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TECHNICAL SPECIFICATION
&
DRAWING

FOR

CLEAN ROOM INFRASTRUCTURE WORKS AT NATIONAL PHYSICAL LABORATORY, PUSA CAMPUS, NEW DELHI

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Technical Specifications

1) Wet Benches:

a) Crystalline Si Solar Cells

**Wet bench (No. 1)** for organics cleaning

- Samples/wafers Size: 156mm x 156mm
- Cleaning tank Size: 200mm (L) x 200mm (W) x 250mm (H)
- No. of tanks: 7 nos
- TCE, Acetone, IPA, DI water (All with ultrasonic agitation & heater upto 80±1 deg C)
- NaOH (with magnetic stirrer, ultrasonic agitation & heater upto 150 ± 1 deg C)
- DI water and dryer
- Tank material: TCE, Acetone, IPA, Dryer: PTFE
  - NaOH and DI water: PVDF
- Material of the body: HDPP
- Size of work surface: 2200mm (W) x 850mm (D) x 950mm (H)
- Overall size: 2250mm (W) x 1150mm (D) x 2200mm (H)
- Work surface will be perforated PTFE with slider, shield in front of the work area
- Organic tanks TCE, Acetone and IPA will be connected (separately) to 2” HDPP drain to be collected outside the service area;
- NaOH tank will be connected to 2” HDPP drain to be collected at ETP container.

**Wet bench (No. 2)** for acid cleaning

- Samples/wafers Size: 156mm x 156mm
- Cleaning tank Size: 200mm (L) x 200mm (W) x 250mm (H)
- No. of tanks: 8 nos
- RCA1, RCA2, Pirana and HF (with temperature control 180 ± 1 deg C), DI water, Metal etch (with temperature control 100 ± 1 deg C with magnetic stirrer), CP4 (with magnetic stirrer, temperature 4-100 deg C, control ± 1 deg C), drying.
- Tank material: RCA1, RCA2, Pirana, HF, CP 4: PTFE
  - Metal etch, DI water, Drying: PVDF
- Material of the body: HDPP
- Size of work surface: 2400mm (W) x 850mm (D) x 950mm (H)
- Overall size: 2500mm (W) x 1150mm (D) x 2200mm (H)
- Work surface will be perforated PTFE with slider shield in front of the work area
- All acids RCA1, RCA2, Pirana, HF, CP4 and metal etch will be connected (separately) to 2” HDPP drain to be collected at ETP container.
b) Amorphous Silicon [Wet bench (No. 3)]
   Should have partition for organic and acid cleaning
   Samples/wafers Size: 100mm
   Cleaning tank Size: 150mm (L) x 150mm (W) x 150mm (H)
   No. of tanks: 6 nos
   Partition #1 : HF, DI water and Dryer
   Partition #2 : Acetone/TCE/ IPA (2 tank), and NaOH
   All Tank material: PTFE
   Material of the body: HDPP
   Size of work surface: 1800mm (W) x 850mm (D) x 950mm (H)
   Overall size: 2000mm (W) x 1150mm (D) x 2200mm (H)
   Work surface will be perforated SS304 with slider shield in front of the work area
   HF tank will be connected to 2” HDPP drain to be collected at ETP container.
   NaOH tank will be connected to 2” HDPP drain to be collected at ETP container.
   Organic tanks TCE, Acetone and IPA will be connected (separately) to 2” HDPP
   drain to be collected outside the service area;

   All wet benches will have automatic control and processing. Acid and solvent drains will
   be provided with solenoid operated valves.

   All wet benches will be provided with fresh water shower and a nitrogen gun SS304.
   Exhaust fans and exhaust ducting is in the scope of the wet bench provider.
2) Nitrogen supply:

a) General Nitrogen, 99.99% or better purity required for dry pump purge and scrubber purge

**General Nitrogen**: Nitrogen plant with capacity of 1000 LPM at 100 psi.

The gas lines will have to be ½” SS304/SS316 to be laid from nitrogen plant to various points of use branching to ¼” and feeding to single stage regulators to be used at various tools.

Line length required for general nitrogen plant to various labs: ½” SS304; 300 meters approx including all fittings, valves etc.
Line length required for general nitrogen from service corridor to tools: ¼” SS304; 200 meters approx including all fittings, valves etc.
Line length required for general nitrogen to Characterization area: ¼” SS304; 100 meters approx including all fittings, valves etc.
3) Installation of high purity gas lines and gas line hook-ups:

Gas lines required for the facilities is as follows:

High purity Toxic & hazardous gases:

From safety point of view double wall electro-polished SS 316L ¼" piping from gas cabinets to tools is preferred as follows:
Crystalline Silicon PV: Approx 200 meters (As per site) for SiH4, NH3, CF4, PH3, B2H6, SF6
Amorphous Silicon PV: Approx 200 meters (As per site) for PH3, SiH4, B2H6, NH3, H2 and CH4

High purity non-hazardous gases:
Single wall electro-polished SS316L ¼" piping from gas cabinets to tools as follows:
Crystalline Silicon PV: 200 meters for Ar, N2, O2, N2O
Amorphous Silicon PV: 200 meters for SF6, Ar, N2
4) Installation of Gas cabinets:

Gas Cabinets are required for full-size cylinders with size in the region of 1500mm height and 250mm diameter. Gas cabinet must be designed for full size cylinders with two cylinders per cabinet with sufficient space left for gas regulators, auto shut-off valves and gas detectors. The gas cabinets will have adjustable stand to place smaller cylinders, if required. Hence the total number of gas cabinets required is 4; 1 in 3 labs to accommodate 6 toxic gas cylinders for each lab with one spare.

The proposed size of gas cabinets is as follows:

750mm (W) x 400mm (D) x 2000mm (H)

**Material of construction:** 2 mm thick MS powder coated with 100mm dia exhaust pipe on the top and 50mm holes with wire mesh one each on each side at the bottom.
5) **Toxic gas detection system with auto shut-off valves:**

The detection of all toxic and hazardous gases based on sensitive sensors with removable detection cartridges. So the entire system involves the following:

a) Sensor cartridges: one each at the source (gas cabinets) and the point of use (tool), Total number required: 4 x 2 (8 nos) for all the labs handling toxic and hazardous gases. Gases to be handled are already been listed above and are the following:
   SiH4, NH3, CF4, N2O, SF6, PH3, B2H6, H2 and CH4 – some of them are in multiple locations

b) Auto shut-off valve (solenoid operated): with VCR fittings right at the regulator output of the toxic gas (to shut-off gas source in case of leakage).

c) Central cabinet: which gets signal from detectors and processes alarm and closes auto shut-off valves in case of leakage. The central cabinet will have all hardware, software and appropriate drivers.

d) All the cabling required from central cabinet to detectors, auto shut-off valve and alarm devices.

e) The central cabinet will have its own UPS system.

The entire system will be integrated at one place in the lab. This is essential from safety considerations since if there is any leak in one lab, all the occupants of the clean room facility should get the alarm so that appropriate action can be taken.
6) Supply & Installation of Abatement system (Gas Scrubbers) for toxic/hazardous gases:

a) One scrubber will be required having four inputs with NRVs. Thermal Processing Units (TPUs) which are based on butane gas for burning the gases and with water shower for wash-out of the remaining effluents will be used.

The scrubber will also require appropriate input piping either with HDPP or SS304 (40mm dia) with KF40 fitting to be connected with scrubber input. HDPP exhaust pipe of 100mm dia will be used for scrubber exhaust. The exhaust rating will be as specified by scrubber manufacturer and will be in the range of 500 CFM. 100mm dia exhaust pipe will be connected to 250mm dia main exhaust pipe.

b) Water Sprinkler based abatement system is required as a standby. Two types of sprinkler based abatement systems be used. In the first type, abatement system will be used along with TPU scrubber, to be used only in case of failure of TPU scrubber. In the second type, sprinkler will be provided in the exhaust of the chemical wet benches at appropriate place. This will have to be installed in line from the chemical bench. All acid benches will have sprinklers in the exhaust lines to neutralize the acid fumes going in atmosphere.
7) DI water system:

a) A centralized RO plant capable of generating 100 LPH of RO water of ~ 2 meg ohm resistivity and a storage tank of 1000L capacity. Tank will have its own pump for pumping water and appropriate level sensors.

b) DI water plant Capacity: 25 LPM at centralised location with 3 nos point of use; Crystalline Silicon, Amorphous Silicon and Organic PV labs in the service area.

c) 3/8” or ½” PVDF line will be connected from tank/pump to DI water system.

d) The DI water system will have in-built resistivity meter to monitor the resistivity of outgoing water.
8) Effluent Treatment Plant (ETP):

Three types of effluents will be generated in the labs and hence will have to be disposed off separately.

a) Acid based effluents: HF, HNO₃, H₂O₄, H₃PO₄, HCl, etc. will be collected in PP drums, capacity 200 L, at the site of Effluent Treatment Plant. There will be HDPP pipes laid from Wet bench (in the labs) right upto ETP plant and the acid effluents will be transported by gravity. The total length of the piping is not expected to be more than 100M so that a reasonable slope can be provided from wet bench to ETP location for the flow of effluents.

b) Alkaline effluents: KOH, NaOH, NH₄OH, etc. will be collected in PP drums, capacity 200 L, at the site of Effluent Treatment Plant. There will be HDPP pipes laid from Wet bench (in the labs) right upto ETP plant and the alkaline effluents will be transported by gravity. The total length of the piping is not expected to be more than 100M so that a reasonable slope can be provided from wet bench to ETP location for the flow of effluents.

ETP will be located within 100M of the labs at a level which will provide sufficient gravity for the flow of various acid and alkaline effluents from various labs to the storage site at ETP. ETP will have a treatment capacity of 500L and each acid/alkaline effluent will be treated separately using appropriate neutralizing agents. The salts generated thereby will be disposed off through external vendors.

Drains:

Labs will have four types of drains.

a) General drain for washing out the work surface with fresh water and disposal of water used for rinse. The piping will be 2" HDPP connected from the wet bench to general drain.

b) Drain for organics effluents: This drain will be connected from the wet benches from various labs to the collection drums kept outside the lab. So
effluents such as TCE, Acetone, IPA, etc. will flow from gravity from the wet bench to the collection drum. 2” HDPP pipe will be used for the drains.

c) Drain for acidic effluents: This drain will be connected from wet benches from various labs to the collection drums kept near the ETP. The acid effluents will flow by gravity to be collected near ETP. 2” HDPP pipes will be used for acid effluents HF, HNO₃, H₂O₄, H₃PO₄, HCl, etc. discharged from various labs.

d) Drain for Alkaline effluents: This drain will be connected from wet benches in various labs to the collection drums kept near the ETP. The alkaline effluents will flow by gravity to be collected near ETP. 2” HDPP pipes will be used for alkaline effluents KOH, NaOH, NH₄OH, etc. discharged from various labs.
Testing and Validation:

a) Pressure Testing: The entire installation shall be validated by IIIrd party for Pressure testing as per relevant ASME standards.

b) Helium Leak Testing: Helium leak testing shall be carried out with dry vacuum pump having leak detection capability upto $1 \times 10^{-11}$ mbar He ltr/sec and shall pass minimum level of $1 \times 10^{-9}$ mbar He ltr/sec.

c) Trace Moisture: less than 1ppm . This will be conducted at all hook up points using analytical equipment having capability to measure as low as 500 ppb moisture.

d) Trace oxygen: Less than 1 ppm. This will be conducted at all hook up points using analytical equipment having capability to measure as low as 500 ppb oxygen.

e) Particle count: 0.1 micron and above. After Trace moisture and Trace oxygen analysis, all the Gas lines will be tested for the particle contamination before charging the process gas. Particle counter shall have capability of measuring particle size as low as 0.1 micron using high pressure diffusion device.

A third party duly approved by NPL/EPI to be engaged by bidder at his own expenses for validation.
List of Preferred makes

1.0 Wet Benches:

1.1 Better Process Systems Inc.
   3942, Valley Avenue Suite J, Pleasanton, CA, 94566.

1.2 Class One Equipment, Inc
   5302 Snapfinger Wood Drive Decatur, Georgia 30035 United States

1.3 Wafer Process Systems Inc.
   3641 Charter Park Drive, San Jose, California 95136

1.4 MEI, LLC Corporate Headquarters - Oregon
   3838 Western Way, NE Albany, OR 97321

1.5 Clean Room Solutions Limited
   P O Box 5156 Hove East Sussex BN 9GJ
   OR equivalent.

2.0 Gas Cabinets:

2.1 Shavo Technologies Pvt Ltd, Pune

2.2 UHP Technologies Pvt Ltd, Mumbai.

2.3 Applied Energy Systems, Inc, 180, Quaker Lane, Malvern Pa, 19355

2.4 Safety Equipment: 1141 Old County Road Belmont, CA 94002
   OR equivalent.
3.0 DI Water Plant:

Millipore (India) Pvt Ltd, New Delhi or equivalent.

4.0 RO system:

4.1 Bionics Advanced Filteration systems Pvt Ltd, Delhi.
4.2 Metro Electronics Lab, Delhi.
4.3 Chemtronics, Mumbai.
4.4 Rions India, New Delhi.

OR equivalent.

5.0 Gas leak Detectors: Honeywell, Draeger, Bionics, Cosmos or equivalent.


7.0 Seamless tubing: Valex USA, Sandvik Sweden, Dockweiler Germany, MASCO Korea or equivalent.

8.0 Tube Fittings, Ball and Diaphragm valves: Swagelok USA, Rotarex France, Parker, Hamlet or equivalent.

9.0 Nitrogen gas generator: M/s Peak Scientific USA (19 Sterling Road Suite #1, Billerica, MA 01862 USA, M/s Peak Scientific India (202, Amsri Shamira, Old Lancer Line, Opp. St. Mary's Degree College, S.D. Road, Secunderabad 500025, India), MVS Engineering Limited, New Delhi or equivalent
Notes:

1.0 Any other material for which preferred make is not mentioned above, the contractor shall take prior approval of the make from EPI/NPL before procurement of the same.

2.0 Except the proprietary items, other bought out items shall be supplied from reputed make. For supply of such bought out items prior approval for make from Engineer In-charge is must at the time of execution. Successful bidder shall submit all supporting documents like supply/installation list, test certificates etc. (Documents for at least three installations of these items in last five years) for approval of make of such items. Engineer In-charge shall have the right to reject/accept any of the make based on documents submitted. The decision of Engineer In-charge in this regard shall be final and binding on supplier.