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CFB, Trombay  
MUMBAI - 400 085

**GOVERNMENT OF INDIA  
BHABHA ATOMIC RESEARCH CENTRE  
Cryo-Technology Division**

Ref: BARC/CrTD/2018/OPA/171727

Date: 05/09/18

**Sub: Invitation to submit your quotation**

On behalf of the President of India, Head, Cryo-Technology Division, Bhabha Atomic Research Centre invites lowest quotation in sealed envelope for the work given below as per the technical specifications enclosed herewith.

S. No.	Description of Job	Completion Period
1	Minor fabrication work for High Pressure External Helium Purifier at CrTD, CFB as per detailed specifications	4 months from date of W.O.

**The terms and conditions are given below:**

**1. Qualifying criteria for bidders**

- 1.1 Firms willing to bid for above mentioned job shall have been vetted by Security Section of BARC.
- 1.2 All the supervisors and workers should have valid Police Verification Certificate (PVC). The list of manpower available with firm shall be submitted along with their details of PVC.
- 1.3 The past work experience certificate of the firm of similar nature in BARC/DAE shall be made available with Work Order copy and satisfactory completion certificate from the user. Also the list of ongoing jobs inside BARC premises with expected completion period shall be provided.
- 1.4 The firm having past experience (minimum of 3 years) in handling fabrication work of cryogenic equipment & piping or similar nature of work in BARC/DAE, only need to apply for this work.
- 1.5 Interested bidders shall contact the undersigned on Phone No. 2559 6819 (Ext. No. 26819) with above mentioned details for getting the Detailed Tender Specification.

2. Detailed job description & scope of work: As per Annexures I & II.

3. Facilities required at firm's site: Machining & fabrication facilities for fabrication of cryogenic equipment & piping, Pressure & leak testing (especially Helium MSLD) facilities for testing of fabricated equipment & piping.

4. The quotation envelope shall be superscripted with **Description of the job and the Tender Ref. No.**, Attn., Sandeep Nair, mentioned above.

P.T.O.

5. The complete quotation shall reach the following address on or before 04/10/2018 by **Registered Post/ Speed post**. The quotations will be opened on the next working day at Cryo-Technology Division, BARC between 1400 to 1600 Hrs.

Head,  
Cryo-Technology Division, CFB,  
Bhabha Atomic Research Centre,  
Trombay, Mumbai- 400 085

6. **There is no FIM.**
7. **Printed Letter Head:** Quotation should be printed on the letter head; computer generated quotation is not valid.
8. **Validity of the Offer:** Validity of the offer shall be 90 days from date of opening of quotation.
9. **Guarantee:** Vendor shall have to give guarantee of the quality and workmanship of work done for the period of 12 months from the date of completion of the work.
10. **Offer of Firm:** Offer of those firms, who do not submit their quotation as per the details given in the technical specification and incomplete quotations in any respect shall not be considered. Contractor shall quote lump sum price for the execution of the complete job
11. The department reserves the right to extend the date of opening the quotations.
12. **Payment Terms:** Accounts Division BARC Mumbai-400085 shall make full and final payment only after submission of the satisfactory work completion certificate issued from the undersigned, bill, guarantee certificate, delivery chalan, ECS and advanced stamped receipt. No advance is admissible.
13. **Income Tax Recovery Clause:** Income tax @ 2% will be deducted from the bill.
14. If any of the employee, consultant, or partner of the company is an Ex BARC employee, the same must be stated in the quotation clearly.
15. **Penalty:** Any delay which attributable to the contractor is liable for penalty @ 0.5 % per week (max 5 %) to be imposed on contractor.
16. **ST/VAT/PAN Number:** Quotation shall consist of GSTN number registered with local GST authority /CGST authority and PAN number of the firm.
17. **Quantity Variation Clause:** Quantity variation of  $\pm 10\%$  is possible during the execution of the job. Actual payment shall be made based on the actual work carried out by the contractor after completion of entire job.

**18. Safety & Security Rule:** The vendor shall follow all the safety procedures as per the normal industrial practice during the execution of the job at site. Any mishap occurring during the work due to unsafe workmanship shall be the vendor's liabilities. Security and transportation rules at BARC, Trombay premises shall be strictly followed.

**19. Confidential Clauses:**

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

**ii. "Restricted information" categories under section 18 of the Atomic Energy Act, 1962 and "Official secrets" under section 5 of the of the Official Secret Act, 1923:** Any contravention of the above mentioned provisions by any contractor, sub- contractor, consultant, advisor or the employee of a contractor will invite Penal consequences under the aforesaid legislation.

**iii. Prohibition against use of BARC's name without permission for any publicity Purpose.** The contractor or Sub contractor, consultant, advisor or the employees engaged by the contractor shall not be use any public purposes through any media like press, TV, or internet, without the prior written approval of BARC

*R.S. Nair*  
*05/09/18*  
( Sandeep Nair R. )  
Scientific Officer – E  
CrTD, BARC

वैज्ञानिक अधिकारी ( E ) / Scientific Officer ( E )  
कार्यो-प्रौद्योगिकी प्रभाग / Cryo Technology Division  
भारत सरकार / Government of India  
भाभा परमाणु अनुसंधान केंद्र / B. A. R. C  
ट्रॉंबे / Trombay, मुंबई / Mumbai-400 085

## **Annexure- I**

### **Technical Specifications Data Sheet for External Helium Purifier**

The purifier shall consist of the following components:

1. A drier unit, operating at ambient temperature and design pressure, consisting of molecular sieve 13X, for removal of water vapour down to 1 ppm (vol. basis) levels.
2. A heat exchanger to cool the inlet impure Helium stream with the exit purified Helium. This will be a helical coil-inside-coil type of heat exchanger.
3. A subcooler, which will reduce the temperature of impure helium stream to around LN<sub>2</sub> temperature and enable condensation of nitrogen impurity. This will be a pipe wound in the form of a helix.
4. A liquid nitrogen/ air separator, cyclone separator with a collector for nitrogen condensed in the subcooler coil.
5. A charcoal adsorber, for removal of remaining nitrogen impurity by cryo-adsorption.
6. A cryostat, which shall house the subcooler coil, the liquid air separator and the charcoal adsorber immersed in liquid nitrogen while the helical coil inside coil heat exchanger will be housed in the vapour space above the level of liquid nitrogen inside the cryostat.
7. A liquid nitrogen level sensor.
8. Interconnecting pipelines and valves.
9. Vacuum system to evacuate the annular space of the liquid nitrogen vessel.

**Schematic:**

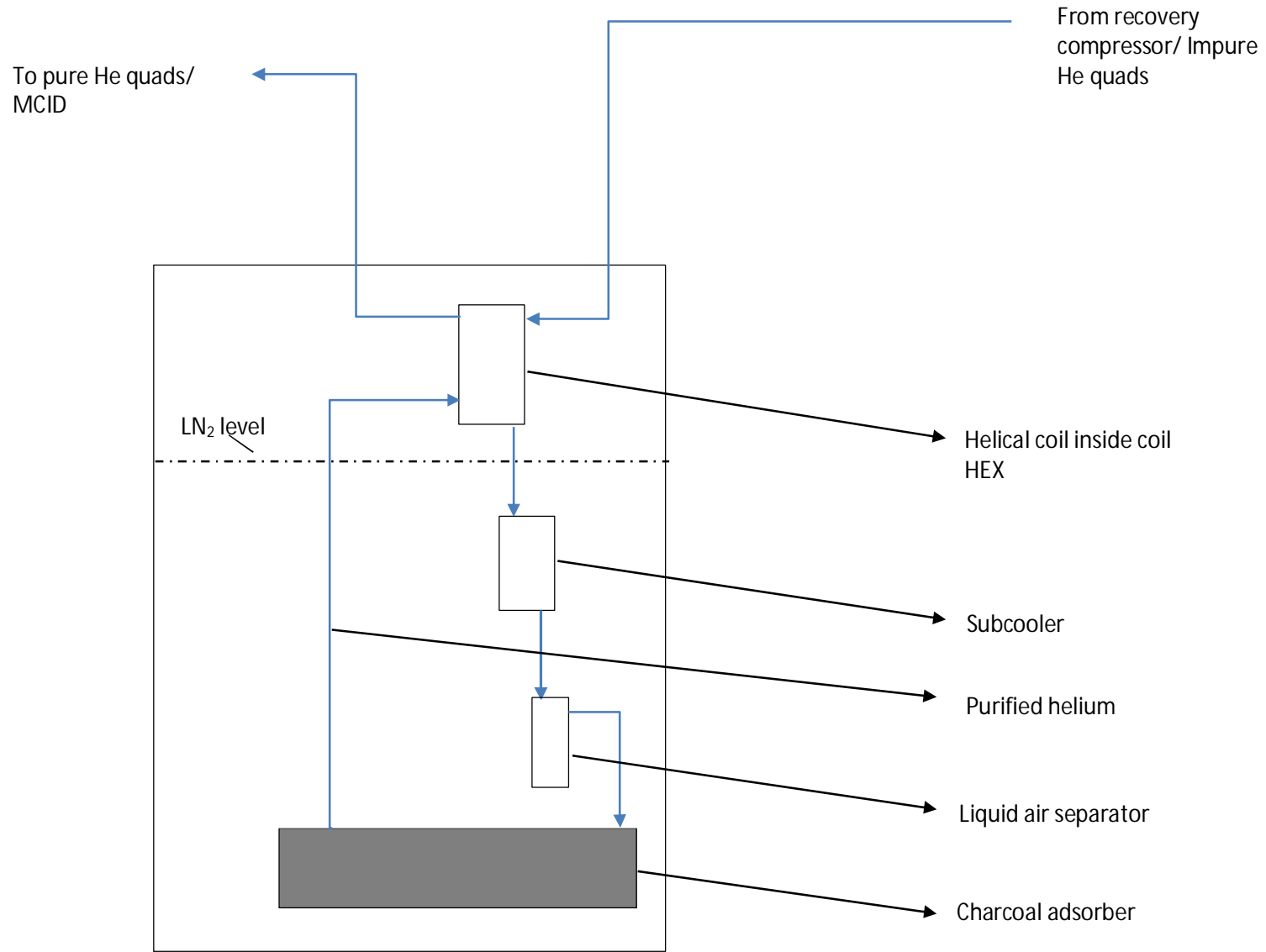


Fig.1 Schematic of external Helium purifier

**Detailed design:**

**a. Design of drier unit:**

As described in the specifications, the drier unit shall contain pelletized molecular sieve (MS) 13X. The design details are as under:

Table 1: Specifications of Drier unit

<b>Parameters</b>	<b>Values</b>	<b>Units</b>
<b>Design pressure</b>	200	Bar(a)
<b>Design temperature</b>	200	°C
<b>MOC</b>	SS 304L/316L	-
<b>Vessel size</b>	50 NB Sch. 80 pipe	
<b>Length</b>	700	mm
<b>Top end</b>	Torispherical	-
<b>Top end thickness</b>	10	mm
<b>Bottom end</b>	Torispherical	-
<b>Bottom end thickness</b>	10	mm
<b>Adsorbent quantity</b>	1	kg
<b>Adsorbent bulk density</b>	721	kg/m <sup>3</sup>

**b. Design of Helical coil inside coil heat exchanger**

This heat exchanger will reduce the temperature of incoming impure Helium stream flowing in outer helical tube to around 100 K by heat transfer with the outgoing purified stream, which flows counter current to the impure stream inside an inner helical tube.

Table 2: Specifications of heat exchanger

<b>Parameters</b>	<b>Inner coil</b>	<b>Outer coil</b>	<b>Units</b>
<b>Inlet temperature</b>	77	300	K
<b>Exit temperature</b>	97	280	K
<b>MOC</b>	SS 304L/316L	SS 304L/316L	-
<b>O.D.</b>	10	16	mm
<b>Thickness</b>	1	2	mm

<b>PCD</b>	300	mm
<b>Pitch</b>	20	mm
<b>Length of coil</b>	8.5	m

**c. Design of subcooler coil:**

Subcooler coil is a helical tube, immersed in liquid nitrogen bath, downstream of coil inside coil heat exchanger which reduces the temperature of Helium to around liquid nitrogen temperature.

Table 3: Specifications of subcooler coil

<b>Parameter</b>	<b>Values</b>	<b>Unit</b>
<b>Inlet temperature</b>	96	K
<b>Exit temperature</b>	77	K
<b>MOC</b>	SS 304L/316L	-
<b>O.D.</b>	16	mm
<b>Thickness</b>	2	mm
<b>PCD</b>	100	mm
<b>Pitch</b>	20	mm
<b>Length of coil</b>	1.5	m

**d. Design of liquid air separator:**

The liquid air separator collects nitrogen impurity condensed in the subcooler coil. It is a cyclone separator. .

$D_c$  = Minimum diameter of the vessel, in mm

Table 4: Specifications of liquid air separator

<b>Parameter</b>	<b>Values</b>	<b>Unit</b>
Inlet temperature	77	K
Inlet impurity	20000	ppm
Exit impurity	5128.2	ppm
Impurity collection rate	1.1	l/hr
Blow down interval	0.25	Hr
MOC	SS 304L/316L	-
O.D. of straight portion	60.33	mm
Thickness of straight portion	5.537	mm
$D_c$ (Refer drawing below)	50	mm
$B_c$	12.525	mm

De	25.05	mm
Hc	25.05	mm
Lc	100.2	mm
Sc	6.26	mm
Zc	100.2	mm
Jc	12.525	mm
Total height, Lc + Zc	200	mm

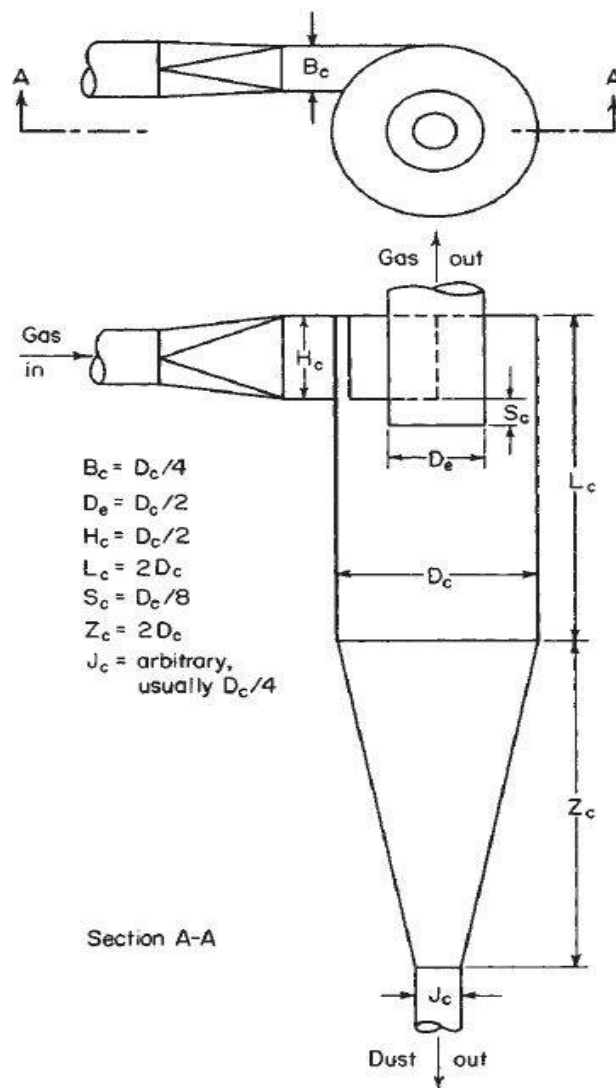


Fig 2. Cyclone separator dimensions

Note:

- 25 NB Sch. 30 pipe will be used for gas exit port.



- The inlet port for impure gas is of rectangular cross section of dimensions  $H_c \times B_c$ . However, for convenience, a 16 mm O.D., 2mm thick inlet tube entering tangentially inside the cyclone body can be used.

**e. Design of Activated Charcoal Adsorber & Liquid Nitrogen (LN<sub>2</sub>) Vessel:**

This will be the last stage of Helium purification where nitrogen impurities shall be reduced to around 50 ppm thus purifying the impure Helium gas to the level of commercial grade 4 (99.995%) Helium. The charcoal adsorber shall consist of pellet charcoal, based on either coal or coconut shell. The specifications of activated charcoal to be used are as follows:

Table 5: Properties of charcoal

Parameters	Value	Units
Type of charcoal	Coal/Coconut Shell	
Appearance/Type	Smooth pellets	
Total Surface Area	1200	m <sup>2</sup> /gm
Hardness Coefficient	85 - 90	% of Ball pan Hardness Number
Ash Content	1 - 4	%
Moisture (When	0 - 2	%
Bulk Density	0.45 - 0.52	g/cm <sup>3</sup>
Particle Density (Hg displacement)	1.2 - 1.4	g/cm <sup>3</sup>
Actual Density (He displacement)	2.0 - 2.2	g/cm <sup>3</sup>
Void volume	38 - 42	%
Specific heat at 100°	0.8 - 1	kJ/kg K
Iodine value	1050	mg/gm
Carbon Tetrachloride Adsorption	60 - 70	%
Benzene value	36 - 40	%
pH value	9 - 10	
Particle size	2 - 4.5	mm

Table 6: Activated charcoal adsorber details

Parameters	Values	Units
Operating temperature	77	K
Operating pressure	200	Bar(a)
Nitrogen impurity removed	1.8	kg
Activated charcoal required	16.5	kg
Bed volume required	34.1	l
Bed vessel O.D.	73.03	mm
Bed vessel thickness	7.01	mm
Bed length	12.5	m

The charcoal adsorber bed will be in the form of either U tube or helical pipe depending on the ease of fabrication.

**Dimensions of LN<sub>2</sub> vessel:**

**Inner vessel:** 508 mm O.D., 4.78 mm thickness and 1600 mm height (Approx.).

**Outer vessel:** 609.6 mm O.D., 5.54 mm thickness and 1646 mm height (Approx.).

**Minimum level of liquid nitrogen:** 1200 mm

**Maximum level of liquid nitrogen:** 1400 mm

**Details of radiation shield:**

**Type:** MLI (Radiation shields)

**No. of layers:** 20 (A single layer consists of a layer each of aluminized Mylar and nylon mesh)

**f. Pipeline sizing**

All the pipelines have been sized according to ASME B31.3 Process piping codes. All the pipelines should have MOC as SS 304L/316L. The details are tabulated below (all dimensions are in mm):

Table 7: Details of piping

<b>Pipeline tag</b>	<b>Description</b>	<b>O.D. (mm)</b>	<b>Thickness (mm)</b>
<b>GHe-001-DN15SCH.20</b>	From impure quads/ recovery compressor to drier unit	21.34	2.108
<b>GHe-002-DN15SCH.20</b>	Line upstream to Drier unit	21.34	2.108
<b>GHe-003-DN15SCH.20</b>	Line downstream to Drier unit	21.34	2.108
<b>GHe-004-16MMODX2MM</b>	Line connecting Heat exchanger with subcooler	16	2
<b>GHe-005-16MMODX2MM</b>	Line connecting subcooler with Liquid air separator	16	2
<b>GHe-006-16MMODX2MM</b>	Line from liquid air separator to charcoal bed.	16	2
<b>GHe-007-10MMODX1MM</b>	Line downstream of charcoal adsorber	10	1
<b>GHe-008-10MMODX1MM</b>	Line downstream of heat exchanger (cold/ return side)	10	1
<b>GHe-009-10MMODX1MM</b>	Branch towards Pure Helium Quad	10	1
<b>GHe-010-10MMODX1MM</b>	Inlet to Pure Helium Quad	10	1
<b>GHe-011-10MMODX1MM</b>	Branch towards MCID	10	1
<b>GHe-012-10MMODX1MM</b>	Inlet to MCID	10	1
<b>GN2-001-6MMODX1MM</b>	Regeneration line to Drier (Inlet)	6	1
<b>GN2-002-6MMODX1MM</b>	Regeneration line to Drier (Inlet)	6	1
<b>GN2-003-6MMODX1MM</b>	Liquid air separator drain (atmospheric)	6	1
<b>LN2-001-6MMODX1MM</b>	Liquid nitrogen supply line	6	1
<b>LN2-002-6MMODX1MM</b>	Liquid air separator drain	6	1
<b>LN2-003-10MMODX1MM</b>	Liquid nitrogen drain line from vessel	10	1

**g. Valves:**

All the valves should have MOC as SS 304L/316L. The details are tabulated below (all dimensions are in mm):

Table 8: List of valves

Valve tag	Description	Opening (mm)	Type
He-BV01 DN15	Upstream of Drier unit	21.34	Ball valve
He-BV02 DN15	Downstream of drier unit	21.34	Ball valve
He-NV01 6MM	Branch line to pure Helium quad	6	Needle valve
He-NV02 6MM	Branch line to MCID	6	Needle valve
LN2-BSV01 6MM	Liquid nitrogen supply valve	6	Bellow sealed valve
LN2-BV01 10MM	Liquid nitrogen drain valve from vessel	10	Ball Valve
GN2-NV01- 6MM	Hot purge gas inlet valve to Drier	6	Needle valve
GN2-NV02- 6MM	Hot purge gas outlet valve to Drier	6	Needle valve
GN2-NV03- 6MM	Nitrogen drain valve from separator	6	Needle valve
BV-01-DN 15	Valve on evacuation line of Drier	21.34	Ball Valve
BV-02-DN 50	Valve on evacuation line of Vessel	60.33	Ball Valve
SRV 01 DN15	Safety valve upstream of Drier unit	21.34	SRV
SRV 02 DN15	Safety valve upstream of LN2 vessel	21.34	SRV
SRV 03 6MM	Safety valve on LN2 drain line	6	SRV
SRV 04 DN50	Safety valve on evacuation line	60.33	SRV

**ANNEXURE - II**  
**GENERAL TECHNICAL SPECIFICATIONS**

**1.0 SCOPE**

This specification establishes the technical requirements for the preparation of shop drawings, supply of raw materials, manufacture, inspection, testing, packaging, guarantee and delivery at site of the External Helium purifier equipment as per the detailed specification sheet and schematic attached with this specification.

**2.0 APPLICABLE DOCUMENTS AND DRAWINGS:**

Notes:

- The latest issues of the documents below constitute a part of this specification to the extent specified herein. In the event of certain requirements of the specifications, drawing or data listed below conflict, the decision will be at the discretion of the purchaser.
- All the documents not mentioned here subsidiary to the documents specified shall be considered to the extent required by the parent document in its true meaning.

**APPLICABLE USERS DRAWINGS/ DOCUMENTS:**

List of applicable drawings/documents is as indicated below and fabrication shall be strictly in accordance with these drawings and notes mentioned there in and elsewhere in the tender document.

- Purifier Schematic.
- Purifier P&ID.
- Purifier Detailed Specification Sheet.

**Note: Changes in these drawings/documents are possible, so the party should accept these changes if and when they occur.**

**2.2. APPLICABLE STANDARD DOCUMENTS:**

- 2.2.1 ASME Boiler and Pressure Vessel code Section II, V, VIII Division1 and IX.
- 2.2.2 IS: 696- Code of practice for general engineering drawings.
- 2.2.3 IS: 3073- Assessment of Surface roughness.

**3.0 MATERIAL:**

3.1 All materials and process of manufacture shall be of high quality and in accordance with good practice pertinent to the manufacture of Stainless Steel

components. Supply of all materials and consumables required for fabrication shall be in scope of the vendor.

3.2 All Stainless Steel Plates shall conform to ASTM A 240 TP 304L/316L.

3.3 All Stainless Steel Pipes shall conform to ASTM A 312 TP 304L/316L.

3.4 Welding Electrodes, Filler materials and consumables shall be as per relevant AWS specifications.

**3.5 All Stainless Steel materials shall be supplied in annealed conditions.**

3.6 Materials and consumables not specifically mentioned here shall be of good commercial quality and in accordance with the practice pertinent to the manufacture of pressure vessels.

3.7 Where ever the use of a material with an alternative/ better specification is proposed the alternative shall be subject to prior approval by the purchaser.

3.8 Materials, which do not conform to any standard, shall be subject to approval by purchaser before start of manufacture.

#### **4.0 MATERIAL TESTING:**

4.1 All raw materials shall be offered for identification and stamping by the purchaser with relevant documents immediately after procurement. Original mill certificates shall be produced where ever possible.

4.2 Chemical analysis and mechanical testing (Tensile test) as called for in by the specified standards shall be carried out on all material

4.3 All stainless steel AISI 304L/316L materials shall be tested for susceptibility to inter granular corrosion as per A 262 Practice A/E.

4.4 All stainless steel AISI 304L/316L materials shall be subjected to flattening/ bend testing as per ASTM A 360

4.5 All plate materials shall be subject to Ultrasonic testing to rule out laminations.

4.6 Test reports in original shall be submitted to the purchaser before commencement of the fabrication for approval.

#### **5.0 FABRICATION AND WELDING:**

General Fabrication and welding details for the various components of External Helium Purifier Assembly are as follows:

5.1 Party shall prepare detailed fabrication drawings for each equipment, immediately on receipt of purchase order. Three sets of the same shall be submitted to the purchaser for approval. Detailed joint designs, sequence of fabrication, bill of materials etc. shall be clearly indicated in the fabrication drawings.

5.2 The fabrication of equipment generally shall be in accordance with ASME Code Sec VIII Div. 1.

5.2.1 The welding procedure and performance qualifications shall be in accordance with ASME Code section IX.

5.2.2 The welding procedure specifications shall be in accordance with ASME code Section IX.

5.2.3 The procedure qualification and performance qualification of the welders shall be carried out after approval of the procedure by the purchaser.

5.2.4 All joints on the main equipment shall be full penetration joints. Inside surfaces of the mating parts shall be matched and merged smoothly.

5.2.5 Prior to welding, 50mm on each side of the weld shall be specifically cleaned using acetone or Alcohol. All surfaces 150mm on each side of the joint shall be free from scale, rust, slag, paint, surface oxide etc. These shall be removed by wire brushing, abrasive blasting or grinding.

5.2.6 Weld edge preparation shall be machined smooth by machining or to a limited extent by grinding.

5.2.7 All welding on stainless steel parts are to be performed by a qualified welder by TIG welding. The weld is to be protected by purging with Argon gas during the welding. The Argon gas used for shielding and purging shall be of high purity. The gas flow shall be continued for a period sufficient to prevent oxidation of the weldment after arc is extinguished.

5.2.8 Track welds shall be wire brushed with a clean brush and inspected for cracks and defects and corrected before first pass is made. After the first pass, the weld is to be DP tested carefully for cracks, craters, pin holes etc. Craters, cracks and rough spots are ground out before the weld is continued.

5.2.9 When track welds are not removed but are to be incorporated into the final weld, they shall be ground so that they do not exceed 1.5mm in thickness and their ends shall be feathered prior to depositing subsequent weld metal. Welds with poor penetration, flux or slag inclusions, pockets, bubbles or surface flaking are not permitted.

5.2.10 Repair of weld defects: All defects such as cracks, blow holes, lack of penetration inclusions etc shall be removed by mechanical means or gauging process after which the joint shall be re-welded or re-inspected.

### **5.3. Component specific notes:**

#### **5.3.1 External Drier Unit:**

5.3.1.1 Before filling MS 13X in the drier unit, the filter assembly is made by bolting successively felt, 50 micron filter and 0.1 micron filter to perforated plates and then welding perforated plates to torispherical ends.

5.3.1.2 The drier unit has to be filled with 1 kg. of MS 13X as per specifications.

#### **5.3.2 Helical Coil inside Coil Heat Exchanger:**

5.3.2.1 The SS tube-in-tube type coil heat exchanger should be fabricated such that the PCD (Pitch Circle Diameter) and pitch of the helical coil remains constant.

5.3.2.2 A spacer wire should be provided in between the concentric tubes before bending which helps to maintain the constant gap between the two tubes.

5.3.2.3 The portion of the helical coil coming out of the External Helium purifier after assembly should be welded to the upper surface of the Top Cover.

### **5.3.3 Subcooler Coil:**

5.3.3.1 The SS tube in the subcooler should be fabricated such that the PCD (Pitch Circle Diameter) and pitch of the helical coil remains constant.

5.3.3.2 The ends of the subcooler coil should be welded to one end of the helical coil inside coil heat exchanger and the tube end of the Liquid Air separator respectively.

### **5.3.4 Air Separator:**

5.3.4.1 The tube ends of the Air separator should be welded to one end of the subcooler coil and the tube end of the Charcoal Adsorber bed respectively.

### **5.3.5 Charcoal Adsorber Bed:**

5.3.5.1 Before filling activated pellet charcoal in the charcoal adsorber bed (in the shape of a U-tube/helical pipe), the filter assembly is made by bolting successively felt, 50 micron filter and 0.1 micron filter to perforated plates and then welding perforated plates to the torispherical ends of the adsorber.

5.3.5.2 The charcoal adsorber has to be filled with 16.5 kg. of activated pellet charcoal as per specifications.

### **5.3.6 LN<sub>2</sub> Vessel:**

5.3.6.1 Intermittent welding is to be done at each of the joints of KF 16 flange and 2" pipe connection with the outer vessel.

5.3.6.2 O-ring is to be placed in the groove provided in the top ring flange of the outer vessel.

### **5.3.7 External Helium Purifier Assembly:**

5.3.7.1 After assembly of the various components is done, the Top Cover should be bolted to the upper surface of the top ring flange of the outer vessel.

5.3.7.2 The skirt support has to be welded to the bottom torispherical head portion of the outer vessel.



## 6.0 HEAT TREATMENT

All Stainless steel parts and end cover shall be annealed after forming.

## 7.0 SURFACE FINISH AND CLEANLINESS:

7.1 All welds shall be finished smoothly and merge with the parent metal without ridges or undercutting. Any gauging marks scratches etc. which occur during fabrication, testing and shipment shall be repaired to the satisfaction of the purchaser.

7.2 All scale oxides, weld spatter, oil, machining chips and other foreign materials shall be completely **removed and buffed** on both the inside and the outside of the equipment. All surfaces that will not permit cleaning after complete fabrications shall be cleaned of all foreign material prior to assembly. Only certified and approved chemicals and cleaning agents shall be employed. After cleaning, the surface shall be free of chlorides and other injurious contaminants like Lead Sulphur. Only potable water with a total free Halogen content not exceeding 50ppm shall be used for flushing operations. All traces of water shall be removed by using warm air or other acceptable means.

**7.3 All the internal as well as external surfaces of pipes and plates shall be electro-polished.**

## 8.0 INSPECTION, TESTS AND REPORTS

The following tests shall be conducted for the various components of the High pressure External Helium purifier.

### 8.1 GENERAL

8.1.1 The manufacturer shall carry out all the testing and inspection called for in this specification conforming to the established practice.

**8.1.2 The manufacturer should have testing facilities for Liquid penetrant examination, Radiographic examination, Pneumatic testing and Helium leak testing (using Helium Mass Spectrometer Leak Detector), of weld joints of the vessel.**

8.1.3 The inspection and testing shall be conducted in a manner satisfactory to, and shall be subject to approval by the purchaser. Inspection by the purchaser or his authorized representative shall not in anyway relieve the manufacturer of the inspection duties called for herein.

8.1.4 The purchaser shall have the right to specify additional inspection or testing as it deems necessary and the additional cost of such inspection or testing will be borne by the purchaser. The manufacturer shall maintain records of all inspection and tests which shall be made freely available to the purchaser or his authorized representative.

## **8.2 Liquid Penetrant Examination**

8.2.1 After the root pass Liquid Penetrant Examination shall be done on all welds. All the completed welds shall also be examined by Liquid Penetrant Examination.

8.2.2 The procedure for Liquid Penetrant Examination shall be as per section V of ASME boiler and pressure vessel code.

8.2.3 Acceptable standards shall be as per Appendix 8, Methods for Liquid Penetrant Examination (PT) of ASME Section VIII Div 1.

## **8.3 Radiographic Examination of Welds**

8.3.1 Following welds shall be subject to radiographic testing (x ray) to the extent indicated.

8.3.1.1 All the full penetration joints on the vessel shall be radiographed 100%.

## **8.4 TESTING**

### **8.4.1 Pneumatic testing**

8.4.1.1 Pneumatic test shall be carried out as per UG-100 of ASME Sec VIII DIV 1 with dry inert gas.

8.4.1.2 The test pressures for individual components of the assembly shall be as indicated in the representative drawings.

8.4.1.3 The pressure shall be gradually increased to not more than 50% of the test pressure. Thereafter the test pressure shall be increased in steps of approximately one-tenth of the test pressure until the required test pressure has been reached. Then the test pressure shall be reduced to a value of four-fifths of the test pressure and held for a period sufficient to carry out inspection of the vessel.

8.4.1.4 Pressure gauges used shall be calibrated high sensitivity gauges with a resolution better than 1 mbar.

### **8.4.2 Soap Bubble testing for detection of leak**

8.4.2.1 All welded joints and flanged attachments on the vessel shall be tested for leak using soap solution.

8.4.2.2 The leak testing shall be carried out at a pressure not less than 50% of the Pneumatic test pressure.

8.4.2.3 The soap solution may be applied to the surface in such a way that it does not form bubbles in the process of applying. Spraying the solution onto the surface is not recommended.

### **8.4.3 VACUUM HELIUM LEAK TEST**

8.4.3.1 After successful completion of the Pneumatic testing, the vessel should be tested for leak tightness using Helium Mass Spectrometer Leak Detector.

8.4.3.2 Gross leakage in to the vessel shall not exceed  $1 \times 10^{-8}$  mbar liters/sec.

8.4.3.3 Vacuum hold in the outer vessel should be of the order of  $10^{-2}$  mbar or better.

8.4.3.4 All testing shall be carried out as per written procedure subject to purchaser's approval.

### **8.5 REPORTS**

8.5.1 The manufacturer shall prepare genuine reports of all inspection and tests carried out.

8.5.2 The correspondence of the items and their reports must be traceable.

8.5.3 Three copies of these reports shall be submitted to the purchaser or his authorized representative and one copy of the report shall be sent along with the equipment.

### **9.0 CLEANING**

9.1 All interior of surfaces shall be cleaned free of slag, mill scale, weld spatter rust etc.

9.2 All subassemblies and equipment shall be brushed free of all loose grit, dust and the like.

9.3 The vessel shall be inspected visually to determine that the interior is clean, dry and free of scale and other loose materials.

### **10.0 IDENTIFICATION AND MARKING**

10.1 Identification and control of materials- Procedural controls for identification of materials including partially processed material shall ensure that the identification is maintained either on the material throughout manufacture.

10.2 Marking components shall be marked by a method, which will not result in sharp discontinuities but shall identify the material during subsequent operations from our end.

10.3 Stamping when used, shall be done with round-nosed interrupted die stamps. Marking shall be made on un-machined external surfaces only. Places of repair shall be marked suitably and their location with short description shall be included in the test reports.

## **11.0 CERTIFICATION AND DOCUMENTATION**

11.1 The manufacturer shall certify in writing to the purchaser that equipment complies with all fabrication, test and cleanliness requirements specified therein.

11.2 As-built drawings for each equipment shall be prepared showing actual dimensions achieved. Specified dimensions shall be shown in brackets near the actual dimensions.

11.3 The manufacturer shall provide the purchaser three sets of as built drawings along with other documents and reports.

## **12.0 RIGHTS AND PRIVILAGES**

12.1 Purchaser reserves the right to inspect any machinery, material, equipment or tool used by the manufacturer for the manufacture of equipment.

12.2 Should the purchaser waive the right to inspect any equipment, tool, machinery item such waiving shall not relieve party in anyway of his obligation for supplying equipments as per this specification.

12.3 Purchaser or his representative shall be permitted free access to party's premises at all reasonable times for the purpose of inspection work at all stages of manufacture of equipment.

12.4 Purchaser or his representative shall be given full assistance in the form of necessary tool, instruments, equipments, drawings, qualified operators and other facilities to facilitate inspection.

12.5 The manufacturer has all the responsibility of providing the purchaser or his authorized representative with all specified information regarding manufacturing and of assuring that the quality control, the detailed examination specified herein are performed to permit them to be meaningful and to the satisfaction of the purchaser.

12.6 Even though the inspection may be carried out by the purchaser or his representative, such inspection, shall not, however relieve part of the responsibility for furnishing equipment conforming to the requirements of this specification nor prejudice any claim, right or privilege which the purchaser may have because of the use of defective and unsatisfactory equipment.

12.7 If the manufacturer fails to adhere to the approved manufacturing schedule or fails to supply equipment as per this specification, the purchaser will have the right to terminate the contract.

## **13.0 SPECIAL NOTES**

13.1 The manufacture shall prepare and submit the detailed fabrication drawings, manufacturing and inspection plan within two weeks of placing the purchase order for approval by the purchaser. When approved in writing by the purchaser, these drawings, procedures and plans shall form a part of this specification.

13.2 The purchaser reserve the right to make minor changes without significantly affecting the scope of work.

13.3 Checking and approval of drawings and procedure by the purchaser do not relieve the manufacturer from full responsibility for ensuring correct interpretation and completeness of drawings and procedures.

13.4 The manufacturing schedule shall be prepared by the party to suit the supply schedule given in the contract and get the approval of the purchaser. No slippage shall be allowed on the approved manufacturing schedule. Purchaser shall be notified immediately along with the reasons for the delay of more than two weeks and shall take appropriate steps to make up the lost time.

13.5 The manufacturer shall also submit, within four weeks of placing the order, shop specifications, welding, inspection procedures in detail and a bill of material, which may be necessary for proper performance and control over the work.

13.6 Deviation from specifications:

13.6.1 If the manufacturer intends to make any deviations from specification they shall be clearly set forth in the quotation giving reasons for deviations.

13.6.2 If the deviations are found acceptable they shall be included in the order specifications.

13.6.3 No part of the work shall be subcontracted without written consent from purchaser. The manufacturer shall be responsible for the execution of the subcontracted work. Necessary inspection and quality measures shall be taken to ensure compliance of the work to this specification.

13.6.4 Minor changes in the Schematic Drawing and specification sheet might be possible at a later stage.

## **14.0 PRESERVATION, PACKAGING AND DELIVERY**

### **14.1 Preservation**

14.1.1 All the equipment shall be protected for the entire period of storage and dispatch against damage due to atmospheric factors and rough handling in transit.

14.1.2 The equipment shall be preserved in their finished form retaining their surface finish and dimensions.

14.1.3 The parts prone to atmospheric corrosion shall be given appropriate protective coating after purchaser's approval.

## **14.2 Packaging**

14.2.1 Sound packaging material suitable to the size and weight of the contents shall be used.

14.2.2 The packaging should be soft enough not to impair the surface and dimensions of the equipment. It shall be soft non-hygroscopic material.

14.2.3 Bundled material shall be rigidly steel strapped over the protective covering such as wooden planks.

14.2.4 The equipment shall be securely fastened and packed to prevent shifting, rolling or rattling.

14.2.5 Following particulars shall be clearly marked on both sides of all packages in block letters, with water proof paint.

a) Destination b) Purchase order No and date c) Dimensions d) Gross weight and e) Handling instructions (if any).

## **14.3 Delivery**

14.3.1 It is the responsibility of the manufacturer to arrange for the delivery of the equipment at the purchaser's stores at B.A.R.C. Mumbai.

14.3.2 The equipment shall not be dispatched without prior consent of the purchaser. The consignee as well as person concerned at the place of delivery shall be intimated at least 10 days in advance about the dispatch of the equipment.