, general & commercial terms?		
40.	Warranty for the commissioned and accepted system is 12 months from date of commissioning.		
41.	A combined Bank Guarantee for 3% of the order value shall be provided immediately within 15 days after receipt of order towards the performance of the contract & the performance of the system as per terms & conditions (ie., warranty period + 60 days)		
42.	Acceptance of Delivery Milestones. Refer Part 3.		
43.	Acceptance of Liquidated Damages. Refer Part 3.		
44.	Acceptance of Penalty for O&M. Refer Part 2.		
45.	Last three years audited financial results are enclosed.		
46.	Registration certificate of the company is enclosed.		
47.	Relevant documents are attached along with technical bid		
48.	The Bidder shall give an assurance that spares will continue to be		

S. No.	Description	Response by the Bidder	Clarification, if any
	available through the life of the plant, which shall be 25 years.		
49.	All OEMs shall not be from Border sharing countries. Even OEM or bidder registered in India, the ownership/ manufacturing shall not be from border sharing countries. Proper authorization from Ministry shall be submitted for considering the offer. All necessary documents shall be submitted.		

Signature of Bidder

CHECKLIST 03

CHECKLIST FOR ICS

S. No.	Criteria / Requirement	Compliance
1.	The ICS executor should have prior experience of minimum 5 years in executing Hot stand by PLC/SCADA/DCS System. The documentary evidence(s) like Purchase Order copies and Completion report from user with user contact details should be submitted along with the technical proposal.	
2.	ICS vendor should be an OEM or Authorized SI of PLC/SCADA/DCS Offered. If Authorized System Integrator, Valid certificate from OEM shall be submitted.	
3.	ICS vendor is responsible for integrating for bus-based field elements with PLC/SCADA	
4.	The configuration of major bought out items like PLC, SCADA, etc., shall be reviewed and vetted by original equipment manufacturer (OEM). Total network architecture shall be wetted by OEM. Based on dept suggestion, configuration should be complied.	
5.	All OEMs including ICS OEM, CCTV OEM, Communication equipment OEM, and FDA OEM has to give declaration that they are not supplying any equipment/component that has been manufactured by OEM/ 3 rd party that is Blacklisted by any Government Department in India or any Government Globally as per GFR2017 Clause 144 (xi) and neither do they get the products manufactured from any of the above companies, else they are liable to be disqualified irrespective of the models offered.	
6.	All OEMs shall not be from Border sharing countries. Even OEM or bidder registered in India, the ownership/ manufacturing shall not be from border sharing	

S. No.	Criteria / Requirement	Compliance
	countries. Proper authorization from Ministry shall be submitted for considering the offer. All necessary documents shall be submitted.	
7.	Technical compliance to the specifications of all ICS elements & architecture of PLC/SCADA shall be vetted by the Manufacturer (OEM).	
8.	Vendor should have backend support from OEM during warranty and post warranty period. Vendor's association with OEM should be clearly brought out with documentary evidences.	
9.	Declaration certificate for the products from Border sharing countries shall be submitted.	
10.	All the conditions of the contract are acceptable.	
11.	Bidder shall deploy minimum 2 person for PLC/SCADA development and sufficient manpower for site execution.	
12.	Department reserve right to evaluate vendor & its sub contractor's capability to supply the systems according to this tender specification and reject, if not capable.	
13.	The CCTV OEM shall be in IP based CCTV manufacturing atleast for last 5 years	
14.	CCTV equipment's shall be ensured that OEM's are not suspended by ONVIF. The OEMs selected should also not get 3 rd party manufacturing (like branding and reselling in India through importer/trader/domestic supplier etc.) done from any OEMs that are suspended by ONVIF.	
15.	The IP based CCTV System OEM &/or Camera OEM must confirm that the MAC address/ Serial Number of cameras; including their firmware & respective Intellectual Property Rights must be registered in the name of the OEM supplying the equipment only. OEMs	

S. No.	Criteria / Requirement	Compliance
	must comply with MAC ID – Authentication shall be done through 3rd party tool.	
16.	Technical compliance to the specifications of CCTV cameras shall be vetted by the Manufacturer (OEM).	

Signature of Bidder

CHECKLIST 04

CHECKLIST FOR ELECTRICAL SYSTEMS

Sl. No.	Qualification Criteria	Compliance	Supporting Documents Required
1.	Experience in the design and realization of indoor substations with a capacity of ~3 MVA, 33/11/6.6 /0.433kV as per latest BIS & IEC standards	YES/ NO	Work Completion Certificate or Performance Certificate. Purchase Orders and Work Completion certificates executed in past 10 years.
2.	Minimum ten years of experience in the design, procurement, realization and maintenance of substation equipment and hazardous & non-hazardous equipment within the facility	YES/ NO	
3.	Executed at least two similar projects involving substation, HT/LT panels, transformers, DG/UPS systems, or electrical works of comparable capacity in process / utility / ASU / chemical plants	YES/ NO	
4.	Shall have minimum 33 KV licence from any govt body from state of Andhra Pradesh / equivalent certificate from other states of India	YES/ NO	License as indicated shall be submitted
5.	Shall have an in-house or associated design and engineering team with qualified electrical engineers capable of preparing SLDs, protection coordination	YES/ NO	Bio-data of Staff and their experience in design. Resources like licensed design software for

Sl. No.	Qualification Criteria	Compliance	Supporting Documents Required
	studies, and detailed engineering documentation as required and as per this RFP		electrical systems design.
6.	The site execution team shall include at minimum: 1. <i>Project Electrical Engineer (B.E./B.Tech, min 10 years' experience),</i> 2. <i>Electrical Supervisors (Min 3 years' experience)</i> 3. Experienced and qualified electricians (ITI, min 3 years' experience)	YES/ NO	Bio data of staff and their experience shall be submitted.

Signature of Bidder

PART 7
ANNEXURES

ANNEXURE 7A

REQUEST FOR DOCUMENTS

Following Documents shall be Submitted by the Supplier for the Air Separation Plant realisation.

S. No.	Document Title	Purpose of Issue (R=Review, I=Information, A=Approve)	With Bid		After Order Award			Upon order Completed prior to shipment		Note
			Copy	CD	Copy	CD	No.of Week	Copy	CD	
A. SCHEDULING DOCUMENTS										
A1	Manufacturing and production schedule	R			4		2			2
A2	Drawing/ Document schedule	R			4	1	2			1,2
A3	Sub-order schedule	R			4		2			2
A4	Periodical status report	R			4		2			3
Notes: 1- The scope and extent of Supplier reporting and scheduling document shall be set forth and agreed with Department for each and every individual purchase order depending on complexity time sensitively and critically of the order. 2- Updated schedule shall be attached to periodical reports 3- Periodical reports shall be furnished as out lined in project										
B. QUALITY DOCUMENTS										
B1	Letter of conformity	R	3							
B2	Bid technical checklist	R	3							
B3	Quality management system manual	I	3							
B4	Inspection & test plan	A			4	1	4	8	2	
B5	Inspection and shop test procedure	A			4	1	4	8	2	
B6	Supplier quality control records	A						8	2	2,4
B7	Certificate of materials	A						8	2	2,4
B8	Welding procedures (WPS,PQR if applicable)	A			4	1	4	8	2	
B9	Welder qualification records (if applicable)	A						8	2	2,4
B10	Final certificate of inspection and release	A						8	2	2,4
B11	NDT records (if any)	A						8	2	2,4
B12	PWHT records / procedure (if any)	A			4	1	4	8	2	2,4
B13	Alloy verification / PMI records (if any)	A						8	2	2,4
Notes: 1- Above mentioned documents also to be included in sub-supplier or sub-contractor if applicable. 2- To be issued in process and before shipment. 3- Need not to be approved by Department. 4- These Documents shall be endorsed by QC team in shop.										

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			Copy	CD	Copy	CD	No.of Week	Copy	CD	
C. SAFETY DOCUMENTS										
C1	Material Safety Data Sheet (MSDS)	R			4	Email	8	8	2	1
C2	HSE Instructions	A			4	Email	8	8	2	2
C3	HSE Plans	I	3	1						3
C4	Fire water network layout for ASU plant	A			4	Email	8	8	2	1
C5	Firefighting equipment layout for ASU plant	A			4	Email	8	8	2	1
C6	Fire and gas alarm system sensor location for the plant	A			4	Email	8	8	2	1
C7	Safety sign layout for ASU plant	A			4	Email	8	8	2	1
C8	Escape route layout for ASU plant	A			4	Email	8	8	2	1
C9	Block diagram for F&G system	R			4	Email	8	8	2	1
C10	Cause and effect for F&G system	R			4	Email	8	8	2	1
C11	Spray system drawing	A			4	Email	8	8	2	1
C12	F&G panel detail drawing	R			4	Email	8	8	2	1
C13	Installation details drawing for firefighting system	R			4	Email	8	8	2	1
C14	Installation details drawing for F&G system	R			4	Email	8	8	2	1
C15	Safety equipment index	R			4	Email	8	8	2	1
C16	Safety Manual	A			4	Email	8	8	2	1
C17	Data sheet for F&G facilities	A			4	Email	8	8	2	1
C18	Data sheet for firefighting equipment	A			4	Email	8	8	2	1
C19	Data sheet for fire safety equipment	A			4	Email	8	8	2	1
C20	Data sheet for safety sign	A			4	Email	8	8	2	1
C21	HAZOP procedure	A			4	Email	8	8	2	1
C22	HAZOP study report	R			4	Email	8	8	2	1
C23	HAZOP action close out	R			4	Email	8	8	2	1
C24	SIL procedure	A			4	Email	8	8	2	1
C25	SIL study report	R			4	Email	8	8	2	1
C26	SIL verification report	R			4	Email	8	8	2	1

Notes:

- MSDS shall be provided for all potentially dangerous materials such as: Chemicals, Catalysts, Lubrication Oil, Foam, Portable extinguishers (all types), Gases (CO₂, Clean Agent, ...), Paint, Solvent, Insulation material (PU, mineral wool, ...), Perlite, Electrode, Resin, Coating material, Lining material (rubber, epoxy, ...), Ionization heat detectors (including radioactive source), Nuclear Level elements (including radioactive source), All radioactive sources, All Laser sources.
- HSE instructions shall be provided for all items of equipment of instrument that may be harmful to human health or safety in case of malfunction, including; electrical items, Rotating items, Instrument Items.
- HSE Plan shall be provided for those manufacturers that our personnel may perform audit or inspection in their workshops, to ensure safety of our colleagues in such plants.

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			Copy	CD	Copy	CD	No.of Week	Copy	CD	
D. TECHNICAL DOCUMENTS										
D1	Catalogue and Brochure	I	3	1						
D2	Dimensional and weight drawings	A			3	1	8	8	2	1,3

Notes:

- 1- To be issued before shipment.
- 2- Need not to be approved by Department.
- 3- Drawings should be approved by Department.

E. PROCESS										
E1	PFD & Material balance	A	2	1	4	Email		8	2	
E2	P&ID	A	6	1	7	Email		8	2	
E3	Process description	A	2	1	4	Email		8	2	
E4	Equipment list	A	2	1	4	Email		8	2	2
E5	Equipment datasheet	A	-	-	4	Email		8	2	
E6	Instrument datasheet	A	-	-	4	Email		8	2	
E7	Process control philosophy	A	-	-	4	Email		8	2	
E8	Process control requirement	A	-	-	4	Email		8	2	
E9	Cause & effect diagram	A	-	-	4	Email		8	2	
E10	Interlock description	A	-	-	4	Email		8	2	
E11	Operating / erection instruction	A	-	-	4	Email		8	2	
E12	Operating / maintenance manual	A	-	-	4	Email		8	2	
E13	Safety Manual	A	-	-	4	Email		8	2	
E14	Specification for oxygen service	A	-	-	4	Email		8	2	
E15	HAZOP study report and close out sheets	A	-	-	4	Email		8	2	
E16	SIL study report and SIL verification	A	-	-	4	Email		8	2	
E17	Utility consumption list	A	-	-	4	Email		8	2	
E18	Chemical, adsorbent, catalyst, resin specifications & consumption list	A	-	-	4	Email		8	2	
E19	Line list	A	-	-	4	Email		8	2	
E20	Insulation property / requirement	A	-	-	4	Email		8	2	
E21	Special piping items	A	-	-	4	Email		8	2	
E22	Effluent Summary	A	-	-	4	Email		8	2	
E23	Material Selection Diagram	A	2	1	4	Email		8	2	-
E24	Block Flow Diagram	A	2	1	4	Email		8	2	-

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E25	Engineering Design Basis	A	2	1	4	Email		8	2	-
E26	Depressurizing Philosophy	A	-	-	4	Email		8	2	-
E27	Isolation Philosophy	A	-	-	4	Email		8	2	-
	CALCULATIONS:									
E28	Calculation data (where applicable) for noise& control valves	R	-	-	4	Email		8	2	
E29	Flow elements calculations	R	-	-	4	Email		8	2	
E30	Safety valves calculations	R	-	-	4	Email		8	2	
INSTRUMENT										
F1	General Index	R	-	-	4	Email		8	2	
F2	Filled out data sheets	R	-	-	4	Email		8	2	
F3	Catalogue and brochure	R	-	-	4	Email		8	2	
	GENERAL DRAWINGS:									
F4	Drawings showing overall drilling and mounting dimensions	R	-	-	4	Email		8	2	
F5	Electrical wiring connection and junction box with terminal arrangement diagrams	R	-	-	4	Email		8	2	
F6	Process and Air Hook ups	R	-	-	4	Email		8	2	
F7	Fabrication / erection drawings	R	-	-	4	Email		8	2	
F8	Field layout indicating instruments and junction boxes locations and cable routing	R	-	-	4	Email		8	2	
F9	Local control panels (dimensions, specifications, front and internal general arrangements, wiring diagrams, terminations, etc.)	R	-	-	4	Email		8	2	
F10	Instruments materials and calibration certificates	R	-	-	4	Email		8	2	
F11	Local gauge board(dimensions, general arrangements, list of materials)	R	-	-	4	Email		8	2	
	LIST:									
F12	Instrument list indicating type, make , characteristics and specification	R	-	-	4	Email		8	2	
F13	Cable list indicating cable type, length, source and destinations	R	-	-	4	Email		8	2	
F14	Instrument air and power requirements	R	-	-	4	Email		8	2	
F15	Alarm and trip set point list	R	-	-	4	Email		8	2	
F16	I/O list	R	-	-	4	Email		8	2	

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	CONTROL CABINET:									
F17	Certifications and approvals for PLC's and other peripheral hardware	R	-	-	4	Email		8	2	
F18	List of consumables for erection, commissioning and start-up	R	-	-	4	Email		8	2	
F19	Sub-Vendor's and main Supplier's listings	A	-	-	4	Email		8	2	
F20	Bill of Material (Hardware and software)	R	-	-	4	Email		8	2	
F23	Technical data sheets with component part no. for each component of the control system	R	-	-	4	Email		8	2	
F24	Proposed layout for the cabinets and other equipment in auxiliary/ control room, indicating dimensions, access spaces, weights, etc.	R	-	-	4	Email		8	2	
F25	Control philosophy (narratives) and proposed control system block diagram showing all system main hardware/equipment and their interconnections	R	-	-	4	Email		8	2	
F26	Electrical power consumption, heat dissipation (both 110 VAC and 24 VDC)	R	-	-	4	Email		8	2	
F27	Electrical power supply distribution diagram which indicates cables size and fusing capacity for each feeder	R	-	-	4	Email		8	2	
F28	Detailed grounding and shielding requirements for all equipment	R	-	-	4	Email		8	2	
F29	Cabinet's dimensions/ general arrangement and cabinets internal arrangements drawings.	R	-	-	4	Email		8	2	
F30	A reference list of projects where the offered system is at least two(2) year in operation	I	-	-	4	Email		8	2	
F31	Functional design specification for hardware and software	R	-	-	4	Email		8	2	
F31	Interconnecting cable schedule with cable list	R	-	-	4	Email		8	2	
F32	System internal cabling and terminations, including system internal cable list	R	-	-	4	Email		8	2	
F33	PLC loop wiring diagrams for each tag No. indicating tag No. , terminals , barriers/relays , I/O channels , installed spares , etc.	R	-	-	4	Email		8	2	
F34	Logic diagram and functional charts of the interlocks and sequences controls	R	-	-	4	Email		8	2	
F35	System configuration indicating system key codes and software distribution	R	-	-	4	Email		8	2	

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			Copy	CD	Copy	CD	No.of Week	Copy	CD	
F36	Hardware assignments including assignments of terminals, isolators, boards, I/O modules and channels, etc. (system data base).	R	-	-	4	Email		8	2	
F37	~~DELETED~~	X	X	X	X	X	X	X	X	X
F38	Factory / Site acceptance test procedure	A	-	-	4	Email		8	2	
F39	Painting Specification	R	-	-	4	Email		8	2	
F40	Modbus list (including exchange signals with FCS system, address ,....)	R	-	-	4	Email		8	2	
F41	Calculation of overall system availability/reliability including the failure mode and effect analysis	R	-	-	4	Email		8	2	
F42	A fault finding/trouble shooting narrative for the complete system(Recommended format is an "if-then" connection diagram	R	-	-	4	Email		8	2	
F43	A list of special tools/ instruments needed for the owner to operate the system.	R	-	-	4	Email		8	2	
F44	Catalogue and Brochure	R	-	-	4	Email		8	2	
F45	Test records (vendor's quality control)	R	-	-	4	Email		8	2	
F46	Test records (factory acceptable test)	A	-	-	4	Email		8	2	
F47	Proposed Graphic display pages based on purchaser initial information (if any).	R	-	-	4	Email		8	2	
F48	Proposed logging and report formats (if any)	R	-	-	4	Email		8	2	
F49	Installation Manual	R	-	-	4	Email		8	2	
F50	Operation Manual	R	-	-	4	Email		8	2	
F51	Maintenance Manual	R	-	-	4	Email		8	2	
F52	Engineering and user's manual	R	-	-	4	Email		8	2	
	VIBRATION MONITORING SYSTEM:									
F53	Manual for configuration software	R	-	-	4	Email		8	2	
F54	Expert and predictive condition monitoring software	R	-	-	4	Email		8	2	
F55	Vibration and condition Monitoring documents including, warning and shut down limits	R	-	-	4	Email		8	2	
	AS BUILT DRAWINGS:									
F56	as built (within 2 weeks after vendor's receipt of marked up drawings)	R	-	-	4	Email		8	2	
	GOVERNOR SYSTEM (if applicable)									
F57	System configuration and I/O listing	R	-	-	4	Email		8	2	

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			Copy	CD	Copy	CD	No.of Week	Copy	CD	
F58	Programming manuals	R	-	-	4	Email		8	2	
F59	Termination panels	R	-	-	4	Email		8	2	
F60	Outline drawing	R	-	-	4	Email		8	2	
F61	Filed connection diagram	R	-	-	4	Email		8	2	
F62	Governor	R	-	-	4	Email		8	2	

MECHANICAL / EQUIPMENTS

G1	General Index	A	2	1	4	Email		8	2	
G2	Complete/Filled-in data sheets (if required)	A	2	1	4	Email		8	2	
G3	Mechanical Catalogue and brochure	R	-	-	4	Email		8	2	1
G4	Un-priced copy of suborders	A	-	-	4	Email		8	2	
G5	Technical Specifications	A	-	-	4	Email		8	2	
	CALCULATIONS									
G6	Weight estimation (item wised)	A	2	1	-	-	-	-	-	
G7	Mechanical design calculations/ FEA analysis	A	-	-	4	Email		8	2	
G8	Thermal design calculation(if required)	A	-	-	4	Email		8	2	
G9	Nozzle load calculation	A	-	-	4	Email		8	2	
G10	External load calculation	A	-	-	4	Email		8	2	
G11	Foundation load diagram and calculation	A	-	-	4	Email		8	2	
G12	Anchor bolt sizing (Material, size and calculation)	A	-	-	4	Email		8	2	
G13	Total volume of fabrication and erection welding at site in kilograms	A	-	-	4	Email		8	2	
G14	Transportation calculation	A	-	-	4	Email		8	2	
G15	Erection calculation	A	-	-	4	Email		8	2	
	DRAWINGS									
G16	General arrangement drawings	A	2	1	4	Email		8	2	
G17	detail drawing with list of components	A	-	-	4	Email		8	2	
G18	Support/ load Drawings	A	-	-	4	Email		8	2	
G19	Part list	A	-	-	4	Email		8	2	
G20	Name plate drawings	A	-	-	4	Email		8	2	
G21	Gasket drawings	A	-	-	4	Email		8	2	
G22	Piping support drawing	A	-	-	4	Email		8	2	
G23	Platform & ladder detail drawings	A	-	-	4	Email		8	2	

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			Copy	CD	Copy	CD	No.of Week	Copy	CD	
G24	Transportation drawing	A	-	-	4	Email		8	2	
	PROCEDURES									
G25	Shop test procedure / condition	A	-	-	4	Email		8	2	
G26	Pressure test procedure	A	-	-	4	Email		8	2	
G28	Heat treatment procedure (if applicable)	A	-	-	4	Email		8	2	
G29	Painting procedure	A	-	-	4	Email		8	2	
G30	Pickling & Passivating procedure for S.S. surfaces	A	-	-	4	Email		8	2	
G31	Repair procedure (if applicable)	A	-	-	4	Email		8	2	
G32	Weld overlay procedure(if applicable)	A	-	-	4	Email		8	2	
G33	Rubber lining procedure(if applicable)	A	-	-	4	Email		8	2	
G34	Refractory/ Lining curing procedure(if applicable)	A	-	-	4	Email		8	2	
G35	Transportation procedures and sketches	A	-	-	4	Email		8	2	
G36	Erection procedure with sketch	A	-	-	4	Email		8	2	
G37	Field test procedure	A	-	-	4	Email		8	2	
G38	Inspection procedure/manual for after commissioning	A	-	-	4	Email		8	2	
STRUCTURE										
H1	Anchor Bolt arrangement /calculation	R	-	-	4	Email		8	2	
H2	Foundation loading dead, operating ,wind & Earth Quake	R	-	-	4	Email		8	2	
H3	Architectural Drawings / Plan & Section With Required Openings	A			4	Email	2			
PIPING										
I1	Piping General arrangement	A	2	1	4	Email		8	2	
I2	Required maintenance / access space	R	-	-	4	Email		8	2	
I3	Piping Material Specification	R	-	-	4	Email		8	2	
I4	Piping isometric	R	-	-	4	Email		8	2	
I5	MTO for consumable material	A	-	-	4	Email		8	2	
I6	MTO for loose piping items	A	-	-	4	Email		8	2	
I7	Plot Plan	A	-	-	4	Email		8	2	
I8	Painting Specification	A	-	-	4	Email		8	2	
ELECTRICAL										
J1	Technical Data & Specifications	R	3		4	Email		8	2	
J2	List of Deviations to Purchase Specifications	A	3			Email		8	2	

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J3	Bearing type/ lubrication/ oil pressure/ flow rate / lubrication intervals	R			4	Email		8	2	
J4	Reference list	R	3		4	Email		8	2	
J5	Data Sheet Completed by Supplier with Actual Equipment Data	R			4	Email		8	2	
J6	General arrangement drawing showing dimensions and weight	R			4	Email		8	2	
J7	Main terminal box drawing showing main connections, size and No. of entries, etc.	R			4	Email		8	2	
J8	Outline drawing Showing Dimensions, Weights, Shipping Sections, Aisle Spaces, Foundation Details, Installation Details, etc.	R	3		4	Email		8	2	
J9	Torque/speed curves with internals & accelerating times at 80 & 100% voltage	R			4	Email		8	2	
J10	Thermal capability curve for MV motors	R			4	Email		8	2	
J11	Current/speed curves	R			4	Email		8	2	
J12	Rotor drawing and data for torsional analysis	R			4	Email		8	2	
J13	Connection diagrams for RTD's heaters & other auxiliaries	R			4	Email		8	2	
J14	Electrical consumer list of package	A	3		4	Email		8	2	
J15	Electrical wiring/termination diagram	A			4	Email		8	2	
J16	Eearthing/Lightning drawings	A			4	Email		8	2	
J17	Cable laying drawings	A			4	Email		8	2	

MACHINERY

	MANUAL:									
K1	Installation Manual (Including alignment data/ drawings)	R			4	Email		8	2	3
K2	Operation Manual	R			4	Email		8	2	3
K3	Maintenance Manual	R			4	Email		8	2	3
K4	Technical data Manual	R			4	Email		8	2	3
	PUMPS:									
K5	Performance curve for operating conditions for each stage and for the whole pump as per API-610	R	3		4	Email	6	8	2	
K6	Filled-out API format data sheets (pump, coupling, gear, lube system, Seal systems, etc.)	R	4		5	Email	6	8	2	
K7	Data sheet and drawings for all equipment and	R			4	Email	6	8	2	

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			Copy	CD	Copy	CD	No.of Week	Copy	CD	
	instrumentation inside the package									
K8	General arrangement drawings for EACH EQUIPMENT and AUXILLIARY SYSTEM showing following items as min. : - Dimensioned location, size, rating and facing of nozzles and all other connections for hookup by others, properly indicated and listed (composite for pumps, turbine, etc.) including list of connections. - Min. height and max. weight for maintenance - Maintenance platform for better access - Location of terminal boxes and control panels - Grounding detail - Direction of rotation - Center of gravity and listing points - Dimensional and weight for all equipment in package	R	4		5	Email	6	8	2	
K9	DELETED	×	×	×	×	×	×	×	×	×
K10	Drawing for Automatic Recirculation valves (if applicable)	R			4	Email		8	2	
K11	Equipment general drawings included all auxiliaries with bill of materials	R			4	Email		8	2	
K12	Name plate drawings	R			4	Email		8	2	
K13	Coupling drawing ,data sheet and catalogue	R			4	Email	6	8	2	
K14	Fabrication / erection drawings	R			4	Email		8	2	
K15	Auxiliary piping & Equipment drawing with loads and estimated moments for foundations and supply limits	R	4		4	Email	6	8	2	
K16	Cross sectional drawing and bill of material	R			4	Email	6	8	2	
K17	Detailed Drawing for sealing system	R			4	Email	6	8	2	
K18	Thrust and radial bearing assembly drawing with parts list and loading data	R			4	Email		8	2	
K19	Rotor assembly drawing with bill of materials and part number	R			4	Email		8	2	
K20	Alignment and leveling diagram and data including allowable tolerances	R			4	Email		8	2	
K21	Equipment drawing and/or specification for each individual equipment, material, etc.	R			4	Email		8	2	

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			Copy	CD	Copy	CD	No.of Week	Copy	CD	
K22	Data sheet and drawings for all equipment and instrumentation inside the package	R			4	Email		8	2	
K23	Surface preparation and painting specifications and procedure	R			4	Email		8	2	
K24	As built clearance	R			4	Email		8	2	
K25	Auxiliary piping & Equipment plant drawing with loads and estimated moments for foundations and supply limits	R			4	Email		8	2	
K26	Part List for all package component	R			4	Email		8	2	
	PROCEDURES									
K27	Shop and site acceptance test procedure	R			4	Email		8	2	4
K28	Performance test procedures	R			4	Email		8	2	4
K29	Run test procedures	R			4	Email		8	2	4
K30	Heat treatment procedure	R			4	Email		8	2	
K31	Erection and preservation procedure	R			4	Email		8	2	
K32	Hydro testing procedure	R			4	Email		8	2	
K33	Fabrication / erection drawings	R			4	Email		8	2	
K34	Certified rotor balance data for multistage pumps	R			4	Email		8	2	
K35	Hydro-testing procedure	R			4	Email		8	2	
K36	Equipment drawing and/or specification for each individual equipment, material, etc.	R			4	Email		8	2	
	COMPRESSOR:									
K37	General Index	R	6		7	Email	2	8	2	
K38	P & I diagram with supply limit and connections	A	6		7	Email	6	8	2	
K39	Filled-in data sheet (proposal/as-built) for Compressor, Gear, Noise, Coupling, control valve, anti-surge valve, etc.	A	4		5	Email	8	8	2	
K40	Performance curve for operating conditions for each stage as per API-617/ 672 (proposal/as-built)	A	2		3	Email	8	8	2	
K41	Start-stop sequences including data on operating restrictions to protect equipment during start-up operation and shutdown	R	3		4	Email	12	8	2	
K42	Utility consumption list	R	4		5	Email	6	8	2	
K43	Lubricant list including type and consumption	R	2		3	Email	14	8	2	
K44	Estimated/ exact weight (machine/ rotor), dimension and max. maintenance weight (proposal/as-built)	R	4		5	Email	12	8	2	

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K45	Part list and bill of material for package	R	2		3	Email	12	8	2	
K46	List of exceptions to API-617/ API 672, and other purchase specifications	A	2						2	
K47	Supplier standard surface preparation and painting specifications	R	3		4	Email		8	2	
K48	Catalogue and Brochure	R	2					8	2	
K49	Technical data and reference list	R	3		4	Email		8	2	
K50	Statement of manufacturer's testing capabilities	R	3							
K51	Un-priced copies of sub-order(s) (main parts)	R			5	Email	4	8	2	
K52	Shipping weights and dimensions (estimated / as-built)	R	4		5	Email	22	8	2	3
K53	Weather protection and winterization required at job site	R	3		4	Email	10	8	2	
	CALCULATIONS									
K54	Mechanical design calculations/ analysis	R			4	Email	22	8	2	
K55	Lateral analysis report	A			4	Email	10	8	2	
K56	Torsional Vibration report	A			4	Email	10	8	2	
K57	Vibration analysis report	A			4	Email	10	8	2	
K58	Thermal design calculation	R			4	Email	22	8	2	
K59	Anchor bolt detail (Material/size/calculation)	R			4	Email	8	8	2	
K60	Foundation load diagram and calculation	R			4	Email	8	8	2	
K61	External load calculation	R			4	Email	6	8	2	
K62	Allowable forces and moments for piping connections	R	4		5	Email	6	8	2	
K63	Foundation block diagram with weights, forces and moments	R	3		4	Email	6	8	2	
K64	Calculation for conditions of maximum thrust during start up and various operating cases.	R	4		5	Email	6	8	2	
K65	Seal leakage rates	R	2		3	Email	6	8	2	
K66	Balance piston leakage rates	R	2		3	Email	6	8	2	
K67	Minimum length of straight pipe required at machine inlet or side inlets	R	3		4	Email	6	8	2	
K68	Maximum and minimum allowable seal pressure for each compressor	R	2		3	Email	6	8	2	
	DRAWINGS									
K69	General arrangement drawing showing following items as min. : -Dimensioned location, weights, size, rating, and									

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	facing of nozzles and all other connections for hookup by others, properly indicated and listed (composite for compressor, turbine, etc.) including list of connections. - Min. height and max. weight for maintenance - Maintenance platform for better access - Location of terminal boxes and control panels - Name plate format - Grounding detail - Direction of rotation - Center of gravity and listing points	A	6		7	Email	6	8	2	
K70	Equipment drawings included all auxiliaries with bill of quantities	R			7	Email	20	8	2	
K71	Equipment part list with bill of materials	R			7	Email	20	8	2	
K72	Dimensional and weight Drawings for all equipment in package	R	6		7	Email	8	8	2	
K73	Auxiliary piping & Equipment plant drawing with loads and estimated moments for foundations and supply limits	R			7	Email	6	8	2	
K74	Foundation drawing with distribution of load and moments, location and anchor bolts detail of compressor and auxiliaries with direction & magnitude of all rotating forces and location of C.G., limits of amplitudes and partial deflections	R	4		5	Email	6	8	2	
K75	Vibration and condition Monitoring documents including, warning and shut down limits, wiring diagram and bill of materials	R			5	Email	10	8	2	
K76	Anti -surge control diagram	R			4	Email	10	8	2	
K77	Cross-sectional drawing of compressor , seal, coupling, gear, pumps and etc. including all tolerances and necessary information	R	3		4	Email	14	8	2	
K78	Seal System drawings including: - Seal system schematic and bill of material - Seal system arrangement drawing and list of connections - Seal system component drawings and data - Seal assembly drawing and part numbers - Buffer gas system schematic and bill of material - Buffer gas system arrangement drawing and list of connections - Buffer gas system component drawing	R			5	Email	8	8	2	

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	and data									
K79	Assembly drawing of compressor, turbine, seal, coupling, gear, pumps and etc. including all tolerances and necessary information	R			6	Email	22	8	2	
K80	Thrust and radial bearing assembly drawing with parts list and loading data	R			6	Email	14	8	2	
K81	Rotor assembly drawing with bill of materials and part number	R			6	Email	22	8	2	
K82	Alignment and leveling diagram and data including allowable tolerances	R			6	Email	24	8	2	
	PROCEDURES / REPORTS									
K83	Site acceptance test procedure	R			5	Email	24	8	2	
K84	Shop performance test procedures	R			5	Email	24	8	2	4
K85	Run test procedures	R			5	Email	24	8	2	4
K86	Hydro/helium testing procedure	R			5	Email	24	8	2	4
	EXPANDER									
K90	General Index	R	6		7	Email	2	8	2	
K91	P & I diagram with supply limit and connections	A	6		7	Email	6	8	2	
K92	Filled-in data sheets (proposal/as-built) for Turbine, noise, control valves, etc.	A	4		5	Email	8	8	2	
K93	Control- and governor-system description and schematic	R			4	Email	12	8	2	
K94	Over speed shutdown system description and schematic	R			4	Email	12	8	2	
K95	Part List for all package component	R	6		7	Email	4	8	2	
K96	Catalogues and Brochures	R	2					8	2	
K97	Technical data and reference list	R	3					8	2	
K98	List of exceptions to API 612 and other purchase specifications	R	2						2	
K99	Supplier standard surface preparation and painting specifications	R	3		4	Email	4	8	2	
K100	Start - Stop sequences	R	3		4	Email	14	8	2	
K101	Utility & lubrications consumption list	R	4		5	Email	14	8	2	
K102	Unpriced copies of sub-order(s)(main parts)	R			5	Email	4	8	2	
K103	Shipping weights and dimensions (estimated / as-built)	R	4		5	Email	22	8	2	3

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	CALCULATIONS									
K104	Mechanical design calculations/analysis	R			4	Email	22	8	2	
K105	Thermal design calculation	R			4	Email	22	8	2	
K106	Anchor bolt detail	R			4	Email	8	8	2	
K107	Foundation load diagram and calculation	R			4	Email	8	8	2	
K108	External load calculation	R			4	Email	8	8	2	
K109	Allowable forces and moments for piping connections	R	4		5	Email	8	8	2	
K110	Vibration analysis data	A			4	Email	10	8	2	
K111	Blading vibration analysis.	A			4	Email	10	8	2	
K112	Lateral critical speed analysis	A			4	Email	10	8	2	
K113	Torsional critical speed analysis	A			4	Email	10	8	2	
K114	Transient torsional analysis.	A			4	Email	10	8	2	
K115	Foundation block diagram with weights, forces and moments	R	3		4	Email	8	8	2	
	DRAWINGS									
K116	General arrangement drawing showing, weights, dimensioned location, size, rating, and facing of nozzles and all other connections for hookup by others properly indicated and listed (composite for compressor, turbine, etc.) including list of connections.	A	6		7	Email	6	8	2	
K117	Equipment drawings included all auxiliaries with bill of quantities	R			7	Email	6	8	2	
K118	Turbine cross section drawing with list of components	R			5	Email	14	8	2	
K119	Seal assembly drawing and bill of material	R			5	Email	6	8	2	
K120	Gland sealing and leak-off schematic and bill of material	R			5	Email	6	8	2	
K121	Gland sealing and leak-off arrangement drawing and list of connections	R			5	Email	6	8	2	
K122	Gland sealing and leak-off component drawings and data	R			5	Email	6	8	2	
K123	Auxiliary piping & Equipment plant drawing with loads and estimated moments for foundations and supply limits	R			7	Email	8	8	2	
K124	Foundation drawing with distribution of load and moments, location and anchor bolts compressor and auxiliaries with direction & magnitude of all rotating forces and location of C.G., limits of amplitudes and partial deflections.	R	4		5	Email	8	8	2	

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K125	Coupling assembly drawing & bill of material	R			5	Email	8	8	2	
K126	Thrust and radial bearing assembly drawing with parts list and loading data	R			5	Email	14	8	2	
K127	Rotor assembly drawing with bill of material and Part number	R			5	Email	14	8	2	
K128	Vibration-probe sensing area/shaft drawing	R			4	Email	14	8	2	
K129	Alignment diagram and data	R			4	Email	24	8	2	
K130	Anticipated thermal movements for major connections	R			4	Email	14	8	2	
	PROCEDURES / REPORTS									
K131	Site acceptance test procedure	R			5	Email	24	8	2	
K132	Mechanical running test procedure	R			4	Email	24	8	2	4
K133	Repair procedure (if applicable)	R			4	Email	24	8	2	4
K134	Hydro-testing procedure	R			5	Email	24	8	2	4
K135	Painting procedure	R			5	Email	4	8	2	
K136	Rotor combined mechanical and electrical run-out	R			4	Email	16	8	2	
K137	Hydro test logs (certified).	A			5	Email	24	8	2	5
K138	Rotor balance logs	R			5	Email	24	8	2	5
K139	Mechanical running test logs	A			4	Email	24	8	2	5
K140	Rigging and lifting instructions.	R			5	Email	24	8	2	3
K141	Preservation Procedure	I			5	Email	24	8	2	3
K142	Preparation for storage at job site before installation	I			5	Email	24	8	2	3
	LUBE OIL SYSTEM:									
K143	General Index	R	6		7	Email	4	8	2	
K144	P & I diagram with supply limit and connections	A	6		7	Email	6	8	2	
K145	Filled-in component data sheets including utility consumption list	A	4		5	Email	8	8	2	
K146	Catalogue and Brochure	R	2					8	2	
	DRAWINGS									
K147	General arrangement drawing showing, weights, dimensioned location, size, rating, and facing of all connections for hookup by others, properly indicated and listed including list of connections.	A	6		7	Email	8	8	2	
K148	Component out line drawings and bill of material	R			7	Email	8	8	2	
K149	system schematics	R	4		5	Email	8	8	2	
	PROCEDURES									

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			Copy	CD	Copy	CD	No.of Week	Copy	CD	
K150	Site acceptance test procedure	R			5	Email	24	8	2	
K151	Testing procedure	A			5	Email	24	8	2	4
K152	Painting procedure and rust prevention	R			5	Email	10	8	2	
SPARE PART LISTS										
L1	Spare part list for erection, pre- commissioning, commissioning and start up	A	6		7	Email	4	8	2	
L2	Spare parts list for 3 years of operation	A	6		7	Email	4	8	2	
L3	Capital spare parts	A	6		7	Email	4	8	2	
L4	List of special tools and devices	A	6		7	Email	4	8	2	
	Mechanical Catalogue & Quality Record Book	R	-	-	1	Email		8	2	1
Notes: (1) Mechanical Catalogue & quality record book shall be submitted to Purchaser. (2) Equipment list shall contain all proper equipment information. (3) To be issued 4 weeks before shipment. (4) To be issued at least two months before performing the shop test. (5) To be issued after performing the test.										

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ANNEXURE 7B

**SPECIFICATIONS FOR SUPPLY OF 40KL ROAD TANKERS (SEMITRAILER)
ALONG WITH PRIME MOVER/HAULER FOR TRANSPORTATION OF
LIQUID NITROGEN AND LIQUID OXYGEN**

S.No.	Item Description		
	Scope: Design, engineering, fabrication, testing and delivery of 40KL super insulated horizontal road tankers with prime movers for transportation of liquid Nitrogen & Liquid Oxygen to SDSC, SHAR.		
A	Tank		
A.1	Technical specifications of Tank		
A.1.1	Tank Configuration	Horizontal (Cylindrical with dished ends) Super insulated vacuum jacketed Cryogenic storage tank necessary support structure.	
A.1.2	Fluid Medium	Liquid Nitrogen (LN2) & Liquid Oxygen	
A.1.3	Capacity, Water Volume	~ 40000 litres NET CAPACITY 95 % (LIN): ~ 38600 Liters NET CAPACITY 66.8 % (LOX): ~ 27100Liters	
A.1.4	Quantity	02 Nos	
A.1.5	Ullage volume	5%	
A.1.6	Evaporation loss when the tank is filled to 75% capacity	<0.10% per day (at ambient temperature of 300K and tank at atmospheric Pressure)	
A.1.7	Operation life	25 years.	
A.1.8	Cleanliness Standard	Oxygen service	
A.2	Design parameters		
A.2.1	Specification	Inner vessel	Outer vessel



S.No.	Item Description		
A.2.2	Material of construction	SA 240 Grade SS 304L/316L or X5 CrNi1810 as PER EN 10028-7	SA 516 Gr.70 Carbon Steel with SS
A.2.3	Max Operating Pressure	3bar(g) maximum	1.013 bar outer + inner vac.
A.2.4	Design Pressure	As per code	1.013bar(g)(external pressure)
A.2.5	Hydro/Pneumatic test pressure	As per code	As per code
A.2.6	Design temperature	77 to 323 K	343K
A.2.7	Corrosion allowance	0 mm	As per standard design
A.2.8	Radiography	100% for all butt weld joints	10% random for butt weld joints
A.2.9	Heat treatment for dished ends	Solution annealing	Normalizing/stress relieving as per standard.
A.2.10	Design Code	ASME SEC VIII, Div 1 or EN 13530-2:2002/A1:2004 or equivalent	ASME SEC VIII, Div 1 or equivalent EN 13530-2:2002/A1:2004
A.3	Insulation		
	- Multilayer insulation of Aluminum foil and fiber glass paper or double aluminized mylar with nylon net/fiber glass paper or equivalent. Other insulations such as perlite not allowed. - Level of warm vacuum shall be better than 1×10^{-3} mbar. - The selection of materials and quantity of adsorbents shall be in such way that no restoration/regeneration of the adsorbent is necessary for a duration of 5 years.		
A.4	Materials of construction		
A.4.1	Inner Vessel	Stainless steel SA 240 Grade SS 304L/316L as per ASTM Standard or X5 CrNi1810 as PER EN 10028-7 or equivalent	

S.No.	Item Description	
		- Plates which are selected for the fabrication shall be of 100% UT tested for detecting defects like laminations, surface / internal cavities etc., prior to its use. - Cold/hot stretched material not allowed. - Cold impact strength tests shall be carried out on all materials subjected to cryo temperatures
A.4.2	Outer Vessel	SA516grade 70 Carbon steel with SS or equivalent.
A.4.3	Piping(SI & uninsulated)	ASTM A 312 - SS 304 L or equivalent. (seamless type only for inner & outer pipe)
A.4.4	Cabinet frame for instrumentation valves and gauges	SS 304 L or equivalent. The components as shown in P&I scheme shall be located inside this cabinet.
A.4.5	Supporting frame for the Complete tank	This shall be of structural steel as per standard to enable the tank for placing on a suitable trailer/pedestal.
A.4.6	Protection of Material	All the materials shall be degreased before chemical passivation. The inner/outer vessel of the tanks on both sides shall be chemically pickled and passivated. All exposed support materials shall be shot blasted and painted. One coat of primer and two coats of finish paint shall be applied to all components including outer vessel.
A.4.7	Thermal Treatment of Materials	For all pressed/formed items like dished ends, solution annealing shall be carried out.
A.5	PIPING AND INSTRUMENTATION SCHEME:	
	The Piping and Instrumentation scheme shall be as per enclosed P&I diagram includes: Supplier's scope shall be as per the P&I Diagram and associated BOQ. - Safety circuit, pressure, level & vacuum measurement circuit with associated flow components (as indicated in above P&ID) shall be integrated along with the tank. - Pressure building unit shall be supplied in loose condition with flanged end terminations, as indicated.	

S.No.	Item Description						
	- Accordingly, tank shall be tested and qualified at supplier’s premises by conducting all the tests as per specifications. Cold shock & NER tests also to be carried out by using temporary arrangement /valves suitably. - Overall integrated P&ID shall be generated by the supplier and submitted to SDSC SHAR for review and approval. PESO approval for the same shall be obtained by the supplier.						
A.6	DESIGN REQUIREMENTS:						
A.6.1	- Tanks shall be designed and fabricated in accordance with ASME Sec.VIII, Div-1 or EN 13530-2:2002/A1:2004 equivalent standard. - Since the tanks are envisaged for cryo temperature service, impact strength tests shall be carried out on all materials associated as per code. - For the outer vessel, corrosion allowance shall be as per standard design.						
A.6.3	Acceleration loads: The acceleration loads during transportation (without product) shall be as given below: ◆ Longitudinal acceleration 2.0 g ◆ Transverse acceleration 1.0 g ◆ Vertical downward acceleration 2.0 g (including self-weight) The design shall be carried out for the most severe requirements including combined accelerations.						
A.6.4	Tank Speed: Speed of the tank during transportation shall be taken as below: <table><tr><td>With product mass</td><td>:</td><td>min 40 KMPH</td></tr><tr><td>Without product mass</td><td>:</td><td>min 50 KMPH</td></tr></table>	With product mass	:	min 40 KMPH	Without product mass	:	min 50 KMPH
With product mass	:	min 40 KMPH					
Without product mass	:	min 50 KMPH					
A.7	WELDING REQUIREMENTS						
	a. Welding of following butt joints shall be performed by GTAW/Plasma TIG process: - Longitudinal and circumferential joints of inner and outer shells - Joints of shell to end plates (dished ends) b. 100% of butt weld joints involving stainless steel pipelines, fittings, hoses, bellows, valves, flanges, pipe unions, nozzles to the inner/outer vessel shells and end plates shall be performed by GTAW/Plasma TIG process with argon purging.						



S.No.	Item Description
	c. CS WELDING: For all carbon steel materials, Submerged Arc Welding (SAW) process shall be followed. Wherever approach is not available to carrying out SAW process second side gouging shall be carried out before welding. Filler wires/electrodes shall be suitable to parent material composition.
A.8	RADIOGRAPHY REQUIREMENTS:
	100% radiography on all butt welded joints (except last one shell & dish end closure joint) of the Inner vessel and radiography of random 10 % butt welded joints of outer vessel including flange to pipeline and pipelines to each other shall be carried out in accordance with documents in force as per ASME code with the documents approval by the third party acceptance. - Those joints which are not subjected to radiography (x-ray) gamma-ray may be considered by getting the approval from the third party inspection agency.
A.9	TESTING AND QUALIFICATION
A.9.1	Pneumatic/Hydro Strength Test: Any one of following tests shall be carried out in presence of third party inspection agency. - Pneumatic test with GN2/dry air (dew point -55 Deg.C [min]) medium at a test pressure of 1.1 times the design pressure. - Hydro test with water or suitable liquid at a test pressure of 1.3 times the design pressure.
A.9.2	Helium Leak Check (Inner Vessel) - All weld joints on the inner vessels shall be qualified for Helium leaks with a mass spectrometer for hermitivity/leak rates of 5×10^{-7} mbar lit/s (or better) by accumulation/probe method at operating pressure. - In addition to the above, vacuum shall be created in the inner vessel to 1×10^{-3} mbar and weld joints of vessel shall be checked for leaks by Helium chamber method with leak rate better than 5×10^{-8} mbar lit/s.
A.9.3	Helium Leak Check (Inner & Outer Vessel) All weld joints on the outer vessel shall be qualified for Helium leaks with a mass spectrometer for a hermitivity/leak rates of 5×10^{-8} mbar lit/s. During the above, annular space shall be at vacuum level not less than 5×10^{-3} mbar. The test shall be carried out on integrated vessel.

S.No.	Item Description
A.9.4	Vacuum Retention Test: Subsequent to the completion of Helium leak check of integrated Vessel, vacuum stabilization shall be observed for a duration of 96 hours during which time no evacuation shall be carried out. The raise in pressure shall be monitored in this test. For pressure rise qualification an in-leakage (leak rate) more than 5×10^{-5} mbar-lit/s (max) for a volume of 1000 litres is not allowed.
A.9.5	Cold Shock Test on Inner Vessel Joints - All inner vessel weld joints shall be subjected to cold shock with LN2 medium at operating pressure of the vessel. - On completion of cold shock test and after warming up of the vessel, vacuum level in the annular space shall be retained at not more than 5×10^{-3} mbar.
A.9.6	Measurement of Evaporation Loss & Heat-in-Leak (NER test) - The tank shall be filled to 75% Level (minimum) with LN2 and the loss due to evaporation shall be measured. - External pressure & temperature shall be near ambient. - The percentage evaporation loss shall be less than the specified value for LN2 medium. - The measurement of evaporation loss shall be carried out in presence of third party inspection agency/ Department's (Purchaser) representative. - Supply of LN2 for this test shall be in scope of manufacturer. - To carry out the test, temporary arrangement with valves and flow meter shall be provided by the supplier at their premise.
A.9.7	IDENTIFICATION AND SEALING - Each vessel should have a name plate permanently fixed to the vessel, with brief specifications duly marked as per ASME Rules. - The inner vessel shall be sealed so that ambient moisture never enters inside. The tanks are to be pressurised to 0.5 bar with dry Nitrogen gas at - 55 Deg.C dew point. - The annular space shall be maintained at 1×10^{-3} mbar vacuum pressure, sealed and delivered. - All the outlet ports in the valve cabinet and outside valve cabinet, metallic dummies shall be provided. The dummies shall be made from same materials as that of parent metal.

S.No.	Item Description
A.10	INSPECTION:
A.10.1	The vessel should be inspected and certified by third party inspection agency (TPIA).
A.10.2	The scope of TPIA inspection is as given below: • Approval of the design calculations (inner/outer vessels, design, saddle supports etc.) and fabrication drawings prepared to ensure that the details are as required by the codes and standards specified. • Inspection of plates at fabricators shop, cuts of plates and samples taken from each plate, witness of tests shall be carried out. Plates (per each heat/lot) shall be tested for chemical, mechanical, UT and IGC (ASTM A262 Practice E or equivalent), irrespective of availability of Mill Test Certificates. The inspection should be carried out in accordance with the requirements of ASME Standards or equivalent. • Welding procedure qualification and welder's performance qualification tests as per ASME Code regulations. • Marking of the shell plates and dished end plates. • Long seam-fit up inspection of tack welds. • Back grinding of seam welds, inspection of welds. • Circularity of shells after rolling. • Evaluation of radiography films of all Butt welds. • Forming of dished ends, stress relieving/heat treatment and radiography of welds. • Cir seam fit up. • Back chip of cir seam welds. • Marking of nozzle orientation. • Nozzle fit up. • Saddle and saddle support fit up. • Dye penetrant test on all fillet welds. • Pneumatic strength test at test pressure. • Dimensional check and verification of Test certificates related to Standard components as per P&I scheme. • Chemical cleaning and drying. • Internal cleaning of vessel & piping confirming to nitrogen service as per ASTM G93 or equivalent.

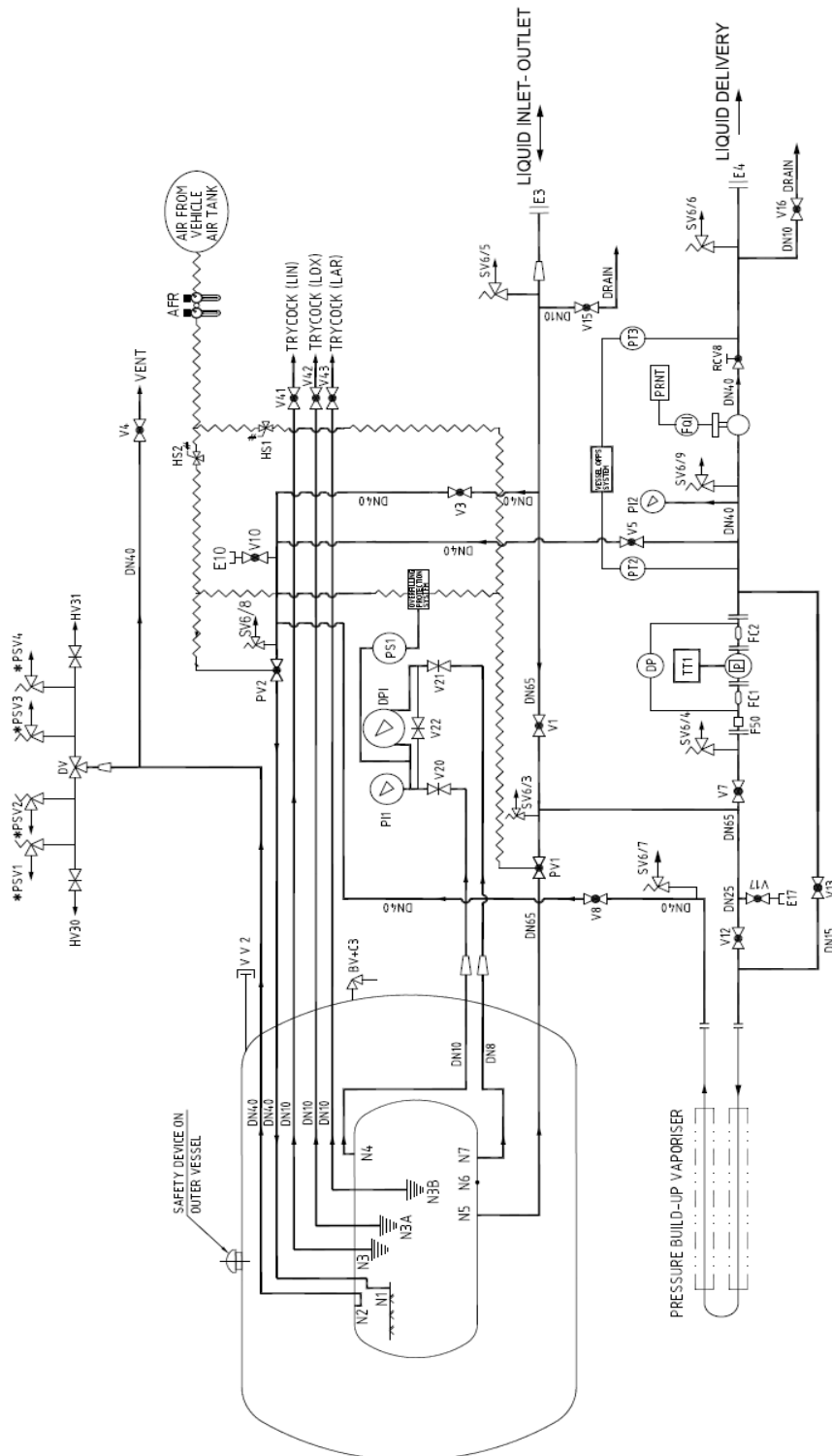
S.No.	Item Description
	- Filling with dry Nitrogen at 0.5 bar and vacuum checks before final dispatch. - Stamping of the vessel and issue of inspection release note. - Results of thermal design calculations of the vessel confirming net evaporation rate. By incorporating the above points, supplier shall prepare and submit a quality assurance plan (QAP) to purchaser for review & approval.
A.11	SUBMISSION OF DRAWINGS AND DESIGN CALCULATIONS:
	Supplier shall prepare detailed design calculations and fabrication drawings and submit one copy to Purchaser for review & approval. Approval of the third party inspection agency and purchaser shall be confirmed prior to the commencement of fabrication.
A.11.1	The following documentation to be supplied for approval prior to manufacturing. - Quality assurance plan (QAP) - Materials used for all elements - Dimensions and thicknesses of the walls - Scope and method of inspection for the inner vessel and outer vessel materials - Welding procedures and welding materials - Scope and methods of inspection of weld joints - Scope and inspection of shell tightness - Scope and method of thermal treatment of parts - Data sheets & drawings of flow components and instruments - Norms of evaluation of weld joints quality - P&I Diagram. - General assembly and fabrication drawings of the vessel duly approved by TPIA. - Calculations for strength and stability of vessels and associated supports /saddles duly approved by TPIA. - Results of thermal design calculations of the vessels confirming net evaporation rate. - Sizing of pressure building unit and associated pipelines. - Sizing calculations of the safety valves duly approved by TPIA. - Calculations of burst diaphragms sizing and selection. - Detailed specifications of the flow components and instrumentation elements as per overall P&ID.



S.No.	Item Description
A.11.2	The supplier shall obtain statutory clearance (towards design and manufacture) from PESO, Nagpur/India. Towards obtaining the same, the following documents are required ▪ Fabrication drawings as approved by Third Party Inspection Agency. ▪ Design calculations of the Vessel as per ASME code approved by Third Party Inspection Agency. ▪ Safety relief device calculations of inner vessel.
A.11.3	One copy of master file and test certificates/ documents shall be supplied by the fabricator along with the tank. Master file should contain the following: • Purchaser order copy and amendments, if any • Inspection Release note by TPI • Approved Design and Fabrication drawings as stamped by PESO-Nagpur, India. • As built drawings of the vessel • Approved design documents for inner/outer vessel considering wind & seismic conditions. • Approved design calculations for safety relief valve sizing • Design and analysis reports. • P&I diagram and layout drawing of tank. • Bill of materials • Material test certificate of plates, pipes, fittings, components etc. • Radiography Reports and films of vessel shall be supplied to purchaser. • Test reports as defined in scope of inspection • Test certificates of all standard items as per legend for P&I diagram. • All radiography films pertaining to the vessel shall be supplied to Purchaser along with third party evaluation reports. • All the above reports/test results shall be bound neatly.
A.13	Quality Assurance: The supplier shall prepare a quality assurance plan considering all the test and compliance reviews mentioned in the technical specifications for approval to SDSC SHAR. A detailed QAP shall be submitted by the purchaser/TPIA.
A.14	General conditions:

S.No.	Item Description
	- Road tank shall be provided with decanting pump as per industrial standards for transfer of liquid oxygen and Liquid Nitrogen. - Party shall prepare a final P&ID diagram considering the attached reference P&ID. - Tanker shall be provided with a transfer hose and a suitable place shall be identified to keep the hoses with tanker. Size of the hose shall be limited to the size of the delivery line.

Reference P&ID:



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B. Technical specifications of Semitrailer along with Prime Mover/Hauler (2 nos) :

Sr. No.	Description	Specification
1.	AXLE TYPE :	TRIDEM PNUMATIC DRUM BRAKE AXLE
	AXLE MAKE:	BPW
	AXLE BOM:	61.40.361.823, HZMSLM 400k ABS 1960 FH445 FM1000 HD AIR BAG (Long wheel stud and hub spigot length) SN4218, QTY: 2 61.40.361.824, HZMSLM 400k 1960 NABS FH445 FM1000 (LONG WHEELSTUD & SPIGOT) SN4218, QTY: 1 02.0329.13.00, BRAKE CHAMBER T30, QTY: 2 02.0329.10.00, SPRING BRAKE ACTUATOR TRISTOP 30/30, QTY: 4 05.00.620917, SET AIR INSTALLATION KIT (WABCO), QTY: 1 05.212.75.49.0, HUB CAP WITH INTEGRATED HUBODOMETER, QTY: 1
	TRACK WIDTH:	1960 mm
	AXLE CAPACITY:	12 Ton
	SUSPENSION MODEL NO:	SLM
	RIDE HEIGHT	400 mm
	HUBODOMETER	REQUIRED
2.	WHEEL RIM SIZE	8.25 X 22.5
	WHEEL RIM MAKE	WHEELS INDIA
	WHEEL RIM MATERIAL	ALLUMINIUM
	MODEL NUMBER	ACV 319
	WHEEL RIM QTY	13 Nos
3.	TIRE MAKE	BRIDGESTONE or EQUIVALENT
	TIRE SIZE	11 R 22.5
	TYPE	DUAL
	NO. OF TYRE	13 NOS
4.	KING PIN MAKE	JOST
	MODEL NUMBER	KZ1012
	QTY	1 NOS
	SIZE	2"
	TYPE	BOLT ON TYPE
5.	LANDING GEAR	JOST
	TYPE	2 SPEED MANUAL GEAR OPERATED, 19" TRAVEL TWO SPEED
	MODEL NUMBER	A400 S. 19
	TYPE	PNEUMATIC SUSPENSION FEET
	QTY	1 NOS
6.	MUDGUARD QTY	6 NOS
	COLOUR	BLACK
	MAKE	PARLOK OR EQUIVALENT

SATISH DHAWAN SPACE CENTER SHAR, SRIHARIKOTA
INDIAN SPACE RESEARCH ORGANISATION



	MATERIAL	POLYPROPELENE
	MODEL NUMBER	102079
7.	MUDGUARD BRACKET	24 NOS
	COLOUR	BLACK
	MATERIAL	POLYPROPELENE
	MAKE	MANSION
	MODEL NUMBER	MGSP1 – MUDGUARD HOLDER ASSEMBLY
	PIPE	DN 40 - " A CLASS"
	QTY	10 METER PER TRAILER
	MOC	MS OR EQUIVALENT
8.	BRAKES	4S3M WITH EBS / RSS SYSTEM
	MAKE	WABCO Part No : 4802070010(TEBS 3rd Mod, valve) Part No : 4494290300(TEBS valve cable)
9.	PALM COUPLING	WABCO OR EQUIVALENT YELLOW & RED (ISO 1728)
	TAIL LAMP	QTY: 2 NOS, TYPE: LED,MAKE: HELLA PART NO. RH 980.890-521 & LH 980.890-511
	SIDE INDICATOR/BLINKERS	QTY: 8 NOS, TYPE: LED,MAKE: HELLA ,MODEL: 329.060-041
	POSITION LAMP	QTY: 2 NOS, TYPE: LED,MAKE: HELLA , MODEL: 961.167-021
	DISHEND TOP LIGHT (REAR ONLY RED COLOR)	QTY: 3 NO'S, TYPE: LED,MAKE: HELLA , MODEL: 328.870-091`
	INSIDE OPERATION BOX LIGHT	QTY: 1 NOS, TYPE: LED,MAKE: HELLA , MODEL: 996.479.001
	OPERATION BOX TOP LIGHT	QTY: 2 NOS, TYPE: LED,MAKE: HELLA, MODEL: 996.479-001
	REVERSE HOOTER	QTY: 1 NOS, MAKE: HELLA , MODEL: 009.148-151
	SOCKET	7 PIN MAKE: HELLA, MODEL: 008.085-001
	VOLTAGE	24 VDC
10.	TOOL BOX MAKE	PLASTIC OR METAL
	MAKE	BAWER OR EQUIVALENT
	MODEL NUMBER	V2020 OR EQUIVALENT
11.	ANTITOW AWAY DEVICE	WABCO
	MODEL NUMBER	SAFE START SYSTEM
	CABLE PART NO	4495350600
12.	TAIL GUARD	MAKE: WABCO, 3 SENSOR
	MODEL NUMBER	4006058560
13.	SPARE WHEEL STRUCTURE WITH TIRE & WHEEL RIM	QTY: 1 NOS
14.	Preferred make of Prime mover	TATA SIGNA 5530.S BS 6

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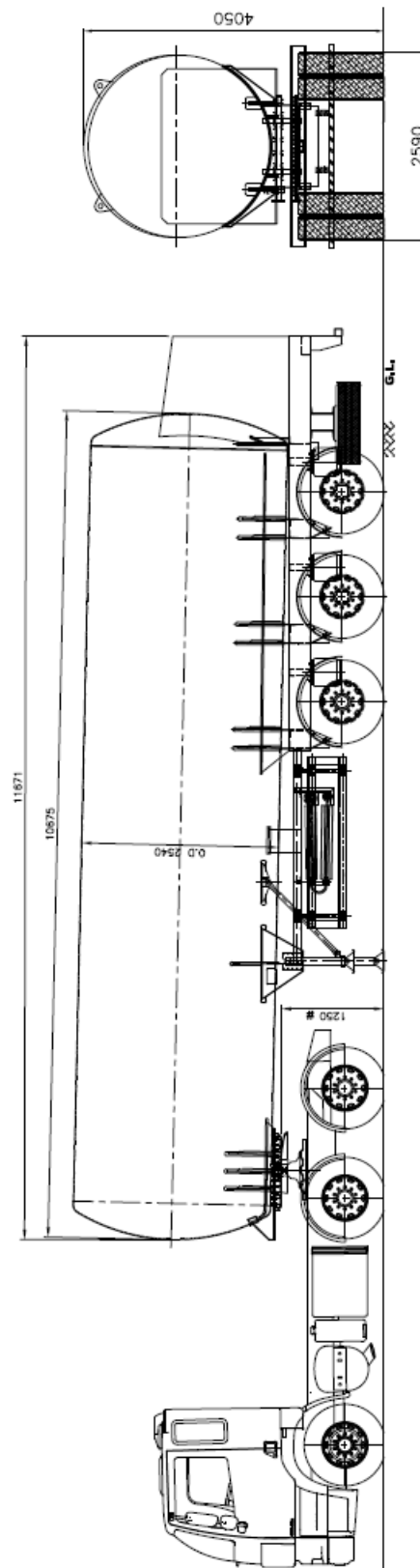
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15.	MANDATORY NOTES: 1. All the quantities are mentioned in this spec is for one job. 2. All lighting SYSTEM+EBS+RSS must be of 24 VDC. 3. All lighting, marking, wheel rim, tire, king pin, mudguard, & braking component shall be type approved. 4. Above makes and model numbers are preferred however supplier may suggest his own model and makes according to their design and market availability of item. However prior approval of purchase is to be obtained in case of any change of make or specification & model no. 5. General arrangement drawing shall be referred for integration and overall understanding of the requirement. 6. ARAI certification for prime mover / road tanker (as applicable) shall be obtained by the supplier.

General Arrangement Drawing:



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ANNEXURE 7C

SPECIFICATIONS FOR DESIGN, SUPPLY, ENGINEERING, FABRICATION, AND TESTING OF VACUUM JACKETED PERLITE INSULATED, LIQUID NITROGEN & LIQUID OXYGEN STORAGE TANKS:

S.No.	Item Description		
	Scope: Design, engineering, fabrication, testing and delivery of 250 Cu.m, vacuum jacketed perlite insulated liquid Nitrogen & liquid oxygen storage tanks to SDSC, SHAR.		
A	Tank		
A.1	Technical specifications of Tank		
		LN2 Tank	LOX Tank
A.1.1	Tank Configuration	Cylindrical with dished ends, vacuum jacketed perlite insulated Cryogenic storage tank with necessary support structure.	Cylindrical with dished ends, vacuum jacketed perlite insulated Cryogenic storage tank with necessary support structure.
A.1.2	Fluid Medium	Liquid Nitrogen (LN2)	Liquid Oxygen (LOX)
A.1.3	Capacity, Water Volume	250000 liters	250000 liters
A.1.4	Quantity	01 No	01 No
A.1.5	Ullage volume	5%	5%
A.1.6	Evaporation loss when the tank is filled to 75% capacity	<0.30% per day (at ambient temperature of 300K and tank at atmospheric Pressure)	<0.30% per day (at ambient temperature of 300K and tank at atmospheric Pressure)
A.1.7	Operation life	25 years.	25 years.
A.1.8	Cleanliness Standard	Oxygen service	Oxygen service
A.2	Design parameters		
A.2.1	Specification	Inner vessel	Outer vessel



S.No.	Item Description		
A.2.2	Material of construction	SA 240 Grade SS 304L/316L	SA 516 Gr.70 Carbon Steel
A.2.3	Operating Pressure	5 bar(g) maximum	1.013 bar outer+inner vac.
A.2.4	Design Pressure	a)1.25xMAWP+vac+Static head b)internal vacuum (1x10 ⁻³ mbar)	1.013bar(g)(external pressure)
A.2.5	Hydro/Pneumatic test pressure	Hydro: 1.3 x Design Pressure Pneumatic: 1.1 x Design Pressure	As per code
A.2.6	Design temperature	77 to 323 K	343K
A.2.7	Corrosion allowance	0 mm	3 mm
A.2.8	Radiography	100% for all butt weld joints	10% random for butt weld joints
A.2.9	Heat treatment for dished ends	Solution annealing	Normalizing/stress relieving as per standard.
A.2.10	Design Code	ASME SEC VIII, Div 1 or equivalent	ASME SEC VIII, Div 1 or equivalent
A.3	Insulation		
	- Evacuated perlite insulation. - Level of warm vacuum shall be better than 1 X 10⁻³ mbar. - The selection of materials and quantity of adsorbents shall be in such way that no restoration/regeneration of the adsorbent is necessary for a duration of 5 years. - The selection of materials and quantity of adsorbents shall be in such way that no restoration/regeneration of the adsorbent is necessary for a duration of 5 years.		
A.4	Materials of construction		
A.4.1	Inner Vessel	Stainless steel SA 240 Grade SS 304L/316L as per ASTM Standard or equivalent	

S.No.	Item Description	
		- Plates which are selected for the fabrication shall be of 100% UT tested for detecting defects like laminations, surface / internal cavities etc., prior to its use. - Cold/hot stretched material not allowed. - Cold impact strength tests shall be carried out on all materials subjected to cryo temperatures
A.4.2	Outer Vessel	SA516grade 70 Carbon steel or equivalent.
A.4.3	Piping(SI & uninsulated)	ASTM A 312 - SS 304 L or equivalent. (seamless type only for inner & outer pipe)
A.4.4	Cabinet frame for instrumentation valves and gauges	SS 304 L or equivalent. The components as shown in P&I scheme shall be located inside this cabinet.
A.4.5	Supporting frame for the Complete tank	This shall be of structural steel as per standard to enable the tank for placing on a suitable trailer/pedestal.
A.4.6	Protection of Material	All the materials shall be degreased before chemical passivation. The inner/outer vessel of the tanks on both sides shall be chemically pickled and passivated. All exposed support materials shall be shot blasted and painted. One coat of primer and two coats of finish paint shall be applied to all components including outer vessel.
A.4.7	Thermal Treatment of Materials	For all pressed/formed items like dished ends, solution annealing shall be carried out.
A.5	PIPING AND INSTRUMENTATION SCHEME:	
	The Piping and Instrumentation scheme shall be as per enclosed P&I diagram (Dwg No: SDSC/ASU/LN2 STO TANK/01 & SDSC/ASU/LOX STO TANK/01) which includes: - Liquid fill circuit - Liquid withdrawal circuit - Pressurisation circuit - Safety and venting circuit - Pressure and level Measurement circuit	

S.No.	Item Description
	f) Vacuum Monitoring circuit Supplier shall refer attached P&IDs SDSC/ASU/LN2 STO TANK/01 & SDSC/ASU/LOX STO TANK/01 for generation of overall P&IDs. Overall P&IDs shall be developed by the supplier and the same shall be submitted to SDSC SHAR for approval. As per the above referred drawing the following shall be noted: • All vacuum jacketed cryo pipelines shall be terminated with heat bridges (isolating the tank vacuum cavity). • Safety circuit, pressure, level & vacuum measurement circuit with associated flow components shall be integrated along with the tank. • Pressure build-up unit (PBU) shall be supplied in loose condition with flanged end terminations. • Tank shall be tested and qualified at supplier's premises by conducting all the tests as per specifications. Cold shock & NER tests also to be carried out by using temporary arrangement /valves suitably. • PESO approval of the overall integrated P&IDs shall be obtained by the supplier.
A.6	DESIGN REQUIREMENTS:
A.6.1	• Tanks shall be designed and fabricated in accordance with ASME Sec.VIII, Div-1 or equivalent standard. • Since the tanks are envisaged for cryo temperature service, impact strength tests shall be carried out on all materials associated as per code. • For the outer vessel, a minimum of 3.0 mm thickness as corrosion allowance over and above the thickness arrived after design shall be included while selecting the shell /dished end thickness. • If any alternate equivalent code (Other than ASME Sec. VIII Div-1) is followed for vessel design, the supplier shall furnish the design compliance with respect to ASME Sec VIII Div-1 as a mandatory requirement.
A.6.2	Wind Loads: (IS875 part3 or equivalent) The tank when mounted on the supports shall withstand cyclonic wind load of 230 KMPH with maximum gust of 3 Seconds. Under normal circumstances, and during transportation the wind loads shall be 60 KMPH with no product in the tank.
A.6.3	Acceleration loads:

S.No.	Item Description						
	The acceleration loads during transportation (without product) shall be as given below: ◆ Longitudinal acceleration 2.0 g ◆ Transverse acceleration 1 g ◆ Vertical acceleration 2.0 g (including self-weight) The design shall be carried out for the most severe requirements including combined accelerations.						
A.6.4	Tank Speed: Speed of the tank during transportation shall be taken as below: <table><tr><td>With product mass</td><td>:</td><td>15 KMPH</td></tr><tr><td>Without product mass</td><td>:</td><td>30 KMPH</td></tr></table>	With product mass	:	15 KMPH	Without product mass	:	30 KMPH
With product mass	:	15 KMPH					
Without product mass	:	30 KMPH					
A.6.5	Seismic loads Seismic loads in accordance with IS1893 part4 or equivalent shall be considered for Sriharikota zone (Andhra Pradesh).						
A.7	WELDING REQUIREMENTS						
	a. Welding of following butt joints shall be performed by GTAW/Plasma TIG process: • Longitudinal and circumferential joints of inner and outer shells • Joints of shell to end plates (dished ends) b. 100% of butt weld joints involving stainless steel pipelines, fittings, hoses, bellows, valves, flanges, pipe unions, nozzles to the inner/outer vessel shells and end plates shall be performed by GTAW/Plasma TIG process with argon purging. c. CS WELDING: For all carbon steel materials, Submerged Arc Welding (SAW) process shall be followed. Wherever approach is not available to carrying out SAW process second side gouging shall be carried out before welding. Filler wires/electrodes shall be suitable to parent material composition.						
A.8	RADIOGRAPHY REQUIREMENTS:						
	• 100% radiography on all butt welded joints (except last one dish & shell joint) of the Inner vessel and radiography of random 10 % butt welded joints of outer vessel including flange to pipeline and pipelines to each other shall be carried out in accordance with documents in force as per ASME code with the documents approval by the third party acceptance.						

S.No.	Item Description
	Those joints which are not subjected to radiography (x-ray) gamma-ray may be considered by getting the approval from the third party inspection agency.
A.9	TESTING AND QUALIFICATION
A.9.1	Pneumatic/Hydro Strength Test: Any one of following tests shall be carried out in presence of third party inspection agency. - Pneumatic test with GN2/dry air (dew point -55 Deg.C [min]) medium at a test pressure of 1.1 times the design pressure. - Hydro test with water or suitable liquid at a test pressure of 1.3 times the design pressure.
A.9.2	Helium Leak Check (Inner Vessel) - All weld joints on the inner vessels shall be qualified for Helium leaks with a mass spectrometer for hermitivity/leak rates of 5×10^{-7} mbar lit/s (or better) by accumulation/probe method at operating pressure. - In addition to the above, vacuum shall be created in the inner vessel to 1×10^{-3} mbar and weld joints of vessel shall be checked for leaks by Helium chamber method with leak rate better than 5×10^{-8} mbar lit/s.
A.9.3	Helium Leak Check (Inner & Outer Vessel) All weld joints on the outer vessel shall be qualified for Helium leaks with a mass spectrometer for a hermitivity/leak rates of 5×10^{-8} mbar lit/s. During the above, annular space shall be at vacuum level not less than 5×10^{-3} mbar. The test shall be carried out on integrated vessel.
A.9.4	Vacuum Retention Test: Subsequent to the completion of Helium leak check of integrated Vessel, vacuum stabilization shall be observed for a duration of 96 hours during which time no evacuation shall be carried out. The raise in pressure shall be monitored in this test. For pressure rise qualification an in-leakage (leak rate) more than 5×10^{-5} mbar-lit/s (max) for a volume of 1000 litres is not allowed.
A.9.5	Cold Shock Test on Inner Vessel Joints All inner vessel weld joints shall be subjected to cold shock with LN2 medium at operating pressure of the vessel.



S.No.	Item Description
	On completion of cold shock test and after warming up of the vessel, vacuum level in the annular space shall be retained at not more than 1×10^{-3} mbar.
A.9.6	Measurement of Evaporation Loss & Heat-in-Leak (NER test) - The tank shall be filled to 75% Level (minimum) with LN2 and the loss due to evaporation shall be measured. - External pressure & temperature shall be near ambient. - The percentage evaporation loss shall be less than the specified value for LN2 /LOX medium. LN2 medium results are to be extrapolated for arriving LOX medium NER. - The measurement of evaporation loss shall be carried out in presence of third party inspection agency/ Department's (Purchaser) representative. - Supply of LN2 for this test shall be in scope of manufacturer / supplier. - To carry out the test, temporary arrangement with valves and flow meter shall be provided by the supplier at their premise.
A.9.7	IDENTIFICATION AND SEALING - Each vessel should have a name plate permanently fixed to the vessel, with brief specifications duly marked as per ASME Rules. - The inner vessel shall be sealed so that ambient moisture never enters inside. The tanks are to be pressurised to 0.5 bar with dry Nitrogen gas at - 55 Deg.C dew point. - The annular space shall be maintained at 1×10^{-3} mbar vacuum pressure, sealed and delivered. - All the outlet ports in the valve cabinet and outside valve cabinet, metallic dummies shall be provided. The dummies shall be made from same materials as that of parent metal.
A.10	INSPECTION:
A.10.1	The vessel should be inspected and certified by third party inspection agency (TPIA).
A.10.2	The scope of TPIA inspection is as given below: - Approval of the design calculations (inner/outer vessels, design, saddle supports etc.) and fabrication drawings prepared to ensure that the details are as required by the codes and standards specified. - Inspection of plates at fabricators shop, cuts of plates and samples taken from each plate, witness of tests shall be carried out. Plates (per each heat/lot) shall be tested for chemical, mechanical, UT and IGC (ASTM A262 Practice E or equivalent),

S.No.	Item Description
	irrespective of availability of Mill Test Certificates. The inspection should be carried out in accordance with the requirements of ASME Standards or equivalent. • Welding procedure qualification and welder's performance qualification tests as per ASME Code regulations. • Marking of the shell plates and dished end plates. • Long seam-fit up inspection of tack welds. • Back grinding of seam welds, inspection of welds. • Circularity of shells after rolling. • Evaluation of radiography films of all Butt welds. • Forming of dished ends, stress relieving/heat treatment and radiography of welds. • Cir seam fit up. • Back chip of cir seam welds. • Marking of nozzle orientation. • Nozzle fit up. • Saddle and saddle support fit up. • Dye penetrant test on all fillet welds. • Pneumatic strength test at test pressure. • Dimensional check and verification of Test certificates related to Standard components as per P&I scheme. • Chemical cleaning and drying. • Internal cleaning of vessel & piping confirming to nitrogen service as per ASTM G93 or equivalent. • Filling with dry Nitrogen at 0.5 bar and vacuum checks before final dispatch. • Stamping of the vessel and issue of inspection release note. • Results of thermal design calculations of the vessel confirming net evaporation rate. By incorporating the above points, supplier shall prepare and submit a quality assurance plan (QAP) to purchaser for review & approval.
A.11	SUBMISSION OF DRAWINGS AND DESIGN CALCULATIONS:
	Supplier shall prepare detailed design calculations and fabrication drawings and submit one copy to Purchaser for review & approval. Approval of the third party



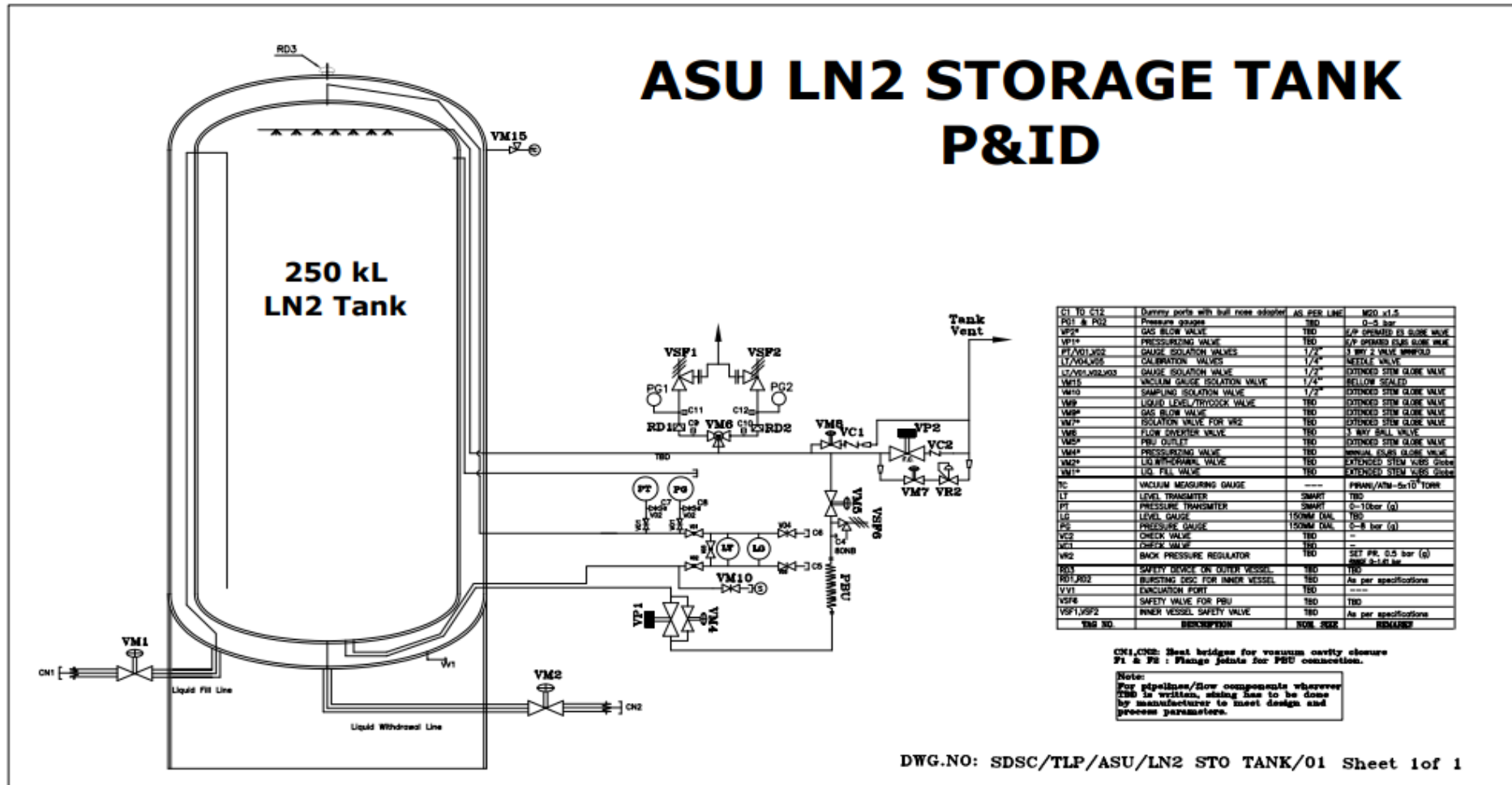
S.No.	Item Description
	inspection agency and purchaser shall be confirmed prior to the commencement of fabrication.
A.11.1	The following documentation to be supplied for approval prior to manufacturing. ▪ Quality assurance plan (QAP) ▪ Materials used for all elements ▪ Dimensions and thicknesses of the walls ▪ Scope and method of inspection for the inner vessel and outer vessel materials ▪ Welding procedures and welding materials ▪ Scope and methods of inspection of weld joints ▪ Scope and inspection of shell tightness ▪ Scope and method of thermal treatment of parts ▪ Data sheets & drawings of flow components and instruments ▪ Norms of evaluation of weld joints quality ▪ P&I Diagram. ▪ General assembly and fabrication drawings of the vessel duly approved by TPIA. ▪ Calculations for strength and stability of vessels and associated supports /saddles duly approved by TPIA. ▪ Results of thermal design calculations of the vessels confirming net evaporation rate. ▪ Sizing of pressure building unit and associated pipelines. ▪ Sizing calculations of the safety valves duly approved by TPIA. ▪ Calculations of burst diaphragms sizing and selection. ▪ Detailed specifications of the flow components and instrumentation elements as per overall integrated P & I diagram.
A.11.2	The supplier shall obtain statutory clearance (towards design and manufacture) from PESO, Nagpur/India. Towards obtaining the same, the following documents are required ▪ Fabrication drawings as approved by Third Party Inspection Agency. ▪ Design calculations of the Vessel as per ASME code approved by Third Party Inspection Agency. ▪ Safety relief device calculations of inner vessel (in both hard copy and soft copy).

S.No.	Item Description
A.11.3	One copy of master file and test certificates/ documents shall be supplied by the fabricator along with the tank. Master file should contain the following: • Purchaser order copy and amendments, if any • Inspection Release note by TPI • Approved Design and Fabrication drawings as stamped by PESO-Nagpur, India. • As built drawings of the vessel • Approved design documents for inner/outer vessel considering wind & seismic conditions. • Approved design calculations for safety relief valve sizing • Design and analysis reports. • P&I diagram and layout drawing of tank. • Bill of materials • Material test certificate of plates, pipes, fittings, components etc. • Radiography Reports and films of vessel shall be supplied to purchaser. • Test reports as defined in scope of inspection. • Test certificates of all standard items as per legend for P&I diagram. • All radiography films pertaining to the vessel shall be supplied to Purchaser along with third party evaluation reports. • All the above reports/test results shall be bound neatly.
A.12	TRANSPORTATION/MOUNTING PARAMETERS
	• The tanks are allowed to be transported by road/rail/sea. • Suitable lifting lugs should be provided for tanks handling by using cranes. • The tank cradles/saddles should be provided with areas for lifting jacks. • Provision for firm anchoring of the tanks (with Liquid nitrogen / Liquid Oxygen) so as to withstand cyclonic wind loads under storage mode when the tanks are installed on the pedestal. • The tank outer jacket diameter and overall length of the vessel (excluding the valve cabinet) shall be decided by the supplier. • Mounting scheme of the vessel has to be decided by the supplier in consultation with purchaser and TPI.
A.13	Quality Assurance:



S.No.	Item Description
	The supplier shall prepare a quality assurance plan considering all the test and compliance reviews mentioned in the technical specifications for approval to SDSC SHAR. A detailed QAP shall be submitted by the purchaser/TPIA.
A.14	GENERAL CONDITIONS:
	The procurement specifications of the bought out standard components listed in P & I shall be submitted along with design documents for approval by Purchaser and TPIA. In general, the flow components of following makes shall be preferred. • Cryogenic Valves: VELAN/SA IRELAND/STOHR/CPC CRYOLAB/CRYOGENMASH • Vacuum valves: VAT make or equivalent • Instrumentation valves: Thompson or STOHR • Safety relief valves: CRYOGENMASH/ANDERSON GREENWOOD CROSBY SANMAR • Pressure and level transducers/transmitters: ROSEMOUNT (Model Nos: PT: 3051S 2 T A 3A 2 E11 A 1A HR7 DA2 B4 K5 Y2 L1 M5 P2 Q4 T1, LT: 3051S 2 C D 2A 2 E12 A 1A HR7 DA2 B4 K5 Y2 L1 L4 M5 P2 Q4 T1) • Level and pressure gauges: WIKA or equivalent • Any deviation from the above can be considered by Purchaser/ Department on case to case basis during detailed engineering stage.

ASU LN2 STORAGE TANK P&ID



REQUEST FOR PROPOSAL FOR ESTABLISHMENT OF
50 MTPD CRYOGENIC AIR SEPERATION PLANT

Ref. No:
2025001463

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ANNEXURE 7D

Scope of works for Operation of 50 TPD Cryogenic Air Separation Unit and auxiliary facilities for producing LOX and LIN in three shifts mode on daily basis

- Contractor has to submit Standard Operating Procedure (SOP) for the Air Separation Plant and Auxiliary systems like Chilled Water Systems, Electrical Systems consisting of Sub-Station, DG & UPS, Fire Fighting Systems, etc to the Department before commencing and during running the Air Separation Plant Operations.
- The SOP shall be vetted with the department for Review & Clearance.
- The scope of the contractor is mentioned below, but not be limited to the following. Any other activity not mentioned but required for successful operation of Air Separation Plant shall also be in the contractor's scope.
 1. Ensuring healthiness of plant equipment viz, Compressors, Air cooling & Purification systems, Cooling water system, ASU, Storage system, Liquid Transfer system, Instrumentation & control system, Electrical system, Backup system (for both local as well as DCS operational activities), Fire Protection system, etc.
 2. Operations of Instrumentation & control Systems viz, Process Readiness Checks during start up, Monitoring the healthiness of instruments / elements, Control valves, MCCs, Solenoid valves, PLC, Documentation/ Data Extraction Activities, etc
 3. Inspection of all equipment and piping system meant for firefighting water, chilled water, air, Oxygen & Nitrogen. Observation and abnormalities / defects, if any during plant operation & maintenance shall be recorded and reported.
 4. Monitoring of consumption of all utilities including water for optimum operation.
 5. Continuous surveillance for identification of leakages of all utilities & gases and arresting the leakages.

6. Procurement of production consumables viz., oils, lubricants, chemicals, Diesel , Spares etc.,
7. Conducting trial runs of equipment after maintenance / repair / scheduled testing / changeover of equipment, monitoring of de-watering pumps etc
8. Entry of technical / operating parameters of the system into Log sheet in prescribed format / digital format. The same shall be maintained and submitted to Department focal point, Weekly.
9. Verification of technical parameters of the equipment are in line with the SOP.
10. Start & Stop of equipment shall be carried out as per the sequence detailed in SOP.
11. Whenever the Plant / System / Equipment parameters are deviating the allowable limits, corrective action shall be taken with the approval of Department.
12. Regular check of healthiness of stand by equipment.
13. Back flushing of equipment as per requirement.
14. Coordination with the Department towards transportation of LIN / LOX and safe connection, disconnection & dispatch of tankers from the plant premises.
15. Monitoring of storage tank parameters, viz Pressure, Level & Temperature.
16. Assistance during simulation checks of FDA detectors as per schedule.
17. Monitoring of Air conditioning and ventilation systems.
18. Conducting product quality checks and verification of Product purities along with portable analyser, whenever required.
19. Transfer of LIN & LOX storage from storage tanks to transportation tankers using pumps / vaporizers
20. Purity checking of Oxygen & Nitrogen from the process stream / liquid storage tanks / road tankers as per SOP and also as and when required. The purity specification of LOX & LIN is provided.

Liquid Nitrogen:

Parameters	Specifications
Purity of Liquid Nitrogen	Better than 99.995%

Liquid Oxygen (LOX):

Parameters	Specifications
Purity of liquid oxygen	Better than 99.8%

21. Operation of Sub Station and Monitoring of functioning of transformers and its associated equipment parameters such as Winding temperature / Oil temperature / oil level / Checking of oil leakage if any, take immediate corrective action to stop the leakage / Logging parameters in in Log book,
22. All other activities that is required towards ensuring power supply to all the connected loads.
22. Operation of DGs in case of power failure for critical operations & monitoring of functioning of DG Sets and its parameters such as:
 - a. Oil Temperature & Oil Level
 - b. Coolant Temperature & Coolant Level
 - c. Fuel level
 - d. DCP Panel of Individual DG Set
 - d. Manual and Auto-start of DG Sets functioning including through Synchronous Panel
 - e. Logging of parameters as per directions/suggestions of OEM and SOP.
23. Operation and Monitoring of functioning of DG Set Control Panel / Synchronous Panel / PLCC Panel / HT and LT Panels of Sub-station and panels / Capacitor Bank Panel
24. Operation and Monitoring of functioning of Breakers, Bus-couplers, MCCBs, all other equipments, accessories, machines, appliances etc. which are and installed in Sub-stations and associated with power supply distribution network.
25. Real time monitoring, control and online logging of Electrical parameters of HV, MV & LV Motors (flameproof & non-flameproof) etc.

26. Cleaning and upkeeping of entire plant systems.
27. Rectification of defects surfaced, if any during the operation of the plant, etc

ANNEXURE 7E

**Analysis of LOX & LIN products from Air Separation Plant to meet the
Department specifications.**

The analytical methodologies to be followed for the quality control and acceptance plan will be mainly based on ASTM and MIL standards. A brief outline of the methodologies for various raw materials, intermediate streams and end products are described.

Following are need to be analysed periodically or as and when required:

1. Analysis of Cooling Water
2. Analysis of Liquid Oxygen
3. Analysis of Liquid Nitrogen

ANALYSIS OF COOLING WATER

SPECIFICATION

pH	: 7.6
Total hardness	: 14.42 ppm max
Chlorides	: 117.09 ppm max
Fe ₂ O ₃	: 3.06 ppm max
Turbidity	: 5.05 ppm max
M – Alkali	: 70.06 ppm max
SiO ₂	: 10.1 ppm max
EC	: 787 micro simen /cm

METHOD OF ANALYSIS

- The pH shall be determined by a pH meter.
- Total hardness shall be determined calorimetrically using water test kit.
Chlorides shall be determined by a turbidity method.
- Fe_2O_3 shall be determined calorimetrically by using o-phenanthroline reagent as per Vogel method.
- Turbidity shall be determined by a Nephelometer.
- M-Alkali shall be determined calorimetrically by using water test kit.
- SiO_2 shall be determined calorimetrically as per the method in Vogels book of quantitative inorganic analysis.

ASSAY OF LIQUID OXYGEN

METHOD OF ANALYSIS

Oxygen content shall be determined by difference by subtracting total impurities from 100.

Other gaseous impurities (Argon, Nitrogen, carbon dioxide volatile hydro carbon and acetylene) shall be determined by a gas chromatograph fitted with a thermal conductivity detector having as sensitivity of not less than 1 ppm and a flame ionization detector with a sensitivity of not less than 0.02 ppm.

ANALYSIS OF LIQUID NITROGEN

METHOD OF ANALYSIS

Nitrogen content shall be determined by difference by subtracting the total impurities from 100. Water content shall be determined by SHAW type moisture analyzer with 1 ppm sensitivity.

Other gaseous impurities (Argon, oxygen, hydrocarbon and Hydrogen) shall be determined by a gas chromatograph fitted with thermal conductivity and flame ionization detectors having not less than 1ppm sensitivity.

SAMPLING METHODS

The frequency of sampling of various intermediate streams and products shall be as per the schedule indicated in the operation manual.

The operations manual shall be prepared in consultation with the Department as per the standard plant operational requirement.

The intermediate streams shall be sampled from the respective sample points using 500ml. SS sample container.

The sample container must be purged well with the samples before it is filled. The sample container and the sample hoses have ¼ " BSP male end fittings. Suitable end fittings must be provided at the sample points to withdraw the samples. For withdrawing the flue gas samples Hamilton super syringe or gas sampling bulbs made of glass be used.

The products LOX and LN₂ shall be sampled in accordance with the method given in MIL-S-27626-D (USAF).

ANNEXURE 7F

Maintenance of Process & Mechanical system equipment, piping, flow components, valve actuators etc.

- The scope shall cover maintenance of all the equipments of 50 TPD Cryogenic Air Separation Plant as well as Auxiliary Systems which includes Water Treatment Plant, Water makeup system, instrument air, Fire Fighting Systems, Cooling water systems & transportation tankers, EOT Crane, etc. The scope of the contractor is maintenance of the plant equipment & machinery for smooth and uninterrupted functioning of the Plant.
- The Scope of work listed above is only indicative and all other works that are necessary for ensuring reliable operations of ASU shall also be carried out as directed by the Department.
- Any breakdowns occurring in the entire plant shall be attended immediately. OEM experts shall be pressed in to service, if required in order to ensure the restoration of plant operations within shortest possible time period.
- **Preventive Maintenance Inspection**
 - ✓ Preventive maintenance (PM) inspection for the equipments shall be carried out as per the formats provided by Department. The PM inspection schedule for all the equipments shall be as per the OEM recommendations / practices at SDSC SHAR. The schedule & formats shall be signed by both Contractor and Department prior to the start of the O & M contract.
 - ✓ Any abnormalities/ defects observed during PM inspection shall be brought to the notice of Department immediately. The abnormalities/ defects observed during the PM Inspection shall be recorded equipment wise and the rectification of these abnormalities / defects shall be taken up in consultation with the Department.
- **Condition monitoring of equipment**

Condition monitoring of the equipments shall be carried out as per the formats provided by the Department. The Plan & formats for the same shall be signed by both Department and the Contractor at the start of the contract. The instruments required for the condition monitoring like vibration measuring instrument, non-contact temperature sensor shall be in the scope of contract agency.
- **Lubrication of bearings/ valves/ actuators**

Lubrication of bearings of rotating equipments, Valves / Actuators etc. mentioned at Annexure-D shall be carried out by the contract agency as per the Plan signed by both Department and the Contractor.

- **Scheduled maintenance**

Scheduled maintenance activities like Monthly / Quarterly / Half yearly / Annual Maintenance of the equipments shall be carried out by the Contractor as per the schedule signed by both Department and the Contractor. The maintenance schedules for the equipments shall be prepared by the Contractor, as per the OEM recommendations.

- **Routine maintenance**

Routine maintenance activities like filters cleaning, oil top up, oil coolers cleaning, filling up of lubricants / refrigerants, etc which are required to be carried out during the production of LOX & LIN and Operation of equipments, etc.

- ✓ Identification and rectification of leaks, servicing / replacement of flow components, repair of equipment and troubleshooting of the equipment/systems
- ✓ Failure analysis and Identification of root cause of the problem
- ✓ Other maintenance activities as required for the smooth operation of the plant shall also be carried out by Contractor.
- ✓ The routine maintenance activities shall be carried out in the presence of shift In-charge and shall be recorded in the logbook.

- **Overhauls**

Overhaul of the equipments of additional special conditions (except that of MAC, BAC) shall be carried out by the contract agency as per the schedule recommended by OEM or based on the running condition of the equipment. However, Spares replacement during the overhaul shall be decided by Department.

- **Shutdown/Breakdowns, corrective & preventive actions including repair / replacement of equipments or parts of equipment.**

In case of breakdowns, the contract agency shall arrange all requisite resources immediately to bring back the equipment to normal working condition in order to minimise the down time.

The Contractor shall make all arrangements immediately to see that work is carried out round the clock to bring back the equipment to normalcy.

Root cause analysis shall also be carried out by the agency for each breakdown and corrective and preventive actions shall be carried out, to prevent such breakdowns in future.

- **Pipeline repair:** Pipeline repair / replacement
- **Structural works:** Temporary Structural works, if any required towards maintenance / overhaul of equipments / subsystems
- **Modification works:** Prior approval shall be obtained from the Department to carry out any modification / change required on the equipment for the ease of maintenance or for the safety of the human or for better performance of the equipment.
- **Safety valves:**
 1. The agency shall carryout testing of safety valves as identified by Department at the beginning of contract, once in a year.
 2. Safety valves shall be periodically tested once in a year at SRV test facility of SDSC SHAR.
 3. Departmental SRV test facility shall be extended for testing of SRVs, at a free of cost. However, the transportation, testing & servicing is in the scope of contractor only.
- The contractor shall submit the complete list of all type of spare parts / repair kits / soft seals, etc within 15 days from the date of acceptance of successful commissioning of the plant and shall supply the same, as per RFP terms during O & M period.
- The contractor shall have to arrange all the necessary tools, measuring devices etc. required for the repair of the equipment, at site.
- The contractor shall maintain the necessary stock of spare-parts / consumables required for maintenance / repair, at site.
- During the process of O & M, if any damage occurs due to poor workmanship, the rectification / replacement shall be done by the Contractor, at a free of cost.

- Site-in charge shall prepare the following reports and to be submitted to the Department from time to time:
 - ✓ Daily report (Equipment wise all the activities carried out on a single day)
 - ✓ Monthly report
 - ✓ Monthly Condition monitoring reports
 - ✓ Break down reports (If any)
- **Miscellaneous:**
 The following activities are required to be initiated by the agency immediately after commencement of O & M Contract.
 - ✓ To maintain minimum day to day requirements of items & consumables.
 - ✓ Returning of the excess material, if any to stores
 - ✓ Collection and disposal of scrap & waste material at designated locations of Utilities department.
 - ✓ The agency shall carry out good housekeeping every day after completion of the maintenance activity at site and maintain surroundings neat and clean always.

ANNEXURE 7G

Maintenance of Electrical equipment, Systems, Substation etc.,.

1. Scope: Maintenance of Electrical systems shall comprise the following:

- HT panels having vacuum Circuit breakers, metering, protective relays etc.,
 - Transformers of Varying capacity from 10KVA to 8000 KVA
 - LT panels comprising ACBs, MPCBs, MCCBs, SFUs, metering and protective elements of Normal Power, UPS, DGs, Change Over panels etc.,
 - D G sets comprising Alternator, Control, panels, synchronizing panels, etc., including Diesel engines.
 - Earthing systems and lightning protection system.
 - Indoor and Outdoor Lighting including path lights installations.
- a) Test & Evaluation documents, checklists and formats shall be submitted for Department approval.
- b) Activities are to be carried out based on the approved documents for operation and maintenance.
- c) A detailed checklist shall be finalized for equipment in the plant, at the start of O&M
- d) The Scope of work listed above is only indicative and all other works that are necessary for ensuring reliable operations of ASU as directed by Department, shall also be in the scope of contract agency.
- e) Any breakdowns occurring in the entire plant shall be attended immediately. OEM experts shall be pressed in to service, if required in order to ensure the restoration of plant operations within shortest possible time period.
- f) All tools like Tester, Screw driver set, Spanner set, Wrenches etc., for each Technician and meters like Multi meter, Insulation Resistance Tester, Clamp Meter, Earth Megger each one, at each work locations, are to be provided by the Contract agency. The tools and meters shall be of reputed make (Fluke / Megger) and periodical calibrations from Government approved agency shall be ensured

by the Contractor.

- g) Special meters / tools / equipments like Contact resistance meter, HV insulation Tester, Battery Impedance Tester, Thermal Imager, Power Analyzer, Venire caliper and ladders shall also be ensured by the Contractor.
- h) Equipments / machineries like transformer oil filtration unit, Battery Load test unit, BDV, ACB Testing, primary and secondary injection kits shall be ensured by the Contractor.
- i) Consumables like insulation tapes, bulbs, switches, plugs, screws, nuts, spacers & saddles, identification tags, cable ties, terminal jumpers, cable lugs, terminals for power, control & communication, connectors and nomenclatures etc., as required for maintenance, shall be ensured by the Contractor.
- j) The Contractor shall ensure thorough cleaning of the area before and after the work.
- k) The Contractor shall submit weekly, monthly, quarterly and annually work report with the details of works carried out, man power allotted etc., in the prescribed format as required and directed by Department
- l) The Contractor shall coordinate with OEMs of equipment and prepare the checklists accordingly and the same shall be approved by the Department. During AMC or breakdown for critical equipment should be maintained under the supervision & guidelines of OEMs.
- m) The details of work mentioned in this document are only indicative. The Contractor shall support for all the plant works as required and as directed by Department.
- n) During the process of work, if any damage occurs due to poor workmanship, the rectification / replacement shall be done by the Contractor, at a free of cost.
- o) The works shall be carried out as per need and as per clearance available after approval from the Department.
- p) **Details of works to be carried out towards Maintenance of 33 KV and 11 KV HT Vacuum Circuit breakers / Ring main units**

- 1. Each HT panel consists of number of VCBs . Each VCB is considered as one unit.

2. All compartments viz., VCB , Cable Chamber , Metering , Terminals etc., shall be thoroughly cleaned with vacuum cleaner
3. Tightness of all control and power connections.
4. All insulation surfaces should be cleaned and closely inspected for signs of tracking, treeing, blistering, and delaminating or mechanical damage. Clean and dry insulators with a suitable cleaning agent.
5. Maintenance of cradle rack in and rack out mechanism like greasing, checking of limit switches etc.,
6. Maintenance of spring charge, tripping and closing mechanisms.
7. Insulation Resistance Test, Contact resistance Tests shall be carried out for all VCBs ,ACBs and MCCBs etc as directed by EIC.
8. Verification and Maintenance of all shrouds/ bushings and safety shutter mechanisms.
9. Auxiliary switches and indicating devices shall be checked and its functional test shall be carried out.
10. The functioning of space heaters shall be checked.
11. Multifunction meters, voltmeters and ammeters shall be checked and if any shall be replaced if required.
12. Readings of meters shall be verified with calibrated with hand held calibrated meter and the error if any shall be recorded.
13. Ensuring that the erosion of contacts are within acceptable limits.
14. Testing of protective relays using primary / secondary injection test kit if required and as directed by the Department. Relay shall be tested for over current and earth fault in indicative four steps covering entire range in all phases individually.
15. Recording the details of trip records from protective relay.
16. Insulation resistance of overall HT panel and cleaning of BUS chambers shall be carried out. If found any defective insulators and same shall be replaced as instructed and directed by Department.

17. The above list is only indicative; any other maintenance required for overall healthiness of the VCB shall be carried out as directed by Department.
18. Potential transformers shall be checked for its healthiness by measuring IR values.
19. Current Transformers shall be checked for its healthiness.

q) Details of works to be carried out towards Maintenance of Power Transformers

1. Power transformers ratings range from 100 KVA to 8000 KVA.
2. All flanges shall be tightened.
3. Oil spillage on transformer surrounding shall be cleaned and tightness shall be carried out to avoid leakage, Maintenance and tightness of HT and LT terminals shall be carried out.
4. If leakage is still persists, necessary all gaskets shall be replaced if required and directed by the Department.
5. Oil level of the transformer shall be verified and oil shall be filled if required and as directed by Department.
6. Silica gel shall be checked for its healthiness and drying it if required.
7. Maintenance of HT and LT bushings and Tightness of all control and power connections.
8. Insulation resistance values of primary, secondary windings shall be measured and recorded.
9. Functioning of oil temperature thermometer and Winding temperature thermometer shall be verified and its tripping connections to VCB shall be verified.
10. Functioning of buchholz relay shall be verified.
11. Neutral earthing and body earthing connections of transformer shall be verified
12. Earth resistance values shall be measured and shall be recorded.
13. Drawing of oil sample and analysing it for its Break down voltage (BDV)

value.

14. If BDV found low, necessary oil filtration shall be carried out using oil filtration plant with necessary pipes connections and as directed by Department.
15. Functioning of various tap positions shall be verified and voltage values at each tap position shall be recorded.
16. Auxiliary switches and indicating devices shall be checked and its functional test shall be carried out.
17. Any other minor works towards maintenance of transformers shall also be carried out.

r) Details of works to be carried out towards maintenance of LT Panels

1. LT panels are ranging from 63A to 5000A
2. LT Panels consists of various switchgears like ACB, MCCB and MPCBs control transformers, ACT & AST controllers and etc.
3. General cleanliness of total panel shall be carried out.
4. Air Circuit Breakers
 - a. Cleaning of Fixed and moving contacts
 - b. Cleaning of arc chutes
 - c. Maintenance of Spring charge, closing and tripping mechanisms
 - d. Measuring Contact resistances values and recording
 - e. Tightness of power and control terminals of all switch gears
5. Insulation Resistance (IR) values of bus bars, Incoming outgoing feeders shall be measured and recorded in the checklist
6. If IR values of any feeder found low, IR values of individual run shall be measured as directed by AIC.
7. Re termination shall be carried out to any feeder if any abnormality or damage observed during maintenance.

8. Indication lamps, display modules, push buttons and control wiring to all I/C & O/G feeder cubicles shall be checked and shall be replaced if found defective.
9. Operation of all switch gears shall be checked. Defective parts if any like handles shall be replaced.
10. Door interlocks shall be ensured.
11. Protection settings of all ACBs, MCCBs and MPCBs shall be recorded.
12. Protection release functioning (LSING) shall be verified using secondary injection test kits/ Test kit.
13. Primary injection testing shall be carried out if required.
14. Past few records shall be noted from display module of trip units.
15. Necessary interlocks functioning, rack in mechanism, Local remote feedbacks to SAS systems shall be verified as directed by Department.
16. All metering data from multi-function meters, voltmeters and ammeters shall be checked with calibrated meters and error details shall be recorded. If found more deviation, meter shall be replaced as directed by Department.
17. All current transformers shall be ensured for its healthiness.
18. Earthing values of LT panel shall be measured and recorded.
19. Functional checks on auto changeovers shall be carried out as required and directed by Department.

s) Details of works to be carried out towards Maintenance of MCC panels

1. Sub Station consists of Power Control Centers(PCCs), Motor Control Centres (MCCs), package unit panels and outdoor units.
2. The PCCS and MCCs have switchgears like ACBs, MCCBs, SFUs, Contactors, OLRs, timers, single phasing preventer, relays, etc.,
3. The following are the details related to maintenance of typical electrical systems.
 - a. General cleanliness of total MCC panel shall be carried out.
 - b. Inspection, general maintenance and tightness shall be carried out.

- c. All power and control contactors fixed and moving contacts, arc chutes shall be cleaned and replaced if required.
- d. Air Circuit Breakers
- e. Cleaning of Fixed and moving contacts
- f. Cleaning of arc chutes
- g. Maintenance of Spring charge, closing and tripping mechanisms
- h. Measuring Contact resistances values and recording
- i. Tightness of terminals of Power and control circuits at all switchgears and terminals.
- j. Insulation resistance values of Bus bars, incoming, outgoing feeders, motors, chiller compressors and CT fans shall be checked and recorded in the checklist and if found low to any feeder, individual run IR values shall be measured as directed by Department.
- k. Re termination shall be carried out to any feeder / motor terminals if any abnormality or damage observed during maintenance.
- l. Indication lamps, display modules, push buttons and control wiring to all I/C & O/G feeder cubicles shall be checked and shall be replaced if found defective.
- m. All metering data from multi-function meters, voltmeters and ammeters shall be checked with calibrated meters and error details shall be recorded. If found more deviation, meter shall be replaced as directed by Department.
- n. Earthing values of MCC panels, chiller units and CT fan motors and chilled water pumps shall be measured and recorded. If any motor or chiller IR value is low, necessary removal of connections and re connection after overhauling shall also be carried out.
- o. Functional checks on auto changeovers shall be carried out as required and directed by Department.

t) Details of works to be carried out towards Maintenance of HT DG sets

1. Cleaning of alternator, control panels, NGR panels, Coil cooler Motor Control

Centers

2. Tightness Power and control terminals at all locations
3. Alternator insulation resistance values for the following to be measured and recorded
 - i. Armature to body
 - ii. Main field to body
 - iii. Exciter Armature to body
 - iv. Exciter field to body
4. Winding resistances of main field, main armature, exciter field and exciter armature shall be measured and recorded.
5. Checking the healthiness of Rotary Rectifier Assembly (RRA) and Automatic Voltage regulators.
6. Coil cooler motor terminals shall be inspected and terminal tightness shall be carried out.
7. Coil Cooler motor switch gears like contactors, OLRs, fuses, indications lamps are to be maintained.
8. Insulation resistance values of CT fans and current values shall be measured. And condition of fan and bearings shall be checked and bearings shall be replaced if required.
9. Condition of the cranking battery and battery charging circuit shall be inspected and Cold Cranking Amperes (CCA) shall be measured and recorded. If founded low and the battery shall be replaced with spare battery as directed by Department.
10. Earthing condition shall be inspected and earth resistance values to be measured and recorded.

At synchronous panel

11. Inspection, general maintenance and tightness shall be carried out to all control terminals, end terminations, fixed and moving contacts, arc chutes.
12. Spring charge mechanism, closing and tripping coil functioning shall be

verified.

13. Insulation resistance values of Bus bars, incoming and outgoing feeders shall be checked and recorded in the checklist and if found low to any feeder, individual run IR values shall be measured as directed by AIC. Re termination shall be carried out to any feeder if any abnormality or low IR during maintenance.
14. Indication lamps, display modules, push buttons and control wiring to all I/C & O/G feeder cubicles shall be checked and shall be replaced if found defective.
15. Protection settings of DG sets shall be verified and recorded. Tripping function shall be verified using secondary injection test kits if required. Past few records shall be noted from display module of trip units.
16. Functional checks on Alarm annunciation panel shall be carried out and shall be recorded.
17. Synchronization of both DG sets shall be checked and necessary metering circuits and control wiring shall be verified as per drawings and shall be recorded.
18. Functioning of protections like under voltage, over voltage, earth fault over current and reverse KVAR and field failures and over temperature etc shall be checked and recorded as directed by Department.
19. Inspection of Neutral to grounding resistor shall be checked and recorded.
20. Inspection and maintenance of supporting mechanisms, condition of neutral CTs and general cleaning of NGR shall be carried out.
21. Maintenance of PTs and CTs
22. Trial run of DG shall be carried out for one hour and all paramours shall be recorded.

u) Details of works to be carried out towards Maintenance of Panels, Batteries, AVR's, Isolation Transformers of UPS systems.

1. Batteries

- Tightness of battery terminals.
- Measuring and recording battery cell voltage during quarterly and Annual load tests.
- Prior to discharge test, shifting of load bank and connection of load bank to correspond UPS unit shall be carried out as directed by Department.
- For C3 or C10 discharge test, At every half an hour, individual cell voltage reading shall be measured and recorded till completion of the test.
- If any cell is less than end cell voltage, same shall be bypassed or replaced with spare battery as directed by Department.
- After recharging of total battery bank, weak cells voltages shall be measured and recorded. If not regained, same shall be bypassed as directed by Department.
- Condition of battery side switchgear shall be checked and terminal tightness shall be carried out.

2. UPS systems, ASTC systems & UPS Distribution panels

- UPS system module to module change over shall be checked and recorded.
- UPS system module to bypass change over shall be checked and recorded.
- Automatic voltage controller functioning shall be checked and recorded using power analyzer.
- At AVR control panel, Indication lamps, voltage raise / fall functions, toggle switches shall be checked.
- UPS Distribution panels maintenance shall be carried out similar to LT panel maintenance
- Auto change over panels
- Inspection, general maintenance and tightness shall be carried out to all terminals, end terminations, power contactor.
- Insulation resistance values of Busbars, incoming and outgoing feeders shall be checked and recorded in the checklist
- Auto source transfer controller functioning shall be checked and recorded

as directed by EIC.

- Indication lamps, multi-function meters, communication wiring to SCADA shall be checked and shall be recorded.

3. Details of works with respect to Motors

- Inspection, general maintenance and tightness shall be carried out for all terminals, bearings, encoder & accessories and rectifying the same.
- Verification of insulation resistance and conductor resistance and earthing etc.
- Replacement of fuse, single phase preventer, MCB, MCCBs, contactor, OLRS, bearings, cooling fan, Encoder, terminal jumpers etc. New items required for rectification will be supplied by Department.
- Re-termination of cables, greasing, painting if required.

4. Details of works with respect to minor complaints

- Attending minor complaints at Substation, AC plants, control rooms, and pump houses and rectifying the same.
- Replacement of all defective components like switches, sockets, indoor light fixtures, fuse, MCB, MCCBs, contactor, OLRS etc. New items required for rectification will be supplied by Department
- Re-termination of cables if required.
- Details of works with respect to operation of Total plant equipment.

ANNEXURE 7H

Maintenance of Automation (Control) and Instrumentation systems

Scope

The activities pertaining to Instrumentation & Control (Automation)-ICS are divided in to five following categories.

1. Regular Facility up-keep activities
2. Periodical Calibration activities
 - a. Removing of Electrical Connection, Dismantling the Field elements, cleaning of field elements, making sensors ready for lab calibration.
 - b. Periodic Calibration - Calibration of Sensors/Transmitters/ Gauges, Line Calibration, Report Generation.
 - c. Proper mounting of field elements after lab calibration in site, Electrical Connection of field elements
 - d. Line calibration of all parameters (AI/ DI/ AO/ DO/ Controller/ Transmitters/ Valves, etc.) at site with certified calibrators.
 - e. Weigh System Calibration with standard loads
 - f. Report Generation of Field Elements & Line simulation activities
3. Regular Preventive maintenance activities
 - a. Software - Checks & Updates
 - b. Preventive Maintenance of Inst/CCTV Systems
 - c. Maintenance report generation
 - d. Monthly Data compilation & Documentation activities
 - e. Periodical backup
4. Regular Network Maintenance
 - a. Network checks
 - b. Support system checks
 - c. Other activities

5. Facility process activities

- a. Process Readiness Checks
- b. Process support/ Breakdown maintenance
- c. Process Data documentation

1. Regular Facility up-keep activities

The regular process Instrumentation & control systems upkeep activities which consist of Regular monthly checklist, Periodical T&E checks, Documentation activities and Periodical panel cleaning activities.

1.1 Monthly Check List

- It is to be carried out for each facility during starting of every month. The work details are given below
- Measurement of 24VDC output of each power supply and Diode Ored Power supply and correcting output to 24VDC.
- Measurement of UPS input power supply and measurement of earth to neutral voltages.
- UPS Change over checks.
- Verification of Sensor terminals and its intactness for each sensor in each facility.
- Noting the ambient values of each parameter and to be entered in pre-defined check list format available with us and shall get approval from SR Team.
- Verification of Overall Functionality of PLC/SCADA as per user requirement
- Creation of New Databases for logging of process parameters.
- Verification of communication/ GPS/ FDA systems by giving test calls to adjacent facilities
- Verification of CCTV Systems by observing Clarity of Pictures from Camera, testing of Pan/Tilt/Zoom Operations, recording functionality of NVRs and its storage capacity, cleaning and verification of Monitors for process views.
- Verification of Network switches and intactness of Ethernet cables at each location and cleaning of Fibre patch cords whenever necessary.
- Ensuring connectivity to centralized Video Management system and Remote monitoring client

- Cleanliness around ICS systems
- All unwanted cables to be removed from floor, trenches, wall, etc.
- All cables shall be ensured with proper tag and to be ensured as per wiring diagram.
- All wiring drawings shall be updated properly.

1.2 Half Yearly Checks

- The works as per monthly checklist shall be carried out for each Half Yearly checks irrespective of Monthly checks.
- Detailed functionality of PLC controllers are to be verified
- Cleaning & verification Healthiness of SCADA Servers/ Engineering stations/ Client PC and updates of PC if required

1.3 Documentation

- Generation of Process check list
- Generation of Half Yearly checklist
- Compilation data & graph

1.4 Panel Cleaning

- Cleaning of IO Panels/ Control Consoles with vacuum cleaners/ blowers, etc.
- Cleaning of filter/ louver/ Server & PC Filters, etc.
- All entries for Rodents/ Lizards inside the panel shall be closed properly.

2. Periodical Calibration Activities

Lab Calibration Activity: Calibration of all sensors of plant in Calibration Lab involves removing of Elements from Field, Cleaning, Calibration, mounting back the items in Field, Report Generation and establishing the connections in field, every year for each process facility.

Calibration facility at SDSC SHAR shall be extended for calibration of instruments at free of cost however, the transportation & testing of instruments shall be in the scope of Contractor only.

The calibration activity consists of following

- Removing of Electrical Connection, Dismantling the Field elements, cleaning of field elements, making sensors ready for lab calibration.
- Periodic Calibration - Calibration of Sensors/Transmitters/ Gauges, Line Calibration, Report Generation.
- Calibration is in the scope of party. In case the Departmental Calibration facility is pre-occupied with their own scheduled activities, Contract agency shall make necessary arrangements for carry out calibration from NABL certified lab or in their lab in which all calibrator shall have traceability certificate.
- Proper mounting of field elements after lab calibration in site, Electrical Connection of field elements
- Line calibration of all parameters (AI/DI/AO/DO/ Recorder/ Controller/Transmitters/ Valves, etc.) at site.
- Breakdown and root cause analysis of all previous breakdowns if any during the period.
- Checking of all critical interlocks with Electrical, mechanical and operation dept. and maintain the record.
- Weigh System Calibration.
- Report Generation of Field Elements & Line simulation activities

Detailed activity to be carried out is given in below. It has to be carried out for each item.

2.1 Calibration of Pressure Transmitters/ DPT

- Removing of electrical connection in field
- Un-mounting the transmitters from Pipe line
- Cleaning of item in Calibration lab
- Calibration of Pressure transmitters in Dead weight test for 3 cycles up & down.
- Tabulate the results in predefined format and publishing results.
- Sticking / Tagging of Items with calibration due date
- Re-Mounting of Transmitters in Field from where they are removed.

- Establishing electrical connection and ensuring the unit is reading ambient value.

2.2 Calibration of Vacuum Transmitters

- Removing of electrical connection in field
- Un-mounting the transmitters from Pipe line
- Cleaning of item in Calibration lab
- Calibration of Vacuum Transmitter in Vacuum Calibrator for 3 cycles up & down.
- Tabulate the results in predefined format and publishing results.
- Stickers / Tagging of Items with calibration due date
- Re-Mounting of Transmitters in Field from where they are removed.
- Establishing electrical connection and ensuring the unit is reading ambient value.

2.3 Calibration of Temperature Transmitter

- Removing of electrical connection in field
- Cleaning of terminals in site
- Calibration of TT using Decade Resistance Box for 1 cycle up & down.
- Tabulate the results in predefined format and publishing results.
- Stickers / Tagging of Items with calibration due date
- Establishing electrical connection and ensuring the sensor is reading ambient value

2.4 Calibration of RTD/ Thermocouple Sensors

- Removing of electrical connection in field
- Un-mounting of Sensor from field
- Cleaning of Thermowell and end connections
- Calibration of Sensors for the given range in Oil bath/Test Bench with settling time of 30 Minutes for each set point

- Tabulate the results in predefined format and publishing results.
- Stickers / Tagging of Items with calibration due date
- Re-Mounting of Sensors in Field from where they are removed with proper glanding and dressing of wires.
- Establishing electrical connection and ensuring the sensor is reading ambient value.

2.5 Calibration of Pressure Gauges

- Cleaning of item in Calibration lab after receiving the gauges from user
- Calibration of Pressure gauges in Gauge calibrator for 3 cycles up & down as requested range by end user.
- Tabulate the results in predefined format and publishing results.
- Stickers / Tagging of Items with calibration due date
- Handing over the gauges to end user for mounting.

2.6 Calibration of Pressure Switches

- Cleaning of pressure switch ports & terminals in Calibration lab after receiving the switches from user
- Calibration of Pressure switches in Gauge calibrator for 3 cycles for rising trip or falling trip as requested range by end user.
- Tabulate the results in predefined format and publishing results.
- Stickers / Tagging of Items with calibration due date
- Mounting back unit and restoring electrical connection.

2.7 Calibration of Level switches

- Removing electrical connection
- Cleaning of level rods
- Functional verification either inline or separately to verify the functionality.
- Tabulate the results in predefined format and publishing results.
- Stickers / Tagging of Items with calibration due date

- Mounting back unit and restoring electrical connection.

2.8 Calibration of Controllers

- Verification of Input & Output ranges
- Simulating the input with current/voltage calibrators for specified range
- Verification relay & AO set points and verification of its functionality
- Tabulate the results in predefined format and publishing results.
- Sticking / Tagging of Items with calibration due date.

2.9 Weighing Systems

- Healthiness checks of Weighing Systems & Maintenance of electronic items in Systems and participating during Calibration of weighing systems

2.10 Calibration of Other sensors

- Sensors, Flow Meters, Flow switch, etc.,
- Removing of electrical connection in field
- Cleaning of terminals in site
- Calibration of sensor as per standard procedure.
- Tabulate the results in predefined format and publishing results.
- Sticking/Tagging of Items with calibration due date
- Establishing electrical connection and ensuring the PT is reading ambient value

2.11 Field Line Calibration Activity

- Temperature Line calibration - Removing terminals from field elements such as RTDs/ Thermocouples in field, connecting calibrators such as Decade Resistance box/ Multi-function calibrator/ HART Communicator in line in place of sensors, simulating temperature for the given steps, observing/ Noting of end display results in calibration sheet, Adjust the correction if required in field transmitter/ PLC/ SCADA, establishing sensor connection back and tabulating the result in a sheet with full scale deviation. It shall be carried out for each Temperature sensor.

- Pressure Line calibration - Removing terminals from field pressure transmitter, connecting HART/ Bus Communicator in line in place of sensors, simulating pressure for the given steps, observing/ Noting of end display results in calibration sheet, Adjust the correction if required in field transmitter/ PLC/ SCADA, establishing pressure Transmitter connection back and tabulating the result in a sheet with full scale deviation. It shall be carried out for each Temperature sensor.
- Frequency Line calibration - Removing terminals from field proximity/ Speed Sensor, connecting calibrator's multi-function calibrator in line in place of sensors, simulating Frequency for the given steps, observing/ Noting of end display results in calibration sheet, Adjust the correction if required in field PLC/ SCADA, establishing sensor connection back and tabulating the result in a sheet. It shall be carried out for each Temperature sensor.
- Line calibration of AI Modules in PLC: Removing the terminals in Field and simulate 4-20 mA to Analog input modules for the given scale for each channel and verification of results in PLC & SCADA, tabulate the results and restoration of connections.
- Line calibration of RTD Modules in PLC: Removing the terminals in Field and simulate DRB/TC simulator to RTD input modules for the given scale for each channel and verification of results in PLC & SCADA, tabulate the results and restoration of connections.
- Line simulation of all other sensors and tabulate the results.
- Verification of DI Channels in PLC: Simulation of DI channels by forcing 24V to each channel and verification of same in PLC & SCADA. Verification of DO Channels in PLC: Simulation of DO channels by forcing command from SCADA to each channel and verification of same in PLC & end element

2.12 Cable Testing:

Removing cable terminals in both ends, isolating each core/ shield, generating 500 VDC between core to core & Core to shield for Insulation resistance checks,

Verification Loop resistance between Pair of cores based on requirement and degradation of cable for replacement.

3 Preventive Maintenance

The Preventive Maintenance consists of following

- Preventive Maintenance (Quarterly) of PLC CPU/IO Panels, Servers/ PCs, FDA/ Safety Systems/ CCTV Systems/ UPS System.
- Software - Checks & Updates
- Maintenance report generation
- Data compilation & Documentation activities
- Periodical software backup

Apart from regular check list the following activities are to be carried out. Implementation of Recommendations/ Emergency Breakdown support, etc. in all process facilities.

1.0 Maintenance of PLC CPU and IO panels

- Powering ON of PLC systems at various locations
- Daily Health monitoring of PLC and IO Systems
- Visual Inspection & LED Indications Healthiness checks, diagnostic check of all the PLC CPU Module for Healthiness
- Testing of the PLC Communication Modules and communication errors identifying using Diagnostics in Status Words and LED Indications
- Diagnostics testing of all the PLC DI, DO, AI, AO & PI modules status and fault identification
- Diagnostics check of the PLC CPU module and error identification
- Checking with Software program for PLC module errors and using status words & bits.
- Checking the healthiness of the batteries & EPROM/Flash PROMs and battery back-up RAM modules
- PLC firmware up gradation shall be provided

- Ensure Firmware compatibility of old and new modules including spares
- Redundancy checks of PLC CPU
- Monitoring and recording of 24V DC voltages
- Tightening of all terminals in PLC CPU and IO panels (Rack power supplies, 24v DC Power supplies, Fan failure detection and Temperature Controller, Panel fans, MCBs, Ethernet Switches, Interface modules)
- Tightening of RJ6 connectors in all panels
- Fan filters cleaning and replacement
- Testing of all IO channels with in the IO panel
- Vacuum cleaning of IO & CPU panels
- Voltage & Grounding checks on the PLC Panels, connection termination and Earth-Neutral voltage checks.
- Testing of all the Spare modules - PLC CPU, CRP, CRA, DI, DO, AI, AO & PI cards etc. for proper functioning
- Logging/recording, of maintenance activities done, problems faced, report generation on tests carried out.
- Load testing of 24V Power Supplies.
- Monitoring and recoding of input 3 phase voltages
- Tightening of all control and power terminals
- Periodical software update

2.0 Maintenance of SCADA System

- Redundancy checks of SCADA Servers
- Communication & Network Healthiness checks of PLC & SCADA systems
- Checking of Software program for diagnostics and communication status
- Checking the healthiness of network components, servers, operator stations and dongles
- Checking the overall network connectivity at all levels and integrity

- Checking the functionality of interface modules and other third-party items configured in the system.
- Verifying the health of the total system as per the configuration and ensure its normalcy
- Fault finding, troubleshooting and rectification of problems in PLC & SCADA system and Engineering / operator stations, Report generation in case of break down maintenance.
- Overall checking of the system performance and taking complete backup of PLC & SCADA Software / system files periodically and handing over a copy to department with version number, date of backup, etc.
- Recovery of license if it gets corrupted or damaged
- Checking healthiness of PLC memory modules and SCADA dongles
- Sample checking of the inputs and outputs (Random Checking).

3.0 Maintenance of Servers/ Workstations

- Support during critical server hardware maintenance activities as per maintenance schedule and checklist.
- Physical inspection and hardware cleaning as required.
- Disk space usage and temp deletion.
- Server status and temperature monitoring.
- Monitoring and recording of server health parameters as per check list.
- Updation of antivirus software updates, in concurrence with department.
- Ensuring disabling of external drive access, in concurrence with department.
- No Data shall be shared to external servers/ outside SDSC-SHAR.

4.0 Maintenance of Operator Clients

- Support during critical server hardware maintenance activities as per maintenance schedule and checklist.
- Physical inspection and hardware cleaning as required.
- Disk space usage and temp deletion.

- Monitoring and recording of PC health parameters as per checklist.
- Updation of antivirus software updates, in concurrence with department
- Installation of required software for operations.
- Ensuring disabling of external drive access, in concurrence with department.
- No Data shall be shared to external servers/ outside SDSC-SHAR.

5.0 Maintenance of Operator Consoles

- Cleaning of fan filters and replacement if needed.
- Ensure healthiness of fan running status.
- Monitoring and recording of UPS voltages.
- Tightening of terminals and cable management.

6.0 Maintenance of Server Racks

- Ensure healthiness of fan running status.
- Monitoring and recording of UPS voltages.
- Tightening of terminals, cables, connectors and cable management.

7.0 Data Extraction Activities

- Retrieval and storage of Process Videos.
- Archival & documentation of Process graphs.
- Generation of T&E document as per T&E procedure document for all systems.
- Generation of software verification documents.

8.0 Maintenance of CCTV Systems

- Maintenance of CCTV Cameras which involves cleaning, ensuring terminal tightness, etc. which are located approximately 4 Meter above ground level during T&E/ Half yearly and as when required
- Verification of PTZ Operation, CCTV Recordings, Monitor clarity, etc. for each camera during every month checklist.

- Ensuring Fibre connectivity between facility Service room/ Bays to Respective Control Rooms and to centralized Monitoring station which involves cleaning of fibre patches, ensuring mating of Fibre patch cords.

9.0 Support System

- Maintenance of all support systems during process activities

10.0 UPS Maintenance

- Support for quarterly maintenance of UPS

4.Network Maintenance

Party shall carryout Interface checks regularly as per the schedule followed in plant.
The activity involved as follows

1. Network Maintenance

- Daily monitoring of network health.
- Physical verification of all network elements periodically
- Maintenance of network modules of PLC and SCADA system a per checklist
- Periodic testing of Fiber Optic Cables and Maintenance of patch panels as per checklist
- Cleaning of Fiber patch points as per the schedule followed.
- Verification of Interfaces between each all Systems
- Splicing of fiber joints in case of damages with suitable enclosures.
- Retrieving asset management system backup and equipment status/details to department (Half yearly)

2. GPS System Maintenance

- Checking of Antenna interfaces with GPS Master
- Checking the functionality of all GPS Slave clocks across the plant
- Checking of Network interfaces of GPS Clock
- GPS Time sync test in all systems to maintain uniform time across the plant.
- Testing functionality of spares periodically

3. IT hardware maintenance

- QUARTERLY cleaning of CD/DVD Drive lens, Mouse, Keyboard, Processor fan, dust filters and other modules
- Blowing of dust on the PC cabinet Monitor and Keyboards.
- Cleaning inside the Cabinet once in three months, depending on the environment
- Checking for loose contact /damage for / to interface connectors, power connectors, memory modules & add-on cards.

4. Maintenance Document Updates

- Updating the checklist periodically based on the system
- Upkeep of all documents and compilation of all calibration reports/ Checklist

5. Stores Maintenance

- Upkeep of all records & details of all items in EICS stores

6. Spares functional Checks

- Testing of all spares periodically as per schedule

ANNEXURE 7I

Deployment of human resources for Operations & Maintenance of Air Separation Unit, Analysis of Products and transportation of LOX & LIN, to Storage facilities of SDSC SHAR. `

- Deployment of human resources (technical / non-technical personnel in different categories) to carry out the plant operations on shift basis, maintenance works, special maintenance works etc., as per the scope contained elsewhere and provide them with all welfare measures and Insurance coverage.
- The contractor shall deploy human resources to carry out Operation and Maintenance activities of Mechanical, Electrical, Instrumentation & Automation equipments, Auxiliary & utility systems, and Housekeeping activities, etc.
- In case of exigency of work, maintenance activities shall have to be carried out beyond General shift hours including Sundays and Holidays also. The decision of the Department is final, in this regard.
- Manpower shall have to be deployed in Shifts / Sundays / Holidays as per Production Plan.
- In case of Breakdowns / exigencies, if required the contract agency shall arrange additional manpower to rectify the same. Charges for the same shall be borne by the Contractor.
- The agency shall deploy manpower as per the approved manpower deployment plan.
- The site in charge shall be responsible for total management including deployment of sufficient man power as per requirement, coordinating with all concerned authorities of Department and prompt action towards emergency situations.
- Bio-data along with proof of experience & Fitness Certificate of Site in charge, Supervisors and all workmen shall be submitted to Department for verification & Scrutiny.
- Manpower working on HT electrical should have "A" grade electrical license covering up to 11kV issued by State licensing board or Authority

- Tentative details of typical human resources required along with their Specialization, Qualification, Experience, and Area of deployment for uninterrupted operation of Air Separation plant shall be worked out and submitted for Department Review & Approval. Human resources provided are meant for round the clock operation. Administrative staff is not indicated.
- **Contractor after understanding the complete scope of work shall submit the final manpower deployment plan. Typical Indicative Deployment of human resources in round the clock operation during Production period of the plant is given below:**

Human Resources: Qualification & Minimum Experience

S. NO	Description	Qualification	Minimum Exp. in years	Preferred area of experience in operation & maintenance of	No. of man power
1	Manager Operation & Maintenance	B.E Mechanical / Chemical	15	Air separation Plant, High pressure compressors, cryogenic fluid transfer and routine maintenance.	1
2	Safety In charge	BSc. Chem/DCE with PG Diploma in safety	5	Safety related Process & Plant operation	1
3	Shift in Charge	DME/BE	5	Air separation Plant, High pressure compressors, cryogenic fluid transfer and routine maintenance	3
4	Operators – Process	DME/ /DChem.E	5	Air separation Plant operations including Fire Fighting Systems, Water treatment plant, Air Compressor, Cooling water system	4

S. NO	Description	Qualification	Minimum Exp. in years	Preferred area of experience in operation & maintenance of	No. of man power
5	Operators – Electrical	DEEE, License holder for 11kva	5	O & M of substation and DG set	2
6	Operator's - Instrumentation & Control system	DECE/DEEE/ Diploma in Instrumentation	5	O & M of Instrumentation & Automation systems	2
7	Maintenance team	ITI Fitter / Diesel Mechanic / Instrumentation	5	Plant maintenance	3
8	Analyst	B.Sc Chemistry.	5	Gas Chromatograph analysis, water analysis	1
9	Driver	HVD with Hazardous licence	5	Driving of LIN/LOX Tankers	2
10	Office Attendant	Unskilled	3	Housekeeping	1
					20 Nos.

Human Resources: Deployment

S. No.	Description	General shift	Per shift	No of shifts	Total
Process, Mechanical, Electrical, Instrumentation, Automation, Transportation, Safety, etc.					
1	Manager for operations	1	-	-	1
2	Process Safety	1	-	-	1
3	Shift In Charge	-	1	3	3
4	Operations & Maintenance crew including analyst for Laboratory	-	4	3	12
5	Transportation & house keeping	-	1	3	3

**REQUEST FOR PROPOSAL FOR ESTABLISHMENT OF
50 MTPD CRYOGENIC AIR SEPERATION PLANT**

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ANNEXURE 7 J

INDICATIVE PROCEDURE FOR PERFORMANCE GUARANTEE TESTING

- All process equipment required for normal operation must be in service & steady during the performance test. The plant shall be stabilized for at least 6 hours.
- All measuring instruments used for performance testing shall be of standard make. Calibration reports for the instruments shall be submitted by the contractor prior to usage for test.
- Measuring instruments (Process & Electrical), Analyzers shall be calibrated at NABL accredited labs traceable to National / International Standards.
- All instruments for measurement of guaranteed parameter must be checked for accuracy prior to including calculations in the PLC.
- Production is measured at face of the cold box; the liquid production shall include tank boil off.
- Liquid Oxygen shall be within specification.
- During the test, the guaranteed parameters and ambient conditions shall be recorded.
- Atmosphere air temperature & Cooling water temperature etc., shall be recorded in PLC. Atmosphere air humidity & Barometric pressure shall be recorded periodically (every 2 hrs duration) using calibrated Meteorology instruments positioned at the Air Separation Plant for the test.
- Liquid Production computation: Storage tank Pressure and Liquid level instruments must be recorded in the PLC and used for the calculation of production without any product drawn during the test period from the storage tank. The computation shall consider Boil off loss, Transfer loss, Flash loss, Level transmitter accuracy and other relevant compensations.
- All the electrical loads shall be operated as required by the process to achieve the guaranteed parameters.
- Standby equipment shall not be operated during the performance test, only the designated operating units shall be run.

- Frequency, power factor and voltage variations shall remain within the acceptable range.
- Performance test data shall be conducted for a total period of 72 hrs of stabilized plant operation on continuous basis with data recorded in the PLC and averaged.
- Guaranteed performance shall be applicable for guaranteed production of 1458 Nm³/hr liquid oxygen with +5% tolerance.
- Guaranteed Liquid oxygen purity shall be > 99.8 % (v/v).
- Power Consumption shall be measured at motor terminals of equipments specified in FORM 19 using Energy meters.
- Energy meters must be supplied by the Contactor with calibration certificate and defined instrument accuracy.
- Energy meters must be independent of any other utilities outside of the actual plant power.
- Rate of power consumption for the ASU shall take into account only the declared Plant core equipment list provided in the FORM -19 of PART 6 for continuous plant operation as per design requirements.
- The power considered and registered for this scope shall be kWh.
- Energy Meters shall be of 0.2S Class CT.
- Total power consumption shall be expressed in kWh/hr.
- The arithmetic mean of measured values shall represent the measured performance of the Air Separation Plant. These measured performances shall be compared to Guarantee Values considering the tolerances.
- If the performance test is interrupted due to reasons not attributable to the Contractor, shall be discussed with Department and finalized.
- If the performance test is interrupted due to reasons attributable to the Contractor, further tests shall be conducted as per details given in Sections 1.2.11 & 1.2.16 of PART 1.
- Third-Party Inspection Agency shall participate for the entire duration of the test.

- Post completion of the test based on the Performance Guaranteed test procedure, a performance test acceptance certificate shall be generated and signed along with the Third-Party Inspection Agency.

ANNEXURE K

ATMOSPHERE AIR QUALITY TEST REPORT



SMS LABS SERVICES PRIVATE LIMITED

TEST REPORT



TC-6118

ULR - TC611825000017227F
Report No : ENR250926004-01

Page 1 of 1
Report Date : 03 Oct 2025

Customer Name : M/s. Associate Project Director (APD) - TLP
Customer Address : SDSC Shar, ISRO Govt. of India, Sriharikota - 524124.
Sample Name : AAQ
Sample Description : AAQ
Reference : Test Request Form Dated 26.09.2025
Sample Location : Helipad Area 1 Km
Sample Drawn By : Customer
Sample Received on : 26 Sep 2025
Test Started on : 27 Sep 2025
Test Completed on : 03 Oct 2025

TEST RESULTS

S.No	Parameter	Test Method	Unit	Results	Limit as per NAAQS Specification
Chemical					
1	Ammonia as NH ₃	IS 5182 (Part 25) - 2018	µg/m ³	BLQ(LOQ:20.0)	400 Max
2	Carbon Monoxide as CO (8hrs)	IS 5182 (Part 10) - 1999 (Reaffirmed 2019)	mg/m ³	BLQ(LOQ:1.14)	02 Max
3	Chlorine as Cl	IS 5182 (Part 19) - 2022	µg/m ³	BLQ(LOQ:10.0)	--
4	Nitrogen dioxide as NO ₂	IS 5182 (Part 06) - 2006 (Reaffirmed 2022)	µg/m ³	22.0	80 Max
5	Ozone as O ₃	IS 5182 (Part 09) - 1974 (Reaffirmed 2019)	µg/m ³	BLQ(LOQ:20.0)	180 Max
6	Particulate Matter (PM ₁₀)	IS 5182 (Part 23) - 2006 (Reaffirmed 2022)	µg/m ³	81.4	100 Max
7	Particulate Matter (PM _{2.5})	IS 5182 (Part 24) - 2019	µg/m ³	25.1	60 Max
8	Sulphur Dioxide as SO ₂	IS 5182 (Part 02) - 2001 (Reaffirmed 2022)	µg/m ³	10.2	80 Max
Hydrocarbons					
9	Total Hydrocarbons	SMSLA/GC/SOP/47 - 2024	mg/m ³	BLQ (LOQ:0.025)	--
Polycyclic Aromatic Hydrocarbons (PAHs)					
10	Benzo(a)Pyrene (Particulate Phase)	SMSLA/GC/SOP/46 - 2024	ng/m ³	BLQ (LOQ:0.050)	01 Max
Trace Elements					
11	Arsenic	Compendium Method IO - 3.4 - 1999	ng/m ³	BLQ (LOQ:0.100)	06 Max
12	Lead	Compendium Method IO - 3.4 - 1999	µg/m ³	BLQ (LOQ:0.001)	1.0 Max
13	Nickel	Compendium Method IO - 3.4 - 1999	ng/m ³	BLQ (LOQ:0.100)	20 Max
Volatile Organic Compounds-NAAQM					
14	Benzene	SMSLA/GC/SOP/43 - 2024	µg/m ³	BLQ (LOQ:1.00)	05 Max

Note : BLQ : Below Limit of Quantification LOQ : Limit of Quantification.
Conclusion : The above tested Sample Conforms to the NAAQS Standards for the above tested Parameters.

/***** End of the Report *****/


M. Sarathkumar
Authorized Signatory-Chemical

Laboratory Address: No 39/6, Puduchatram, Thiruvallur High Road, Thirumazhisai Via, Poonamallee Tk, Thiruvallur, Chennai, Tamil Nadu, India
Note: Test results relate only to the items tested. Test Report shall not be reproduced in full or part without the approval of SMS Labs. Non-Perishable remnant samples will be disposed 15 days from the date of receipt unless otherwise agreed with the customer except in case of regulatory samples, which will be retained for a specific period as per regulatory requirements; while perishable and environmental remnant samples will be disposed consequently upon completion of testing. Samples are not drawn by laboratory unless or otherwise stated. A satisfactory test report in no way implies that a product so tested is approved by NABL. The Laboratory accepts no liability with regard to the origin or source from which the sample(s) is/ are said to be extracted

REQUEST FOR PROPOSAL FOR ESTABLISHMENT OF
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ANNEXURE J

RAW WATER ANALYSIS REPORT



SMS LABS SERVICES PRIVATE LIMITED

TEST REPORT



TC-6118

ULR - TC611825000017228F
Report No : ENR250926004-02

Page 1 of 2
Report Date : 03 Oct 2025

Customer Name : M/s. Associate Project Director (APD) - TLP
Customer Address : SDSC Shar, ISRO Govt. of India, Sriharikota – 524124.
Sample Name : Raw Water
Sample Description : Raw Water
Reference : Test Request Form Dated 26.09.2025
Sample Location : Helipad Area 1 Km
Sample Drawn By : Customer
Sample Quantity : 5Ltr x 1No
Sample Received on : 26 Sep 2025
Test Started on : 27 Sep 2025
Test Completed on : 03 Oct 2025

TEST RESULTS

S.No	Parameter	Test Method	Unit	Results
Chemical				
1	Ammonium as NH ₄	IS 3025 (Part 34) - 1988 (Reaffirmed 2019)	mg/L	BLQ(LOQ:0.1)
2	Bicarbonates	APHA 24th Edition 2320 B - 2023	mg/L	54
3	Phosphate as PO ₄	IS 3025 (Part 31) Sec 1 - 2022	mg/L	0.07
4	Potassium as K	IS 3025 (Part 45) - 2024	mg/L	5.1
5	Silica as SiO ₂	IS 3025 (Part 35) - 2024	mg/L	1.6
6	Sodium as Na	IS 3025 (Part 45) - 2024	mg/L	16
Clause 4, Table 1 Organoleptic And Physical parameters				
7	pH at 25°C	IS 3025 (Part 11) - 2022	--	8.50
Clause 4, Table 2 General Parameters Concerning Substances Undesirable In Excessive Amounts				
8	Calcium as Ca	IS 3025 (Part 40) - 2024	mg/L	24
9	Chloride as Cl	IS 3025 (Part 32) - 1988 (Reaffirmed 2019)	mg/L	38
10	Iron as Fe	IS 3025 (Part 53) - 2024	mg/L	0.19
11	Magnesium as Mg	IS 3025 (Part 46) - 2023	mg/L	5.9
12	Nitrate as NO ₃	APHA 24th Edition 4500 NO ₃ B - 2023	mg/L	4.0

M. Sarathkumar
Authorized Signatory-Chemical

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Note: Test results relate only to the items tested. Test Report shall not be reproduced in full or part without the approval of SMS Labs. Non-Perishable remnant samples will be disposed 15 days from the date of receipt unless otherwise agreed with the customer except in case of regulatory samples, which will be retained for a specific period as per regulatory requirements; while perishable and environmental remnant samples will be disposed consequently upon completion of testing. Samples are not drawn by laboratory unless or otherwise stated. A satisfactory test report in no way implies that a product so tested is approved by NABL. The Laboratory accepts no liability with regard to the origin or source from which the sample(s) is/ are said to be extracted.

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ANNEXURE J

RAW WATER TEST REPORT (CONTD.,)



SMS LABS SERVICES PRIVATE LIMITED

TEST REPORT



TC-6118

ULR - TC611825000017228F
Report No : ENR250926004-02

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Report Date: 03 Oct 2025

S.No	Parameter	Test Method	Unit	Results
13	Sulphate as SO ₄	IS 3025 (Part 24) Sec 1 - 2022	mg/L	14
Hydrocarbons				
14	Total petroleum hydrocarbons (TPH)	SMSLA/GC/SOP/47 - 2024	mg/L	BLQ (LOQ:0.100) each
Others				
15	Free Ammonia as NH ₃	IS 3025 (Part 34) - 1988 (Reaffirmed 2019)	mg/L	BLQ(LOQ:0.5)
16	Total Suspended Solids (TSS)	IS 3025 (Part 17) - 2022	mg/L	4.8

Note : BLQ : Below Limit of Quantification LOQ : Limit of Quantification.

/***** End of the Report *****/


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