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TENDER NO. IPR/TN/PUR/TPT/ET/20-21/14 DATED 18-02-2021

CRYOCOOLER ASSEMBLY SPECIFICATION

APPLICATION

The cryocooler will be used in the custom made cryopump which will be used in neutral beam injector. The cryopump consists of cryopanel which is thermally shielded from ambient temperature at ~85K using LN2. The cryopanel will be cooled by cryocooler in the temperature range of 15-20 K with approx. heat load of 20W. The cryopump will be placed in the vacuum chamber where the pressure of the order of $\sim 10^{-4}$ - 10^{-5} Torr will be maintained. The cryocooler will be mounted horizontally on vacuum port of the vacuum chamber at the atmospheric pressure and the cold tip of the cryocooler will be connected to cryopanel in the vacuum chamber. There is no concern of vibration for this application.

SCOPE OF SUPPLY

The scope of supply for cryocooler assembly includes following components whose specifications are mentioned below:

Quantity of Cryocooler Assembly: 11 set

CRYOCOOLER

1. Cold Head:

- Cooling capacity in **Vertical Orientation**: Minimum **20W** @ $\leq 15.5\text{K}$ at 50 Hz (AC Power Supply)
- Cooling capacity in **Horizontal Orientation**: Minimum **20W** @ $\leq 19\text{K}$ at 50 Hz (AC Power Supply)
- Lowest temperature in Vertical Orientation: $\leq 14\text{K}$ with no load
- Cool down time in Vertical Orientation: ≤ 70 minutes to reach 20K
- Maintenance interval: ≥ 5000 Hrs.

2. Compressor:

- Type: Water cooled
- Electrical rating: $415 \pm 10\%$ VAC, 3Ph, 50 Hz
- Power consumption: < 15 kW
- Cooling water flow rate and pressure with water quality: Shall be specified by the vendor
- Input power cable of appropriate rating of length: minimum 3 m
- Maintenance interval: ≥ 20000 Hrs.
- Noise Level: ≤ 80 dBA at 1 meter (approx.)

3. Flexible/Gas Lines (along with Cold head to Compressor Power Cord):

- Length of Supply and Return Flexible/Gas Line: 20 m each (Minimum).
- Length of Cold head to Compressor Power Cord: 20 m (Minimum).

4. Measurement and test components:

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- Temperature sensor, suitable to operating temperature: 01 No. (to be mount on Cold Head during testing)

5. Accessories & Spares:

- The Vendor along with the Cryocooler Assembly shall provide all the mandatory spares. Following spares and standard accessories shall be included.
 - Tool kit (gas charge valves, required wrenches etc.)
 - Compressor Hose Nipples/Couplings/Fittings
 - Compressor Chilled Water Hoses (~ 10 feet for supply and return each)
 - O-rings/Gaskets/Seals between Cold Head Unit and Vacuum Chamber
 - Operation and Technical Instruction Manual for Cold Head and Compressor Unit

6. Remote Operation:

- The system shall operate in Remote Mode with either RS232/RS485 compatible.
- Any kind of faults / alarms shall be made available to users in local panel and computer.
- Required Signal/Error List for remote operation is as follow:

Sr. No.	Signal/Error	Type of Signal
1.	ON / OFF	Control
2.	High water supply temperature	Monitor
3.	Low water flow	Monitor
4.	High helium gas temperature	Monitor
5.	Low helium pressure	Monitor

7. Acceptance Criteria:

- Vendor has to provide a TEST CERTIFICATE for each supplied Cryocooler Assembly for the **Performance Test** (for the test mentioned below) carried out at Factory (Vendor's site) prior to shipment of the ordered items for approval of purchaser. Shipment to be made only after approval of TEST CERTIFICATE and release of shipment clearance letter by Purchaser.

a) Performance Test (at Vendor's site)

- Cool down time test in Vertical Orientation: ≤ 70 min to reach 20K
- Cooling capacity test **in Vertical Orientation**: Minimum **20W** @ $\leq 15.5K$ at 50 Hz
- Cooling capacity test **in Horizontal Orientation**: Minimum **20W** @ $\leq 19K$ at 50 Hz
- Lowest temperature test in Vertical Orientation: $\leq 14K$ with no load
- Noise level test: ≤ 80 dBA at 1 meter (approx.)

b) Acceptance Test (at ITER-India Lab, IPR)

- Cool down time test in Vertical Orientation: ≤ 70 min to reach 20K
- Lowest temperature test in Vertical Orientation: $\leq 14K$ with no load
- Remote Operation: Operating the device remotely for performing standard operating functions like ON/OFF, Faults/alarms (High water supply temperature/ Low water flow) through open source hyper terminal software (RS232/RS485)
- Noise level test: ≤ 80 dBA at 1 meter (approx.)

8. Testing at ITER-India Lab, IPR:

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- Vendor shall arrange testing engineer for performance testing of equipment at ITER-India Lab, IPR, Gandhinagar, India and all 11 nos. cryocooler assemblies shall be tested for the specified parameters for **Acceptance Test (at ITER-India Lab, IPR)** and test report shall be signed by testing engineer after completion of testing. Final acceptance of order items will be given after successful completion of **Acceptance Test (at ITER-India Lab, IPR)**. Timeline for completion of Acceptance Test of all 11 nos. cryocooler assembly at ITER-India Lab, IPR is 22 working days from starting date of testing. Starting date of testing will be decided mutually by vendor and IPR after delivery of complete scope of supply.
- Following activities to be carried out by testing engineer during performance testing of all 11 nos. cryocooler assemblies. **IPR will provide supervisory support in following activities. Required manpower will be arranged by vendor.**
 - a. To remove all components from boxes and check for transport damage.
 - b. To check helium pressure.
 - c. To perform opening of Vacuum vessel. **(Vacuum Vessel without LN2 shield, Vacuum Connections and Fittings will be provided by IPR).**
 - d. To perform assembly of cold head with vacuum vessel.
 - e. To perform assembly of supplied temperature sensor with cold head. Suitable sensor mounting hardware will be arranged by Vendor.
 - f. To perform connections between Temperature Monitor and sensor lead wires using Feedthrough. **(Temperature Monitor, Feedthrough and extension wires will be provided by IPR).**
 - g. To perform wrapping of MLI on cold head **(MLI will be provided by IPR).**
 - h. To check sensor reading for room temperature and ensure proper contact of sensor with cold head.
 - i. To perform closing of vacuum vessel.
 - j. To perform assembly of flexible/gas lines (Supply and Return) between cold head and compressor.
 - k. To make necessary water connections between compressor unit and water chiller. **(Water Chiller will be provided by IPR).**
 - l. To connect power cord between cold head and compressor.
 - m. To pump down the vacuum vessel using vacuum pumps. **(Vacuum Pumps will be provided by IPR).**
 - n. To perform Cool down time test in Vertical Orientation: ≤ 70 min to reach 20K.
 - o. To perform Lowest Temperature Test in Vertical Orientation: ≤ 14 K with no load.
 - p. To perform Remote Operation: Operating the device remotely for performing standard operating functions.
 - q. To perform Noise level test: ≤ 80 dBA at 1 meter (approx.).
 - r. To perform disassembly of test setup

- **Day wise Planning for testing of all 11 nos. cryocooler assembly**

Day	Activity	Tested Cryocooler	Day	Activity	Tested Cryocooler
1	a to m		13	r, a to m	
2	m to q	1	14	m to q	7

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3	r, a to m		15	r, a to m	
4	m to q	2	16	m to q	8
5	r, a to m		17	r, a to m	
6	m to q	3	18	m to q	9
7	r, a to m		19	r, a to m	
8	m to q	4	20	m to q	10
9	r, a to m		21	r, a to m	
10	m to q	5	22	m to q	11
11	r, a to m				
12	m to q	6			

9. Warranty:

- Warranty for all the supplied items: One year from the date of final acceptance against all sorts of manufacturing defects, faulty material and poor workmanship.

10. After Sales Support:

- The vendor should have technical support team in India for post sales and service. Vendor should ensure that they will keep inventory of critical spare parts/components for 5 to 8 years to ensure round the clock operation of the supplied system.

11. System Requirements:

- Cold head overall max. dimensions: H: 650 mm x W: 250 mm x L: 400 mm
- Compressor unit overall max. dimensions: H: 850 mm x W: 850 mm x L: 850 mm
- Helium pressure: Shall be specified by the vendor
- Ambient temperature range: System should be operated between 10 to 35°C

12. Duty Cycle of Operation: ~8 Hrs. per day

Note:

- Vendor shall fill and submit the Technical Compliance Sheet as per Annexure-1 along with their offer.
- IPR shall facilitate/provide the following items during testing at ITER-INDIA Lab (IPR). Vendor has to take utmost care while handling these items.

Sr. No.	Particulars of Items	Quantity
1.	Vacuum Vessel without LN2 shield (Material: SS, Length: ~ 1.3 m, Diameter: 650 mm)	01 No.
2.	Vacuum Connections and Fittings	As per requirement
3.	8 channel Temperature Monitor	01 No.
4.	Flange mounted, 60-Pin Subminiature C-type Feedthrough	01 No.
5.	Extension Wire (Phosphor-Bronze, 4-Lead wire)	As per requirement
6.	MLI (Foil: 6 µm, 10 Layer, Spacer: 10 layer)	As per requirement
7.	Air Cooled Water Chiller (8 TR/60LPM/2 Bar)	01 Unit
8.	Rotary Pump (1500 Lit/min)	01
9.	6 inch Diffusion Pump	01

- Required utilities like electric power supply, water supply, overhead crane, floor crane access will be provided by IPR.

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ANNEXURE-1

Technical Compliance Sheet for Cryocooler Assembly

Sr. No.	Technical Parameter	IPR Requirement	Vendor's Response
1)	Quantity of Cryocooler Assembly	11 Set	
2)	Cold Head:		
	Cooling capacity in Vertical Orientation	Minimum 20W @ $\leq 15.5K$ at 50 Hz	
	Cooling capacity in Horizontal Orientation	Minimum 20W @ $\leq 19K$ at 50 Hz	
	Lowest temperature in Vertical Orientation	$\leq 14K$ with no load	
	Cool down time in Vertical Orientation	≤ 70 min to reach 20K	
	Maintenance interval	≥ 5000 Hrs.	
3)	Compressor:		
	Type	Water cooled	
	Electrical rating	$415 \pm 10\%$ VAC, 3Ph, 50 Hz	
	Power consumption	< 15 kW	
	Cooling water flow rate and pressure with water quality	Shall be specified by the vendor	
	Input power cable of appropriate rating of length	minimum 3 m	
	Maintenance interval	≥ 20000 Hrs.	
	Noise Level	≤ 80 dBA at 1meter (approx.)	
4)	Flexible/Gas Lines (along with Cold head to Compressor Power Cord):		
	Length of Supply and Return Flexible/Gas Line	20 m each (Minimum)	
	Length of Cold head to Compressor Power Cord	20 m (Minimum)	
5)	Measurement and test components	Temperature sensor, suitable to operating temperature: 01 No. (to be mount on Cold Head during testing)	
6)	Accessories & Spares	The Vendor along with the Cryocooler Assembly shall provide all the mandatory spares. Following spares and standard accessories shall be included. <ul style="list-style-type: none">• Tool kit (gas charge valves, required wrenches etc.)• Compressor Hose Nipples/Couplings/Fittings	

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		<ul style="list-style-type: none"> Compressor Chilled Water Hoses (~ 10 feet for supply and return each) O-rings/Gaskets/Seals between Cold Head Unit and Vacuum Chamber Operation and Technical Instruction Manual for Cold Head and Compressor Unit 																		
7)	Remote operation	<ul style="list-style-type: none"> The system shall operate in Remote Mode with either RS232/RS485 compatible. Any kind of faults / alarms shall be made available to users in local panel and computer. Required Signal/Error List for remote operation is as follow: <table border="1" style="margin-left: 20px; border-collapse: collapse; width: 100%;"> <thead> <tr> <th style="text-align: center;">Sr. No.</th> <th style="text-align: center;">Signal/Error</th> <th style="text-align: center;">Type of Signal</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">1.</td> <td>ON / OFF</td> <td>Control</td> </tr> <tr> <td style="text-align: center;">2.</td> <td>High water supply temperature</td> <td>Monitor</td> </tr> <tr> <td style="text-align: center;">3.</td> <td>Low water flow</td> <td>Monitor</td> </tr> <tr> <td style="text-align: center;">4.</td> <td>High helium gas temperature</td> <td>Monitor</td> </tr> <tr> <td style="text-align: center;">5.</td> <td>Low helium pressure</td> <td>Monitor</td> </tr> </tbody> </table> 	Sr. No.	Signal/Error	Type of Signal	1.	ON / OFF	Control	2.	High water supply temperature	Monitor	3.	Low water flow	Monitor	4.	High helium gas temperature	Monitor	5.	Low helium pressure	Monitor
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Acceptance Test (at ITER-India Lab, IPR)		
Cool down time test in Vertical Orientation	≤ 70 min to reach 20K	
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- j. To perform assembly of flexible/gas lines (Supply and Return) between cold head and compressor.
- k. To make necessary water connections between compressor unit and water chiller. **(Water Chiller will be provided by IPR).**
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Warranty for all the supplied items	One year from the date of final acceptance against all sorts of manufacturing defects, faulty material and poor workmanship.
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11) After Sales Support

The vendor should have technical support team in India for post sales and service. Vendor should ensure that they will keep inventory of critical spare parts/components for 5 to 8 years to ensure round the clock operation of the supplied system.

12) System Requirements:

Cold head overall max. dimensions	H: 650 mm x W: 250 mm x L: 400 mm
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	Compressor unit overall max. dimensions	H: 850 mm x W: 850 mm x L: 850 mm	
	Helium pressure	Shall be specified by the vendor	
	Ambient temperature range	System should be operated between 10 to 35°C	
13)	Duty Cycle of Operation	~8 Hrs. per day	