REQUEST FOR PROPOSAL & SPECIFICATION DOCUMENT

MEMS & NANOFABRICATION SEMICONDUCTOR CLEANROOM FACILITY

DEPARTMENT OF AVIONICS

INDIAN INSTITUTE OF SPACE SCIENCE AND TECHNOLOGY (IIST)

THIRUVANANTHAPURAM, KERALA

INDIA

Department of Avionics
Indian Institute of Space Science and Technology
Department of Space, Govt.of India
Valiamala P.O., Thiruvananthapuram – 695 547
Kerala, INDIA

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1. Introduction & Scope of work

Indian Institute of Space Science and Technology (IIST), Thiruvananthapuram, intends to set up a state-of-the-art MEMS and Nano-fabrication facility in the Department of Avionics which focuses on Research and Education in the areas of micro/nano-scale electronics, devices, technologies, materials, micro & nano electromechanical systems (MEMS/NEMS) and various types of Microsystems. The facility is planned for Clean Room of area around ~ 100 Sq.M & Related Facility Utilities including Bulk & Process gas distribution system as mentioned in the scope of work in the Ground Floor of Avionics Department Building (D3) in IIST Campus.

The Clean Room shall conform to ISO 5 (Class 100) and ISO 6 (Class 1000) with associated Support areas. To realize the facility, IIST intends to engage a suitable Vendor (also mentioned as Party/Contractor in this document) to undertake the Design & Detailed Engineering and Supply, Installation, Testing, Commissioning and Validation of the Cleanrooms, related HVAC, Facility Utilities & distribution network of all facilities & services is to be provided up to the point of use as per the utility matrix given at annexure 4 , as mentioned in the scope of work on a 'Turn Key' basis. The Vendor/parties/firms has to demonstrate post installation & commissioning performance of all the installed services for Compliance to the required specifications. The Party/Vendor has to strictly comply with the requirements mentioned in various sections of this document. The Vendor may inspect the site on a working day and during working hours up to 3 days prior to the last date of uploading of the Bids, to get acquainted with the site conditions.

A. The scope of work comprises of Design & Detailed Engineering, and Supply, Installation, Testing, commissioning & Validation of Clean Rooms as per ISO 14644, with related HVAC systems, process chiller unit Cleanroom accessories, Electricals, power distribution, Lighting, Fire detection & Suppression protection system, Process Extraction Systems, , Compressed dry Air, BMS, LAN, telephone, CCTV, access control, Bulk & Process Gas Distribution system along with Total Gas Management system, Tool hook-up viz distribution network of all facilities & services is to be provided up to the point of use as per the utility matrix given

at annexure 4, Validation of Cleanrooms & Bulk-Process Gas Distribution system as per the respective Standards. The Vendor shall provide compliance sheet with supporting details/justifications against each of the RFP technical specifications. The Vendor shall also indicate the relevant section and page no. of their technical bid which conforms/complies to the RFP specifications. The HVAC of Clean Rooms are to be designed considering the climatic/ambient conditions in Thiruvananthapuram & after applications corrections to Outside Ambient Conditions of the proposed site. Vendors are required to give compliance to the technical specifications in this document.

Vendors will also be required to make a technical presentation of their respective proposals to the IIST's Technical committee. Provisional layout of the Clean Room facility is at Annexure: 1 of this document.

B. The specifications in this document are not intended to contain all parameters/requirements for design and supply/installation/testing/commissioning of clean rooms, utilities systems/Plants/ equipment. Any other item needed for realization of the proposed facility will be the vendor's responsibility. The vendor shall provide all clean room materials, plant, equipment/ machines and other items conforming in all respects to high standards of engineering, design and workmanship meeting relevant codes etc., and shall be capable of performing in continuous commercial operation up to the vendors'/contractor's guarantee in a manner acceptable to the technical Committee at IIST, who will interpret the meaning of drawings, specifications etc, and shall have the power /right/discretion to reject any work or materials, which in his/her/their judgment are not in full accordance therewith. The quantities, sizes and capacities of various plant, equipment, components, pipelines etc., specified in this document, are for contractor's guidance only. The contractor (vendor/party) shall carefully check all the above mentioned details while selecting and offering the above items based on the design approved by IIST.

C. Standards to be Considered: The equipment and installation shall conform to the following standards wherever applicable. The generally applicable Indian Standards are:

a) IS 3615 Glossary of terms used in Refrigeration & Air Conditioning.

b) IS 732: Code of practice for electrical wiring and fittings for the buildings.
c) IS 16678 Refrigerating systems and heat pumps - Safety and environmental requirements
d) IS 660: Mechanical refrigeration safety code.
e) IS 325: Three phase induction motor.
f) IS 1554 (Part 1): PVC Insulated heavy duty electrical cables for working voltages and including 1100 V.
g) IS 1367 Technical supply conditions for threaded fasteners.
h) IS 4671: Expanded polystyrene for thermal insulation.
i) IS 7240: Code of practice for industrial application and finishing of thermal insulating material at temperature from -80 deg C to 40 deg C.
j) IS 277: galvanized sheet metal.
k) IS 655: Metal Air ducts.
l) Any other IS code(s) applicable for the materials and installation in the scope of work mentioned in this document.

D. Safety systems applicable for bulk & process gas distribution system:

- **Code reference:**

a) Applicable code - ASME B31.3.
b) SEMIS2-0703 Environmental Health and Safety Guidelines for Semiconductor Manufacturing Equipment.
c) SEMI S6-0618 Safety Guideline for Ventilation
d) SEMIF1-0521 Specification for Leak Integrity of High-Purity Gas Piping Systems and Components
e) NFPA 55 Compressed Gases and Cryogenic Fluids Code
f) NFPA 318 Standard for Protection of Semiconductor Fabrication Facilities
g) NFPA 70 National Electric Code
h) CGA G13-2006 Storage and Handling of Silane and Silane Mixtures

i) Any other Safety Code Applicable shall be considered

j) Shall meet the Pollution Board safety norms as applicable

- **Codes & standards:** For design of the utility systems various International and Indian standards and codes, as applicable will be used. Below mentioned gives the list as applicable:
- **Table of Codes and Standards**

Sl. No.	Item Description	Standards & Codes	Remarks
1	Piping Design	ASME B31.3 & B31.8	American Std.
2	SS316 Pipe	ASME A312 TP316	American Std.
3	SS304 Pipe	ASME A312 TP304	American Std.
4	SS316 Tubes	ASME A269	American Std.
5	Pressure Vessel Design	ASME Section VIII Div 01	American Std.
6	Welding	ASME Section IX	American Std.
7	Gas Cylinder Storage	Gas Cylinder Rule no.44 (2016)	Indian Std.
8	Gas Detectors and Detection Panel	BS EN 50073:1999 and IEC60079-29-2 Edl.0: Explosive atmospheres - Part 29-2: and EMC to EN50270, flammable to EN50054	British/International /European Standards
9	Gas Manifold	UL407	United Laboratory
10	Pressure Regulators	UL252	United Laboratory
11	Electro polishing	ASME A269/A270	Suitable Std.
12	Piping design	ASME B31.3 & B31.8	Suitable Std.
13	Color coding	IS 2379:2024	Suitable Std.
14	Hydrogen Pipeline systems	AIGA 033-14	Suitable Std.
15	Code of practice phosphine	AIGA 051-08	Suitable Std.
16	Storage & handling Silane	AIGA 052-16	Suitable Std.

17	Principles of handling & distribution of Toxic gases	AIGA 026-13	Suitable Std.

NOTE: All equipment mentioned in the above must be confirmed SEMI-S2 (related SEMI-S2 approved certificate to be produced) and international FIRE code & All Sensors for flammable gas must be intrinsically safe as required by NEC code. Sprinkler must be UL (United Laboratory)/FM approved. The appropriate international and Indian standards should be followed for the design and execution of the gas distribution line and the related utilities.

2. Eligibility Criteria

The Vendors/parties/firms participating in the tender should be technically competent and experienced in having undertaken Clean room projects for semiconductor/ MEMS/nano-fabrication facility with the following eligibility criteria (points i-viii).

IMPORTANT NOTE: ***Bids of only those bidders who fulfill the tender stipulated eligibility criteria as provided below shall only be considered for further evaluation of technical bid documents.***

i. Vendors/Parties/ firms means: PRIME BIDDER". Prime Bidder should have successfully completed at least two (2) "similar works". "Similar Work" shall mean "Supply, installation, testing, commissioning and validation of Clean Room facility (Class 100/ISO 5 or better, as per FED Std. 209E/ISO14644) including associated utilities such as HVAC, bulk and process gas distribution, Process Extraction, per the respective Standards for semiconductor/Microelectronics/ Nano fabrication/ MEMS facilities". Vendor shall have the in-house design capability for design of the clean rooms associated systems and the infrastructure to generate drawings in 'Revit' software platform.

NOTE: "The prime bidder" should have the requisite experience in Clean rooms, related HVAC works, Cleanroom accessories, Related electrical for cleanrooms & Validation of Cleanrooms in semiconductor/microelectronic/nano-fabrication/MEMS facilities.

ii. The vendor should have completed, within the previous seven years :
At least one similar cleanroom project of not less than INR 6 crore in a single order or two similar cleanroom project of not less than INR 4 crore each

iii. For the vendors who do not individually meet the criteria in clauses I & ii, the PRIME BIDDER may associate with other Service PROVIDERS (experienced in the relevant field other than Cleanrooms, viz. Bulk & Process Gas Distribution system along with Total Gas Management etc. Tool hook-up, compressed dry air, Process extraction systems /High purity Utilities distribution network) and in such cases the combined experience of the consortium members for the "similar work" shall be taken into consideration for determining the eligibility. In such cases, "THE PRIME Bidder" should have the requisite experience in Clean rooms, related HVAC works, Cleanroom accessories, related electrical for cleanrooms & Validation of Cleanrooms in semiconductor/microelectronic/nano-fabrication/MEMS facilities. The fulfilment of all the Contractual obligations for successful execution of the project shall be the sole responsibility of the Prime bidder. Copy of the Memorandum of Understanding (MoU) between the prime bidder and the firm/party with whom they shall associate for the project shall be submitted along with the bid. The validity of MoU between prime bidder and service providers shall be minimum two (2) years post three (3) year on-site comprehensive warranty period of the facility.

iv. Copies of Purchase Orders/ work orders in respect of "similar work" executed by the party/firm with Documents evidencing satisfactory completion issued by the respective clients/organizations shall be submitted along with the bid. In case the firm/party associates with other firm/party, copies of the POs/work orders executed by the other firm with

Documents evidencing satisfactory completion issued by the respective clients/organizations shall also be submitted along with the bid. IIST may inspect any of the completed or ongoing similar projects for the vendor(s), for which the vendor(s) shall have to provide cooperation/assistance. IIST may also take inputs from such clients. In case performance of the vendor(s) is found to be unsatisfactory, their bid is liable to be rejected.

v. Financial turnover, solvency certificate of the prime bidder shall only considered for evaluation.

vi. Average annual financial turnover should not be less than Rs. 5 crores during the last 3 years. The prospective firm/party shall provide Chartered Accountant's certificate for the annual financial turnover.

vii. Should have a solvency of not less than Rs. 2.5 crores. The prospective firm/party shall provide current (not prior to six (6) months) solvency certificate from any scheduled bank.

viii. Should not have incurred any loss in more than 2 years during the last (five) 5 financial years. The prospective firm/party shall provide the copy of audited Annual Accounts by a chartered accountant for the previous 5 (five) financial years.

3. Material & Workmanship

A. All materials used in the work shall be of high-grade quality free from defects and imperfections and of recent manufacturer and unused/ new. Materials used shall conform to latest specifications of the Indian Standards Institution and/or other equivalent specifications. Liberal factors of safety shall be used throughout the design for various systems/equipment etc.

B. The plant and equipment shall be designed and manufactured for safe, proper and continuous operation.

C. The operation of the plant and equipment should be free of vibration and noise.

D. The contractor (vendor) shall ensure that no damage will occur during shipment or storage prior to installation under climatic conditions prevailing.

E. **Proposals** shall be submitted strictly in the form as required in the specifications, complete with all required information, drawing literature etc.

F. The contractor/Vendor shall design and provide all required Design Documents and Drawings

G. The Contractor shall furnish all utility lines, Power lines requirement for the main and auxiliary equipment of the proposed facility in line with the standards of Clean Room Practice.

H. The contractor shall be deemed to have carefully examined the specification in its complete form and to have fully informed and satisfied himself as to the details of the work to be carried, site conditions and other pertinent matters and details. The contractor shall consider the environmental conditions at IIST, Trivandrum for designing Clean room and all associated systems/ Plants.

I. All necessary fittings, assemblies, hardware, accessories such as clamps, foundation bolts, terminal for electrical connections, cable glands, junction box, wall cowls, bird screen gaskets, brackets, hangers, screws, nuts, bolts, washers etc., which are useful and necessary for proper assemble and efficient working of systems shall be supplied by the contractor and the cost of the same shall be deemed to be included in their quote/offer whether specifically mentioned in specification or not. Any material and labor which may be necessary to complete the work in accordance with the intent of the specification shall be furnished by the contractor without any extra cost as if they are fully described and called for in this specification.

J. The contractor shall fully co-operate with the IIST team in the mutual exchange of various drawings, dimensions and other information of related equipment supplied by sub-vendor/ subcontractor, if any, so as to ensure complete co-ordination in design, arrangements, manufacture and installation of all the related equipment.

4. Submittals & Deliverables

This tender is a two part tender with the Part 1 being the Technical bid and Part 2 the Price bid. The details of submittals for technical bid and price bid are provided in Subsection 4.1 and 4.2. IIST will conduct a tender Prebid meeting tentatively after 2-3 weeks from the date of release of tender.Vendors may please visit the site before submitting the bid.

The submittals and deliverables are to be planned as per the following stages:

4.1 Submittals with Techno commercial/Technical bid

A. Assessment of eligibility of the vendors vis-à-vis the stipulated eligibility criteria will be carried out by IIST before the evaluation of the technical details of the bid. First, in case the bid /offer does not meet the eligibility criteria as spelt out in this document, the same shall be rejected by IIST.
B. The Prime Bidder shall be Cleanroom Vendor/Contractor. Prime bidders/Cleanroom Contractor, who have participated in as a consortium/Service Providers shall submit MOU with the matrix of responsibilities among the Prime Bidder and their consortium/Service Provider. The Prime Bidder is Responsible for all the Correspondence. Prime bidder shall also submit letter from their consortium partner stating their participation in the Project as defined in the Matrix of responsibilities. Further, IIST committee if it considers necessary may seek participation of the consortium partner also for the technical bid presentation.
C. The vendor shall have to provide details of sub-contractors/service providers for executing specialized work included in scope of the contract. Details like project executed by such sub-contractors/service provider and their technical capability in terms of trained manpower, tools and equipment shall be enclosed along with the tender. Service providers, particularly for the

piping /tubing /plumbing shall have to be well versed with Orbital and PVDF welding. Coordination with the responsibility of the vendor.

D. The vendors meeting the eligibility criteria only will be called for presenting their submitted Technical Bid to IIST, Technical evaluation committee. The place, date and time would be notified to the vendors by the IIST team. During such presentations the team representing the vendor should be competent enough to give technical details raised by the IIST team. No video conferencing or teleconferencing will be entertained for such presentations. In case the bid /offer does not meet the technical requirements as spelt out in this document, the same shall be rejected by IIST.

E. The Vendor shall submit the following technical details with their **Technical & un-priced bid**

Sl No.	Description
1.	**Detailed compliance sheet as per the given format for RFP and Annexures.** An item wise compliance statement indicating clearly any deviations if any, from specifications, recommended makes etc. The Vendor shall submit all required documents mentioning Annexure number clearly, in support of compliance to the specifications. If the offer deviates from the specifications and is not acceptable to the IIST technical committee, vendor is bound to change the materials, otherwise the bid shall not be considered for further processing.
2.	**Detailed un-priced Bill of Quantity/Materials** envisaged for the project, Make/Brands of all the equipment's/materials conforming to the specifications in this RFP document, etc. along with only technical part of the bid. 1. The Vendor shall submit detailed un-priced BOQ/BOM of all the items envisaged for the Project in the Technical part of the Bid. No pricing information shall be submitted in the Technical Bid. In case of pricing information being disclosed in the Technical bid, the bid shall be summarily rejected.

	2. The priced BOQ shall be submitted as part of priced bid. Vendor shall be solely responsible for the quantity of various items mentioned by them in the BOM/BOQ. *(Please refer to the details in the section on the submittals with Priced bid)* 3. Note on BOQ : The BOQs of all the items in confunction with the specifications mentioned in the RFP shall be submitted by the vendors. (a)Model o BOQ provided as Annexure-BOQ Model (b)Guide Lines to Submit the BOQ: Please follow the below mentioned SEQUENCE while attaching /Submitting the BOQs. It will facilitate the Evaluation correctly & will not consume More time for Evaluation of BOQs 1) CLEANROOM Interiors like wall & ceiling panels, Flooring, Cleanroom lighting, Cleanroom accessories etc. 2) HVAC LOW side like AHUs, Ducting etc. 3) HAVC High side like Chillers etc. 4) Electricals 5) Process Extraction systems 6) CDA 7) Fire Fighting & fire suppression, smoke detectors etc. 8) BMS 9) Bulk & Specialty Gas Distribution systems 10) Process cooling 11) Others
3.	**Technical Submittals: Following are the technical details to be submitted by the vendors along with technical bid, without which the technical bid submission will not be considered.**

Any other Document/information considered relevant to this project by the contractor/vendor, but not limited to, the following information shall be submitted

1. Heat Load Calculations Room wise all sheets & summary sheet (without this Heat Load calculation the Technical Submittal will not be accepted)
2. Summary of Design & Selection of TR, Supply Air, return air, AHU Capacity, Fresh air, Heater etc. (without this Heat Load calculation the Technical Submittal will not be accepted)
3. Typical P&ID for chillers and AHUs
4. Air flow Diagram AHU wise supply air, return Air & Fresh Air etc.
5. AHU wise Zoning Layout Drawing
6. Pressure Gradient Zoning Layout drawing
7. Cleanroom Layout Plan showing Modular Wall Panels, Glazed View Panels, Doors, Return Air Raisers positions.
8. Detailed Cleanroom Layout Drawings of Reflected ceiling plan of all clean rooms showing Ceiling panels, HEPA Filters, Light fixtures
9. Some typical Cross section of the Cleanrooms
10. Single Line diagrams of electrical system, P&ID diagrams of relevant Electrical items
11. Utilities distribution layouts
12. Compressed Dry Air Piping layout with reference to the Compressor & Connecting to the Process tools. P&ID of Compressed dry air indicating all the Components Like Valves, regulators, fittings, Gauges etc.
13. Schematic of Gas pad/gas yard layout and drawing, indicating the Location of GAS distribution System
14. Gas cabinets/ Gas panels/Gas Manifold / VMBs layout and typical P&ID diagrams for all services including the GAS Cabinets with relative Gas Panels. Piping Layout connecting the process tools with Gas panels, Gas cabinets scrubbers & connecting to Extraction Exhaust connections & Utilities etc. Schematic Process

	Exhaust/Extraction System including Exhaust Duct routing/size etc with reference to Process tools take off points & P&ID 15. SEMI S2 certificate of the Gas cabinet and gas panels. 16. Relevant catalogues & Technical Specifications of the proposed makes
4.	**Other Submittals:** 1. PERT/GNAT Chart (Time schedule – Mile stone chart) 2. Organization Chart of the Key personnel proposed for the proposed Project. Site and project management by experienced Clean room team.

4.2 Submittals with Financial Priced bid

SNo.	Description
1.	**Detailed priced Bill of Quantity/Materials envisaged for the project, Make/Brands of all the equipment's/materials conforming to the specifications in this RFP document, etc. along with techno commercial/priced bid.** *(Please refer to the note on BOQ with previous section on submittals with Techno commercial bid)* 1. Priced BOQ/BOM with itemized rates separately for Supply and Installation (including Testing, Commissioning, and Validation) shall be submitted in the Price Bid. 2. Vendor shall be solely responsible for the quantity of various items mentioned by them in the BOM/BOQ. Any quantity variation over& above the quantity considered in the BOM/BOQ submitted by the Vendor shall be deemed to be covered under the price quoted by the Vendor and nothing extra shall be paid on this account. 3. Any not item not mentioned specifically in the BOM/ BOQ but required for completion of the project as per the scope of work defined in this document shall be deemed to be included in the overall price of the Vendor and nothing extra shall be paid on this account.

	4. In the event of increase in the scope of work beyond the scope of work defined in this document, the Vendor shall be paid at the agreed unit rates as per the BOQ/BOM forming part of the contract.

4.3 Submittals for the Selected Vendor

1.	**The selected vendor/contractor shall be required to submit Design Document containing design analysis /details for various systems mentioned in this document for IIST approval, based on which detailed Engineering drawings shall be made by the vendor. Detailed Design including design analysis & data for Clean rooms, HVAC systems, Utilities distribution, Electricals Systems and distribution, Fire Detection and Suppression, LAN etc. for all the works covered under the scope of work of the RFP, for approval of IIST.**
2.	In the case of bidders who have participated in as a consortium shall submit valid MOU with the matrix of responsibilities among the Prime Bidder and their consortium member. Prime bidder shall also submit letter from their consortium partner stating their participation in the Project as defined in the Matrix of responsibilities.
3.	Detailed Engineering Drawings for approval of IIST. The approved engineering drawings shall be referred to as Approved for Construction (AFC)/Good for Construction (GFC) Drawings. The work shall be executed as per the AFC/ GFC Drawings. The detailed engineering drawings not limited to the following shall be submitted:- 1. Cleanroom Layout Plan showing Modular Wall Panels, Glazed View Panels, Doors, Return Air Raisers positions. 2. Detailed Cleanroom Layout Drawings of Reflected ceiling plan of all clean rooms showing Ceiling panels, HEPA Filters, Light fixtures, 3. Clean room layout with services and utility distribution network marked on the drawing, Plant Room concept design drawing 4. Cross section of the Cleanrooms 5. Duct Routing with reference to Air Handle¬rs location. 6. AHU wise Zoning Layout Drawing

	7. Routing of Fire Detection & Suppression systems. 8. Single Line diagrams of electrical system, P&ID diagrams of relevant Electrical items and location of Electrical Panels 9. Lighting layout 10. BMS configuration, routing and layout drawing 11. Utilities distribution layouts 12. Compressed Dry Air Piping layout with reference to the Compressor & Connecting to the Process tools. 13. P&ID of Compressed dry air indicating all the Components Like Valves, regulators, fittings, Gauges etc. 14. Gas pad/gas yard layout and drawing, indicating the Location of GAS distribution System 15. Gas cabinets/ Gas panels/Gas Manifold / VMBs layout, 16. P&ID diagrams for all services including the GAS Cabinets with relative Gas Panels 17. Piping Layout connecting the process tools with Gas panels, Gas cabinets scrubbers & connecting to Extraction Exhaust connections & Utilities etc. Process Exhaust/Extraction System including Exhaust Duct routing/size etc with reference to Process tools take off points & P&ID
4.	On completion of the project, the Vendor shall submit 'As Built Drawings' in CAD format and Hard copy (three sets) of each Drawing.
5.	Operating and Maintenance Manuals in hard copy and electronic format.
6.	Handover and operator instruction.

5. Clean room Layout

The Provisional layout of the Cleanroom is evolved by IIST based on functional requirements including equipment being procured and available spaces. Refer **Annexure 1 & 2.** This Provisional

layout shall be further developed and detailed out by the selected contractor based on the site conditions for approval of IIST.

Clean room Parent Building and Utility areas

The parent building construction features reinforced concrete (RCC) columns and Beams, and RCC roof slabs. The parent building perimeter walls are constructed having cement Concrete Blocks. Contractor shall paint the wall surface and columns/Beams.

The perimeter walkway/UTILITY corridor around the Cleanroom shall be as per the dimensions in the drawing. All utilities of the related equipment's should be placed/installed adjacent to the cleanroom in such a way to avoid sound and vibrations. All required isolation pads etc., shall be provided by the Vendor.

The layout of the space allocated in the parent building is provided as **Annexure-1&2**.

The locations of associated utility Plants/systems like HVAC Chillers, AHUS, Process Extraction systems, Scrubber, Gas Pad (for Gas cabinets), Gas Manifold etc. are also shown in Annexure-2. The vendor shall along with their bid submit drawing indicating the placement/arrangement of utilities equipment etc. with dimensions and the utility area/ size requirement.

The utility buildings shall be constructed by IIST through other agency. Similarly, Civil works for foundations of Utility equipment (Chillers, Pumps/motors etc.) shall be provided by IIST. Vendor shall provide details/data to design and construct all such foundations by IIST. Foundation Bolts etc. and its grouting shall be in the Vendor's scope. Cut-outs in the walls for Ducts shall be made by IIST. Making all other penetrations/cut-outs required for running pipe lines /cables etc. shall be in the Vendor's scope.

All pipe supports made of Mild Steel/RCC/GI uni-struts etc. for running Utilities lines from Plants /systems (Generation/ source) up to the parent building into the cleanrooms is also in the Vendor's

scope. The vendor shall also submit drawings for cut outs/openings in the parent building walls for utility connection ns/ducting etc.

6. Technical Specification & Data for Design:

DESIGN CONDTIONS OF THIRUVANANTHAPURAM

	Design Conditions for PHOTOLITHOGRAPHY LAB				
SEASON	DB deg F	WB drg F	RH %	DP deg F	Gr/lb
SUMMER	92.0	80.0	59.8	76.0	137.0
MONSOON	85.0	80.0	80.7	78.4	151.0
WINTER	72.0	65.0	69.2	61.4	81.3
ROOM	69.8	57.0	45.0	47.6	47.7

	Design Conditions for Diffusion & Wet process LAB etc.				
SEASON	DB deg F	WB drg F	RH %	DP deg F	Gr/lb
SUMMER	92.0	80.0	59.8	76.0	137.0
MONSOON	85.0	80.0	80.7	78.4	151.0
WINTER	72.0	65.0	69.2	61.4	81.3
ROOM	69.8	58.3	50.0	50.4	54.5

Specification of different functional areas (ROOM BOOK)

PHOTOLITHOGRAPHY (AHU1)	
Area	322 SQ ft.
Class of Cleanliness	ISO 5 (Class 100) Mixed Flow
Particle Counts	*≤ 3520 Particles/m³ of size 0.5µm as per ISO 14644 Standard*
Inside Room Temperature deg C	21 ± 2
Inside Room Relative humidity	45 ± 5
Inside Room Positive pressure (+ Pa) with ref to atmosphere	+ 30 ± 5 Pa (+15 Pa higher than Deposition LAB is most Important)
Supply Air change rate per hour	As per ISO 14644-4 standards

Filter coverage	100 % The exact no. of filters for each area shall be worked by the vendor as per the design of HVAC systems being a part of the scope of the vendor.)
Supply Air Velocity	0.45 meters per second ± 20% (90 fpm +/- 20fpm)
Types & Quality of Filters	HEPA filter (H-14) with efficiency- 99.995% down to 0.3 µm size particles@ MPPS acc. to EN1822
Supply Air PLENUM	FFU Modules Concept with HEPA filter (H-14) with efficiency-99.995% down to 0.3 µm size particles. There shall be a Supply Air FFU Plenum BOX fixed to the roof of the Parent Building(please refer drawing
Supply Airflow Pattern	Downward Mixed Flow
Sound pressure level	Around 55 ±5 dB
Lighting in Photolitho Lab	550 nm Wave Length (Yellow Lighting) tear drop Light Fixture
Height of False ceiling from FFL	3M
Height of True Ceiling from FFL (from bottom of secondary ceiling)	4.5 M
Connected Equipment Load in kW	18 kW
Diversity factor for equipment load for Heat Load calculation	0.35
Max No of People at any point of time	06
Process Exhaust	900 CFM
Number of Fresh air Changes per hour	02
Outside design conditions to be considered	Data as per ISHRAE/relevant standard for Thiruvananthapuram conditions with suitable Corrections
Treated Fresh air	Adequate to offset exhaust and to maintain specified RH and Pressure in the clean room.
Deposition and Etch Lab (AHU2)	
AREA	1130 SQ ft.
Class of Cleanliness	ISO 6 (Class 1000) Mixed Flow
Particle Counts	≤ 35200 Particles/m^3 of size 0.5µm as per ISO 14644 Standard
Inside Room Temperature deg C	21 ± 2

Inside Room Relative humidity	50 ± 5
Inside Room Positive pressure (+ Pa) with ref to atmosphere	+ 20 ± 5 Pa (+10 Pa higher than Changing room is most Important)
Supply Air change rate per hour	156
Filter coverage minimum	30 % The exact no. of filters for each area shall be worked by the vendor as per the design of HVAC systems being a part of the scope of the vendor.)
Supply Air Velocity	0.35 to 0.45 meters per second ± 20% (90 fpm +/- 20fpm)
Types & Quality of Filters	HEPA filter (H-14) with efficiency- 99.995% down to 0.3 µm size particles@ MPPS acc. to EN1822
Supply Air PLENUM	FFU Modules with HEPA filter (H-14) with efficiency- 99.995% down to 0.3 µm size particles. There shall be a Supply Air FFU Plenum BOX fixed to the roof of the Parent Building. (please refer drawing
Supply Airflow Pattern	Downward Mixed Flow
Sound pressure level	Around 55 ±5 dB
Lighting	600 LUX White
Type of Flooring	2 mm thick ESD Tiles of resistivity 10^5-10^7 ohm –cm
Height of False ceiling from FFL	3M
Height of True Ceiling from FFL (from bottom of secondary ceiling)	4.5 M
Connected Equipment Load in kW	158 kW
Diversity factor for equipment load for Heat Load calculation	0.35
Max No of People at any point of time	15
Process Exhaust	1200
Number of Fresh air Changes per hour	02
Outside design conditions to be Considered	Data as per ISHRAE/relevant standard for Thiruvananthapuram conditions with suitable Corrections

Treated Fresh air	Adequate to offset exhaust and to maintain specified RH and Pressure in the clean room.
Changing Room (AHU2)	
Area	48 SQ ft.
Class of Cleanliness	ISO 7 (Class 10000) Mixed Flow
Particle Counts	≤ 352000 Particles/m³ of size 0.5µm as per ISO 14644 Standard
Inside Room Temperature deg C	21 ± 2
Inside Room Relative humidity	50 ± 5
Inside Room Positive pressure (+ Pa) with ref to atmosphere	+ 10 ± 5 Pa (+10 Pa higher than Corridor is most Important)
Supply Air change rate per hour	60
Filter coverage minimum	12- 15 % The exact no. of filters for each area shall be worked by the vendor as per the design of HVAC systems being a part of the scope of the vendor.)
Supply Air Velocity	0.35 to 0.45 meters per second ± 20% (90 fpm +/- 20fpm)
Types & Quality of Filters	HEPA filter (H-14) with efficiency- 99.995% down to 0.3 µm size particles@ MPPS acc. to EN1822
Supply Air PLENUM	FFU Modules with HEPA filter (H-14) with efficiency- 99.995% down to 0.3 µm size particles. There shall be a Supply Air FFU Plenum BOX fixed to the roof of the Parent Building (please refer drawing)
Supply Airflow Pattern	Downward Mixed Flow
Sound pressure level	Around 55 ±5 dB
Lighting	550- 600 LUX white Light
Type of Flooring	2 mm thick ESD Tiles of resistivity 10^5-10^7 ohm –cm
Height of False ceiling from FFL	3M

Height of True Ceiling from FFL (from bottom of secondary ceiling)	4.5 M
Connected Equipment Load in kW	4 kW
Diversity factor for equipment load for Heat Load calculation	0.35
Max No of People at any point of time	5
Process Exhaust	Nil
Number of Fresh air Changes per hour	02
Outside design conditions to be Considered	Data as per ISHRAE/relevant standard for Thiruvananthapuram conditions with suitable Corrections
Treated Fresh air	Adequate to offset exhaust and to maintain specified RH and Pressure in the clean room.
Service Corridor (AHU3)	
Area	700 SQ ft.
Class of Cleanliness	UNCLASSIFIED
Particle Counts	NA
Inside Room Temperature deg C	23 ± 2
Inside Room Relative humidity	55 – 60
Inside Room Positive pressure (+ Pa) with ref to atmosphere	+ 05 (+5 Pa higher than outside the corridor is most Important)
Supply Air change rate per hour 10	10
Filter coverage minimum	NA
Supply Air Velocity	NA
Types & Quality of Filters	NA
Supply Air PLENUM	Through SA AND Return air Ducts with suitable Diffusers
Supply Airflow Pattern	Random Flow

Sound pressure level	Around 55 ±5 dB
Lighting	450- 500 LUX
Type of Flooring	2 mm thick Vinyl sheet Flooring
Height of False ceiling from FFL	3M
Height of True Ceiling from FFL (from bottom of secondary ceiling)	4.5 M
Connected Equipment Load in kW	**6 kW****
Diversity factor for equipment load for Heat Load calculation	0.35
Max No of People at any point of time	5
Process Exhaust	Nil
Number of Fresh air Changes per hour	02
Outside design conditions to be considered	Data as per ISHRAE/relevant standard for Thiruvananthapuram conditions with suitable Corrections
Treated Fresh air	Adequate to offset exhaust and to maintain specified RH and Pressure in the clean room.
Important note on inner walls of parent building in Service corridor.	The inner walls of the parent building in the corridors between Cleanroom walls & Brick walls(The exposed surfaces of the plastered wall of cement concrete Blocks/ brick masonry, and , RCC beams and columns in the service corridor) shall be properly epoxy painted to have a smooth and dust free finish.

WET PROCESS HOODED HEPA CONCEPT ONLY (AHU4)	
AREA	108 SQ ft.
Class of Cleanliness	ISO 6 (Class 1000) Mixed Flow
Particle Counts	≤ 35200 Particles/m³ of size 0.5µm as per ISO 14644 Standard
Inside Room Temperature deg C	21 ± 2

Inside Room Relative humidity	50 ± 5
Inside Room Positive pressure (+ Pa) with ref to atmosphere	+ 20 ± 5 Pa (+10 Pa higher than Changing room is most Important)
Supply Air change rate per hour	150
Filter coverage minimum	30 % The exact no. of filters for each area shall be worked by the vendor as per the design of HVAC systems being a part of the scope of the vendor.)
Supply Air Velocity	0.35 to 0.45 meters per second ± 20% (90 fpm +/- 20fpm)
Types & Quality of Filters	HEPA filter (H-14) with efficiency- 99.995% down to 0.3 µm size particles@ MPPS acc. to EN1822
Supply Air PLENUM	HOODED HEPA filter (H-14) with efficiency- 99.995% down to 0.3 µm size particles. The Hooded HEPA shall be fixed in the False ceiling & connected to the SA duct with Flexible duct & VCD (please refer drawing)
Supply Airflow Pattern	Downward Mixed Flow
Sound pressure level	Around 55 ±5 dB
Lighting	600 LUX White
Type of Flooring	2 mm thick ESD Tiles of resistivity 10^5-10^7 ohm –cm
Height of False ceiling from FFL	3M
Height of True Ceiling from FFL (from bottom of secondary ceiling)	4.5 M
Connected Equipment Load in kW	9 kW
Diversity factor for equipment load for Heat Load calculation	0.35
Max No of People at any point of time	02
Process Exhaust	1800 CFM
Number of Fresh air Changes per hour	02
Outside design conditions to be Considered	Data as per ISHRAE/relevant standard for Thiruvananthapuram conditions with suitable Corrections

Treated Fresh air	Adequate to offset exhaust and to maintain specified RH and Pressure in the clean room.

Note Pre-gowning Area: IIST will be making the pre-gowning room in the area before the main entrance to the cleanroom.

7. Approach Methodology of Cleanroom Air Management & Cleanroom related HVAC

The cleanroom shall be self-contained pre-fabricated modular system containing wall panels, Ceiling Grid, ceiling panels and suitable number of FFU with HEPA filters to provide clean air to achieve cleanliness level of classes indicated above. The clean air shall travel/enter the clean space through FFU having HEPA (H-14) housed in the false ceiling of the ISO 5, ISO 6, 7 &8 cleanroom. The vendor shall provide the necessary cutouts in the wall panel, ceiling panel, and flooring by using Clean room compatible material, as required for fixing/installing utilities & accessories such as electrical items, light fixtures, LAN ports etc.

7.1.Supply air scheme:

The Cleanroom HVAC conceptual design is to be based on negative pressurized supply Air plenum (FFU PLENUM BOXING). The schematic drawing illustrating airflow is shown in Figure 1 below. The required Quantity of dehumidified air shall be supplied into the space between False ceiling & the true ceiling of FFU PLENUM BOXING which are right above respective Cleanrooms of class 100 and class 1000 including the Changing Rooms.

Supply air scheme: In the Photolithography lab, Deposition lab & Changing Room, the 'Negative Pressure Plenum' will be achieved using Fan Feed Units (FFUs). The supply air shall have a unidirectional vertical downward MIXED flow with negative pressurized plenum located over the proposed "clean spaces" having FFUs with HEPA 14 filters for ISO 5 rooms, for ISO 6 & ISO 7 Rooms, housed in the false ceiling system & to deliver filtered air into the Cleanrooms Mentioned above.

For Unclassified Areas: like Service Corridor: The proposal is Turbulent flow air supply system to the proposed "Unclassified Areas" having SA Diffusers with VCD housed in the false ceiling system to deliver the air into these areas.

7.2.Supply air plenum for Cleanrooms:

Supply air Scheme shall be of FFUs PLENUM BOXING comprising of A PLENUM with FALSE CEILING in which FFUS are Housed &SECONDARY CEILING above False Ceiling surrounded by four side Walls. FFUS installed in the FALSE CEILING having Aluminum Honey Comb False Ceiling Panels 44mm thick with Heavy Duty Aluminum extruded T grid system (refer specification of the tender DOC) AND the secondary Ceiling Above False ceiling shall also be Aluminum Honey Comb False Ceiling Panels 44mm thick with Heavy Duty Aluminum System (with suitable ceiling grid & Blanks Walkable type). Also all the four Wall surfaces of the FFU Plenum shall be made out of 44mm thick Aluminum Honey Comb panels. This Secondary Ceiling shall be hooked to the roof of the PARENT Building

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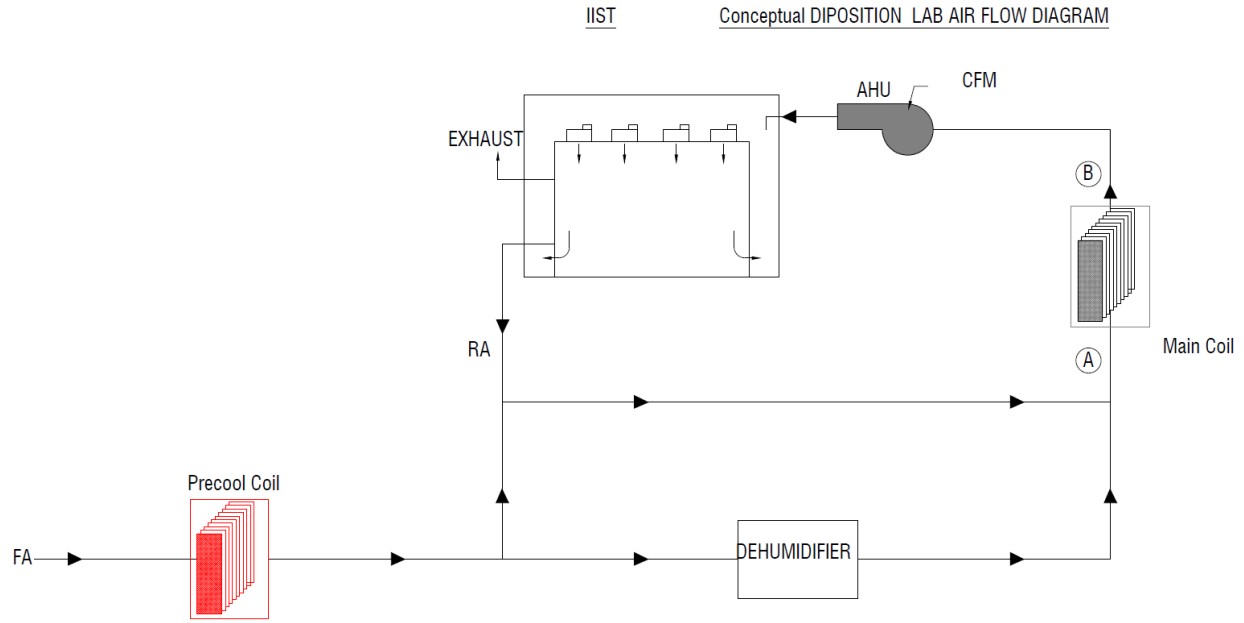

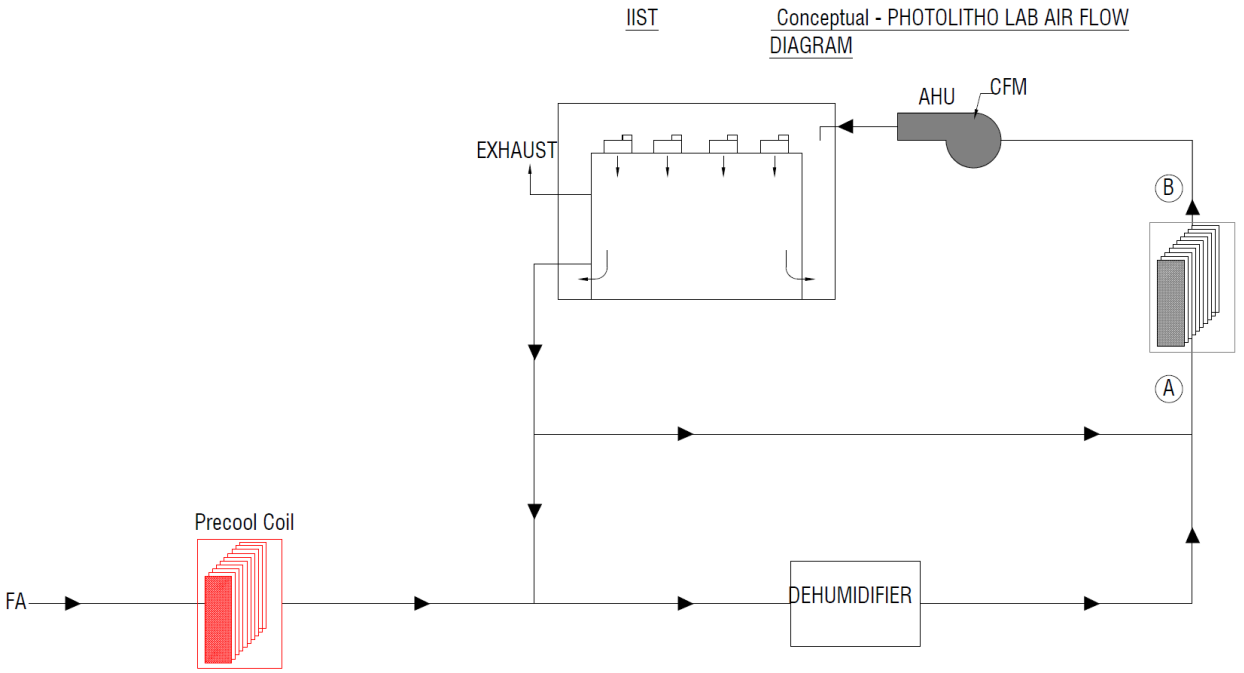

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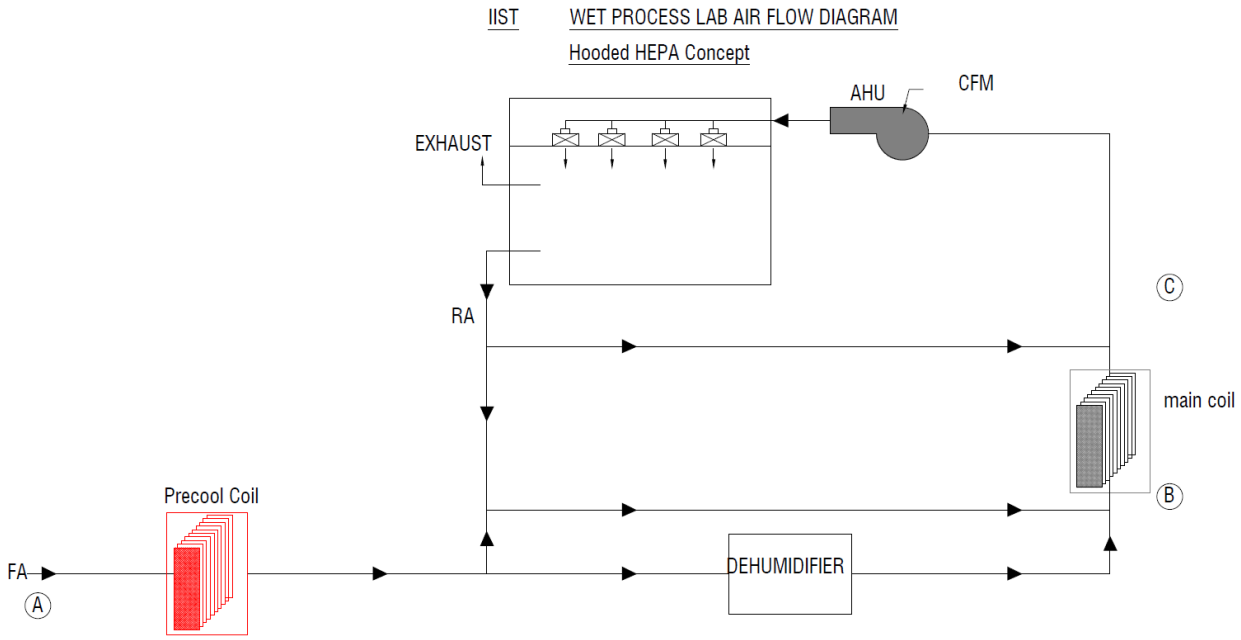

Figure 1: Cleanroom Airflow Schematic –Air Flow Diagram for Deposition Lab and Photolithography (FFU Based) and Wet process Lab (Hooded HEPA concept) (Conceptual drawings for reference only)

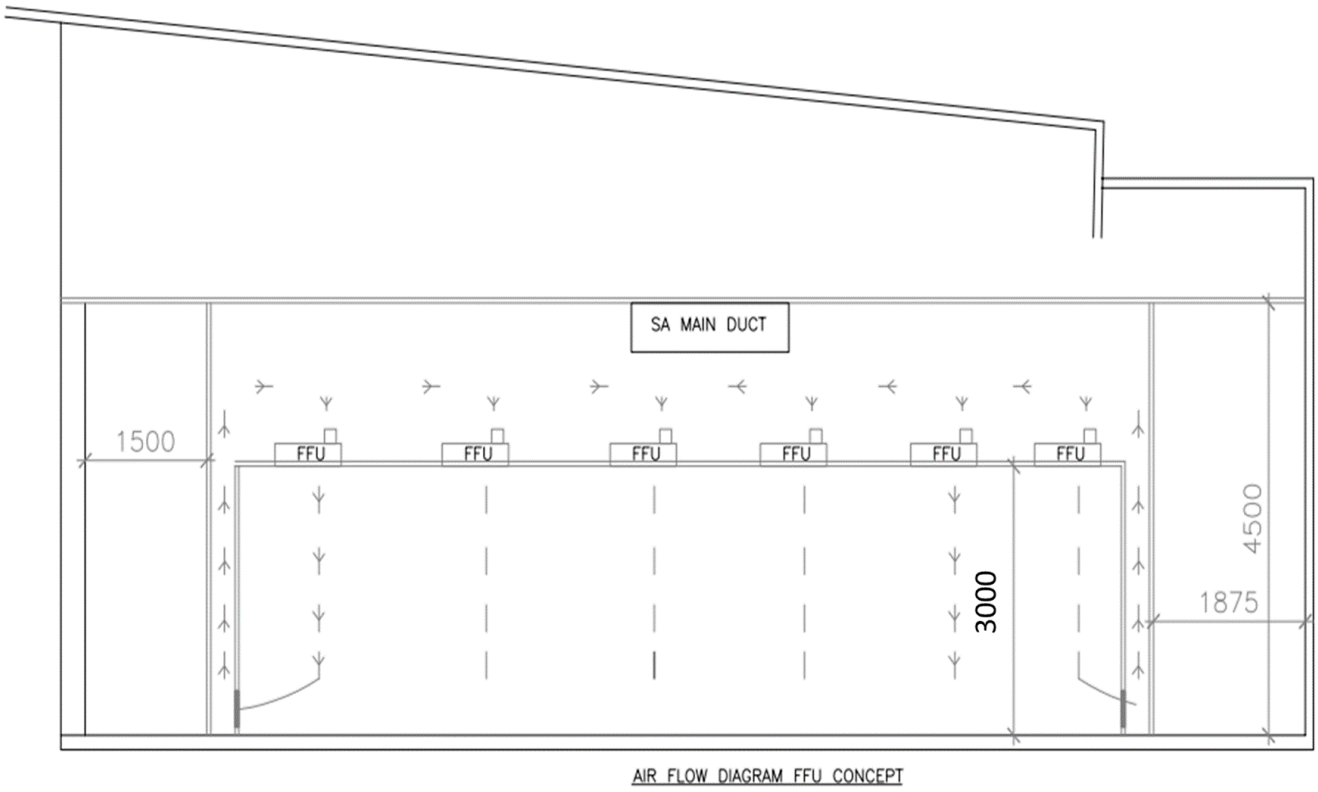

Figure 2: Air flow diagram (Conceptual drawing illustrating FFU Pelnum box and the titled roof of the area)

7.3.Recirculating Air Handlers:

The number of AHUs for each areas of the cleanroom are also mentioned on the room book table as well.

7.3.1. Recirculation Air Handlers:

- Suitable Recirculation AHUs & Fresh air Handlers are to be located outside the Parent Building area & in the envelope called as utility area. The Air Handlers shall be fitted with suitable capacity cooling coils, Mist eliminators, Blowers with Motors, Strip heaters, 3 stages of filters, suitable numbers of Magnehelic gauges at each Filter Banks, etc. Complete., to maintain the required temperature and RH.

- The required quantity of dehumidified air should be delivered through suitably sized SA ducts, which penetrate into the building and run horizontally over the fab area in the overhead interstitial space, from where the air is supplied to the negative pressurized plenum called as "FFU PLENUM BOXING".
- NOTE: Dedicated recirculation Air Handlers shall be considered for Photolitho lab, Deposition Lab & Changing rooms and Wet chemical lab independently
- Suitable Capacity Dehumidifiers & humidifiers if required may be Considered as required on order to meet the inside Cleanroom Conditions of Temperature.
- The scope includes supply, installation, testing, commissioning of appropriate number of Air Handling units of as per design to maintain the specified environmental conditions in the clean room.

7.3.2. Air Handlers for Unclassified Areas like Service Corridors

- The required quantity of dehumidified air is delivered through suitably sized SA ducts, Supply Air Diffusers with VCD located in the overhead interstitial space into the Unclassified Areas. A dedicated Recirculating Air Handler shall be provided for these areas.

7.4. Local recirculation Air Management System in Cleanrooms using FFU SA Plenum Concept:

- The following system is proposed for local recirculation to Achieve required Cleanliness:
- Double wall panel system to be considered with a void of ~ 300 mm between the inner and the outer wall panels of the cleanrooms. The supply & return of Clean air will be via this 300 mm void utilizing FFUS housed in the False ceiling in order to achieve the required number of Air change rate & hence Clean air.
- Scheme shall be of FFUs plenum boxing comprising of a plenum with false CEILING in which FFUS are housed & secondary ceiling above False Ceiling surrounded by four side Walls made

out of 44 mm thick Aluminium honey comb panels.. FFUS installed in the false ceiling having Aluminimum Honey Comb False Ceiling Panels 44 mm thick with Heavy duty Aluminimum extruded T grid system (refer specification of the tender doc).

- The secondary Ceiling Above False ceiling shall be a System with suitable ceiling grid & Blanks Walkable type & 44 mm thick Aluminium honey comb panels . Also all the four Wall surfaces of the FFU Plenum shall be made out of 44 mm thick Aluminium honey comb panels. This Secondary Ceiling shall be hooked to the roof of the parent building
- The outer wall panels shall be installed up to the true ceiling of SA FFU plenum boxing of the cleanrooms shell in order to avoid ingress of contaminated air from the uncovered areas in between the true and the false ceilings. This will also isolate the air recirculating from the Photolithography lab (critical process area) & Deposition Lab from mixing with the air of the other areas and thus avoid the cross-contamination.
- The return air from the respective Cleanrooms will enter into the Negative Pressure plenum, wherein the FFUs re-circulate the clean air in & out of the Cleanroom
- Certain Quantity of air (called as dehumidified air) from the Cleanroom will be drawn to the Recirculating Air Handler into the Mixing Chamber of the AHU through Return air raisers (called as fabricated RA raisers) housed in this Void at different Locations of the inner walls at Low level (of the inner wall panels) via Return air grilles made out of Aluminum along with VCD and having GI Powder coated collars, located at about 200 MM above the floor level, fixed on the periphery of the cleanroom wall panels in order to provide the required dehumidified cfm of air to maintain the required temperature & Relative Humidity within designed tolerance in the Cleanrooms.
- Velocity in return path (risers) Built-in Return Air Raisers & Return Air Grilles shall be selected in such a way that the Noise & Vibrations are at minimum

7.5. Return Air Raisers, Return Air Grilles, Volume Control Dampers etc.

7.5.1. Fabricated Return Air Risers for Local recirculation by FFUS:

- The required quantity of the return air which is required to maintain the temperature and RH shall be drawn from the Cleanrooms to the through the dedicated Return Air Risers situated at different locations on the periphery of the cleanroom wall fixed at "low" level of the Cleanroom wall panels.
- Shall include return air grills with Volume Control Dampers (VCD). The RA grill system consisting of linear type grilles made out of Aluminium material along with VCD and having GI powder coated collars, located at low level of wall panels, fixed on the periphery of the cleanroom.
- Return Air Risers with suitable supports shall be made out of 22 G, GSS Material.
- Return air Risers shall be provided at selected locations on the periphery of the Wall panels to return suitable quantity of air to the Recirculating Air Handlers through Return Air Ducts.
- Also the adjacent space of the pillars may be utilized to install Return Air Raisers to the maximum extent if possible
- Suitable size and number of Return Air Grills shall be fixed to the RA risers to allow required quantity of dehumidified air to be returned from Cleanrooms to the recirculating Air Handler. The grilles shall have maximum NC 35 aerodynamic noise power. Return air grilles shall be of linear type with 15-degree deflection angle; made out of Aluminium along with 20G GI powder-coated collar.
- The return air volume control shall be possible by operating the RA Volume Control damper with the help of a lever Manually from Room side.
- Construction of frame for RA grills shall be of high quality extruded aluminium profile with 30 mm flange width as standard sized flange widths. Face bars shall of high quality aluminium profiles of 15°- 1way throw and 15°-2way throw. Bar spacing can be 6 mm/12 mm & shall be grill width as required.

7.5.2. Insulation for Fabricated Return Air Raisers wherever required:

- Insulation for Fabricated Return air Raisers: shall include Thermal Insulation 9 mm thick with Aluminium foil faced Class 'O' close cell Nitrile Rubber Insulation with proper sealing of joints to RA Risers if the RA raisers are located outside cleanrooms.

7.5.3. Return air Riser Grills for RA raisers of return air to AHU (dehumidified CFM):

- Return Air Risers Shall be provided to allow the required dehumidified Air quantity to be returned from Cleanrooms to the recirculating Air Handler having the Cooling Coil & dehumidifier, in order to maintain the required temperature & relative humidity in clean rooms. Suitable sized & number of Return Air Grills shall be fixed to the RA rises to collect only the required quantity of Air from the cleanrooms.
- Return Air Riser Grilles shall be selected for an aerodynamic noise power value not in excess of NC 35. Return air diffusers shall incorporate volume control dampers. Return Air velocity through RA grilles through shall not exceed 400 fpm.
- Return air grilles shall be of linear type with 15 deg deflection angle; made out of Aluminium along with 20G GI powders coated Collar, with Volume control damper for mounting on Fabricated Return air Riser. The return air volume control shall be possible by operating the RA Volume Control damper with the help of a lever Manually from Room side.
- Construction of Frame shall be of high quality extruded aluminium profile with 30 mm flange width as standard sized flange widths. Face bars shall of high quality aluminium profiles of 15°- 1way throw and 15°-2way throw. Bar spacing can be 6mm/12mm & shall be grill width as required.
- Frame and face bars shall be of high quality extruded aluminium profiled construction with the advantages of corrosion resistance and rigidity. Horizontal face bars with 0°, 15°-1-way throw and 15°-2-way throw are to be fixed rigidly to the frame with suitable sized pipes

- Vertical aluminium aerofoil blades should to be fixed at the rear side of the frame by nylon bushes. These aerofoil blades can be adjusted individually in the vertical plane to obtain Configuration. Can be with- clamps for proper fixing.

7.5.4. **Velocity of Air in Main Supply Duct:**

- The Supply Air Velocity of the Main Duct of air handlers shall not exceed 1200 fpm, and the ducts shall be sized accordingly.
- The return air Velocity considered to design the size of RA risers shall not exceed 500 fpm and the velocity for RA grills shall not exceed 350- 400 fpm. These velocity values are of an indicative nature; the vendor should verify these depending upon the design conditions.
- For UNCLASSIFIED AREAS Supply air diffusers shall be of powder coated extruded aluminium construction. They shall be complete with Volume control dampers of aluminium mounted directly on the return Air Duct fixed in the false ceiling. The vanes shall be 3 mm thick and 25 mm deep horizontal type. The width of the perimeter flanges shall be 25 mm.
- Return air diffusers shall also be Powder coated extruded aluminium construction. They shall be complete with Volume control dampers of aluminium mounted directly on grilles & there shall be provision for operating the VCD from room side of the Unclassified Areas. The perimeter flanges shall be 25 mm width. The vanes shall be 3 mm thick and 25 mm deep. The pitch of vanes.

7.6.Fresh Air:

Treated fresh air needs to be provided in order to compensate the air required for process extract, ex-filtration, and to maintain spatial positive pressure required in the Cleanrooms. Precooling Coils with suitable pre filters, VCD & mixing box etc. shall be provided for the fresh Air intake of each Air handler separately.

 Note: A common Treated Fresh air system in not required as individual Air handler shall be provided with fresh air as mentioned above

7.7.Specification of Recirculation Air Handlers:

Supply & Installation of Modular Double Skin Air handling unit constructed out of minimum 22 G (0.8 mm) with pre coated GI sheet as outer skin and 22G (0.8 mm) plain GI sheet as inner skin with 45 mm thick PUF insulation injected HFC - Filler PUF insulation material having 48 +/- 2 Kg/M3 density, sandwiched between inner & outer sheets/skins. Air Handling unit to be horizontal floor Mounted Ductable type, Sheet metal sectionalized cabinet Configuration and the entire frame work shall be mounted on GSS Channel base. It Shall comprise of thermal break profile and internal coving & extruded section frame structure of Aluminum & Complete with necessary frame work for supporting channels, foundation bolts Complete.

Shall include Cooling Coil Section with Casing made of GI for Chilled Water System, with 6 row deep using Copper Tube of suitable thickness & diameter, Aluminimum fins not less than 13 FPI -- including Coil Header with adopter, two bends Mist Eliminator Section made out of PVC, Condensate drain pan shall be of minimum 1.2mm SS 304 material with minimum 19mm thick nitrile rubber insulation. Pressure test not less than 21Kg/Sq.cm.

The maximum face velocity across the coils & of filters to be considered as 450 FPM. Shall Comprise of a one stage of Pre filter section before cooling coil with Suitable number of Flange type EU 4 / G 4 filters down to 10 microns at 90 % efficiency Flange type Washable, Each filter section will have Magnehelic gauge (Constructed out of minimum 22 G (0.8 mm) with pre coated GI sheet as outer skin and 22 G (0. 8 mm) plain GI sheet as inner skin with minimum 45 mm thick PUF insulation.

Shall comprise of Blower/ Fan Section with PLUG FAN (Direct Driven), SISW centrifugal backward curve type and driven by suitable Non flame proof TEFC squirrel cage IE3 Electrical induction motor with drive set complete & motor with suitable variable frequency drive. Fan and motor should be selected for 10% extra capacity. Shall comprise with anti- vibration mounts,

inspection windows, limit switch, marine type light etc. The Blower shall be backward curved type, with suitable static pressure. Shall comprise of Supply plenum with Aluminimum dampers suitable for both Manual/ Automatic and Double skin rexin fire retardant flexible connection for fan outlet. The volume control dampers shall be m mounted on flange of the air handling unit and shall be lockable type with extended shaft of minimum 150mm length from the base plate.

Shall comprise of Final two stages of Filter Sections comprising of EU6 / F6 Filters down to 5microns at 99 % as per Euro vent / EN 779 standard & Filters section of F7 /EU7 99 % efficiency down to 3 microns with galvanized steel sheet (GSS) Flange/ frame type as final filters after Blower. Each filter section will have Magnehelic gauges to check the pressure drop across the Filter section.

Shall comprise of Inlet and outlet connections complete with service doors and with inlet, outlet and fresh air dampers in GI construction and bleed off dampers in Aluminium low leak construction and shall comprise of suitable number of fresh air and bleed off filters and Magnehelic gauges across all filters. Shall have provision for Electrical Heater Section with Strip type heater as required.

Shall include Heater section with Electric Tubular SS Heaters, duly insulated with thyrister controls of suitable capacity with mounting arrangement / 2 row deep hot water coil in the AHU

There shall be provision for measuring the Temperature & Velocity of air before & After of Cooling Coil, in the mixing Chamber, at the inlet of the return air in the RA duct before Mixing Chamber & at the out let of the Blower & at the outlet of the Main Supply Air duct.

Pressure measuring ports (6mm SS) with dead nut shall be provided across each section to monitor the pressure drops. Temperature measuring ports (20 mm SS) at the inlet and outlet of

cooling/heating coils shall be provided to monitor the temperature. Velocity Measuring port after the Fine filter of AHU shall be provided

7.8.Fresh air handler specification:

The AHU shall contain a suitable Fresh air module with sufficient fresh air intake with extruded Aluminimum Low leakage type Manual volume control damper. Shall comprise of EU3/G3 pre filters at 90% efficiency down to 20 microns as per Eurovent & EN 779 standards respectively. Shall include Bird Cowl & mesh for fresh air etc. Shall have Aluminum extruded louver with wire mesh of galvanized steel with mounting arrangement for connection of duct opening to atmosphere for all AHU. Shall have provision for connecting the pre Cooling Coil. Filter area shall be suitable for twice the quantity of fresh air. Including Electrical Cable between starter panel to AHU motor with earthlings.

7.9.Precooling Coil Unit Specification:

Supply & Installation of Pre Cooling COIL for Fresh Air System for all cleanrooms. Pre - Cooling Coil System of with MODULAR BOXING made out of Double Skin with thermal break profile and internal coving. Sheet thickness for internal sheet shall be 22 G Galvanized Steel Sheet(GSS) Plain & 22G GSS Pre coated for outer skin. Panel thickness shall be minimum 50 mm PUF insulation. It Shall Comprise of Modular Boxing shall comprise of Fresh Air cut-out with damper, EU 4 filter section, Coil Section with 6 Row DX coil, Capacity. Shall include PVC Moisture Eliminator and SS drain pan. with suitable VCD, Rough Filters (G4 Filters) with Bird Cowl & mesh etc.

7.10. Further elaboration on AHU:

A. **Mixing Chambers for all the AHUS.** The two way mixing box shall be designed, supplied & made out of 20G GI, for efficient mixing of fresh air and return air by means of interconnecting dampers. Canvas connection. The fan shall be isolated from casing by flexible connection; it

should be made of polyester fabric, temperature resistant up to 160°C with high tearing strength. These should be connected on both sides with surrounding air tight duct connection flange flanges. The vendor to provide sample of canvas connection after getting the order. The flexible connection to be provided with counter flange to connect the duct on the discharge side Dampers.

B. Fresh Air Intake Louver & Bird Mesh: The AHU shall contain a suitable Fresh air module with sufficient fresh air intake, Extruded Aluminium low leakage type with Manual volume control damper. Shall comprise of EU3/G3 pre filters at 90% efficiency down to 20 microns as per Eurovent & EN 779 standards respectively. Shall comprise of Bird Cowl & mesh for fresh air etc. Shall have Aluminium extruded louver with wire mesh of galvanized steel with mounting arrangement for connection of duct opening to atmosphere for all AHUS.

C. Fresh Air Intake Louver & Bird Mesh for each Air Handlers shall have:

- Filter area shall be suitable for twice the quantity of fresh air.
- All the louvers shall be rain protection type & made from GI powder coated section shall be in modular panel. The outer frame shall be made structurally rigid & Corners of frame shall be welded. The louver shall be free from waves and buckles. Horizontal blades shall be truly horizontal.
- Additional intermediate equally spaced supports and stiffeners shall be provided to prevent sagging / vibrating of the louvers, at not more than 750 mm centers where the louvers length is longer than 750 mm.
- A bird wire screen made of 12mm mesh in 1.6 mm Stainless steel wire held in angle or channel, Frame shall be fixed to the rear face of the louver & complete with G2 type panel filter with fixing frame.
- Rain protection type modular panel, free from waves and buckles, with additional supports to prevent sagging / vibrating.

7.11. In general AHU shall comprise of the Following:

A. Cooling coil: The cooling coils shall be of heavy gauge seamless copper tubes with firmly bonded plain corrugated etc. face velocity of air across the cooling coil does not exceed 2.25 m/sec. (450FPM). The cooling coil shall be of minimum 6 rows deep for each circuit. The face and bypass damper/bypass arrangement shall be provided. Cooling coil to be connected to Chilled water system & shall have Standby Coil header, flanges finished with suitable paint of non-corrosive type.

- Heavy gauge seamless, plain/ corrugated copper tubes, minimum 6 rows deep for each circuit.
- Area of coils shall be such that the face velocity of air across the cooling coil does not exceed 2.8 m/sec (450 FPM).
- 'U' bends shall be of forged copper and shall be brazed to tubes using silver solder on
- Mist eliminator to be provided after cooling coil

B. Fans:

- Single inlet, Single width centrifugal fan with backward curved steel blades.
- The impeller shall be mounted on a steel shaft of adequate size, the shaft shall be supported with minimum two bearings mounted on the outside of casing for easy access and maintenance.
- The fans shall be statically and dynamically balanced.

C. Fan drive:

- AHU shall be equipped with FAN PLUG as per manufacture standard for achieving desired result

D. Fan motor:

- The impeller shaft shall be driven by an enclosed fan-cooled squirrel cage induction motor having speed not greater than 1470 rpm. The AHU motor shall be suitable for continuous duty rating and base mounting type.

E. Canvas connection

- The fan shall be isolated from casing by flexible connection; it should be made of temperature resistant (up to 160 °C) fabric with high tearing strength.
- The flexible connection to be provided with counter flange to connect the duct on the discharge side Damper
- These should be connected on both sides with surrounding air tight duct connection flanges. The vendor to be provide sample of canvas connection after getting the order.

F. Dampers

- Damper composition: MOC extruded Aluminium, Low Leakage, and Aero foil Volume Control Dampers with extended shaft suitable for Manual & Motorized operation. May include Bleed Module with EU-9 filter.
- The manually operated dampers should be provided with Graduation & locking arrangement. The locking device to remain perfectly locked at all operational conditions of AHU.
- The dampers should be provided with following accessories.
    1. Mechanical Lock with handle and graduation of opening marked on handle. Identification of open and close is must on damper handle side.
    2. Suitable Cover for Gear Train to avoid dust accumulation.

G. AHU name plate

- Containing Fan details with all capacities, Static pressure, Filtration level, Motor HP, Coil details., Arrows for air directions, AHU No. and the area it is feeding.
- Each compartment is to be separately named including filtration level, filters, initial and final pressure drop, cooling coil data, heating coil data, etc.

H. Electric Strip/ Duct Heaters for AHU:

- Electric Tubular SS Heaters, duly insulated in ducts Complete having Thyrister controls & with mounting arrangement in the AHUs as per standard sizes of the respective zones which they would serve.

I. Schematic Airflow diagrams

- Each AHU Shall be provided with laminated colored AHUGA drawings showing all the Components / Airflow Drawings duly pasted on AHU.

J. BMS integration

- All AHU's shall have provision (Like instrumentations pocket) for integration with BMS system and for measuring the parameters like temperature, pressure drop across filters, speed etc.
- Number of AHUs to be Considered as per the ROOM BOOK provided in the Tender Document & the respective areas to be considered.

K. Provision for Measuring the Temperature & velocity of the Air in AHUS:

- There shall be provision for measuring the Temperature & Velocity of air before & After of Cooling Coil, in the mixing Chamber, at the inlet of the return air in the RA duct before Mixing Chamber & at the out let of the Blower & at the outlet of the Main Supply Air duct. There shall be opening for cable entries for motor in section & there shall be access door across every section of AHU.

7.12. All air handling unit shall be supplied with following Accessories:

- Marine Type Light LED, limit switch for blower section, safety grille for blower section and view glass for fan and filter sections shall be provided.
- Motor will be Non-flame proof type and Fan will be Non-spark proof type.
- Fan and motor should be selected for 10% extra capacity
- Mist eliminator after cooling coil, each air handling unit shall be provided with manual air vent at high point in the cooling/heating coil and drain plug in the bottom of the coil

- Shall comprise of suitable sized Thermal break as the AHU is required for Cleanroom application.
- Pressure measuring ports (6mm SS) with dead nut shall be provided across each section to monitor the pressure drops.
- Temperature measuring ports (20mm SS) at the inlet and outlet of cooling/heating coils shall be provided to monitor the temperature.
- Fresh air Louver with bird mesh, return air, by pass air, bleed air and supply air opposed blade Low leakage type volume control dampers suitable for manual and motorized operation.
- Magnehelic gauges Mounted in a SS box shall be provided for all type of filters. Magnehelic gauges and differential pressure switches with electrical contacts for BMS (supply BMS scope) and local indication (Light indication). DP Ports shall be provided on AHU casing

7.13. Dehumidifier (If required) shall be Considered.

- Non-cyclic, rotary, desiccant type dehumidifier.
- The dehumidifier shall be able to dry the air by process of continuous physical adsorption to control humidity.
- The desiccants used shall be nontoxic, nonflammable having maximum moisture removal capacity. The throughput of Dehumidifier should be calculated & provided separately for each area if required.

Need for Dehumidifiers, Humidifiers & pre cooling Coils:

Dehumidifiers:

- Because of the high Moisture content of the air in peak Monsoon at some Locations, it is suggested to consider De humidifiers to meet the Rh requirements if required in some designated critical Cleanrooms.

- Desiccant-based dehumidifier units need to be provided in the return air path to maintain RH as required respectively, as the moisture content is high at Thiruvananthapuram , especially during and after monsoon.
- The preferred type is the desiccant-impregnated wheel based dehumidifiers with a process side and a reactivation side. The desiccant is reactivated through passage of high temperature air.
- The whole unit shall be mounted on a single skid with necessary microprocessor based control panels for operation of process and reactivation blowers, heaters and the rotation of desiccant beds. The system operates automatically to maintain the RH inside the cleanroom with the required humidistat.
- These Dehumidifiers shall be located in the return air path with required by pass arrangement to ensure the required quantity of air will be dehumidified and the remixing at the inlet of the air handling unit mixing chamber.

Precooling Coils for fresh Air required for connecting the Dehumidifiers:

- Shall include Pre -Cooling Coils System for fresh air intake with suitable Capacity (TR & air Quantity) with MODULAR BOXING made out of Double Skin with thermal break profile and internal coving. Sheet thickness for internal sheet shall be 22 G Galvanized Steel Sheet (GSS) Plain & 22G GSS Pre coated for outer skin. Panel thickness shall be minimum 43 mm thick with PUF insulation.
- Shall Comprise of Modular Boxing & comprise of Fresh Air cut out with damper, EU 4 filter section, Coil Section with 8 Row Chilled water coil of suitable Capacity Shall include PVC Moisture Eliminator and SS drain pan. With suitable VCD, Rough Filters (G4 Filters) with Bird Cowl & mesh etc.

7.14. Humidifiers:

Shall include Pan Humidifiers to maintain RH not below 40 % during seasonal variation in humidity in the outside environment. Pan Humidifier shall be made out of Stainless sheet of minimum 2 mm thick with steam generation capacity & with required heater capacity, with steam outlet nozzle, immersion heaters, low level cut out, humidistat, safety stat, float valve, sight glass, ball valve for drain Connection etc., including GI pipes (as applicable), all as Specified & or directed or as needed to complete its performance.

7.15. Electric Strip/ Duct Heaters:

Electric Tubular SS Heaters, duly insulated in ducts Complete with mounting arrangement in the AHUs as per standard sizes of the respective zones which they would serve

7.16. Controls & Instruments:

Shall include- Humidity Stats, Thermostats, Instruments & sensors, SITC of duct mounted combined T& RH sensors & SITC of multipoint flow sensor with DPT for VFD etc. complete to achieve the required Cleanroom condition.

NOTE: *Detailed heat load calculations (considering the environmental conditions at Thiruvananthapuram and the cleanroom layout/equipment @ IIST) along with the assumptions to be submitted with the technical bid.*

7.17. Fan Filter Units specification: Supply & Installation of FFU Modules:

- Approximate sizes 1200 mm × 600 mm × 275 mm height, made out of Galvanized Al-Zn Alloy, with H-14 HEPA FILTER, with top air inlet & with Prefilter
- FFU Modules Shall Comprise of H-14 HEPA filters of nominal size around Size: 1195(L) x 595mm (W) x 70(H) mm with an efficiency of 99.995%@0.3µm @ MPPS acc. to EN1822

along with gaskets. Minimum flow 650 cfm to 700 cfm (around 1060 CMH), filter media of glass fibre, minimum depth of around 50 mm, top entry air inlet, factory sealed for leak proof operation and provided with DOP port and necessary supports as per specifications etc. complete.

- The filter shall have face guard & shall be epoxy coated expanded steel.
- Shall Comprise of a suitable Blower assembly & Blower of the FFUs shall be statically and dynamically balanced.
- Noise: 55 dB
- Speed Controller: Group Control
- Pressure Sensor
- Approx. Power Consumption: 220 W
- The FFU Modules shall be fitted with suitable pre-filters to protect H-14 HEPA filters
- The HEPA filter shall be easy to be replaced at site from top side & HEPA filter module
- shall be accessible for maintenance from above the False Ceiling side.
- Shall include Pre- filter of 10 microns at the inlet of the FFUs in order to protect the HEPA filters.
- MOC of Body of FFU: Galvalume (Steel,Aluminium, Zinc alloy)

Detailed Specification of H14 HEPA housed in the FFU:

- Replaceable type -
- Body housing shall be Light Weight -
- Body housing - Anodized Aluminimum extrusion.
- Size Overall - 600 mm x 1210 mm x 70 mm
- Filter media of glass fiber, minimum depth of 48 mm,
- Media - - Ultra fine fiber glass
- Acceptance Level Efficiency - H14 Min. 99.995%, @ MPPS acc. to EN1822
- Efficiency EN1822 - @ MPPS 99.995 %.

- Initial Pressure drop: 110Pa @0.45m/s Face Velocity: 0.45m/s
- For 70mm thickness H14, initial pressure drop is 110Pa@0.45m/s
- Total static Pressure Drop for AC type 4x2 FFU, total static pressure is 310Pa@0.45m/s
- Nominal Air Flow- For 0.45m/s, the airflow will be around 1060 CMH
- Classification ranges H14, in accordance with EN1822, due to their high efficiency
- classification, the filters are extremely effective in providing the necessary levels of contamination control in cleanrooms.
- Hermitically Sealed -
- Functional reliability: leak or scan tested.
- Separators - Thermoplastic -
- Bond - Cold cured resin -
- Gasket - neoprene gasket /(EPDM) on air leaving side
- Faceguard Material: Epoxy Powder Coated Steel -
- Faceguard - on both side
- Temperature limit - 70˚C
- Inlet air from top side
- Inlet Prefilter –size around 48 mm height G-3 grade disposable
- MOC of Body of HEPA FILTER: Anodized Aluminimum Casing

7.18. Remote Controls for FFUS:

FFUs should incorporate variable speed DC fan motors for remote bus control.

Supply and Installation of Remote Control system to vary FFU speeds in groups which can be connected to BMS system. FFU group remote Control system required to vary the speed in a group. AND within the group individual FFU control is desirable AND Controller box for each FFU, Speed control based on pressure drop across filter, Individual controls through PC interface, Control of on/off of assigned units remotely PAO point for checking the integrity

of the filter, Software for operation RS 485 ebm BUS control system, Graphic user inter-phase, Area-wise and sequential operation as required during holidays/ non-operating period.

7.19. FOR WET PROCESS LAB: DISPOSABLE TYPE HOODED HEPA FILTERS CONSIDERED

HEPA Filters to be considered:

Disposable type Hooded HEPA (H-14) with Ceiling Module.

- Hooded H-14 HEPA filters, disposable type, of nominal size around 1200mm x 600mm x 152mm depth with an efficiency of 99.995% HEPA filter (H-14) efficiency will be 99.995 @ MPPS acc. to EN1822 along with gaskets,
- Minimum flow 650 cfm to 700 cfm (around 1200 CMH), **filter media of glass fibre, minimum depth of around 48 mm,** top entry air inlet with built in inlet round collar of 300 mm diameter, factory sealed for leak proof operation and provided with DOP port and necessary supports as per specifications etc. complete. The filter shall have face guard & shall be epoxy coated expanded steel.
- The HEPA filter shall be easy to be replaced at site from top side & HEPA filter module shall be accessible for maintenance from above the False Ceiling side.

MOC of Body: Aluminum Casing

Detailed Specification:

- Disposable type
- Body housing shall be Light Weight
- Body housing - Anodized aluminum extrusion.
- Size Overall - 600 mm x 1210 mm x 152

- Filter media of glass fiber, minimum depth of 48 mm,
- Media - - Ultra fine fiber glass
- Acceptance Level Efficiency - H14 Min. 99.995%, @ MPPS acc. to EN1822
- Efficiency EN1822 - @ MPPS 99.995 %.
- Nominal Air flow - @ o.45 M/sec ----1200 CUM /hr. (700 cfm)
- Classification ranges H14, in accordance with EN1822, due to their high efficiency classification, the filters are extremely effective in providing the necessary levels of contamination control in cleanrooms.
- Hermitically Sealed
- Functional reliability: leak or scan tested.
- Separators - Thermoplastic
- Bond - Cold cured resin
- Gasket - neoprene gasket on air leaving side
- Faceguard - on air leaving side
- Temperature limit - 70˚C
- Initial resistance table at nominal airflow for H -14 Filter 125 pa 0.45 m/sec
- Inlet collar –250/300 mm diameter.
- MOC of Body: Aluminum Casing

Flexible Ducts to Connect the HEPA filters to the Supply Air Duct in case of HOODED HEPA Supply Air Scheme:

The Flexible Ducts of diameter 250/300 mm duly insulated & connecting the HEPA filters to the Supply Air Ducts with suitable Clamps

8. DUCTING: (Factory fabricated and manually fabricated/site fabricated ducts):

Shall Comprise of Factory fabricated uninsulated GI sheet metal Ducting with zinc deposition of 180gms/Sq.M as per SMACNA with all required accessories & fittings with RTV sealant, gaskets complete with GI supports, MS flanges duly painted, fully threaded GI rods, GI nuts and bolts, vanes, splitters etc. as per SMACNA standards for pressure class Rectangular Ducts.

Air flow direction to be marked on the respective ducts. The Gauge of ducting Material shall depend upon the sizes as per Standards mentioned below

- 18 G (1.27 mm thick) suitable for > 50 inch diagonal ducts
- 20 G (0.95 mm thick) for > 40" ducts
- 22 G (0.8 mm thick) for > 30" ducts
- 24 G (0.64 mm thick) for > 20" ducts

A. Construction Features (applicable only for factory fabricated ducts)

- All ducts transformation pieces and fittings shall be made on CNC profile cutters & all ducts shall be factory made using lock forming machine. The sheet thickness, brazing, flanges and length of the ducts shall be as per ISO standards.
- Non-toxic, AC-application grade P.E or PVC gasketing shall be provided between all mating flanged joints gasket sizes shall conform to flange manufacturing specifications.
- To avoid leakage silicon sealant shall be used & leakage from duct joints shall be minimum (3 to 5%)
- The specific class of transverse connectors for a given duct dimensions shall be as per SMACNA2005 standard for duct pressure class of 4” wg (1000 Pa
- Duct supports and Hangers: Rectangular duct shall be supported from roof / purlins / truss / ceiling using hanger rods. Ducts shall rest on supporting MS slotted angle or channel. The supporting angle or channel shall be supported by MS rods with threads. Steel anchor fasteners shall be provided by contractor for duct hanging (wherever required) Anchor fasteners shall be loaded to maximum 20% of the maximum rated capacity specified by the

manufacturer, engineer in charge shall approve all anchor fasteners used for supporting duct.

- The size of angle and round rod above are indicative of general requirement. However higher sizes of MS angle and MS rod shall be provided for duct supports if required. Lock nuts (double nuts) shall be provided to each MS rods supporting the ducts, lock nuts (double nuts) shall be provided to each GI rods supporting the ducts.
- All bends offsets and branch connections shall be made for smooth and noise less flow of air and minimum pressure drop. In case of full radius elbow optimum ratio of centreline radius of elbow to duct dimension of 1.25 shall be considered. However due to space constraint shorter radius shorter radius elbow or square elbow with guide vanes may be provided contractor shall furnish the details of guide vanes i.e. Number of vanes, Location etc., in the drawing.
- All curved elbows shall be provided with air turning vanes consists of curved metal blades of vanes arranged so as to permit the air to make abrupt turns without appreciable turbulence.
- Every duct tap-off from supply and return air duct shall be complete with opposed blade volume control damper. A volume control damper shall regulate the flow of air to the branch duct.

B. Duct supports and Hangers

- Rectangular duct shall be supported from roof/purlins/truss/ceiling using hanger rods.
- Ducts shall rest on supporting MS slotted angle or channel. The supporting angle or channel shall be supported by MS rods with threads.

C. Supporting details for ducts:

Large side of duct in mm	Supporting angle (min size of angle to be used) in mm	Vertical rod diameter in mm	Maximum spacing between supports in mm

Up to 1000	35 × 35 × 3	10	3000
1001 to 2250	50 × 50 × 6	10	3000
2250 and above	65 × 65 × 6	12	2400

- The size of angle and round rod above are indicative of general requirement. Higher sizes of MS angle and MS rod shall be provided for duct supports if required. Lock nuts (double nuts) shall be provided to each MS or GI rods supporting the ducts
- Steel anchor fasteners shall be provided by vendor for duct hanging (wherever required), and the fasteners shall be loaded to maximum 20% of the maximum rated capacity specified by the manufacturer
- Transformation: Duct transformation shall be used to change the shape of duct and shall be made for easy and noiseless flow of air. Maximum slope of transformation shall be 1:4.

D. Ends offsets and branch connections

- All bends offsets and branch connections shall be made for smooth and noiseless flow of air and minimum pressure drop.
- In case of full radius elbow, optimum ratio of centerline radius of elbow to duct dimension of 1.25 shall be considered. However due to space constraint shorter radius elbow or square elbow with guide vanes may be provided.
- All curved elbows shall be provided with air turning vanes consists of curved metal blades of vanes arranged so as to permit the air to make abrupt turns without appreciable turbulence.
- All right angle elbows shall be provided with double thickness aerofoil turning vanes extending over at least 50 percent of the while curvature of the elbow. The turning vanes shall have a flange covering the whole base be riveted to the duct at not more than 60 mm centers.

- Every duct tap-off from supply and return air duct shall be complete with opposed blade volume control damper.
- Caulking and drain: All the openings between masonry and duct work shall be neatly caulked or sealed by the vendor to prevent movement of air from one space to the adjoining space.

E. Duct Insulation:

- Shall include Supply & Return Air Duct Thermal Insulation with Aluminium foil (thickness is around 12 to 16 microns) faced Closed Cell Nitrile Rubber Insulation with proper sealing of joints, Air flow direction to be marked on the respective ducts.
- Shall comprise of 19 mm thick & 13 mm thick depending upon the Supply & return Ducts.
- All the Ducts surface exposed to outside atmosphere shall be insulated with 19 mm thick Nitrile rubber for supply Duct & 13 mm thick for return ducts.
- Duct Insulation shall be of Polyolefin Closed Cell Cross linked Foam/ Nitrile Thermal Insulation with Reinforced Aluminium foil with adhesive & KValve of 0.032W/mK at 23 Degree & Class O materials with proper sealing of joints.
- Physically cross linked polyolefin foam insulation with factory applied reinforced aluminium foil facing on one side. The density of the foam should be not less than 25kg/m^3 and the maximum thermal conductivity should be 0.032 kcal/m² hr °C at 0°C mean temperature. The water vapours permeability should be better than 0.8gm/m^2 at all times (90%RH, 38°C).
- The minimum fire rating property of the insulation material when tested to BS 476 part 6 & 7 should be Class O.
- The insulation material should pass through the smoke toxicity test as per BS6853 andISO5659 standards.

- Each duct is to be insulated separately; flanges should be insulated with a 120 mm wide strip of insulation material, ensuring joints are sealed with 75 mm reinforced aluminium foil tape.
- All supporting hangers should be lined with the same insulation material to avoid excess compression of insulation.
- No air pockets should remain during the installation of the insulation to the duct. Any minor surface cuts should be covered with aluminium foil tape.
- The joints should be kept to the minimum possible number while adhering to the recommended constraints of duct length.
- All joints should be butted firmly against each other and sealed with self-adhesive 75 mm wide reinforced aluminium tape.

F. Scope of work of duct insulation

- The installation contract includes supply of all necessary insulating materials, with accessories including scaffolding / weather protection, etc.
- The contractor shall supply and install the insulating materials on the respective surfaces as per shop drawings.
- The contractor shall supply all necessary skilled and unskilled labour and supervision required for carrying out the insulation as per these specs and with good engineering practical knowhow.

G. Installation of Insulation:

- Insulation must be installed in accordance with manufacturer's instruction.
- All joints should be butted firmly against each other, seal all joints with overlapping self-adhesive 75mm wide reinforced aluminium tape, procured from the manufacturer of same material as the base insulation.

- Insulate each duct separately, flanges should be insulated with a 120mm wide strip of insulation material, ensuring joints are sealed with 75mm reinforced aluminium foil tape, procured from the manufacturer of same material as the base insulation.
- All supporting hangers should be lined with the same insulation material to avoid excess compression of insulation. (Refer manufacturer's instruction)
- Ensure no air pockets during the installation of the insulation to the duct. Any minor surface cuts should be covered with aluminium foil tape.

H. Aluminium Cladding

- For the insulated Supply Air and Return Air ducts exposed to outside atmosphere, 26 G aluminium cladding is required for protection against rain and other extreme atmospheric conditions.

I. Fire Dampers:

- Shall be of fusible link type fire control damper in GI Construction.
- Fire Dampers shall be provided as per the air flow Management & shall be at least of 90minutes fire rating of fusible link type. The damper shall consist of outer frame, damper blades, SS Spring, plated steel linkage, Twin Micro Switch, UL stamped fusible linkage, handle & sleeves. The blades & outer frame shall be formed out of 1.6 mm thick GSS as required.
- Fire damper blades shall be one piece folded high strength galvanized steel construction. In normal position, these blades shall be gathered and stacked at the frame head providing maximum air passage and preventing passing air current from noise chatter.
- The blades shall be held in position through fusible links. In case of fire, the intrinsic energy of the folded blades shall be utilized to close the openings. The thrust form closing of the damper shall operate a one of the two limit switch mounted in the bottom frame of the fire damper within the damper, closing of this limit switch shall shut off the power supply to the air handling unit stopping all air flow instantaneously & the second Limit switch shall give a signal to DDC panel for shut off the power supply to the air handling unit.

- All Fire dampers shall be complete with factory fabricated & fitted duct sleeves as per manufacturers recommendation. Access doors shall be provided in accordance with the manufacturer's recommendation. Certificate for Fire performance from CBRI is required. Minimum 2Nos Fusible Link shall be tested at site.
- The damper shall consist of outer frame, damper blades, SS Spring, plated steel linkage, Twin Micro Switch, UL stamped fusible linkage, handle, and sleeves. Fire damper blades shall be made in one piece, from high strength galvanized steel.
- The thrust from closing of the damper shall operate one of the two limit switches mounted in the bottom frame of the fire damper. Closing of this limit switch shall shut off the power supply to the AHU, stopping all air flow instantaneously. The second limit switch shall give a signal to the main switchboard for shutting off the power supply to the AHU.

J. Volume Control Dampers:

- Volume control dampers shall be placed at all suitable points in Supply and Return Air duct for proportional volume control of the system.
- **Configuration:** lockable, louvered zero leakage, multiple opposed blade type with extended lever, tightly fitted in epoxy painted MS angle iron frame.
- Where required, dampers shall have an indicating device, clearly showing the damper position at all times like open/close position indication.
- Dampers shall be placed in ducts and at every branch (whether or not indicated on the drawings) for the proper volume control and for balancing the system. Neoprene rubbers seals at tips of blades shall be provided.
- Volume Control Dampers shall be placed in ducts and at every branch for the proper volume control and for balancing the air flow. Shall include VOLUME CONTROL DAMPERS for Terminal HEPA filters & Return Air Raisers also.
- Dampers should be constructed in anodized aluminium, finished with powder coating. The dampers should have aerofoil design for minimum pressure drop. The dampers should be

air tight (means 100%, vendor to demonstrate why his dampers are 100% tight). The damper are certified and approved to DIN 1946 Part 4, with opposed blades, distortion-free hollow profile aluminium fins, sealed with special rubber lips.

- Frame should be made of galvanized sheet steel with 60µm powder coating, depth 150mm.Bearing should be made of polyamide. The gear wheels for the drive should be located outside the air stream.
- The manually operated dampers should be provided with Graduation & locking arrangement. The locking device to remain perfectly locked at all operational conditions of AHU.
- The dampers should be provided with following accessories-
    a. Mechanical Lock with handle and graduation of opening marked on handle. Identification of open and close is must on damper handle side.
    b. Suitable Cover for Gear Train to avoid dust accumulation.

K. Magnahaulic Gauges & Temperature Gauges for Cleanrooms

- The Magnehelic gauge shall be clean room compatible type of size 100mm diameter with pressure range of 0-10 mm. the magnahaulic gauge shall be supplied with necessary SS mounting/box, PVC tubing etc.,
- Digital Temperature and Rh Indicator: The digital temperature and RH indicator shall be of clean room compatible type with range of 0 to 50 °C and 0 to 90% RH with display.

L. Temperature & Rh Indicators:

- The Digital Temperature and RH indicator shall be of clean room compatible type with range 0 to 50 deg. C and 0 To 90% RH, with 100 mm diameter Digital Display

M. MS frame work:

- Shall include MS Fabrication Works for HVAC system duly painted for piping Supports, pump etc.

9. HVAC Section for Cleanrooms

9.1.Technical specification of air cooled/ water cooled chiller units

Desired Configuration - Air Cooled Chilled Water Package:

Chilled water package shall be High Efficiency Air Cooled Chiller Package consisting of Multiple compressor with twin Screw design with independent refrigerant circuit complete &Axial fans, Copper/Aluminium Condenser coils and R134a /Equivalent refrigerant. Suction, discharge valves, relief valve, oil filter, suction filter, dual pressure switch, oil safety switch, and crank case heater complete.

Screw chiller:

- **Screw compressors-** The chiller should be with multiple compressor Semi-hermetic twin rotary screw-compressors with 2 five and six-lobe rotors with independent refrigerant Circuit. The Compressor cooling power should be continuously modulated from 100 to 25% with the help of Slide Valves. In addition to the standard no-load starting feature, the motors should be fitted with electric starting devices which limit the power absorbed during the compressor starting phase. Lubrication should be forced, without the use of an oil pump. The high efficiency built-in oil separator should ensure the constant presence of oil in the compressor. The rotors should be dynamically balanced to ensure that the vibrations should not occur. Each compressor should be fitted with manual-reset motor thermal protection, delivery gas temperature control, an oil level float, an oil level sight-glass and an electric resistance for heating the oil when the compressor is stopped.

- **Evaporator**: Shall include the Evaporator having shell & tube Dx type / flooded type heat exchanger with asymmetric refrigerant paths to maintain the correct refrigerant velocity during both liquid and gaseous phases. The steel shell should be insulated with a closed-cell anti-condensation lining. The copper pipes should be internally grooved so as to

improve the area of heat exchange. The pipes should mechanically have expanded onto the tube plate ends. An antifreeze electric heater to be fitted to prevent the formation of ice inside the casing of the exchanger when the unit is not operating, but connected to the electrical supply. Differential pressure switch for controlling the water flow should be provided as standard part.

- **Air Cooled Condenser:** Shall include Air cooled condenser made out of **copper tubes and Aluminium fins type heat exchanger**. The aluminium fins should be correctly spaced to ensure the best heat exchange efficiency. The lower part of the heat exchanger shall function as a sub-cooling circuit thereby increasing the cooling capacity.

- **Fans:** The air cooled Condenser shall be with axial electric fans, protected to IP 55, with external rotor and profiled die cast aluminium blades. Housed in aerodynamic hoods complete with safety grille. 6-pole electric motor with built-in thermal protection. Pressure switch condensing control by sequentially excluding certain fans.

Main Components of Refrigerant circuit shall comprise of --

- - compressor discharge check valve,
- - compressor discharge shut-off valve,
- - liquid line shut-off valve,
- - liquid line solenoid valve,
- - dryer filter with replaceable cartridge,
- - refrigerant line sight glass with humidity indicator,
- - externally equalised thermostatic valve,
- - high pressure safety valve,
- - low pressure safety valve,
- - high and low pressure transducers

- - high pressure switches,
- - differential pressure switch for water

Electric power and control panel Should be complete with:

- - control circuit transformer,
- - general door lock isolator,
- - power circuit with bar distribution system,
- - fuses and contactors for compressors and fans,
- - terminals for cumulative alarm block (BCA),
- - remote ON/OFF terminals,
- - spring-type control circuit terminal board,
- - electric panel for outdoor installation,
- - electronic controller.
- - phase sequence relay
- Performance Data: The COP and IPLV at AHRI Condition should not be less than 3 and 4.5 respectively including condenser fans. (COP at AHRI: > 3 & Min IPLV: > 4.5)
- Fouling Factor : 0.0001 FPS / 0.000018 MKS (Fouling factor - 0.018 -m^2K/kW
- Water/Fluid inlet temperature to chiller (cooling mode) shall be: 12 °C
- Water/Fluid outlet temperature of the chiller (cooling mode) shall be:7 °C
- The Chiller shall be designed with a EWT of 50 Deg F and LWT of 44 Deg F
- Cost shall include suitable BACnet/Modbus integrator)
- Cost shall include Auto tube cleaning system
- Necessary arrangement of concrete pedestals for the Chiller shall be provided by the Contractor
- Tendered rate shall be inclusive of factory inspection and load testing of all the 3 chillers on a ARI certified bed within India

- The chiller to be completely BMS compatible for all types control and information purpose.
- Shall comprise of all the required Components like : liquid inlet, liquid outlet, purge valve, pressure relief valve, water chillers with anti-freeze thermostat, cooling thermostat, thermostatic expansion valves, liquid line strainers, shut-off valves, chiller insulation, air cooled condenser with condenser coil, protection guard, condenser fan motors, interconnecting refrigerant piping, fittings, suction line insulation, microprocessor based panel, first charge of refrigerant and oil etc Complete
- All the Components should be assembled together in a common factory fabricated GSS framework and casing mounted frame work, include casing mounted on vibration /helical spring isolators.
- The chiller shall have a machine-mounted starter panel incorporating incoming main and disconnect switch, contactors, over load relays, timers, single phasing preventers etc., separately for each motor including condenser fans, all housed in a weather proof double door sheet metal enclosure conforming to IP-55 grade of protection. All exposed surfaces of the chiller package shall be given 2 coats of anticorrosive paint.
- The noise level of Chiller should not exceed 75 dB ----at a distance of 3M from the chiller
- The chillers shall be certified for **EUROVENT /AHRI** & the Manufacturer should have a performance test facility at their manufacturing plant where the chiller is manufactured.
- **Factory Acceptance Test:** The vendor should have a certified test bed at their factory where they produce the chiller and they should perform 4-point factory acceptance test at the design condition.
- Supporting frame Base and frame in thick hot-galvanised shaped sheet steel. All parts should be polyesters-painted.

Note:

a) Wherever the words Air Cooled Chiller Units are mentioned in the tender Specification it shall be considered as “FACTORY-MADE AIR COOLED CHILLER UNIT”.

b) Wherever capacity of the "FACTORY-MADE AIR COOLED CHILLER UNIT" has been mentioned as " -- TR" capacity in the tender specification it shall be read/considered as "Capacity not less than ---- TR as the specified rating \ conditions.

c) Wherever the word "Specification Rating condition" is mentioned in the tender specification it shall be the rating conditions as indicated in the description It shall be Air cooled Chiller of capacity of ------TR with Scroll/screw type compressor complete with copper piping, R-134a/R-407A/R-407C/R-410a, refrigerant, expansion valves, thermostats for tripping the compressors after reaching the temperature in conditioned areas and with insulation of the suction line. Air cooled condensing coil with fan and motor along with angle frame for mounting the unit complete. Total -----TR with Multiple Compressors.

d) REDUNDANCY: 2 nos' suitable capacity Air Cooled Chillers in which one will be Working & one Stand by shall be provided)

9.2. Pumps for HVAC:

In Line / Single stage centrifugal coupled horizontal type End suction pump set with axial suction port and radial discharge port with Variable speed drive motor (VFD) including providing suitable variable speed drive, bronze impeller mechanical seal, IE3 type motor with IP55 protection, class F insulation having a speed of 4 pole with inertia base, vibration isolation springs, rubber isolation bellows, flexible coupling for chilled water circulation.

- Two end-suction pumps with **appropriate capacity**----- Gpm against a head of --- M with Efficiency class as IS 2615 Type 1 motor (IE3) (equivalent to BEE 3-star rating) & pump efficiency not less than 70% efficiency **are needed** for chilled water circulation & Chilled Water for cooling coils of AHUs. One working and the other as standby.
- Shall comprise of Components like: completely enclosed fan-cooled motor, base plates, couplings, coupling Guard with Base frame and mechanical seal.

Pressurization units to be considered for making up the water in the line and maintaining required design pressure. Complete chilled water lines to be duly insulated using approved insulation material and cladded with Aluminum sheet as per the standard practice and specifications.

9.3. Chilled Water Piping for HVAC:

Supply of Chilled Water for cooling coils of AHUs located in the Mezzanine Floor/ first floor of the Utility building is envisaged from the chillers located on the roof of the utility building

Desired Configuration:

Above ground piping with CS (Carbon steel) as per ASME standard 36.10 and ASTM material specification ASTM A105, fluid flow velocity is maintained to 1.5 - 2.0 m/s which is acceptable for pipes less than or equal to 125 mm OD.

- Mild steel pipes (C class as per IS 1239 for pipe sizes up to 150mm and minimum thickness of 6.35mm and as per IS3589 for sizes above 150mm dia) chilled water plumbing (with necessary supports, clamps, vibration isolators, valves, strainers, gauges etc.) adequately supported on MS rigid factory made supports with spacing as per the CPWD specifications and duly insulated with rigid polyurethane foam.
- Insulating material minimum density shall be 32kg/m3, thermal conductivity of 0.023W/mK at 25 Deg C, covered with 120 gm/Sq. polythene sheet (vapor barrier), 0.5 mm x 20 mm G.I. wire mesh and finally applying 0.50 mm aluminum sheet cladding complete with Type 3, grade I roofing felt strip (as per IS: 1322 as amended up to date) at the joints etc. as per specifications complete etc. as required.
- Pressure and temperature gauges at all inlet and outlets to be provided.

9.4. Chilled water pipe insulation:

- Insulation for the pipes above the ground and inside building limit shall be done by preformed PUF pipe sections of appropriate thickness, having a cladding of 24 gauge aluminium sheets. Thermal conductivity of the insulation should not be more than 0.032 kcal/m² hr °C at 0 °C mean temperature.

- Generally, PUF insulation thickness is 50 mm for pipe sizes more than 25mm OD and PEF thickness of 25 mm is used for insulating pipes of sizes equal or less than 20 mm OD.

OR

100 dia - 32 mm thick insulation
101mm dia - 32 mm thick insulation
50 mm dia - 32 mm thick insulation
40 mm dia - 25 mm thick insulation
32 mm dia - 19 mm thick insulation
25 mm dia - 19 mm thick insulation

- Insulation work for chilled Water piping shall be carried out for chilled water piping as per IS Standards Codes - IS 8183, IS7413 & IS3144 for thermal insulation materials and finishing materials abiding to Codes of Industrial Applications.

- Insulation material for chilled water Piping shall be insulated with cross linked Polyolefin foam with factory applied 9µ reinforced foil insulation with UV protect coating on insulation. Thermal conductivity should not be more than 0.032kcal/m² hr °C at 0°C mean temperature.

- Insulation shall be applied only after the piping system has been satisfactorily tested for leaks as per specifications.

9.5. Valves & Gauges:

HVAC System shall include all the required Components & accessories like ball valves, butterfly valves, 'Y' type strainer, 3-way modulating valve, balancing valve, check valve/non return valve, and drain valve & piping etc.

- **Butterfly Valves:** Internally moulded rubber lined body, EPDM seal material, central ductile iron disc & overall conformity to STD API 609 category IS 13095 Butterfly valve with Pressure rating of PN 10 and insulation with nitrile rubber insulation of following thickness with vapour barrier, thermal conductivity of 0.028W/mK, complied Class 'O' fire rating, density not more than 25 kG/Cum as per specifications etc. complete as required**.**

- **Motorized Butterfly valve :** (100 mm dia) with insulation as per above complete with Actuator with required torque as per Technical specifications, transformer (240 /24V), inbuilt controller, matching flanges, necessary inbuilt limit switches for OPEN/CLOSE status feedback to BMS, IP 65 rated, handle and gear type of extended stem made of C.S /M.S painted with 200 microns thick Fusion Bonded Epoxy (FBE), body of C.S / D.I with FBE, Bronze bearing with graphite inner coating or of PTFE without any coat, seal ring with EPDM, stem of SS316, disc with SS316 including vulcanizes disc and body, matching flanges with hot dipped galvanized bolts, nuts and washers etc. as per specifications etc. complete as required

- **Globe valve:** (200 mm dia) Motorized modulating type, operated based on DP sensor / BTU meter feedback with pressure rating of PN 10 & insulation as per specifications, including providing standardized mounting kits as required and as per ANSI class 250(PSIG) standard, Factory tested as per specifications etc. complete as required

- **Ball Valves:** Ball valves with thermal insulation, made of closed-cell foamed polyethylene with additional firm mesh effect made of PE of approved make, with 26 gauge aluminium cover**.**

- **Y type strainers** with CI body and Flanged end connections to match the pipes, drain plug with Pressure rating of PN 10 and insulation with nitrile rubber insulation of following thickness with vapor barrier, thermal conductivity of 0.028W/mK, complied Class 'O' fire rating, density not more than 25 kG/Cum as per specifications etc. complete as required**.**

- **Drain valve** with insulation of 19mm thick nitrile rubber insulation with vapour barrier, thermal conductivity of 0.028W/mK, complied Class 'O' fire rating, density not more than 25 kG/Cum as per specifications etc. complete as required**.**

- **Balancing cum flow measurement valves** pressure independent (PIBCV) - with Pressure rating of PN 10, BMS integradable & Communicable and insulation with nitrile rubber insulation of suitable thickness with vapour barrier, thermal conductivity of 0.028W/mK, complied Class 'O' fire rating, density not more than 25 kG/Cum as per specifications etc. complete as required**.**

- **Balancing valves** with CI Flange having pressure test cocks in SS-410 stem EPDM sealing disc & Pressure rating of PN 10 and insulation with nitrile rubber insulation of following thickness with vapor barrier, thermal conductivity of 0.028W/mK, complied Class 'O' fire rating, density not more than 25 kG/Cum as per specifications etc. complete as required insulation as per specifications.

- **Check valves** with CI body cover, Ball Type single plate, Nitrile rubber coated ball and vertical/horizontal installation with 50mm thick nitrile rubber insulation with vapour barrier, thermal conductivity of 0.028W/mK, complied Class 'O' fire rating, density not more than 25 kG/Cum as per specifications etc. complete as required**.**

- **25mm dia Automatic Purge valve / Automatic Air vents** & insulation with 19mm thick nitrile rubber insulation with vapor barrier, thermal conductivity of 0.028W/mK, complied Class 'O' fire rating, density not more than 25 kG/Cum as per specifications etc. complete as required**.**

- **Test points** with rubber cap on the existing piping etc. complete as per specifications as required**.**

- **Suction guide** of CI body, with outlet guide vanes, removable SS strainer & fine mesh (brass/SS) start up strainer with 50mm thick nitrile rubber insulation with vapor barrier, thermal conductivity of 0.028W/mK, complied Class 'O' fire rating, density not more than 25 kG/Cum as per specifications etc. complete as required

- **electromagnetic Flow meters** complete with control wiring with probe suitable for **200mm** dia pipe (excluding insulation) in the existing chilled water lines as per specification etc. complete as required (The supply of the Flow meter shall be measured in the BMS Sub Head as a separate item).

- **Pressure gauges** - 100mm dia Dial type, Glycerine filled with control ball valve on the existing piping etc.

- Industrial type SS-**Analog thermometers** on the existing piping etc.

- **Magnehelic Gauges:** The Magnehelic gauge shall be clean room compatible, accurate within 2% and able to measure relevant pressures in the Cleanrooms & HVAC system as necessary.

- **Digital temperature and RH indicator:** The digital temperature and RH indicator shall be cleanroom compatible with range of 0 to 50 ^{0}C and 0 to 90% RH with display.

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10. Cleanroom fabrics & ancillaries specification

Cleanroom Fabric & Ancillaries	
INNER and OUTER WALLS OF CLEANROOMS	**Cleanroom Fabrics of INNER and OUTER WALLS OF ALL THE CLEAN ROOMS including Photolitho lab, deposition& Etch, wet checmical lab changing room etc.**
Modular Inner Wall System (wall panels: minimum 44mm thick with ESD coat of resistivity 10^6-10^9 ohm –cm based Aluminimum honeycomb)	Supply & Installation of NON-PROGRESSIVE (demountable type) modular wall panels finished with mill applied, anti-static Roll coated epoxy/PE, and zero out gassing, compatible to Class100/1000 as applicable. The panels should be minimum 44 mm thick with Al Honeycomb core and 0.8 mm thick Aluminum skin sheets. The wall Panels shall be Stud less & Sealant less joints. The panels are perfectly fixed between powder baked design white finished Aluminum Head Track and Floor Track with intermediate posts along with covering strip with all accessories and HEAVY DUTY WALKABLE extruded T-Grid Ceiling Systems for all areas. All the framing members like head track, floor track, batten strips, corner posts, wall ends, vertical post etc. Shall be made of extruded Aluminium in designer white finish matching to wall panel system. The panels shall be manufactured to a minimum width of not less than 1100 mm and of any suitable length as required in a continuous length lamination. There shall be Provision for accommodating doors, electric sockets, conduits, boxes, ducts, utility piping and process machines/tool penetration & accessories of tools etc. It shall be able to maintaining its air seal to avoid air leakage and shall possess structural stability. Suitable reinforcement shall be provided between the panels from the floor to ceiling wherever the room doors are shown in the drawing. The height of external wall panel system made Surrounding the Cleanroom envelopes shall be 4500 mm from the surface of the Finished floor

	There shall be provision for accommodating doors, electric sockets, conduits, boxes, ducts, utility piping, and process machines/tool penetration etc **Cladding the Protruding Concrete Pillar inside the LABS**: The protruding concrete Pillar inside the LAB shall also be covered up to the False ceiling with 44 mm thick aluminum Honey comb Material same as that used for the internal walls. ***For the Dimensions of the pillar Please refer the Drawing*** ***The approx. height of inner panels shall be minimum 3Meters*** ***NOTE: Inner walls of the cleanroom shall be of 3M height & its outer wall shall be up to 4.5M from FFL (i.e. bottom of the secondary Ceiling grid). Please refer drawing Fig.2***
	Internal partitions to be made completely demountable to enable future relocation of internal modules
PVC CONDUITS IN OUTER WALL PANELS	Shall Comprise of Providing and fixing of PVC conduit 32mm in the wall panels
Doors Cleanroom Compatible	Provide suitable Doors as per the drawing. Door should match the partition modules. Proper Door should be provided for all the Cleanrooms. Supply& Installation of Cleanroom-compatible Aluminimum Manual Swing Doors, c/w standard ironmongery: SUS Lever Handle on both sides of door with mortise lockset, SUS Butt Hinge, appropriate pressure hydraulic Door closer and locking astragal for double leaves door with one piece of door closer only. The door is 'designer white' finished**; minimum 44 mm thick and 101.5 mm wide Aluminimum frame (6063** alloy, T-5 temper door frame) **with Aluminimum honeycomb core panel.** Door panels: Door panels: static dissipative of 10^6-10^9ohm-cm., double skin with minimum 0.8 mm thick powder coated anodized aluminum with in-fill of aluminum

	honeycomb between the aluminum skins sheets (same as Wall Panel material). Minimum door thickness: 44 mm. a.) Airtight, Swing configuration, flush type, double glazed with see-through portion at the top half of the door using 6 mm thick tempered glass b.) Doors Accessories shall include SS D Handle Back to back / SS D Handle one side and one side SS push Plate. Dead Lock with Both side key operations, SS ball bearing hinges, tower bolt, SS Kick plate 0.8 mm thick up to 300 mm height, Door closer & Door stopper, concealed type Bottom Drop seal, Concealed type Flush Bolt **(please refer Layout drawings for more details)** a) For Photolitho LAB: Single leaf door size: 1000mm × 2100 mm; (glazed view window shall have Yellow colored film of Wave Length of 550 nm) ---1 no b) For Changing Room: Single leaf door size: 1000mm × 2100 mm with glazed view window 6 mm thick ---1 no c) For Deposition LAB: Double leaf door: 1500 x 2100 mm with glazed view panel with 6 mm thick toughened glass (adjacent to Photolitho LAB) ---1 no
EMERGENCY DOORS	**Emergency exits to be provided as per safety norms at locations as indicated in the layout. (Please refer drawing)** **i) For Photolithography LAB:** Emergency Double Door size 1500 mm × 2100 mm.ht –I no (Photolithography lab emergency door's glazed view window shall have Yellow colored film of Wave Length of 550 nm) **ii)** For Deposition LAB Emergency Double Door size 1500 mm × 2400 mm.ht –I no **iii)** For Outer wall of the SERVICE corridor Emergency Double Door size 1500 mm × 2400 mm.ht –I no Emergency Doors shall have Panic Bar arrangements & shall be fire rated
View windows / view panels:	• **Windows / view panels**: Vision Panels of Flush double glazed fixed in the wall partition panels using 6 mm thick tempered glass with extruded aluminum midline (V shaped) frame in powder baked designer white, finished & gasketed. • View Panels to be placed at ~ 1000 mm – 1200 mm above the finished floor level on the wall panels.

	• All the joints between toughened glass and wall panels shall be sealed • MOC: Toughened and tempered double glass of minimum 6 mm thickness • View panels/Windows of Photolithography LAB: All the Windows/ view panels of photolithography Lab covered with imported yellow films having UV filtered Yellow color film & wave length of 550 nm to match the required process of photolithography area. • *Door leaves should be complete with vision panel, pull handle, push plate, mechanical door closer without oil, door seals and shoot bolt and all other hardware, as appropriate.*
Door in outer periphery corridor of existing wall for entry	• Air tight PUF panel doors 50 mm thick with all hardware (lock, handles, SS hinges etc.), with vision panels, bottom door seal etc. size – 1000 mmx 2100 mm ht ---I no
Coving in Cleanrooms	**Coving: to be provided between wall to wall, wall to floor, wall to ceiling & 3D corners** • Radius around 55 mm. • MOC: anodized Aluminimum. • To be fixed along the joints between walls panels, walls & the false ceiling joints, and 3D covings at the Corners as required.
CUT Outs in WALL Panels for Electrical items like Sockets, Switches etc.	Supply & Installation of Suitable factory made cut outs wherever required shall be provided in the wall panels with proper fittings as per specifications Factory made cutouts in wall panel for Electrical sockets, switch boards, MG s, etc.
CUT outs in CEILING PANELS for FFU with HEPA FILTERS & Light Fixtures	Suitable factory made cut outs wherever required shall be provided in the ceiling panels with proper fittings as per specifications for FFUS with HEPA Filters. Factory made ceiling cut-out for FFUS with HEPA Filters, Light Fixtures, Quantity and size as per requirement. Quantity will be as per the HVAC design and will be finalized on drawing approval. a)CUT outs for FFU sizes 600 mm X 1200 MM b)Cut outs for Light Fixtures sizes **600 mm X 600 MM**

Pass box	Wall mounted for wafer movement located on perimeter walkway to class 1000. Floor mounted for acid movement located on perimeter walkway to class 1000 (wet etch are) Pass Box size shall be 600 × 600 × 600 mm (approx.) and made of SS304, Non-EP, smooth and powder free, fitted with door interlocks The pass box shall also be fitted with appropriate dimension of viewing glass made of tempered glass supported by HEPA filter. Hinges and handles shall also be of SS304. The door shall have a release switch on either side of the pass box.
ESD Flooring for Cleanrooms	The electrostatic dissipative flooring should be provided for fabrication lab areas as well with the specification below: ESD Flooring Shall Comprise of ESD Conductive flexible homogenous, compressed ESD Vinyl floor tiles in flooring/skirting, having size around 615 x 615 x 2 mm (thick) . The ESD tiles shall have electrical conductive resistance in the range of 5x10^5 Ohm to 1x10^7 ohm and shall have dimensional stability of 0.05%, Static decay time of less than 0.1 sec, body voltage generation of less than 20V and combination resistance with shoes of less than 3.5 X 10^5 Ohms as per IEC 61340 series standards and shall be resistant to acids, chemicals and fire, ESD floor tiles shall be laid on existing cement concrete flooring including providing and laying of approved conductive primer including necessary conductive adhesive. Joint between the tiles shall be PVC welded and copper foils shall be provided and laid all as per manufacturer's specification. Shall include laying of Conductive adhesive, formation of Copper strip at site, grooving / welding of joints and certification of Electrical resistance such as Point to Point, Point to Ground and Body to Ground resistance, Combination resistance of the installed system and Body voltage resistance, meeting to international standards. • Load carrying capacity of the material shall be 750PSI (min.) confirming to BS 2050. • The joints shall be welded by thermo chord weld. • he flooring shall Include providing and laying (P/L) suitable copper strip (foil) grid of size 10' x 10' (approx.) as recommended by manufacturer and connecting to the earthling as per IIST's requirement

	• ESD Flooring work includes preparation of existing surface with suitable (compatible for clean room application) floor levelling material so as to make the surface free from any undulations, fixing the PVC ESD Tiles with conductive adhesive (water based) of approved make (Fevicol SR 505 or as per manufacturer's recommendation) rolling with 100lb roller and sealing up the joints with fuse welding as per manufacturer's specification. • A separate grounding shall be supplied and installed by the vendor. (Earth pits of suitable size will be provided by CMD,IIST based on the specification given by vendor.
Flooring for service corridor	**For Service Corridor**: Flexible, homogenous, color-matched vinyl flooring/skirting including coves laid on the cement-concrete flooring including floor self-levelling compound. Dimensions: 2 mm thick sheets and 1.5 mt. width. The joints between the laid PVC sheets shall be fuse welded, as manufacturers specs.
False Ceiling System for of all the Cleanrooms Grid Ceiling System	The true roof of the parent building is of slanted (sloped one) as indicated in Drawing Ref no. While fixing the false ceiling system of the cleanrooms, careful study and understanding is required as how to hook the ceiling system to the true roof of the parent building. The Supply Air PLENUNM BOXING shall be installed by hooking the Top ceiling system with grid of BOXING to the Concrete ROOF of the parent Building. (please refer the Drawing) **NOTE**: Hence Vendors/Contractors shall visit the site to access the Slanted roof of the parent Building to which the Supply air FFU Boxing to be securely Suspended **For All Cleanrooms**: The False Ceiling system shall Comprise of Heavy Duty Aluminimum Extruded T Grid walkable type & Ceiling Blanks shall be 44 mm thick Aluminimum honey comb material

	FOR ALL CLEANROOMS: Shall be HEAVY DUTY WALKABLE anodized aluminum extruded T-Grid Ceiling Systems (56 mm inverted T-width, 78 mm height, gasket type sealing) 1200 mm x 600 mm hanging configuration & grid size of 1200 mm x 600mm. Ceiling grid color should match wall panel color (Designer white shade). The system shall be able to accommodate FFUS, Tear-drop light Fixtures, Sprinklers, etc. The system shall include 56 mm wide aluminum extruded cross connectors with hammer head bolts & nuts, M8 bolt and matching square hanger and other standard accessories complete as per Specification. All the suspension material in Galvanized finishes. Reinforcing clamps and brackets.
Secondary Ceiling Grid	The secondary ceiling grid(top ceiling of FFU boxing) should be suspended from the parent building roof having sloped roof with adequate size fasteners etc. for ensuring structural stability of the ceiling.
Additional Ceiling Grid & accessories for supporting the 600 mm X 600 mm Lighting Fixtures etc.	Shall Provide Additional T Grid Ceiling & accessories, for supporting the 600 mm X 600 mm Lighting Fixture in the T grid Ceiling System
CLEANROOM CEILING BLANK PANELS with Aluminimum honeycomb Core Material	Supply & Installation of 44 mm thick minimum, HEAVY DUTY WALKABLE Aluminimum Honeycomb core material Ceiling Blank Panels. NOMINAL dimension 1200 mm x 600mm x 44 mm thick, using minimum 44 mm thick Aluminimum honeycomb core material, laminated with 'designer white' finished with minimum 0.8 mm thick Aluminimum skin with static dissipative -10^6-10^9ohm-cm, with polyester roll coated surface finish & zero outgas. All four edges taped with Aluminimum tape.

Ceiling system for SERVICE corridor	**SAME AS FOR CLEANROOMS** **For Service Corridor**: The ceiling Grid shall be formed from a HEAVY DUTY ALUMINIUM WALKABLE extruded T-Grid Ceiling Systems for all areas. Ceiling grid color should match wall panel color (designer white shade). The ceiling grid shall be heavy duty walkable inverted T-grid ceiling system of approx. 50 mm T width (gasket type ceiling) to be provided on 600mm X 1200mm hanging configuration, the system shall include aluminum (approx. 50 mm wide) extrusions, aluminum extruded cross connector with hammer head bolts and nuts, M8 bolt and matching square hanger and other standard accessories. The grid should be suspended from the parent building roof with adequate size fasteners etc. for ensuring structural stability of the ceiling.
Blank Panels for Service Corridors	**For Service Corridors**: The Ceiling Blank Panels shall be with Infill of PUF insulation having Density of minimum 38+/-2 Kg/M3, including all hardware accessories, and joint sealing with Food Grade silicon sealant. Sheet thickness minimum - 0.8 mm on both sides & total Ceiling Blank Panel Thickness shall be not less than 50 mm, with smooth surface finish. The Ceiling Panels shall be finished with pure polyester powder coating of minimum 60 Microns Sandwich Panels made up of Galvanized Iron sheet Galvano Plain Single Pass (GPSP) GI with Zinc Coated minimum 120 G SM on both sides, Grade -D, Minim al Spangle, with all accessories.

Lighting for PHOTOLITHOGRAPHY LAB	• For ISO 5 (class 100 Cleanroom) teardrop light fittings of Wave length 550 nm; Yellow lighting shall be provided • Supply & Installation of Light fixtures of Tear Drop type yellow light fixtures suitable for housing in the HEAVY DUTY Aluminimum False Ceiling grid. Yellow Tear Drop LED/fluorescent lights of 36 W shall be provided of Wavelength 550 nm (to be imported). Overall length 1200 mm T5 type. • Provision shall be made for a few light fixtures to provide emergency illumination in case of Main Power failure through UPS
Lighting for other cleanrooms other than Photolitho LAB	• **For All the Cleanrooms -other than Photolitho LAB**: surface mounted fittings to be provided throughout the facility to achieve the desired lighting level of 550-600 Lux • Supply & Installation of Light fixtures suitable for housing in the HEAVY DUTY Aluminimum false ceiling grid. White LED lights with LUX level around 550 - 600, **Surface mount type of size 600 mm X 1200 mm./ 600 mm X 600 mm** • Provision shall be made for a few light fixtures to provide emergency illumination in case of Main Power failure through UPS • Lighting control should be located on the walk way corridor and switch to be provided at convenient location in each room
Planar Grounding	All metallic components within the Cleanroom fabric should have separate earth point outside the parent building to be provided as per the requirements under the supervision of CMD, IIST.
Air-shower	Class 100 Air shower (2 persons) shall be provided at the entrance of cleanroom gowning area.
	Materialof Cconstruction (MOC) – SS with SS door frame construction

	Unit shall be self-contained, self-supporting
	The doors should have interlock. Exit doors of the air shower should be locked when the entry door is open. The air shower cycle should begin upon entry to the air shower after entry door closes. All doors should automatically get locked during the air shower cycle. Emergency/bypass switch to be provided. The blower shall be statically and dynamically balanced and shall be with programmable speed controller. **SIZE: apprx-1100 mm x1100 mm x 2400 mm height**
Step-Over bench	**Stainless steel 2000mm x 300mm x 400mm** Step-Over Barriers should be provided within the Gowning Lobby, with integrated shoe compartments for the storage of the dedicated Cleanroom footwear of regular staff.
Garment Storage	Garment storage units to be provided in the Gowning Lobby for the storage of 'in use' garments, complete with stainless steel handing rail and retained stainless steel hangers suitable for use in cleanrooms. Garment storage unit should be enclosed with HEPA filters and blower and UV light for sterilization.
	Size - 1200× 600×2000 mm Height or higher
	A full-length gowning mirror should be provided in the Gowning Lobby so that staff can check that they are appropriately attired prior to entering the facility.
	MOC: SS 304
Access Panels/Doors for approach in to the FFU plenum and Duct Work	Access panels shall be provided with double panel type; material of construction shall be same as duct material.
	Access doors shall be adequately reinforced to prevent distortion, and hinged so that internal air pressure holds the door closed. Clamping type latches and handles, which can be operated from both sides of the door, shall be provided

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11. Central Utilities

11.1. Process Extraction / Exhaust Systems

Process Extraction /Exhaust Systems
Vendors to design supply/construct and install corrosion resistant, soundproof and vibration free (less than 70 dB) systems for DRY & WET exhaust meeting the local pollution control board norms. Process Extract Duct with proper exhaust Piping/Duct Work with proper Support routed through UTILITY CORRIDORS & connected to a suitable blower for all the process equipment in clean room etc., as per the requirements.
After considering the total exhaust volumes as provided in the Utility Matrix, 20% extra exhaust flow should be considered for selecting the capacity of the fans and scrubbers.
The Exhaust System comprising of ducting, blowers, casing to be of corrosion resistant Material of construction (MOC) to handle the gases/fumes.
Exhaust distribution system from process equipment for Acid Exhaust to be SS316 L. Fan shall be constructed of MS with FRP lined. Shaft shall be of SS 316. **Acid/Toxic exhaust to be released after wet scrubbing in Exhaust systems installed outside the Parent Building & should be elevated till the top floor of the building.**
GI for solvent and Heat exhaust along with control dampers/ Magnehelic gauges and flexible ducting wherever required. Suitable exhaust fan to be provided for solvent and heat exhausts.
Ducting exposed to ambient to be firmly supported with galvanized brackets & tie rods.
Similar equipment exhaust to be clubbed inside, Dissimilar exhaust should be clubbed together outside the building.
The system to be sound proof in nature (< 70db) and vibration free.
Proper exhaust should be there for all cabinets, gas pods, pumps, scrubbers etc. as per the requirements. **Flammable gas exhaust to be of SS 304 for minimum length of 8 m.**
Exhaust system should be elevated till the top floor of the building.
A minimum of 4 no. Magnehelic gauges will be provided for exhaust monitoring
ISO – 5 (Class 100) areas **Solvent Bench – take-off point with proper scrubber system (activated carbon filter) provided just near the wet bench tap off.**

ISO – 6 (Class 1000) Wet Bench Area **Two (2) Wet Chemical bench take- off points with wet scrubber-** **Two (2) Chemical Storage cabinet take- off point with wet scrubber**
ISO – 6 (Class 1000) **ICPRIE take- off point** **ICPCVD take- off point** **Plasma Etch System take-off point** **2D Material Deposition system take-off point** **DC/RF Sputtering take- off point** **RTP take- off point (Standby condition for future hook up)** **Photolithography take off point** **XeF2 etch system take off point** **CPD system take off point** **Vendor shall provide suitable drain pipes from wet chemical bench and solvent bench.**
Note: **Provisional Process Extraction line diagram Model** is provided in Annexure 2 which is only a provisional sketch for guidelines. Vendors have to generate their own Systems & Drawings

11.1.1. Specification of wet Extraction System (ACID/TOXIC EXHAUST SYSTEM)

The scope covers Design, detailed engineering, Supply and installation of wet Extraction (Acid/Toxic Exhaust system) at proposed location. Utility matrix shall be referred for the list of equipment and exhaust volume. Vendor shall consider 25% extra above the exhaust volume based on Utility Matrix. Annexure 4

VERTICAL PACKED WET BED TYPE FUME Extraction Systems (Acid/ Toxic Exhaust)

- **Quantity: 2 no.**
- **Capacity of each wet scrubber requirement shall be as per utility matrix + 25%.**
- For working out the capacity of the wet scrubbers, the exhaust from the dry scrubber shall also be included.
- Acid removal efficiency - 99% for Sulphur acid and 94% for HCL
- A bed of cylindrical/spherical packing made of polypropylene (UV resistant) supported with corrosion resistant plastic members designed to reduce solids build up.

- Spray section comprising liquid distributor, PVC make spray header banks with removable PVC nozzles, PVC (schedule-40) piping and fittings with ball valves to regulate the flow.
- Polypropylene mesh pad type or PVC chevron blade type mist-eliminator capable of removing 99% of entrained moisture from air stream.
- Scrubbers Casing made of fiberglass reinforced polyester material (fire resistant) complete with external water circulation tank of fiberglass reinforced polyester material, supports, inlet and outlet connections with flanges and gaskets, access panels. The water circulation tank (external) shall be provided with make-up connection with isolating ball valve and float valve, quick fill connection with ball valve, drain connection with ball valve, visual level indicator, overflow connection and interconnecting piping etc.
- Liquid re-circulation pumps for scrubbers: 02 (Two) numbers. Common pump will be used for liquid re-circulation in both the scrubbers and recirculation tanks. Pumps will be arranged in N+1 arrangement (one working + one standby).
- Pump type: Vertical pumps in SS316 material, with high efficiency drive motor (IE3 Class) suitable for 400±10% V, 50±5% Hz, 3 Phase, stainless steel strainer, pressure gauge with valve at inlet and outlet (wetted parts of the gauges shall be made of SS-316), isolation valves at inlet & outlet, check valves at outlet and other fittings. The piping and fittings shall be of SS 316, schedule 40. All the valves shall be of SS 316. The valves of size 2'' and above shall be butterfly type and smaller size valves shall be ball type. The butterfly valves, check valves and strainers shall be PN-16/Class 150 rated and the ball valves shall be rated at 300 PSI

ACID/TOXIC EXHAUST FANS

- Quantity – 02 (Two) nos. – N+1 arrangement - (1 working + 1 stand by) suitable for continuous operation.
- Static pressure – 250 mm of WC
- Type: SISW, belt driven, straight but backward inclined blades.
- Material of construction: Fan shall be constructed of MS with FRP lined. Shaft shall be of SS 316.

- RPM - 750
- Accessories: High efficiency drive motor (IE3) as per IS 12615 (latest amendments) suitable for Variable Frequency Drive (VFD) with 400±10% V, 50±5% Hz, 3 Phase supply, scrawl casing with inlet outlet connection, supports, belts, belt guard, pulleys, slide rail, inlet & outlet dampers, common base frame for fan and motor, flexible connections made of neoprene coated heavy duty canvas or polypropylene at inlet and outlet, drain plug with the fan casing etc.

STACK

- Quantity – 1 no.
- Type – Self-supporting type
- Material of construction – MS sheet, not less than 5 mm thick.
- Height shall be according to the norms of the local Pollution Control Board and diameter shall be sufficient to handle the designed capacity.
- The stack shall be complete with grouting frame, bolts, nuts, rain protection hood, inspection door, drain connection with valve etc. and wire rope supports to take care of heavy wind and other eventualities. The stack shall be properly painted (in& out) with epoxy.

EXHAUST DUCT WORK

- The MOC of the Ducts shall be SS316L.
- The ducts shall be designed and constructed as per SMACNA standard and thickness of duct shall not be less than 2mm.
- Ducting shall include Point of connections (POCs). The POCs shall be complete with dampers. POCs shall be having the flange connection at outlet for assembly of the line to process tool. SS316L dead flange shall be provided for each POC. Material of construction for POCs, dampers (with locking arrangement), flange and dead flanges will be SS316L.
- The Exhaust ducting shall be suspended utilizing 10 mm dia. threaded GI rod and spring mounted isolators of GI or coated suitable for clean rooms.

- Selected vendor shall carry out detailed engineering to work out actual duct routing layout and will submit the drawings including shop floor drawings to IIST for approval before commencement of the duct work fabrication and installation work.
- The ducting up to the scrubbers' inlet shall be SS316L. The ducting from scrubber outlet till stack inlet will be MS with thickness not less than 2 mm and epoxy coated from inside and outside.
- SS316L dampers shall be provided at the inlet and outlet of the scrubbers and epoxy coated MS dampers at the inlet & outlet of fans. Dampers shall be heavy duty, nearly zero leakage type with non-jamming bushes and locking arrangement.

MAKE UP TANK

- Quantity - 01 no
- Plasticized Tank (Syntax/Dip last make) of sufficient capacity complete make up connection with float valve and isolating ball valve, quick fill connection with ball valve and the GI (Class-B) piping with required fittings, supports etc. up to scrubbers.
- Inlet for the make-up tank will be taken from an existing line at an approximate distance of 20-25 m.

INSTRUMENTATION AND CONTROL

- pH meter for liquid recirculation tanks
- Level sensors for liquid recirculation tanks
- Flow meter in the common outlet duct
- Static pressure sensor in the duct
- Magnehelic gauges at the last point of the duct in the process area and in the main inlet duct feeding the scrubbers
- Pressure switch in the common recirculation pumps discharge line
- Pressure gauges with isolation ball valves at inlet and outlet of all the pumps

- VFDs for fans
- Solenoid valve at recirculation tank drain line
- Level switch in the make-up tank

CONTROL PHILOSOPHY

- Out of two fans, one fan will be operational and second will be stand by.
- The fan speed will be controlled using a static pressure sensor in the main duct. If the static pressure drops below the set static pressure, the fan speed will increase and vice versa.
- The solenoid valve in the drain line of the recirculation tank will controlled from the pH sensor in the recirculation tank.
- The flow meter in the common outlet duct will provide the exhaust flow in the main line.
- The level sensor in the liquid recirculation tank will provide the water level in the tank.
- If the pressure in the common discharge line of recirculation pumps drops below the set point, the running pump will be stopped and stand by pump will be taken in line.

11.1.2. **DRY Scrubber Specifications:**

Description: Dry Extraction/Exhaust System including - Dry scrubber unit with Necessary chemical media, Filters and Fans with drive arrangement, Interconnecting Ducting and Exhaust Stack.

Shall be of Floor mounted horizontal type Dry Scrubber unit. Made with Sheet metal sectionalized cabinet type Dry scrubber in double skin construction fabricated from Aluminium extruded section frame structure. The inner skin 0.8 mm SS & outer skin 0.8mm Precoated GI construction with 50/43mm thick PUF insulation panel, with internal coving etc. complete with necessary frame work for supporting channels, foundation bolts and complete with following section Exhaust air Section with SS manual volume control damper provision for actuator, Pre Filter Section with Flange type G-4 filters and No. of stages Chemical media sections with necessary rain protection sheeting as per requirement and Post cleaning filter section and

Exhaust **Blowers(1W+1S**) section with complete with DIDW/SISW centrifugal fan, motor, & mounted on common base frame. Canvass connections at the outlet of the fan. And outlet SS manual volume control damper. Limit switch & Marine light in fan section.

There shall be opening for cable entries for motor in section, Provision for Magnehelic Gauges with Necessary Tubing across pre & post filter.

Shall comprise of SS 304 Ducting (Straight ducts, reducers, transition pieces, Y connection ducting) from tool to Before scrubber with necessary Gasket and supporting above/below false ceiling inside the lab building / gas bank room as per SMACNA standards

Shall include SS 304 tube Dia. 12.5mm vent connection

Should be Fire rated construction Axial Flow Fan with FLP Motor of Capacity ----- CFM

Supply, installation, testing & commissioning of Electrical Control Panel for outside application and DDC control for 1 no. of dry Scrubber systems (Dry scrubber 2 Fans with VFD's, FA fan without VFD - 1no, All control field instruments like across the Filter DP switches, Duct static pressure sensor & cabling, termination)

FLAMMABLE EXHAUST DUCTING:

Flammable gases Exhaust air ducts made of SS 304L -1mm thick as per approved TDS.

Flammable exhaust Volume Control Dampers made up of SS304 16 gauge will be provided as per P&ID. Duct design as per local exhaust ventilation design guidelines for exhaust systems (10 m/s)

All Exhaust Duct hanger supports made up of GI will be provided @2.4m max interval distance. Exposed duct supports will be as per site condition

The exhaust stacks of process exhaust air unit are set up on main header and go up over the Building roof top most Level for 3m minimum.

All the other fastening and accessories belong to the scope of delivery, measuring ports displaced by 90° and a fine-meshed bird protection grid.

Stack cowl design to meet Min. outlet velocity 15 m/s.

There must be an inspection platform in order to access the measuring ports.

All supports and bracings necessary for wind and other loads are included.

The location of the port shall be 8 times the diameter from straight discharge from fans.

A static certificate should be submitted in a way that it can be checked.

11.2. Compressed Dry Air System (approximately 4-7 bar of each equipment)

- The vendor shall consider the utility matrix as annexed in *(Annexure: 4)* this document to estimate the total load to be catered by CDA system. After considering the total CDA requirement, 20% extra flow shall be considered for arriving at the CDA system capacity.
- The approximate flow rate is around 50 CFM
- Dew point of Compressed Dry Air (CDA) to be at least -105deg F**. (- 40 deg)**
- Shall be Oil free, rotary screw air compressor of suitable rating and suitable sized air receiver shall be provided. The system shall have Desiccant type air dryer to meet the Pressure Dew point of -105 Deg F or better. The system shall also include suitable air filters i.e. 10 micron pre filter and 0.1-micron post filters in the line. Sufficient margins (not less than 20%) for purge losses shall be considered in case the heat less desiccant dryer is selected.
- Compressed dry air shall be distributed through SS316L (non –electro polished) orbital welded tubing work with all associated ancillaries and equipment in clean room.
- All POU (Point of Use) connections of CDA shall have Isolation valve and pressure regulator with double ferrule mechanical joint (Swagelok type) end connections.
- Pressure regulators and valves required for each tool.
- The vendor shall submit the P&ID for the compressed air distribution system including all the related valves, gauges and pressure regulators etc.

11.3. Central Utilities (Electrical)

Central Utilities (Electrical)	**Appropriate location adjacent to the main cleanroom area. The electrical cabling with socket from the main power cabinet to instruments and unit of the clean room is the scope of Vendor.**
Power Distribution	The main electrical distribution panel will be located near the clean room area
	IIST shall provide power (UPS/DG) in the panels at a location near clean room facility. Vendor shall provide further distribution comprising of cables, MCC, MCBDBs, wiring, Lighting etc. all complete (for UPS and emergency supply) for the entire facility – Clean rooms, Utility Plants, Process Equipment etc.
	All process equipment and critical utilities including safety systems and illumination shall be on UPS power with DG backup. The Clean room HVAC systems, FFUs and other non-critical utilities shall be on DG supply. 30% of illumination in Clean rooms shall be on DG supply.
	The bus-bar systems will incorporate MCB's at the power take off points for local protection/isolation
	Vendor has to provide the power requirements for the clean room ancillaries and utilities along with quote.
	Power shall be distributed suitably in the service corridor and for equipment support tools like chillers, vacuum pumps etc.
	Service sockets (16 A) with the following numbers shall be provided at class 100 (4 nos), class 1000 (8 nos), service corridor (8 nos.)
	Power rating of equipment as per Annexure 3.
	Electrical cabling to be laid out from the main panel to the tools, clean room ancillaries and utilities is scope of the vendor.

	Additional 20% starters shall be provided in the distribution system..
Electrical Panels	Main switchboard components include switch-gears, relay panels, control panels and indicators, and synchronization panels with the specifications, •Switchgears: On each side (HV/LV) of the transformer, for DG Set (415V, 3Ø, 50Hz) and for the UPS (415V, 3Ø, 50Hz). The switchgear will incorporate monitoring and display of Voltage, Current, kWh, Frequency and the power Factor. The monitoring units will provide a data feed to the BMS. •MCC panels: to provide power to HVAC Equipment and distribution system •Starter panels: for AHU motors. Local control/Emergency push button should be given for all motors. •Wiring & earthling from electrical panels up to the process tools in the cleanroom should be provided. Earthling can be provided in accordance with the overall electrical load and the possible need of individual tools. Electrical details can be found the Annexure 3. •All circuits are to be protected with suitable circuit breakers. •The electrical supplies should be configured for auto-change over in the event of mains power failure. •Motor control centers should be provided complete with all associated isolators, contactor terminals, overloads, selector switches and indicator lamps. •The incoming power is to be terminated with suitable cables from the substation or main electrical panels from the facility. •Cable sizing and selection for the utilities building should be designed to sustain the maximum short circuit current in the system. The cables should be laid in built up trenches, directly buried underground, on cable trays, in pipes and clamped directly to the walls or stable structures. •A suitable bus bar ducted system should be designed above the false ceiling for distribution of power to the lighting and for the tools located inside the clean rooms. This system will ensure that electrical interference to equipment and tools will be minimal.

	•Cleanroom compatible power outlets (3-phase and single phase) should be installed on the wall panels for all the cleanroom equipment. •Earth pits with ISI standard GI pipes and Copper plates with suitable rating should be constructed around the cleanroom building at an interval of 3 meters in triangular points. The required clay, salts, activated carbon are added to the pit accordingly. •Synchronization panels should be used to synchronize raw and DG power in the range of 50 Hz, 430 V. •All relevant electrical controls should be integrated with BMS.
General Electrical distribution	•The incoming power to be terminated with suitable cables from the substation or main electrical panels from the facility. Bus bar ducted system for distribution of power to the lighting above the false ceiling and for the equipment and tools located inside the cleanrooms should be designed. This system will ensure the electrical interference to equipment and tools will be minimal. •Cabling for all loads in the utilities building will be by ARMOURED Medium Voltage PVC sheathed Armored Aluminimum Conductor Cables XLPE insulated, cores laid-up with Polypropylene central filler and tape, extruded PVC inner sheathed, GI wire/strip armored and PVC outer sheathed overall confirming to IS 1554 part I 1988 with latest amendments and specifications, laid in built up trenches, directly buried underground, on cable trays, in pipes, clamped directly to wall or Structures. This cabling will be terminated at various loads as in the equipment's in the utility building connected loads. •Bus Trunking of respective load grade from each of the distribution board to individual cleanrooms. The Trunking system either can be in the void of raised floor/ above the false ceiling/inside the cleanrooms on the periphery of the walls. Individual tools or equipment's can be connected at required tap-off points as required. The bus bar Trunking system provided all flexibility to connect the tools/equipment.

	•Earth pits provide pits with ISI standard GI pies and Copper plates of appropriate thickness electrolyte grade. The moisture content of earth surrounding should be 2%. The earth pits are at an interval of 3 m in triangular points around the Fab building. The required clay, salts, activated carbon are added to the pit accordingly. **Note: Vendor should seek approval from IIST on all SLD & GA drawings before fabrication.**
Motor Control Centers	Motor control centers should be provided complete with all associated isolators, contactors terminal, overloads, selector switches and indicating lamps
	The operational mode of the connected device should be selected from the front panel of the motor control Centre by the associated three position selector switch
	MCC should have provisions to start/stop all the drives from remote location (FCMS)
Variable Frequency Drives	Supply and extract fans should be controlled via variable frequency drives for the benefits of managing energy consumptions and automatic system control
Grounding	All metallic components of the Central utilities should be grounded to a building earth point under the supervision of CMD, IIST.

11.4. Life, Safety and Security Systems

A. Fire and Smoke Detection System	Appropriate fire and smoke detection system shall be supplied and installed. The fire detection system will incorporate break glass call points and alarm sounders throughout the facility. Fire sensor OEM to be specified. Detailed technical specifications as per Annexure 5
B. Local Fire Suppression System	Clean room compatible (Clean agent) gas-based fire suppression to be provided. Clean agent based gas

	suppression system (Novec 1230 / FK 5 -1 -12)shall be designed as per NFPA 2001.
C. Emergency Showers	An emergency personal drench shower with eyewash should be provided in the Wet Etch. City Water supply shall be gravity fed via a storage header tank on the upper floor level as per site condition.
	Eye-wash to be located in the wet etch area and safety shower in the corridor outside. Town water distribution shall be considered for eye wash/eye shower.
	Emergency showers and storage tank of 1000 L capacity shall be made of SS.
	Waste water should be contained in a bonded area in the Clean room floor void with a gravity drain to the outside of the Building
D. CCTV system with number of cameras, NVR and displays	CCTV cameras to be installed in following areas: One for ISO – 5 (Class 100, Photolithography) and 3 for ISO – 6 & 3 for service corridor and 1 in pre-gowning before entering service corridor The CCTV monitoring displays at BMS room with network access
E. Local Area Network and Telephone	Local area network infrastructure cabling shall be provided within the Clean room connecting to a patch panel and switch within the Control Room

	Vendor shall also coordinate with the system administration and maintenance department of IIST for telephone connection

F. Access Control System

The scope of work includes Supplying, Installation, Testing, Commissioning of biometric based Access control system in the entire building. Biometric Reader is used for Attendance management, The Electronic Access Control System is to monitor and restrict access to specified general areas and to report on the activity and violations of restricted access in those areas.

Access control door shall be integrated with Fire panel such that doors should act like normal door in case of fire emergence. The purpose of an access control system is to provide quick, convenient access to those persons who are authorized, while at the same time, restricting access to unauthorized people. Electronic Access control panel is considered for all the Cleanrooms like Entry in Main Building, Photolitho Lab, Deposition, Change room & Service Area.

Electronic Access control panel location is proposed in Service area or above walkable ceiling. From Each doors control cables shall be connected to Electronic Access control panel. All Electronic Access control panels shall be connected to the port switch through Cat 6 cable. The emergency switch / Glass is proposed to open all the doors simultaneously in emergency conditions. biometric reader shall be considered for employee door access. IN shall be through Biometric & OUT shall be through exit push button. Biometric shall be considered for both IN & OUT for Hub Room & BMS Room.

A suitable access control software shall be programmed/loaded on the computer (compatible with latest Windows OS) to allow perform the following operations such as : Create database for bio-metric readers for the authorized persons, Assign the access rights to the individual. Enable/disable access for specified time periods (for visitors etc.) Record the transactions and generate transaction reports.

No. of doors control - Minimum 2 / 4/ 8, Recognition of holidays, Anti pass back system - Yes (system to refuse exit unless there is valid entry. Min Frequency - 125 KHZ, Reading Time should be less than 5 second. Output interface - RS-232 / RS-422 / RS 485, Baud rate - More than 19000 bps, Power - 12 to 24 VDC, Use capacity should be Not less than 100.

The electromagnetic lock shall conform to the Holding Force to be at least 650 Lb per door with Operating Voltage - 12/24 VDC or 12/24 VAC, Anticorrosive material/finish & Residual Magnetism (There should be no residual magnetism after release of Electromagnetic lock)

The access control system shall be powered through UPS supply for uninterrupted operation even during mains power failure.

The access control system shall be integrated with the third-party system like Fire alarm system, CCTV system etc as per the directions of Engineer in Charge. The access control system shall have provision such that in case of fire the entire access control system of the building shall be disabled.\ Cabling

- 8C and 4C 1.0 Sqmm Armored ATC FRLS color sheathed cable with FRLS PVC Heavy duty conduit is considered.
- 2C 1.5 Sqmm Armored ATC FRLS color sheathed cable is proposed from Fire panel to Electronic Access control panel.

Security Management System Operational Requirements:
Access Control System Software Along with required licenses for 96 readers,1 client License, Graphical layout and shall scalable to till 192readers.

- Windows Authentication Login: The Security Management System shall use an integrated login method which accepts the user ID of the person who has logged on to Windows.
- Password: The Security Management System shall use an integrated authentication method which utilizes Windows user accounts and policies.

- Information Access: The Security Management System shall be capable of limiting operator access to sensitive information. Operators must have proper authorization to edit the information.
- Shadow Login: The Security Management System shall allow users to Login over a currently logged-on user without having the current user log off the Security Management System or out of the Windows operating system.
- Graphical User Interface: The Security Management System shall be fully compliant with Microsoft graphical user interface standards, with the look and feel of the software being that of a standard Windows application, including hardware tree-based system Configuration.
- Keyboard Accelerators: The Security Management System shall allow the user to use a shortcut key to enable designated system commands.
- Operator Log: The Security Management System shall be capable of creating an action log in the history file following actions performed by an operator.
- Alarm Routing: The Security Management System shall be capable of defining routing groups that determine what event information shall be routed to a user or class of users.

DOOR INTERLOCKING SYSTEM:

- The Door Interlock System is proposed for airlocks and change rooms - in case of any critical area that requires door access control with additional security.
- Standard standalone Door interlock system is proposed, and logic shall be only one Door opens at a time.
- When the Egress button pressed to open, the door Green LED turns ON for 5 seconds to indicate Door is released and for those 5 seconds on for other doors which are not allowed to open.
- In case of Emergency / Fire, press Emergency button connected to Door interlock system panel, it allows to open all doors simultaneously.
- 600lbs Heavy duty Magnetic lock is proposed for door interlocking system.

- Door controller shall be integrated with Fire panel such that doors should act like normal doors in case of fire emergency.
- Touch less Egress switch is proposed as input switch to access the door by simply passing the hand close to the switch.
- Emergency release push button is proposed to open all the doors simultaneously in emergency conditions.
- 8C and 4C 1.0 Sqmm Armoured ATC FRLS color sheathed Copper cable with FRLS PVC Heavy duty conduit is considered.
- 2C 1.5 Sqmm Armoured ATC FRLS color sheathed cable is proposed from Fire panel to Electronic Access control panel.

11.5. BUILDING MANAGEMENT SYSTEM (BMS)

The BMS system shall have complete hardware, control electronics and software etc. to control the critical parameters like Temperature, RH etc. automatically. Vendor to provide detailed scheme/configuration and control philosophy to automatically control Temperature, RH etc. in the Clean rooms etc. for IIST review.

The BMS should monitor all major units of the cleanroom and the utilities. The following are its desired specifications and functions:

- Able to monitor and display humidity, pressure, and temperature across all zones of the facility
- Based around outstations with associated I/O modules and a PC (SCADA) supervisor station within the Control Room. Control cabling should be routed throughout the facility on a suitable cable management system.
- PLC controller should have a CPU with communication port for logic development and communication with supervisory controller or HMI and smart device connection.

- Inbuilt and extended I/O modules are to support remote field I/O e.g. Sensors, Transmitters, Actuators, Drives etc.
- High electrical noise rejection threshold as compared to other programming devices.
- PLC shall communicate with Slave controller (Life Safety Controller) and Supervisory controller (SCADA) to retrieve field instruments values continuously and shall take a proper action.
- All field devices and slave controller shall be interlocked with hooter and final control element for process i.e. SOV and shall take necessary action as per safety norms.
- Testing Documentation as CE, FAT and control system wiring.
- GA drawing and Internal Electrical drawings.

A. Communication Protocols:

- General used communication protocol MODBUS, TCP/IP, Profinet and RS 232.

B. Logic:

- Logic will be based on client application and need of process and process safety.

C. PLC Housing:

- Housing for PLC has front facia LED for power check, three tier hooter for signal indication as healthy, warning and critical.
- PLC is powered up through MCB (for 240 Vac) followed by SMPS and 2nd MCB (for 24 Vdc).
- Mounting DIN rail and rack to install MCB, SMPS, PLC and extended I/Os module.
- Internal wiring of PLC controller to Relay board and terminal block to connect remote field I/Os of process control and safety devices.

D. SCADA

- Gives exact real time data of Field I/Os.
- Communicate with Master Controller to retrieve remote field I/Os reading and alarm events.
- Mimic representation of distribution facility shall be amended with all I/Os for status.

- Operator interface machine that logs all alarms, events and provide visible readings from sensors / Instruments etc.
- Feeding value (range, set points) manually to I/O's as per process control and process safety.
- Layer authentication to control process, Process safety and confidential information from SCADA.
- Real Time and Historical Trends.
- Graphical representation and animation
- The makeup air plant supply fan speed should be VFD controlled, with the VFD proportional drive signal being derived from the Building Management System via the input of velo-probs and pressure transducers to maintain a constant makeup air velocity (and associated volume) as filer pressure drop increases. The makeup air plant fan speed will also respond to the facility positive differential pressure cascade to prevent over pressurising the facility in the event of exhaust volume not meeting design.
- Airflow proving differential pressure switches will establish that the makeup air fan is running and delivering a suitable pressure differential. Once airflow is proven associated plant should be available to run via the dictates of the control interlocks. Filter status pressure switches should be incorporated to provide guidance on preventative maintenance. Cooling and dehumidification control should be at the dictates of fresh air, supply air, return air, dry bulb temperature and dew point sensors, which will call for cooling/dehumidification of the makeup air volume to maintain the Cleanroom environment within design tolerances.
- Process extract fans should be interlocked with the makeup air and supply system to ensure that the facility cannot run at negative differential pressure. The process extract fans should be VFD controlled, with the VFD proportional drive signal being derived from the BMS via the input of veloprobs and pressure transducers to maintain a constant extract air

velocity In the event of the makeup air supply being lost, the extract fans will automatically shutdown to prevent the Cleanroom being negatively pressurized.

- Airflow proving differential pressure switches will establish that the extract fans are running and delivering a pressure differential. Once airflow is proven associated plant should be available to run via the dictates of the control interlocks. The extract scrubber system should be interlocked with the associated extract system to provide airflow proving.
- Process Cooling Water Temperature control should be via the dictates of the BMS. Process cooling water flow temperature will regulate the control of the primary chilled water to the heat exchanger and speed of the duty pump. Flow and return water temperatures should be monitored as analogue inputs by the BMS.
- Chilled water temperature control should be a function of the integrated chiller controller. The chiller will control on water flow temperature. The chiller will provide the status feed back to the BMS for monitoring and alarm purposes. Flow and return water temperatures should be monitored as analogue inputs by the BMS
- The compressed dry air system will incorporate an integrated controller, which will provide all necessary control functions for the safe operation of the system and will indicate; pressure, dew point, compressor/drier status. The integrated controller will provide status feed back to the BMS as digital inputs to monitor status/alarm conditions. The BMS will incorporate a pressure transducer in the compressed dry air distribution pipework to monitor available operational pressure.
- The ultra-pure water system will incorporate an integrated controller, which will provide all necessary control functions for the safe operation of the system. The integrated control will provide status feed back to the BMS as digital inputs to monitor status/alarm conditions. The BMS will incorporate a water resistively transducer in the ultra-pure water distribution pipe to monitor available water quality.
- Power monitoring devices within the switchgear will provide an input to the BMS for the remote display of plant power status at the supervise station.

- General Alarm Monitoring plant status alarms and parent facility alarms should be announced in the Control Room either within the BMS local workstation or alarm panels. Magnehelic type differential pressure indicators should be positioned in the Control Room to indicate the positive differential pressure cascade of the facility to the ambient perimeter walkway.
- Portable Particle Counter should be provided within the facility for the routine assessment of local cleanliness. The particle counter should be provided with a stainless steel transit trolley, local thermal printer and temperature/relative humidity transducer.
- The particle counter should be provided with data interrogation software to enable result to be downloaded to a local PC within the facility, with data being available to the Control Room staff via local area network.
- Complete BMS control system (with both auto and manual operation facilities) will be provided for control to HVAC, Process Exhaust and scrubbers, Compressed Dry air system
- Fire detection and suppression system, House vacuum, UPW system, Gas system, HVAC Chiller
- The chiller shall be enabled to run whenever the outside air temperature is greater than the specified temperature. The chiller shall run subject to its own internal safeties and control
- Emergency Shutdown: chiller shall shut down and an alarm generated upon receiving an emergency shutdown signal status.
- Chilled Water Pump: The chilled water pump shall run anytime the chiller is called to run. The chilled water pump shall also run for freeze protection whenever the outside air temperature is less than a user definable set point. The chilled water pump shall start prior to the chiller being enabled and shall stop only after the chiller is disabled. The delay times shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing.

- Alarms shall be provided to Chilled Water Pump Failure: Commanded on, but the status is off. Chilled Water Pump Running in Hand: Commanded off, but the status is on. Chilled Water Pump Runtime Exceeded: Status runtime exceeds a user definable limit.
- The chiller shall be enabled a user adjustable time after pump statuses are proven on. The chiller shall therefore have a user adjustable delay on start. The delay time shall be set appropriately to allow for orderly chilled water system start-up, shutdown and sequencing. The chiller shall run subject to its own internal safeties and controls.
- Alarms shall be provided as follows: Chiller Failure: Commanded on, but the status is off. Chiller Running in Hand: Commanded off, but the status is on. Chiller Runtime Exceeded: Status runtime exceeds a user definable limit.
- Chiller Chilled Water Supply set-point: The chiller shall maintain a chilled water supply temperature set point as determined by its own internal controls.

E. Chilled Water Temperature & Pressure Monitoring:

- The following temperatures & Pressures shall be monitored: Chilled water supply. Chilled water return.
- Alarms shall be provided to High Chilled Water Supply Temp: If the chilled water supply temperature is greater than specified temperature. Low Chilled Water Supply Temp: If the chilled water supply temperature is less than specified temperature. Consider Integration chillers (max. 250 soft points) with BMS with proper Communication Protocol. Through which data from chiller panel shall be made available on BMS server for monitoring
- The vendor should provide ladder diagrams and separate alarms for controlling the following components: Make up air unit, make up Fan, Supply Air Duct Velocity Control, chilled water coil valve, Electrical Strip Heaters, Return Air Humidity and temperature, Pumps for process cooling, Room Parameters, Process Extract Fan Control, Compressed Dry Air System, Fan Filter Units, Ultra-Pure Water System, Power Monitoring System.

11.6. Process cooling system:

NOTE:

- Vendor is to install separate piping system for existing single chiller procured for the two equipment (ICPCVD,ICP RIE). This Chiller location outside service corridor.
- As specified in the utility matrix, dedicated chillers are available for existing process equipment's like DC/RF sputter system, 2D anneal system, Oxygen Plasma Etch system etc. Those chillers to be kept in service corridor. Need chiller connection for hookup of equipments.

- **Process Tools Cooling Chiller. 2 Numbers**. (**Note: This is optional item for Future Expansion)**
- One working & another stand by is to be installed with the following specifications.

- Chilled Water Flow rate shall be 15 USGPM Pressure at the point of use required is 3 bar Inlet temperature to process cooling required is 19 deg C Outlet temperature to process cooling is 26 deg C.
  - The system shall Comprise Air Cooled Process Chiller with Scroll Compressor with Complete Electricals & Controls.

    Shall have Provision for Auto stand by Compressor automatically start in case of running compressor fails

  - Shall use Refrigerant shall be R407 / R134 A (non CFC).
  - Shall Comprise of Condenser Air Cooled type with Copper Tube & Aluminium Fins (Air Cooled 3 Rows with Copper Tube) along with suitable capacity Stainless Steel Tank with suitable Pumps & fans.
  - Shall include Evaporator of Shell & Tube High Heat Transferable (Tank in Coil & Removable bundle type).

- Shall have Thermostatic Expansion Valve, Filter drier, pressure Switches, and Shut off valve, gauges, temperature Controllers, Actuators, relays, Contactors, Indicators. Proper insulations for piping etc. Complete.
- Shall include Suitable Piping duly insulated along with valves, fittings, Fittings & Regulators, flexible piping as required & complete

12. Bulk and Process Gas Distribution/Hook up System

12.1. Details on Gases

Gases		Specification
Bulk Gases	UHP N_2, UHP O_2, UHP Ar, N_2 (Commercial grade), He	Gases distribution as per the requirement. Bulk gases (N_2, O_2, H_2, Ar& He) to be supplied through separate gas cylinder manifolds to be installed by the vendor.
Specialty Gases/ **Process gases** **(For existing systems)**	**ICP CVD - process equipment** Bulk nitrogen- 60 lpm (60000 SCCM) Process Nitrogen – 0.2 lpm (200 SCCM) Ar- 0.2 lpm (200 SCCM) He- 0.1 lpm (100 SCCM) CF4- 0.1 lpm (100 SCCM) N2O- 0.2 lpm (200 SCCM) H2- 0.1 lpm (100 SCCM) SiH4 – 0.1 lpm (100 SCCM) **ICP RIE- - process equipment** Bulk Nitrogen – 60 lpm (60000 SCCM) Process Nitrogen – 0.1 lpm (100 SCCM) Ar – 0.2 lpm (200 SCCM)	**Note**: Follow Annexure utility matrix and for details •This shall require following equipment to be installed as per the semi-S2 standards by the vendor & Semi S2 certificate shall be produced •Detailed specifications provided in the subsequent sections. A) Gas cabinets

	He- 0.1 lpm (100 SCCM) CF4 – 0.05 lpm (50 SCCM) C4F8 – 0.2 lpm (200 SCCM) SF6- 0.5 lpm (500 SCCM) O2 – 0.1 lpm (100 SCCM) **Plasma Etch System** Ar, ----- 0.2 lpm (200 SCCM) O2 ----- 0.2 lpm (200 SCCM) CF4----0.2 lpm (200 SCCM) **2D Deposition/Annealing furnace** Ar, -- 0.5 lpm (500 SCCM) H2, -- 0.5 lpm (500 SCCM) O2 --- 0.5 lpm (500 SCCM) Ar + H2 Mix – 0.2 lpm (200 SCCM) CH4 – 0.3 lpm (300 SCCM) **Sputtering System** Bulk N2- 7 lpm (7000 SCCM) Process N2: 0.1 lpm (100SCCM) Ar- 0.1 lpm (100SCCM) O2- 0.1 lpm (100 SCCM) **Wet bench** N2- 2000sccm **Mask aligner** N2- 15 lpm (15000 SCCM) **Solvent Bench (Spinner)** N2- 3 lpm (3000 SCCM)	One each for SiH4, NH3, N2O & B2H6. B)For H2 Gas Panel in a safe Place Outside Parent Building with all safety systems C)VMB for H2 D)Gas panels One each for CF4, SF6, CHF3& C4F8 E)Gas Panels one each for O2,Ar,N2
Specialty Gases/ **Process gases**	**XeF2 Silicon etch system***** Bulk N2- 30 to 40 lpm (40000 SCCM) Process N2- 5 lpm (5000 SCCM) **E beam Evaporator*****	

(For future hookup *** Equipment yet to be procured in future)	Bilk N2- 5 to 7 lpm (7000sccm) Process N2- 0.1 lpm (100sccm) O2- 0.1 lpm (100 sccm) **RTA***** Bulk N2- 5 lpm (5000sccm) Process N2- 2 lpm (2000sccm) Ar- 2 lpm (2000sccm) **ALD***** Argon : 1lpm (1000sccm) O2 : 1lpm (1000sccm) general N2: 1lpm (1000sccm) process N2: 1lpm (1000sccm) **SEM/E beam lithography ***** Bilk N2- 2 lpm (2000 SCCM) **Wafer Bonder** Process N2: 15 lpm (15000 SCCM)	

12.2. Gas cylinder manifolds for the gases like (N2, O2, Ar, H2

a. Vendor shall install separate gas cylinder manifolds for hooking as under:
   i) UHP Nitrogen 6N (2x2cylinders) for Process tools
   ii) UHP Nitrogen 6N (2x2cylinders) for GAS Cabinets/Gas panels Purging
   iii) General Nitrogen 5N (2x3cylinders) for Process tools
   iv) UHP 6N Oxygen (2x1 cylinders), UHP 6N Ar (2x1 cylinders), UHP 6N Helium 2x1cylinders)
   v) Other specialty Gases like 6N CH4 (2x1 cylinders), 6N CHF3 (2x1 cylinders),6N CF4 (2x1 cylinders), 6N CF8 (2x1 cylinders) & 6N SF6 (2x1 cylinders

b. The manifolds to be built by the vendor shall include automatic changeover system (mechanical/spring based changeover, Single stage pressure regulators with in-let and out-let gauges, NRV, Safety relief Valve, all Diaphragm Valves /Isolation valves/Change

over Valve, Emergency Shut off valve, etc and pig tails with suitable CGA valve connections as per gas type.

c. For hooking high purity Hydrogen gas cylinders, vendor shall install gas manifold (1x1 cylinder) with auto changeover. The manifold shall include single stage pressure regulators with in-let and out-let gauges, Isolation valves, High pressure Vent Valve, Low Pressure Vent Valve, pressure safety valve, Emergency Shut off Valve, excess flow monitoring switch, etc. and pig tails with suitable CGA valve connections. The manifold out-let shall have excess flow switch. N2 Purge & N2 Venture Systems. Any other safety requirements shall be incorporated in toto

d. The Hydrogen manifold shall be located in well ventilated area and all electrical fittings/lighting system in the area shall be Class 2C explosion proof. This Location shall be AWAY from the GAS YARD. Vendor shall incorporate suitable safety systems including Gas Leak detectors & exhaust system along with Flash Back Arrester. Vendor to use seamless SS 316L, internal electro polished 10Ra micro inches pipes/tubes with VCR fittings.

e. All distribution pipeline network for the gases to be of **seamless SS 316L**, internal electro polished 10Ra micro inches (RMS) pipes/tubes. All valves shall be orbital weld-able, Pack less bellows type rated at 200 psi and provided with 316L stainless steel bodies, Kel-F seats. Valves in the main headers /laterals shall have integral purge ports downstream of seat with VCR type fitting caps.

f. The main header for all UHP bulk gas lines shall have suitable filter units (0.2 microns rating), N+1 configuration with VCR type end connections Vendor should confirm that there is no pressure drop during the high flow uses.

g. Point of Use (POU) connections/ tool hook-up shall include isolation valve, POU filter (if required) and SS EP Pressure regulator with discharge pressure gauge, of suitable range.

h. Vendor to also provide suitable gas control panels

12.3. Semi-automatic Gas Cabinets for Toxic, Pyrophoric/Corrosive & flammable Gases

NOTE: The Conceptual/Representative P&ID drawings for GAS CABINETS are provided in Annexure 2. These are only for reference. Vendors shall submit the respective P&ID drawings with necessary provisions and safety systems not limited to what is provided in the representative drawing.

a. For storage and supply of toxic, pyrophoric, flammable or corrosive gases as per SEMI S2 standards for gases. The Semi-S2 certification is a must & simply Compliance statement will not be considered.
b. Vendor to supply, install, test, commission & validate Gas cabinets with respective Gas Panels (with the respective process gas) for SiH_4, NH_3, B_2H_6, and N_2O. Shall include all the safety features like ROR, suitable GLD, Sprinkler, Exhaust, Exhaust monitoring system, excess flow monitoring, Coaxial tubes wherever needed, Coaxial monitoring switches etc. & shall inclusive of all Safety features
c. All facility connections should be located on top of the cabinet enclosure and sides of control enclosure.

12.3.1. Supply panel for Toxic, Pyrophoric/Corrosive & flammable Gases housed in the gas cabinet-

- The process gas panel shall be five Diaphragm valve configuration including High pressure isolation valve (HPIV), High Pressure Vent Valve, Low pressure Process Isolation valve (LPIV) Low Pressure Vent valve, and Emergency shut-off **(ESO) valve Automatic Pneumatically Operated**,
- Shall include One He leak test port with manual Diaphragm Valve.
- Shall Comprise of 316 L Stainless steel single stage pressure Regulator, High & Low pressure dial type pressure gauges, High pressure & Low Pressure Transmitters, Mechanical Pressure Safety Relief Valve, Vent Pressure Gauge, VCR face Seal Connections

- The panel shall also have the Process gas regulation with cylinder pressure & process gas pressure display/transducers, with Excess flow switch, and with SS 316-L EP Coaxial tube with 10 micro inch Ra Max Finish & Co – axial Pressure Monitoring switch
- Shall include Venturi vacuum generator with Vacuum Assist Diaphragm Valve, NRV for N2 Venturi, Nitrogen purge mechanism with inlet Diaphragm Valve, Check valves etc. as per industry standard.
- Shall have Rigid Pig-tails for process gas with CGA Cylinder Connection, 0.4-micron process gas pre filter and purge gas (Nitrogen) shall be fitted with appropriate CGA valve connection.
- Provision for Automatic Emergency shut off valves on detection of gas leak and/or loss of cabinet ventilation.
- Shall comprise of Fine Metal Line filters (0.003 microns rating, with VCR type connections) between regulator and process cylinder shall be provided.
- Shall be with 316 L Stainless Steel Mirror Finish Back Plate

12.3.2. **The gas cabinets for Toxic, Pyrophoric/Corrosive & flammable Gases - (gas panel enclosure)**

- The GAS Cabinet should be SEMI-S2 (Semiconductor Equipment & Material International) Certified
- Test Certificates, must accompany the gas cabinets certificate of conformity, operating manuals& general assembly from OEM Shall Conform to Uniform building & Fire Codes such s NFPA
- Cabinet/Enclosure shall be of cold rolled steel (min 12 gauge UK BG), all welded Construction with white / Grey polyurethane paint for superior corrosion resistance. Cabinet Protective Edge shall prevent water penetration in case of water flooding

- Cabinet shall be fitted with self-closing and self-latching door fitted with enclosure gasket & Opening angel of the door shall be 120 deg(minimum). Shall be key operated self-latching doors with two point locking mechanism to disable Un authorized access. Neoprene gaskets around door to ensure a positive seal.
- The cabinet shall also be fitted with a self-closing viewing window for quick view/access to the purge panel & ¼ inch thick safety glass window. Window shall be fitted with wire-reinforced safety glass. Doors fitted with inlet air louvers with removable air-filters.
- The Cabinet shall be fitted with suitable units of wall-mounted kits including Heavy Cast corrosion resistant cylinder brackets and chrome steel safety strap to accommodate cylinders each of size 9" diameter and 61" height (max.).
- Cabinet shall have a provision for vertically adjustable shelf for cylinders up-to 34-inch height for proper alignment of cylinder valves connection and pig-tail. User should have the ability to change Cylinder shelf height when needed according to the application.
- Adjustable cylinder shelf in order to provide a convenient means of installing small cylinder suitable perforations in the shelf to allow air to sweep around the entire cylinder
- Weighing scale for the liquefied gases like AMMONIA GAS etc. Heat tracing and controller for liquefied gases as required (jacket for cylinder, regulator & line) Provision of regulator and line heating system with control systems to be provided for liquefied gas cylinders.
- Cylinder restrains to ensure that all cylinders held securely I place during storage and during operation
- Cabinet floor shall be corrosion proof, non-skid type and shall allow easy installation and removal of gas cylinders
- Exhaust port to be provided for maintaining at least 250 scfm (425 m^3/h) air flow along the length of the cylinder. Vendor to determine based on cabinet size and gas type.
- Shall include exhaust monitoring switch. Cabinets to have connections for exhaust ducts for continuous ventilation.

- The exhaust duct from all the gas cabinets made out of suitable material (SS304) and diameter to be connected to the dry scrubber. The exit of the gas from dry scrubber system to be terminated at a safe height from the facility after Neutralization in a WET Extraction/Exhaust system
- The Branch exhaust ducts from pyrophoric gases like B2H6 & SiH4 shall be connected separately through Main duct to the Dry Scrubber using SS 304 Duct with suitable diameter
- The branch exhaust ducts from other gases like NH3 and N2O shall be connected separately through a main duct to the Dry Scrubber using SS 304 Duct with suitable diameter
- Venturi drive valves for both low and high pressure side venting. The vent lines to be connected to exhaust through respective Scrubbers.
- The cabinet to have in-built mounting of fire sprinkler Head for placement of sensor head for toxic gas leak detection. Provision of Water Tank of suitable capacity with pump for supply of water at the required pressure to the Sprinklers in the Gas cabinets.
- UL approved bee waxed coated fire sprinkler head, with155° F (68° C) actuation shall be mounted.
- Shall include ROR for all gas cabinets, suitable gas leak detectors, co-axial tube pressure monitoring switch, exhaust Monitoring switch. Flashback arrester for Silane gas & Hydrogen gas panels.
- UVIR Gas Leak Detectors for SIH4, B2H6 Gas Cabinets & H2 Gas Panel
- Standard Leak Detector for N2O gas Cabinet
- All Gas Cabinets Shall Comprise of Emergency Shut off Valve Pneumatically operated
- All Gas Cabinets shall have Emergency Push Button to Switch off the system (Push button)
- Proper audio-visual alarm system to be provided
- Shall be equipped with PLC Controller**,** PLC control system along with HMI Compatible to Connect to the Main PLC of GAS System

- Shall comprise interlock function that prevents potentially dangerous operations & Shall include Pre-set alarms comprising – shut down(EMO), low pneumatic supply, high& Low process gas delivery pressure, low scale weight, low purge gas pressure, etc.
- Shall Continuously monitor system conditions for alarms & Shall maintain detailed alarm logs. And shall be Capable of Intuitive operating interface & Control
- The gas cabinets to be user friendly for maintenance of gas control panels without removing the gas cylinder. Shall include ergonomically positioned color touch screen
- Shall include safety options that include key enclosures locks which prevent access to the controller interior shall be available
- Labelling – all specific gas labels and hazardous labels shall be put on the front doors. Labels shall be according to the applicable standards and Label content per MSDS.
- All components of the process as well as purge gas panels shall be 316L SS electro polished with surface finish Ra <10.
- Safety measures to be provided as per the requirement for each gas.
- VCR fittings to be considered in the design.
- Vendor to provide Test certificates, certificate of conformity, operating manual and general assembly drawings from the OEM.
- **SEMI S2 certified (The SEMI S2 certification for the gas cabinet to be offered shall be submitted by the vendor along with the technical bid)**
- **Special note:** Vendor shall provide suitable scrubbers required to neutralize the vent gases from respective panels like NH3, B2H6, N2O, SIH4 etc. and after neutralization these neutralized mixtures shall be exhausted through wet extraction / exhaust systems as required by respective Gas

12.4. Gas Control Panels for Specialty gases like CF_4, CH4, SF_6, CHF_3 & C_4F_8

- Gas control panels to be provided for Process and bulk gases.

- Control Panels to be Considered for the Gases are - CF_4, SF_6, CHF_3 & C_4F_8.
- Gas control panels Shall have minimum features like CGA connections, diaphragm valves, filters (Prefilter: 0.4micron particle filter and final filter:0.003micron particle filter), double/Single stage Pressure regulators with pressure gauges, Mechanical Pressure Safety Relief Valve, check valves, high pressure and low pressure side vent Valves facilities through venture drive Diaphragm valve. Vacuum Generator, N2 Purge Diaphragm Valve etc. Vent Pressure Gauge, VCR face Seal Connections.
- Shall have Pig-tails for process gas with CGA Cylinder Connection, 0.4-micron process gas pre filter and purge gas (Nitrogen) shall be fitted with appropriate CGA valve connection.
- Shall be with 316 L Stainless Steel Mirror Finish Back Plate
- Shall comprise of Automatic Emergency shut off valves on detection of gas leak
- The gas control panels shall meet SEMI S2 Standards and vendor to provide SEMI S2 certification for the gas control panels.
- The gas control panels have to be process gases compatible. The gas control panels must be accompanied by Test certificates, Certificate of conformity, Operating manual and general assembly drawings from OEM.
- For CF_4, SF_6, CHF_3 & C_4F_8, 6N N2 gas panels with common purge gas panel *(N2 cylinder)* may be installed
- Hydrogen and Oxygen gas manifolds– Panels should have pigtail connection in compliance to PESO Gas Cylinder Rules. Should comprise of flash back arresters in the respective Vent lines.

12.5. Gas yard for Hazardous/corrosive/pyrophoric/inert/Bulk gases

Gas Hook up Area (Gas yard) shall comprising of the following facilities at a designated Gas hook up area as mentioned in site plan. The GAS YARD will be constructed by IIST based on

the facilities & type of flooring which shall be provided by the Vendors/Contractors

Hazardous/Corrosive/Pyrophoric/Flammable Gases:

a. Hydrogen gas manifold
b. N2O gas manifold in respective Gas Cabinet
c. Silane (SiH4) gas manifold with respective Gas Cabinet
d. Di-Borane (B2H6) gas manifold with respective Gas Cabinet
e. Ammonia (NH3) gas manifold with respective Gas Cabinet

Other Gas Manifolds:

a. Oxygen Gas Manifold- Panel
b. SF6 Gas Manifold - panel
c. C4F8 Gas Manifold - Panel
d. CH4 Gas manifold - panel
e. CHF3 Gas manifold - panel
f. CF4 Gas Manifold - Panel
g. Argon Gas Manifold – Panel
h. UHP Nitrogen 6N (2x2cylinders) for Process tools
i. UHP Nitrogen 6N (2x2cylinders) for GAS Cabinets/Gas panels Purging
j. General Nitrogen 5N (2x3cylinders) for process tools

12.5.1. Location for H2 gas Panel, (Special NOTE)

- Vendor shall design & Build suitable Gas yards for H2 Gas with all the required Safety Features to fulfil the Semiconductor Industry standard.
- The H2 Gas Manifold-panel shall be installed in a safe place away from parent Building & GAS YARD with all the Safety precautions as required. It shall be Semiautomatic type.
- Should Comprise of Flash back arresters in the respective Vent lines.
- UVIR flame detection system and 2-Hr Fire Rated walls and fencing as required. (For purging a dedicated 3x2 N2 Purge panel (1 no.). Suitable Gas Leak Detectors like UVIR to be provided. Should comprise of Emergency Shut off valve pneumatically operated

12.5.2. **The Requirements of SAFE Enclosure are as under:**

- The walls of the GAS yard shall be fire rated for minimum 2 hours The shelter of the H2 Gas shall be built in an open space from the wall for better ventilation purposes
- The front face of the Gas yard shall be made of steel Fencing & gate
- Flame proof Lighting shall be provided in the GAS Yard
- Flashback arrester/Flame arrester shall be provided
- Adequate Lighting Protection to be provided
- Proper Earthing shall be provided
- The flooring of the gas yard shall be made of levelled Concrete slab
- Water sprinkler system shall be installed in the GAS YARD
- GAS Detector & UVIR detector also shall be provided for both H2 Gas & Silane gas.
- Any other safety system as needed can be provided.
- Gas manifold- Panels should be installed at dedicated Gas Hook up area (gas yards) with all safety standards.
- Vendor should design the gas Hook up area (Gas yards) as required with all international safety standards including safety vents, gas detection systems and UVIR flame detection system and 2-Hr Fire Rated walls and fencing as required.
- Hydrogen and Oxygen gas manifolds– Panels should have pigtail connection in compliance to PESO Gas Cylinder Rules. Should comprise of flash back arresters in the respective Vent lines

12.6. Piping Distribution network for Specialty & Bulk Gases

- Vendor to design and build distribution pipeline networks from each gas cabinet and gas distribution panels to various process tools with appropriate components like valve

manifold boxes and valves, regulators, pressure transmitters, Pressure gauges, Safety relief valves, excess flow valves, non-return valves, filters etc. as per the requirement.

12.6.1. **Bulk & Specialty Gas Piping Distribution:**

a. Automated Orbital Welding of all gas tubes. Orbital Welding shall be carried out by using inline purifier for Argon shield. The impurity of argon as shield gas shall be such that moisture shall be less than 0.5ppm and Oxygen shall be less than 0.5 ppm to ensure good quality orbital welding.
b. Either factory made pre-electro polished elbows be used in the installation or Bending of electro polished tube can only be done with long radius benders of dia. up to ½".
c. All process gas end connections are Face seal ends(VCR)
d. One spare Nitrogen gas line to be provided in each bay.
e. Civil work related to gas piping to be in the scope of the vendor.
f. All clamps and support material used in the clean room should be clean room compatible.
g. Proper labeling of the tubes at the origin and termination to be carried out for clear identification. The gas lines shall be color coded for ease of identification.
h. Vendor to provide the purity certificates of gases to be used in welding or other testing / calibration purposes.
i. The gas lines (Single and co-axial) to be tested and validated for pressure, particles, leak, oxygen and moisture as per SEMI standards. A document containing the specifications of these analytical tests to be provided by the vendor. Certificates of validation to be provided by the vendor
j. Helium leak test- to be carried out with dry vacuum pump having a leak detection capability upto 10^{-11}mbar.ltr/sec and should pass at least 10^{-9}mbar.ltr/sec

k. Particle count- as per SEMI standards for particle size upto 0.1 microns in pressurized gas flow.
l. Oxygen content- ≤1ppm
m. Moisture content- ≤1ppm
n. Pressure test- Tubes to be held pressurized at 1.1 times the operating pressure and tested for at least 24 hours.

12.6.2. **Distribution Pipeline Network for TOXIC/Pyrophoric/Corrosive gases Like CF4, SF6, CH3& C4F8 etc.:**

a. Vendor/Contractor Shall use Seamless Stainless Steel pipes/tubes of grade 316L, EP eletropolished10 Ra micro inches (RMS) and Face-Seal fittings.

b. Vendor/Contractor to build distribution pipeline network from each gas cabinets and gas distribution panels to various process tools with appropriate components like valves, regulators, pressure transmitters, Pressure gauges, Safety relief valves, excess flow valves, non-return valves, filters etc. as required with appropriate end connection. Valve Manifold Panels & Valve Manifold Boxes if required

c. **For process gases like CF4, SF6, CH3& C4F8)** vendor shall install single SS 316L EP <10 Ra tubing from the gas panels up to the tools and make the tool-hook-up per the connection size /type on the tool port.
d. Vendor to build Co-Axial pipelines for all hazardous gases (viz. SiH4, NH3, N2O & B2H6) with vacuum switches. Distribution shall be through SS316L EP Co-axial tubing. Inner tubing shall have less than 10 Ra finish.
e. One spare Nitrogen gas line connection of SS316 L Seamless, ¼" size with requisite isolation valve & pressure regulator to be provided in each bay.
f. One spare CDA line of SS316 L Seamless, ½" size with requisite isolation valve & pressure regulator to be provided in each bay.

g. Vendor to use compatible components/ materials to build bulk and process gases facilities.

h. Vendor to erect equipment and distribution lines with appropriate supports /trays/pipe racks as per P&I diagrams adhering to the clean room protocols.

i. Vendor to label the gas facilities according to the gases as per NFPA symbols

j. Vendor to test, purge, analyze and certify the facilities as per SEMI S2 standards.

k. Rigid vacuum line between tools and pumps as per the requirements

l. Some flexible pipe working has to be considered during tools installation

m. The supports/hangers for the distribution lines shall be 'Unistrut type'.

12.6.3. Distribution Pipeline Network Tubing/Piping Material Specifications Details:-

Stainless steel piping/tubing shall be Seamless, 316L EP, ASTM A 213, ASTM A 269, ASTM A 632; having a controlled inside diameter finish with a maximum roughness not to exceed 10 micro inch and a hardness of Rb 60 to Rb 80, with 5% maximum allowable chromium carbide, 0.005 to 0.017% maximum Sulphur content, and chrome/iron ratio 2:1. The tubing supplied shall have the same heat number for the same size. Seamless tubing shall conform to the following:

OD SIZE inches	**ASTM NO.**	**Interior EP Surface Finish (micro inch)**	**Wall thickness prior to EP (Inches)**	**Permissible Variation**		
				Diameter (Inches)	**Ovality(Inches)**	**Wall Thickness (%)**
¼"	A632	7 Ra (Avg.) 10 Ra (Max.)	.035	+.004/-.000	n/a	15%
½"	A269	7 Ra (Avg.) 10 Ra (Max.)	.049	±.005	± .010	10%

¾"	A269	7 Ra (Avg.) 10 Ra (Max.)	.065	±.006	± .010	± 10%
1"	A269	7 Ra (Avg.) 10 Ra (Max.)	.065	±.006	± .010	± 10%
1.5"	A269	7 Ra (Avg.) 10 Ra (Max.)	.065	±.006	± .010	± 10%
2"	A269	10Ra (Avg.) 15 Ra (Max.)	.065	±.008	± .010	± 10%

Coaxial Tubing and Fittings

Process Gas distribution system with Co-axial gas lines shall be based on the characteristic & nature of the Gas. The Co-axial gas distribution network shall be based on the Process Tool Matrix & in line with the Process Tool Layout Plan.

The Co-axial tubing should be SS 316 L EP 10 Ra, seamless tubes & face – seal tube fittings. The coaxial lines shall have Co axial pressure monitoring switch and shall be Automatic type

a) The containment jacket for co-axial tubing shall be of seamless 316L stainless steel, meeting the requirements of ASTM A269 and ASTM A362. Diameter shall conform to the following:

Gas Transmission pipe OD size (IN)	Containment Jacket Pipe OD Size (IN)	Wall thickness (IN)
0.25	0.50	0.049
0.50	0.75	0.065

b) The tubing supplied shall have the same heat number for the same size.

c) The coaxial lines to be vacuum type and not nitrogen purged type.

d) In the case of catastrophic failure of Co-axial gas Lines with vacuum switch, the system shall have auto shut off scheme.

e) Co-axial Tees and elbows shall be of the same heat number as that of the pipe. Fittings shall be fabricated

from same tubing used for pipe system.

f) ***Tees*:** Fabricated by using seamless 316L EP stainless steel tubing stock with after fabrication dimensions and tolerances compatible with orbital welding equipment.

g) ***Elbows*:** Manufactured, long radius type with the same wall thickness and heat number as that of tubing for each respective size. Field bending will not be acceptable. Fabrication dimensions and tolerances shall be compatible with orbital welding equipment.

LEAK TESTING OF EACH VALVE:

i) Each valve shall be tested by Pressurization to 150 psi with 100 % Argon.
ii) Valves shall be tested for compliance with a leak rate not exceeding 1 x 10-9 atm Cu.cm/sec between the valves and ambient and across seat.

FINISH: Electro-polish interior valve surfaces to a surface finish 10 Ra Micro-inch Max tube extensions and purge ports have been welded to valve body.

NOTE: *Diaphragm Valves rated for at least 250 psi, provided with SS body, Electro-polish interior valve surfaces to a surface finish 10 Ra Micro-inch, PTFE seat. VCR fittings and metal seat on value outlets to be installed for GN_2 point of connections.*

12.6.4. Equipment Qualification Testing Requirements:

Equipment Qualification Testing Requirements shall include the following

Line certification shall be performed in the sequence to meet the semiconductor standard

a) Gas piping & Continuity Test
b) Conditioning of Gas distribution system including number of cycle purges
c) Radiography test for all weld joints
d) Pressure decay test & Service test – pressure decay test shall be carried out on the whole gas distribution system as per the semiconductor standards
e) Pressure test- Pressure test shall be carried out for 24 hours upstream 3000 psi max. 0 psi min (for high pressure systems). Downstream 100 psi max. 90 psi min. with Ar/N2 grade 6.
System shall also be pressure tested to 1.1 times of design pressure for a minimum of 12 hours with Zero pressure drop.In accordance with the upstream and low stream working pressure, pressure test should be conducted.
f) He Leak Test- Helium leak testing shall be carried out with dry vacuum pump having leak detection capability up to 1 X 10^-11 mbar He L/sec and shall pass minimum level of 1 X 10-9 mbar He litres/sec

g) Purity Tests: Moisture, Trace oxygen & particle tests shall be carried out for: Moisture< 500ppb.
Oxygen < 500 ppb
Particles < 5 particles/ft^3 @ 0.1µm

Manufacturer shall submit all records and test method for all the above-mentioned tests and results. Helium leak integrity test procedure shall comply with the Semi standard (F1- 96).

However, above vendor needs to fulfil all the required qualification requirements according to prevailing Semiconductor industry international safety standards.

12.6.5. Valve Manifold Boxes for Hydrogen

- VMBs shall have 4 valve sticks for hydrogen. Each valve stick shall have isolation pack less diaphragm valves (both inlet & out-let), Single stage pressure regulator, Point of use filter (0.003 micron rating), Pressure gauge and Vent line (with valve, NRV etc.). The operations of the VMB shall be manual.
- All components of the manifolds shall be SS 316L EP. VMBs to have provision for fire suppression.
- Key operated, self-latching doors with two point locking mechanism to disable unauthorized access.
- VMB shall have Safety glass viewing windows

12.7. Gas monitoring, Toxic/Hazardous gas monitoring system

12.7.1. Gas monitoring and Safety Sensors: Introduction

- Gas cabinets, VMBs and process tool gas boxes to be monitored by **Toxic/Hazardous** gas monitoring.
- All alarms to be connected by hard wire to the **Toxic/Hazardous** Gas Monitoring system and to the control room.

- There should be appropriate hooters installed at acceptable distances for gas alarm.
- Toxic/Hazardous gases should be isolated

12.7.2. Toxic Gas Monitoring (TGM) & Toxic Gas Leak detection system.

➢ **Toxic Gas Monitoring (TGM)**

Toxic gases monitoring system, preferably Electro-Chemical Technology for gas cabinets, gas panels Process Equipment's exhaust, VMBs and process bays, (For Flammable gases can use Electrolytic beads type technology) with following features:

- Directly display gas concentration in PPB, PPM or % Volume.
- User settable dual alarm levels.
- Common reset buttons.
- Latching Relays
- Key switch for disabling external alarms.
- System to have visual and audible alarms.
- Multiple monitoring system with central control unit.
- Alarm system to be integrated with gas cabinet's emergency shut off valve, any other facility alarms/Building Monitoring System in order to cut-off the source.
- Shall comprise of advanced communications with Built-in configurable PLCs, Capable of providing physical evidence of gas event, Automated leak test with line integrity option, Touch screen, Radio frequency identification tag (RFID) to ensure eliminating human errors
- UV & IR detectors shall be integrated with life safety System.
- The Concept shall be if there is a gas leak- it shall automatically trigger shut down of the gas supply with activated sound Warning Light
- TGM Main Rack/ panel shall be of suitable for electronic enclosure with base frame, glass glazed front door, free standing type and shall consist of mainly Dragger Regard Control cards as under:

- Suitable Channel Display Module
- Suitable-Channel Display Card
- Relay Display Module
- Relay Card
- Master Card
- MODBUS Card
- Analog Time Delay Relay
- Power Supply with MCB etc.
- Convertor/Isolator for protection of MODBUS Card
- PC Communication Card with PC interface data cable
- 19" Rocker whichever is suitable

- Stacking Modular Beacon & Horn units for the process areas shall be located in a manner so as to cover the entire building for annunciation of toxic gas monitoring system at high level alarm with Green Light always ON to indicate healthy status. The sounder shall automatically turn-off when gas concentration falls below set value while the Flashing Red Light status shall remain to indicate abnormal TGM status.

- **Field devices** (Transmitters) shall be hard wired to Main TGM Panel. All wiring to interconnect field devices with main panel, air sample tubing, Stacking Beacon and horn units shall be provided

- **Toxic Gas Leak detection system.**

- Toxic gas leak detection system (fixed gas detector electrochemical type) for monitoring accidental gas leak in clean room/Process tools/Gas cabinets/ VMB(s). The system shall include installation of gas sensor at strategic locations in the downstream of the scrubber (per gas one sensor), Gas cabinet and VMB. Any detection of the gas shall raise an alarm and the data of continuous monitoring shall be available at a separate work-station/PC.

- Shall include ambient O_2 level Detector for each work area of the Facility.
- Suitable number of gas leak detector should be provided in the process areas like photolithography, deposition area depending upon the specialty gases used for the process.

Gas leak detectors of suitable type for respective gases shall be kept on the cleanroom wall near each process tools.

- Suitable number of gas leak detectors shall also be considered in the utility/Service corridor where these specialty gases pipes are laid.
- Quantities shall be computed for each gas for Gas cabinet, Valve Manifold Box and Exhaust of Process tool. For each gas cabinet one gas sensor of appropriate type shall be provided, Valve Manifold Box (VMB) and Exhaust of Process Tool.

➢ **Gas Leak Detector Specifications for Toxic, Corrosive, and Flammable gases:**

- The detection should be based on electrochemical reaction principle.
- For Flammable gases like H2, catalytic Bead type GLD to be used.
- Gas leak detectors should take continuous samples via pump installed inside detectors. Also Wherever UVIR detectors are required – to be Considered based on the nature of the GAS
- The Instrument shall have alphanumeric displays with separate measurement units. The output should have Visual Alarm, Power and Fault lights as well as back-lit LCD with all gas readings and events. The sample flow rate should be above 400 ml / min and should be less than 30 seconds. The Cartridge should have calibration certificate. The product should have suitable certification such as CE Marked meeting EN 50270:1999 (Type 2). It shall be designed to meet UL 2075.

(i)Ammonia gas detector:

Ammonia [NH_3] vapor detector system) having a solid state instrument panel and sensor capable of sensing ammonia concentrations of 25 to 800 ppm shall be installed in Class 1000 Clean room & service bay for environmental monitoring. This is in addition to the detectors provided in Gas cabinet, Valve manifold box and process exhaust. Detailed specifications as below:

a) NH3 detector shall detect any accidental gas leak.
b) The NH_3 detector shall have a progressive LED light tree display.
c) The detector shall have relays for early warning (pre-alarm), Alarm and auxiliary equipment's/alarm.
d) Power requirements of the system shall be 230V 50Hz AC & 16V AC or 24V DC
e) The detector shall not contain any radio-active materials.
f) The system shall have a non-adjustable early warning set point at 250ppm and adjustable alarm set point at 500ppm.
g) The detector system shall have a Service mode switch for servicing, testing or calibration.
h) The detector shall be capable of initiating a supervised alarm, resulting in corrective action.

12.7.3. **Toxic gas monitoring (TGM) system design concept:**

The Toxic Gas Monitoring System shall be continuous type and is intended for online monitoring of leakage of hazardous gases in the process tools installed in IIST facility and Source Gas cabinets in GAS YARD. The monitoring shall be at the point of tool exhaust / facility source panel and exhaust of Gas Cabinets, VMBs etc. The Toxic Gas Monitor (TGM) shall be installed in combination with air sampling pump with inline particulate filter as per the recommendations of the OEM and shall have local display with feature for indicating sensor vitality. The system upon detection of specified gas at half of defined Threshold Limit Value (TLV) shall initiate a local alarm with local display on detecting device with actual concentration of gas leak. The alarm shall be both visual and audible. The audible local alarm shall be distinct from all other alarms. In the event of high level (≥ TLV) alarm from the detection device the respective source gas cabinet shall also be tripped with or without time delay.

The TGM system shall be networked / interfaced with SCADA.SCADA shall display/monitor of detector parameters, trend of online gas concentration, acknowledge alarm with history for one month and auto save on hard drive having retrieving feature.

SCADA shall have 5 level Access Protection through passwords like PC Lock, Operator, Admin, Developer etc. The said Facility Control & Monitoring room (Control room) is approximately about 10mts from the gas hook-up area. The SCADA is to be built on suitable platform for display of online status of field transmitters and trend of Toxic Gas leak, if any.

TGMS (Toxic Gas Monitoring System) is a dedicated life safety system, like a fire alarm system, that is designed to detect the presence of harmful gases in an environment and signal that presence to the building occupants.

Toxic Gas Monitoring Systems shall provide warning to plant personnel about a release of a combustible gas so that actions such as automatic and/or manual can be taken to control the release before any significant damage can occur.

These actions can include process system shutdowns and suppression or mitigation systems actuation. A well designed Toxic Gas Monitoring Systems will increase the level of plant safety. TGMS controls the overall hazardous systems by having Gas Detectors, Heat Detectors, and Pressure Transmitters etc. to ensure the LEL% of gases in environment.

12.8. Safety system details for Gas Management System:

12.8.1. Controller for Gas Management System:

Dedicated PLC for Safety: A dedicated programmable logic controller (PLC) is needed for the management of the GAS MANAGEMENT SYSYTEM process gases. Slave PLCs at each

GAS Cabinets/Panels shall be linked to Dedicated centralized PLC. This network of Main PLC of Gas Management & Slave PLCS shall be Compatible to link to IIST BMS system.

Programmable Logic Controller (PLC):

- PLC controller should have CPU (relay logic based) with communication port for logic development and communication with supervisory controller and smart device connection. Inbuilt and extended I/Os modules should support remote field I/O e.g. Sensors, Transmitters, Actuators, and Drives etc.
- Shall have High electrical noise rejection threshold
- PLC shall communicate with Slave controller (Life Safety Controller) and Supervisory controller (SCADA) to retrieve field instruments values continuously and shall take a proper corrective action.
- All field devices and slave controller shall be interlocked with hooter and final control element for process i.e SOV and shall take necessary action as per safety norms.
- Testing Documentation as CE, FAT and control system wiring should be provided.
- GA drawing and Internal Electrical drawings should be provided.
- The PLC Cause-Effect logic should be provided for the entire system.

- **Communication Protocols**: General used communication protocol MODBUS, TCP/IP, Profinet and RS 232.

- **Logic:** Logic should be based on client application and need of process and process safety.

❖ **PLC Housing:**

- Housing for PLC should have front facing LED for power check, three tier hooter for signal indication as healthy, warning and critical.
- Mounting DIN rail and rack to install MCB, SMPS, PLC and extended I/Os module.

- Internal wiring of PLC controller to relay board and terminal block to connect remote field I/Os of process control and safety devices.
- PLC is powered up through MCB (for 240 Volts) followed by SMPS and 2nd MCB (for 24 Vdc).

❖ **Life Safety Controller:**

- Life safety controller shall be embedded micro controller to control GC or VMB parameter to monitor and control a safe process operation.
- Life Safety System shall have a microcontroller and Solenoid Valve to control or shut down process pneumatic valve when critical situation reaches based on installed instruments (Gas Leak Detector, PT, Magnehelic or exhaust sensor, Excess Flow Switch and Emergency Shut Down).
- It Must work as a slave controller on remote field and receive a counter signal continuously from Mater controller to ensure safety. Life safety controller should communicate with Master controller on MODBUS and share continuous real data of instruments connected.

❖ **Safety logic:**

- Gas Leak Detector (GLD) shall be installed at point of use in the Cleanrooms near the process tools and at the source i.e. Gas Cabinet/Gas Panels, Local controller / Life safety of gas cabinet, GLD (POU) & hooter shall be interlocked using a common controller. The common controller should take necessary action (shutdown) in case of critical situation as per safety norms.
- Pressure transmitter and Excess Flow switch shall be installed in Process outlet. It shall be interlocked with solenoid valve and visual Hooter indication when sudden exceed in pressure (from set value) and flow from set point flow rate.

- Magnehelic or Exhaust sensor is for continuous observation of negative suction in gas cabinet and VMBs, so that if any gas leaks inside this enclosure, it will be thrown out in a safe manner.

❖ **System back up:**

- TGMS server system is to be set up so that it is entirely backed up weekly. (Will be controlled and maintained by TGMS Services).

❖ **Fire/heat detectors:**

- Heat detectors shall monitor explosive/flammable gasses set to alarm at 150°F (65°C) to detect fire. When heat detectors sense a high temperature of 150°F or greater, it shall shut down all tool/equipment/systems.
- Heat detectors shall be placed in the exhaust ducts coming from gas cabinets, Valve Manifold Boxes (VMBs), CDUs, GIBs and exhausted enclosures that carry flammable and pyrophoric materials.
- IR detectors should be installed and monitored in gas cabinets, VMBs, and tool gas boxes that house pyrophoric gases

❖ **Controller (HMI Fixed on respective gas cabinet):**

- The controller shall automatically monitor and control the operation of the gas cabinet. The controller shall be anchored to the top of the cabinet and shall come with a standard set of inputs and outputs. Controllers must have an emergency shutoff button, a local audible alarm, a local visual alarm, and pneumatic connections for input and output for emergency shut off valve control
- In view of the safety involved vendor shall ensure that controller hardware, software, logic control & control philosophy be fail-safe.

- Entire purge sequence, vacuum /pressure lock tests etc. required to be performed during cylinder replacement as well as for component /filter replacement shall be carried out automatically through a PLC/microprocessor based controller.
- Controller shall have provision for selecting different purge options e.g. cylinder purge, etc. and shall also enable manual sequencing of valves (password protected) for troubleshooting and maintenance, if required.
- System controller/software should support auto operations/purge sequences for process and purge panel/stick.

❖ **Controller sensors shall include:**

- Hi Delivery Pressure
- Excess Flow
- Exhaust Fail
- Gas Detector Warning
- Gas Detector Alarm

All controllers should be cord and plug, requiring about 25 Watts. Some controllers can power gas detection monitors, but this needs to be verified with the manufacturer.

❖ **Gas Detection**

- Gas detection sensor should be located inside the cabinet. The gas detection system shall detect the presence of gas at 25 % of the lower explosive limit (LEL) for flammable gases or the permissible exposure limit (PEL), or ceiling value, for toxic gases.
- A local alarm shall initiate and automatically shut off the gas at the source when these limits are detected. A signal shall be transmitted to a constantly attended control station whenever a hazardous condition is detected.

❖ **Exhaust Detection**

- Exhaust shall be monitored to ensure that the cabinet is ventilated when in use. The monitor shall be connected to the controller to automatically shut off gas when the ventilation drops below a set point.
- A continuous visual indicator, such as a Magnehelic gauge, shall be installed so the user can visualize that adequate ventilation is being provided to the cabinet.

❖ **Pneumatic Supply**

- The automatic shutoff valve shall be pneumatically operated by nitrogen

❖ **Display of HMI:**

A suitable Human Machine Interface via touch screen panel (minimum 7") is required for the following:

- Selecting purge sequences — cylinder purge or gas panel purge.
- Changing set values for pressures, weight etc.
- Display valve status, gas panel (left-right) status, etc.
- Warming and alarm status,
- Cylinder pressure and weight.
- Process gas pressure.
- Gas consumption and gas supply interruption histogram date/day wise.

12.8.2. **Automatic Sprinkler System for Gas hook up area & Gas Cabinets**

The gas cabinets, gas panels and the hook up area shall be provided with ceiling sprinkler protection including interconnection of sprinkler extension pipe to the Gas Cabinets from sprinkler head.

The sprinkler shall be of 68°C rating, Quick Response Quartzite Sprinkler Pendant type. The sprinkler system shall be fed by independent ICV. ICV shall be provided with Main isolation valve with limit switches for monitoring close and open condition and flow switch in the main riser. The cable from limit switches and flow switch shall terminate in Junction Box for interface with Fire Detection system for annunciation of alarm condition for water flow and close & open condition of main isolation valve.

The sprinkler system shall be hydraulically designed as per NFPA -13. The system shall comprise, the required booster pumps, valves, hook-ups etc. The water required for the sprinkler nozzles shall be obtained from the campus yard hydrant system.

13. Tool hook-up

a. Vendor to hook up the gas facility lines and the required safety features to the process tool.

b. Package of tool install as per each tool requirement.

c. Vendor should have a proven experience in design and installation of the facilities for semiconductor tools.

d. Vendor to provide Gas Hookup for the existing systems such as ICP CVD, ICP RIE, DC/RF Sputtering system, Mask Aligner, *2D anneal furnace*, *CPD*, Oxygen Plasma Etch system and Wet and Solvent bench, as per the port size and type given on individual process tool.

The vendor has to hookup the existing scrubber system for ICP RIE.

Point of connections(poc) shall be provided for other major equipment as mentioned in the utility matrix.

e. Additional 10% of the total number POCs shall be provided.

14. Commissioning & Validation

Facility air supply should be balanced to ensure that the design supply air volume is achieved
Positive differential pressure cascade should be commissioned with the extraction systems running and doors closed
The ISO – 5 (class 100) Lithography Cleanroom will have highest differential pressures, with the differential pressure diminishing across thresholds
The pressure cascade and extraction losses will dictate the fresh air volume of the system, with suitable ductwork leakage factors being taken into account during the detail design stage
Commissioned airflow volumes should be within 10% of design calculations. Remedial action should be required where measured rates are greater or less than 10% of design
Tests shall be performed in accordance with the testing Procedure specified in ISO 14644 **The Contractor should validate the Cleanroom as per ISO14644 & shall include validation of parameters Mentioned below& Submit along with Validation Reports, Test Certificate for equipment/Materials & Detailed engineering drawing** • **Temperature** • **Relative Humidity** • **Particle count** • **Filter Integrity test** • **Air velocity test** • **Differential room pressure test (pressure Zoning)**

• **Recovery test** • **Air balancing.** • **Pressure balancing**
Validation by an independent agency experienced in validation of clean rooms is in the contractor's scope. The "independent" testing firm shall have experience of having conducted Clean Room testing /validation for certification of minimum 2 (two) Class 100 Clean Rooms in the last 5 years.
As-Built room particle counts (as per ISO-14644)
At-Rest room particle counts (as per ISO-14644)
FFM air volumes should be measured with a barometer
Temperature and relative humidity should be measured in each area
Light levels should be measured at the working plane (at a height of 900mm from floor)
Sound levels should be measure to demonstrate the achieved noise spectrum.
Magnehelic gauges should be compared with the calibrated commissioning macro-manometer instrument and adjusted as necessary.
The said independent agency to be deployed by the Vendor shall be approved by IIST.

15. Project Duration, Payment Terms & Warranty:

The turnkey project shall be executed in two (2) Phases. The phase I of the work covers the works of installing Clean rooms including all utilities distribution network, Utilities

Plants/Systems (complete Base Build) etc. The period for completion of Phase 1 shall be 10 months to be reckoned from 7th day of the date of placement of the Purchase Order/Contract signing with the selected Vendor.

Phase II of the work shall cover Tool hook- up and the period for completion of the Tool Hook up work shall be 2 months to be reckoned from 7th day of the date of issuance of instructions by IIST to commence Tool Hook- up work. While it is envisaged that the Tool (Equipment) move-in shall be undertaken by immediately upon certification of the clean rooms under "As Built Condition", in the event there is delay in the Tool move-in due any unforeseen reason, the vendor may, if it so desires, de-mobilize the site, and thereafter re-mobilize the site within two (2) weeks upon instructions from IIST to take up the Tool hook-up work. There shall be no financial implication on IIST on account of de-mobilizing the site by the contractor.

The vendor shall facilitate Tool move-in activity by removing the wall panels etc., as required, for the Tools to be moved to the location within the Clean Rooms, including Bulk-Heading, making cut outs/penetrations in the wall panels, sealing and re-installing the wall panels etc. for smooth Tool move-in activity. The quoted rates shall be deemed to be inclusive of the costs on these activities.

15.1. Project Acceptance/completion:

Project acceptance/completion shall be on successful installation, testing and commissioning of all the systems covered in the contract agreement and acceptance of the project (Phase I&II). Acceptance of the project shall be given by IIST on successful demonstration of all clean room parameters and other system parameters for a period of 4 weeks after commissioning.

The following shall be part of the project acceptance:

i. The Standard Operating Procedure of each gas cabinet, toxic gas monitoring and control system and other equipment to be provided as documentation by the vendor.

ii. Vendor to provide Test & quality certificates from the OEM of all the materials and equipment supplied with all relevant details.

iii. All industrial safety practices to be followed during the implementation of the project. Appropriate training to be provided to IIST staff employed for the facility, with respect to the operation and first level maintenance and monitoring. Vendor should also train the staff to carry out routine measurements of all utility parameters. The vendor must also provide a set of document detailing all protocols. The person should also be trained for purging and changing cylinders and first level of accident containment.

15.2. Payment Terms:

The vendor is expected to submit the relevant submittals as mentioned in section 4.3 before start of the work. The process includes submission of Detailed Engineering Drawings for approval from IIST. The work shall be executed as per the Approved for Construction (AFC)/Good for Construction (GFC) Drawings.

1. **Supply:**

   Vendors to note: 1. Supply cost shall not exceed 75% of the total cost of Supply and Installation, Testing & commissioning for each item of the BOQ.

   2. Payment @60% of the Supply cost shall be made upon delivery at IIST and acceptance of the item by IIST. This acceptance shall, however, not absolve the vendor from the responsibility of satisfactory Testing and commissioning of the item.

2. **Installation:**

   20 % of supply value and 80 % of the value of installation will be paid on installation on milestone basis based on the progress of the project

Milestone	Major activities
Milestone 1: Installation related to cleanroom	Installation of cleanroom fabrics, structural material for support, flooring, coving and cleanroom accessories (As per RFP Section 5, 6, 7, 10)
Milestone 2: Installation of HVAC systems	Chillers, piping, pumps etc. and AHU, Duct, duct insulation, pipe, piping insulation, Dehumidiers, humidifiers etc. (As per RFP Section 7,8,9)
Milestone 3 Installation of Utilities	Installation of utilities, Process Extraction Systems in RFP section 11
Milestone 4: Installation of Gas distribution systems, Building management system, safety systems	As per RFP Section 11, 12 and Annexure 5.

3. Validation and Certification

- The 10% of the supply value and 10% of the installation value will be paid on successful commissioning and testing and validation (As Built)
- The final 10% of the project value will be paid on Tool Hookup, Validation (Validation At Rest") of cleanroom, validation of gas distribution system and other utilities mentioned in RFP and submission of validation document approved by IIST and expiry of the warranty period of three (3) years.

In lieu of cash retention of the 10% of the supply and installation value, the vendor shall have the option to provide Bank Guarantee of equivalent amount valid till the expiry of warranty period.

15.3. Warranty and AMC

1. Vendor shall provide three (3) year on-site comprehensive warranty for the entire installation and include the same in their base price. The warranty shall be for 3 year from the date of installation and acceptance on successful commissioning. 2. During the warranty period vendor shall carry out Preventive Maintenance once every quarter at his own cost. Further, Vendor shall attend to break-down in any of the installation performed under the PO/Contract at his own cost within 48 hours of intimation from IIST.
3. Vendor shall also quote post warranty 5 -year comprehensive AMC price separately, as an option.

16. General Conditions:

A. Build Clean Protocol

Entry to the work area shall be restricted to vendor's authorized personnel and IIST concerned staff. Standard Build clean protocol during installation and testing/certification as applicable for Class 100 and Class 1000 Clean Rooms shall be strictly followed by the vendor who shall arrange at his cost shoe covers, Booties, Masks, Hand Gloves etc. for vendor's workmen, supervisor(s) and **IIST** staff. No street shoes shall be permitted in the work area. Regular cleaning of the work space/area by deploying adequate workmen and using industrial vacuum cleaners, lint free and low particulate Clean Room wipes suitable for Class 100/Class 1000 etc. shall also be vendor's responsibility at no extra cost to IIST. Vendor shall ensure that Tools

for installation are cleaned up regularly using Class 100/1000 Clean Room compatible tissue papers, lint free wipes, and Isopropyl alcohol wipes etc. to ensure use of clean tools & tackles.

B. Safety

Vendor shall ensure adherence to safe construction practices which shall inter-alia include use of Personnel Protection Equipment (PPE) by their workmen, supervisors etc. deployed on the work. PPE viz., safety helmets, safety shoes, harnesses, safety glasses, gloves etc. shall be provided by the vendor for the safety of all the personnel at the site of work. Vendor shall take adequate measures to ensure that no damage or loss is caused to IIST's buildings, equipment and personnel due to any activity carried out by the vendor relating to the performance of the Contract. Vendor shall be liable to make good the loss/damage including any consequential damage caused by them and in case of failure to do so, IIST shall effect financial recovery for the same from the vendor.

C. Technical Manpower

The contractor shall deploy qualified and experienced engineers and supervisory staff during execution for an efficient and effective supervision of the work ensuring compliance to the specifications and the AFC/GFC drawings. The Project Manager shall have experience of 7 years (minimum) post degree qualification in Engineering in relevant field, and the engineers shall have experience of 3 years post degree qualification in Engineering or 5 years' experience post Diploma in engineering in the relevant field.

The technical manpower strength shall be: one (1) Project Manager and two (2) engineers' minimum during the project execution.

D. **Co-ordination**

Work shall be carried out in a coordinated manner by the vendor with all concerned agency(ies) for smooth implementation of the Project

E. Materials

All material selection shall be as per the Recommended Makes listed in this Document.

F. **Site Visit**

Interested bidders may visit the site of work to get fully acquainted with the site conditions, on any working day(Monday-Friday) between 9.00 A.M. to 3.00 P.M. up-to one week before the bid closing date for bid submission.

G. **Electricity**

Electricity required for installation shall be provided by IIST at no charge basis to the vendor. For this, electricity connection will be provided at single point and further distribution shall be the vendor's responsibility. Vendor shall provide wattage of all the electrical loads required for installation and install all safety and protection devices viz., MCB/MCCB/ELCB/RCCB etc. as per the applicable electricity rules.

H. Civil Works

Civil works for utility buildings/machine foundations etc. and pregowning shall be carried out by IIST as mentioned in this document.

I. Security Procedure

Vendor shall be required to follow the security procedures in vogue at IIST for the movement of vendor's personnel, materials etc. into/from IISTcampus.

J. Labor Hutment; Site office; Storage space

No labor hutment shall be allowed inside IIST premises. Vendor shall make necessary arrangement for the accommodation of their labor/workmen to be deployed by them for project execution at their own cost. Vendor shall be permitted to construct temporary site office near the site office for their staff.

Vendor shall also make temporary storage shed for the materials brought to site by them for incorporation in the work, at their own cost close to the site of work.

17. Recommended Makes

Note:

Department of Avionics
Indian Institute of Space Science and Technology
Department of Space, Govt.of India
Valiamala P.O., Thiruvananthapuram – 695 547
Kerala, INDIA

✍ It is mandatory to choose items with models satisfying the respective technical specifications from this list of recommended makes.

Item Category	**Recommended Mak List**
Cleanroom Fabrics	
Wall Panel Aluminimum Honey comb panels- cleanroom doors & accessories in cleanrooms	Plascore/Channel system/American Cleanroom Systems/ Modular Cleanroom
Heavy duty Aluminimum ceiling grid	CHANNEL SYSTEM / PLASCORE/ AAF/ American Cleanroom Systems /Modular Cleanroom/MAY AIR
Cleanroom PUF Panel	NICOMAC/ICLEAN/FABTECH/GMP TECH/ AHLADA
Aluminimum/PVC COVING	NICOMAC/ICLEAN/FABTECH/GMP TECH/ AHLADA
Door Closure	DORMA/EVARITE
Doors in outer periphery of service corridor.	Air tight PUF panel doors with all hardware (locks, handles, SS hinges, Tower Bolts etc. of approved make), door seal; Fire check doors shall be provided with panic bar. NICOMAC/ICLEAN/FABTECH/GMP TECH/AHLADA
ESD Flooring	FORBO/VPI Corporation/GERFLOR/MICRON SYSTEM
Air shower	I clean/ Fabtech/GMP/Nicomac/Ahlada
Garment storage Cubicle	I clean/ Fabtech/GMP/Nicomac/Ahlada
Pass box.	I clean/ Fabtech/GMP/Nicomac/Ahlada
Fan filter unit (FFU or FFM) with HEPA	**EXYTE/CAMFIL/AAF/ MAYAIR/NITTA /ENVIRCO**
HEPA Filters H-14	**CAMFIL/AAF/ MAYAIR/NITTA /ENVIRCO**
Magnehelic gauge	WAREE/DWYER
RH and temperature indicator	Siemens/Honeywell/VAISALA
HVAC SYSTEMS	**HVAC SYSTEMS**
Air cooled Condensing units/chiller	**Carrier/ Climaventa -Mitsubishi /Trane/Daiken**
Motors	CROMPTON GREAVES/ABB/SIEMENS/BHARAT BIJILI

Starter	Siemens/ABB/L&T/SCHNEIDER
Insulation	ARMAFLEX/K-FLEX/SUPREME/TROCELLENE
AHU	CITIZEN/FLAKTWOODS/EDGETECH/SYSTEM AIR
AHU blower	NICOTRA/KRUGER/Ziehlabegg/Greenheck
Pumps	Johnson/Grandfos/Armstrong/ Bell and Gossette/ Tour & Anderson
Isolation valves	L&T/Microfinish/Avcon/Advance
Check Valve	Advance/Inter valve/L&T
MS Pipe	Tata/SAIL/Jindal
Three way motorized flow control valve	Siemens/Johnson control/Honeywell/Sauter
Exhaust Fans	Sarala/Suburban/Balti boy/Flakt/Kruger/Nikotra
SS Pipe	Nikka/Ratanamani/Jindal
Pre filter and Fine filter	**AAF/DYNA/Camfil/Freedenberg/NITTA/MechMaark**
Thermostats/Humidistat	SAUTER/SIEMENS/JOHNSONS/HONEYWELL
Grills/Diffusers/Dampers	Air Master/System Air/Cosmos/ Caryaire/Dyne craft/Ravi star
Dehumidifiers	Bry AIR/Munters/
Fire damper actuator(Motorized)	HONEYWELL/SIEMENS/BELIMO/JOHNSON/SYSTEM AIR
PAN HUMIDIFIERS	Nordmann/Walter Meier/ Rapid Cool or equivalent
Heaters	Heatcon/Daspass/Escorts/KEPL/Rapid Cool
GI sheets	Sail/Jindal/Tata
	ELECTRICALS & BMS MAKES
Electrical LT Panels/ MCC PANEL	CPRI Approved
Air Circuit Breaker & Bus Couplers	L & T/Siemens/Schneider/ABB
MCCB	L & T/Siemens/Schneider/ABB/CG/Hagger
MCB's	L &T/Siemens/Schneider/ABB/CG/Hagger
Power/Control Contacts, Over load Relays, Timers, etc.	L & T/Siemens/Schneider/ABB.
Switch gear	Schneider/ABB/Seimens/L&T
Fuses	Cg/L & T/Siemens
Energy Meters	L & T/Conserve
Power Cables/Control Cables/Wires etc.	Polycab/Havels/Finolex/Universal/KEI
Cable Trays	INDIANA/MEK/Equivalent
Electrical Conduits	Bharat/Gupta Or Equivalent Make With ISI mark.
Switches & Sockets	Mk/Hagger/Lingguard

Modular Switches & Sockets	CRABTREE / NORTH WEST / HAVELLS / ABB /LEGRAND
Industrial type Metallic plug sockets	LEGRAND / CG / ABB/ SIEMENS / INDOASIAN /L&T
MS Conduits Accessories	AKG, BEC , BHARATH OR ISI EQUIVALENT
GI CONDUITS	TATA , JINDAL , ZENITH
VFD	ABB/SEIMENS/DANFOSS/SCHNEIDER/Equivalent
Tear Drop Light Fixtures(Yellow & White)	Philips/Wipro/Havels/Channel Systems/AAF
Yellow films for glazed surfaces/view windows, doors	Uv Process Usa / Channel System/ or equivalent
Standard Light Fixtures	**Philips/Wipro/Havels/ Starlight /PMEA**
JUNCTION BOXES	HANSEL, L&T, LEGRAND, ABB, SCHNEIDER
LED Monitor	SAMSUNG / PANASONIC / LG/ SONY
COMPUTER SETs	HP, DELL, IBM
BMS	Honeywell / Siemens/ SCHNEIDER/Equivalent
Temperature/RH /Pressure sensor	Honeywell / Siemens/Equivalent
For monitoring (PLC, SCADA and HMI)	For PLC &HMI: Siemens, Omron, Mitsubishi, Allen Bradley, Delta For SCADA :Wonder ware, Movicon
	Makes GDS Systems
Gas Cabinets & Gas Control Panels,VMB,VMP	**Applied energy Systems/Air products/Sempa Systems/ JIN Solutions/Kelington-(SEMI S2 CERTIFICTION MANDTORY)**
Gas Regulators and other components	Parker, Swagelok, APTech, Tescom, Rotarax
High Purity tubing, Coaxial tubing & fittings SS 316 EP	**Valex, Dockweiler, Sandvik, DK LOK, Swagelok/Parker**
Diaphragm Valves	Parker/ Swagelok/ AP Tech/ Tescom/Hamlet/ Rotarax/ DK-LOK
Gas Detectors	Honeywell, Draeger, MDA, Bionics,Riken kikki,Pro-sense
Pressure gauges	TK Fujikin/ Wika/Tescom/ Swagelok
Gas Purifiers	Saes/Entigris / Piccolino/Tera
SCADA, HMI	Siemens/ ABB / Honeywell

Micron Filters	Pall, , Dominick hunter, Porvair
Tube clamps	Swagelok/Stauff
Anchor fasteners	Hilti/Bosch
Fire Suppression System	Honeywell, NAFFCO
Unistrut support system and accessories (Nuts, bolts, L plates, straight plates, all GI items)	RSSIPL/SSS/JHAAPS/ HILTI
Particle counter	TSI/Lighthouse/PMS
	EXHAUST SYSTEM SMAKES
ACID SCRUBBER	JR FIBRE GLASS/ Kosyma/CK AIRTECH/SM Air
ACID EXHAUST FANS	JR FIBRE GLASS/ Kosyma/CK AIRTECH/SM Air
DRY SCRUBBER	REHOBOTH Systems/ CLEANSORB/
General/ Dry scrubber Exhaust Blower	Kruger / Nicotra/ Comferi/Greenheck
Dosing pumps	Standard make
Recirculating pumps	Grundfoss /KSB/Kirloskar
Pipe and pipe fittings	Grundfoss /KSB/Kirloskar
SS 304	sigma roto lining/Equivalent
GI spiral ducts	GI spiral ducts/ Hyderabad tubes
PP FRP ducting	JR FIBRE GLASS/ Kosyma/CK AIRTECH
Supporting Structure	JINDAL/TATA/SAIL/
BUTTERFLY VALVE	Castle / Audco/Advance/Belimo
BALL VALVE	Castle / Audco/Advance/RB
NON RETURN VALVE	Castle / Audco/Advance/
Y-STRAINERS	Sant/Emerald/Equivalent
RUBBER BELLOWS	Standard make
3 -WAY VALVES	Honeywell / Siemens/Belimo

WATER FLOW SWITCH	Honeywell / Siemens/Belimo
TEMPERATURE GAUGE	Waree / Wika/H Guru
PRESSURE GAUGE	Forbesmarshall / Wika/H Guru/Sevacon
SS/ GI DUCT SHEETS	Tata /Sail/Jindal
VCD	Air master / Cosmos /Rehoboth/ Ruskin Titus / System air/
FIRE DAMPER & Butterfly	Air master / Cosmos /Rehoboth/ Ruskin Titus / System air/
ACTUATORS	Honeywell / Siemens/Belimo
PRE /FINE FILTERS	AAF/Freedenberg/Spectrum/ Thermodyne
SS 304 pipes	JR FIBRE GLASS/ Kosyma/CK AIRTECH/

18. Annexures

SNo.	Annexure	Content
1.	Annexure 1	IIST Cleanroom layout
2.	Annexure 2	Site details with relevant drawings , conceptual P&ID drawings
3.	Annexure 3	Equipment Power Rating
4.	Annexure 4	Matrix for Clean room and Utility Design
5.	Annexure 5	Fire Detection System and Control Panel Specifications
6.	Annexure 6	Model BOQ (Sheet)
7.	Annexure 7	Compliance Matrix
8.	Annexure 8	Supporting documents of process tools for hook up (Additional reference for Annex.4)