

Title	Tender No. I-I/ET/25013/25-26 Ceramic Based Vacuum Feed Through for Grid Application
Subtitle	PART-I: Scope of Supply, Scope of Work and Technical Specifications



Delivery Location: DNB lab, ITER India lab building,
Institute for Plasma Research, Gandhinagar


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1.0. Introduction:

Ceramic based vacuum feed-throughs are necessary for isolating high-voltage water lines from the grounded vacuum vessel of the TWIN Source during the beam extraction phase of the experiment. The beam extraction system of the TWIN source comprises three stages of grid segments: the Plasma Grid (PG), Extraction Grid (EG), and Ground Grid (GG), along with their mounting flanges. Anticipated beam current is approximately ~8A at an extraction voltage of 9-11kV, with further acceleration up to 50 kV. As the beam passes through the apertures of each grid segment, it is expected to generate high heat flux in the range of 6-10 MW/m² in the vicinity of the aperture areas, necessitating water cooling for these grids. The water lines connected to each grid segment will also serve as a conducting medium for high voltage, requiring isolation from the vacuum vessel as depicted in Figure-1 (Ref Figure-1).

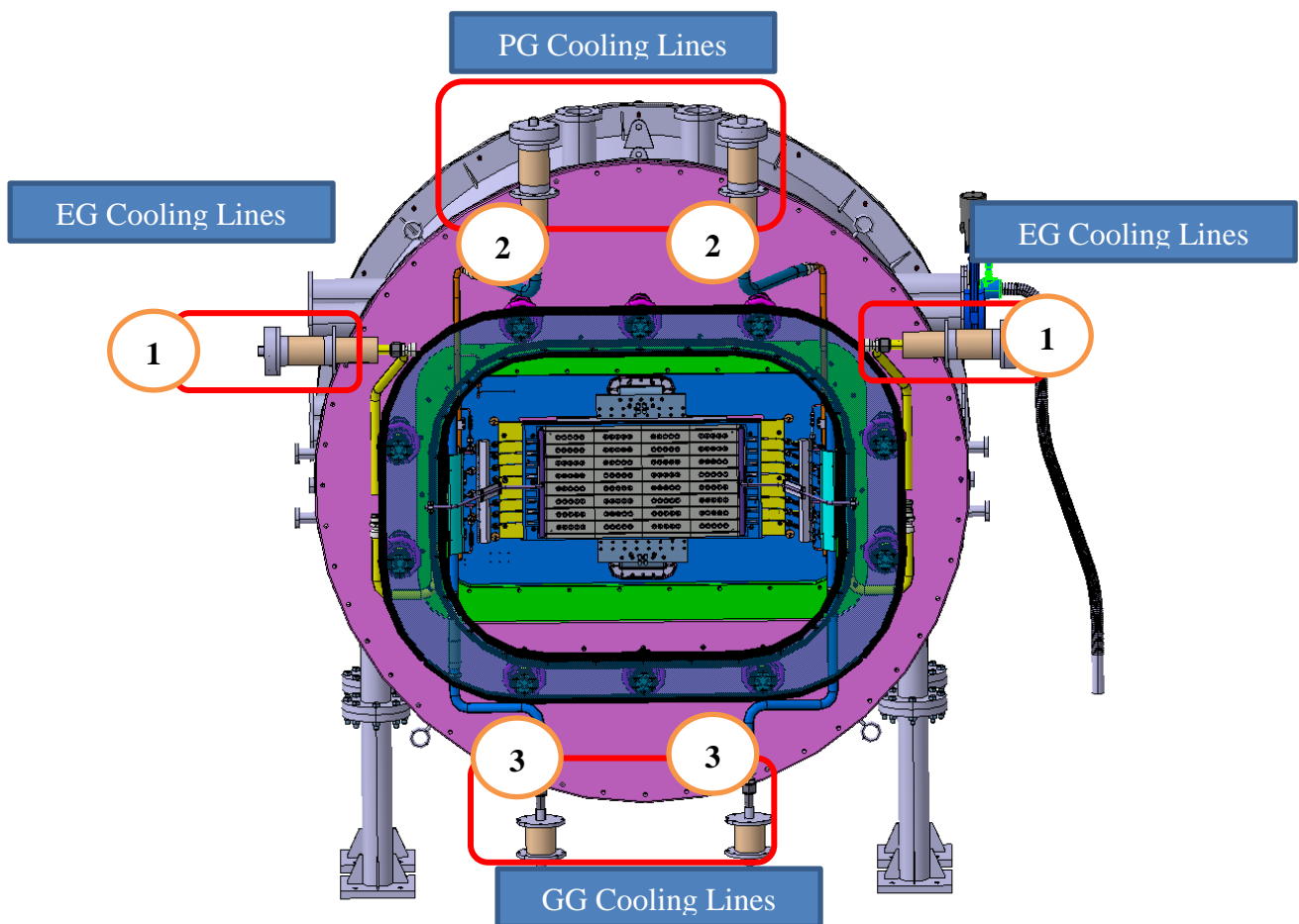



Figure 1 TWIN Source extrctation system

Total **5 pairs (TEN numbers)** of feed throughs are required (on pair for each grid segment) including spares.

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2.0. Scope of Work:


1. Detailed engineering design of the Ceramic based vacuum feed through meeting the required functionality and load conditions as mentioned in relevant subsections of this tender document. Bidder shall prepare the design /analysis report and submit the same to ITER-India for approval.
2. Preparation of manufacturing drawing and getting approval on the same by ITER-India prior to start o manufacturing.
3. Any change in approved engineering design would not be allowed unless re-approved by ITER-India.
4. Preparation of Manufacturing and Inspection Plan (MIP), inspection and testing procedures. *Bidder shall submit all the drawings, manufacturing, and inspection plan to ITER-India for approval with proper documentation.*
5. Procurement of all the materials required for manufacturing including materials required for all qualifications, tests, tools, jigs & fixtures.
6. Manufacturing of vacuum feed through assembly per the final approved drawings and approved MIP.
7. Manufacturing tools, jigs & fixtures and tooling required for all manufacturing activities, handling, surface treatment, assembly, inspection, testing, and packing.
8. Inspection and testing's at various stages before / after / during manufacturing as asked by the various sections and annexures of this specification and drawing.
9. Completion of all factory acceptance tests.
10. The issuance of "Inspection Release Note" / "Dispatch Clearance" from the purchaser or his authorized representative shall be considered as "Factory acceptance test".
11. Supply of items at ITER-India site.

3.0. Design Requirements:

Bidder must design the Ceramic based Vacuum feed through to satisfy the below mentioned boundary conditions and the load criteria. Additionally, the design must ensure the functionality and inspection testing requirements mentioned in section 4.1 and 6.0 of this tender document.

3.1. Boundary Conditions:

Ceramic based vacuum feed through would be mounted on the vacuum vessel port. One end of the feed through would be mounted over vacuum vessel while at the other end, flange carrying welded water line would be mounted, as shown in following sketch below:

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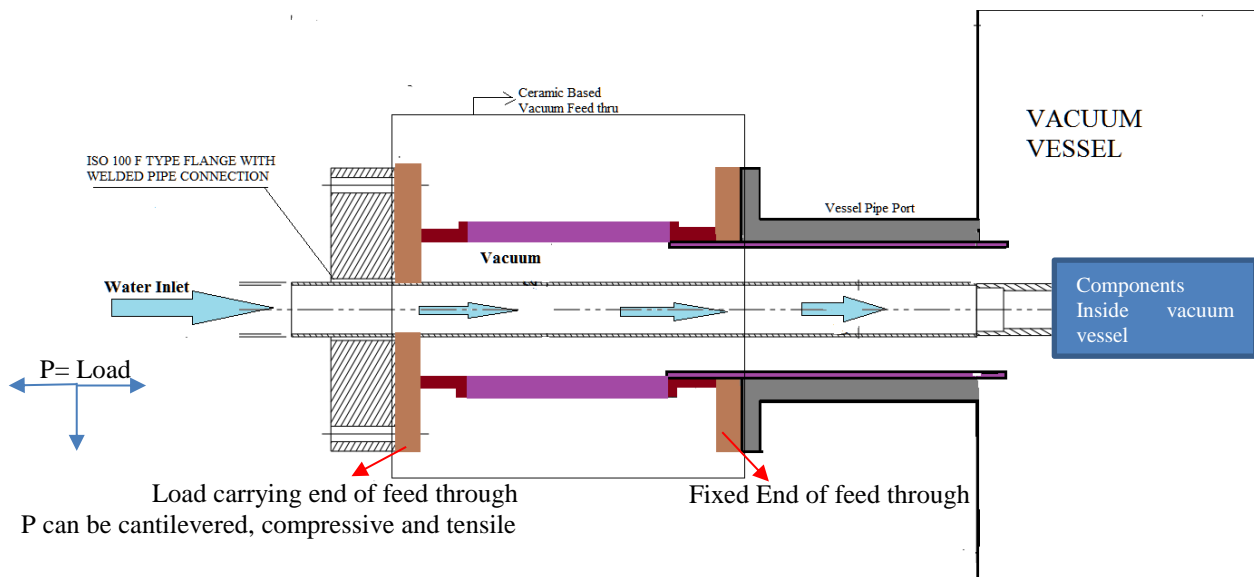


Figure 2: Sketch of Feed through mounting over vessel port and boundary conditions

Inside feed through vacuum would be maintained and outside would be exposed to external atmospheric pressure conditions. Water and high voltage carrying SS tube would pass within the feed through.

3.2. Load Conditions:

Vacuum feed through would be subjected to following load conditions:


- Structural / Mechanical load:** Includes Dead weight of ISO 500 Flange with water Carrying 1 “inch welded pipe, self-weight of Ceramic and end metallic flanges. The mechanical load can be cantilevered, compressive and tensile in nature for feed through 1, 2 and 3(as shown in figure 1) respectively.
- Pressure / Vacuum load:** Ceramic based feed through would be under application of external atmospheric condition of 1 atm pressure during the operation.
- High Voltage load:** A DC voltage of 50 kV would be applied at one end flange, having the welded pipe connection of Ceramic based feed through, while other end fixed to vessel port shall be at ground potential.

Design of Ceramic vacuum feed through must be capable of handling the load and boundary conditions stated above. Bidder needs to provide a design report along with detailed engineering and manufacturing drawing.

ITER-India is providing a sketch as per the annexure- A which only states the functional requirements. The dimensional numbers mentioned in the sketch are suggestive only. Bidder must take their own design that shall meet the load, functional, inspection and testing requirements of this tender document.

Limits of Design: While carrying the detailed design, Bidder must take following limits of design that shall be maintained:

- I.D Of feed through- The minimum ID of feed through shall be 90 mm.
- End Flanges of feed through- End flanges must be of ISO F type / or compatible making it ready for easy mounting on existing vacuum vessel port.

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4.0. Manufacturing Requirements:

Bidder needs to do the detailed design, engineering and prepare the manufacturing drawing meeting the functional requirements. Bidder shall be responsible for meeting all the acceptance requirements of testing and inspection.

4.1. Functional Requirements:

- a. Vacuum Integrity: Vacuum feed through shall provide a vacuum leak tightness of less than 5×10^{-09} mbar-lit/sec under the load conditions.
- b. Electrical Isolation: Vacuum feed through must sustain a voltage of at least 50kV across two metallic end flanges.

4.2. Pre-manufacturing Qualification Test:

Following mentioned qualification test would be in scope of Bidder and shall be witnessed by ITER-India representatives. Bidder's quotation shall include the cost of qualification test:-

•One number of feed through is to be manufactured initially and would be tested at Bidder site for the following:


- Test Voltage of 60 kV DC for the duration of 30 minutes in atmospheric condition.
- Helium leak testing in actual or equivalent structural/ mechanical load conditions as mentioned in section 3.2 section of this document. Helium leak test shall be done after completion of HV test for all braze and welded joints.

•Acceptance Criteria:

- No breakdown shall occur 30 minutes of voltage application.
- Feed through must be able to hold a vacuum level of less than 1×10^{-05} mbar-lit/sec with a leak rate of less than 5×10^{-09} mbar-lit/sec in local mode.

If vacuum feed through fails in first attempt, second chance for the manufacturing of vacuum feed through would be provided to Bidder. In case of second consecutive failure, the purchase order would be cancelled without any compensation to the Bidder.

- After successful completion of qualification test by ITER-India the clearance for bulk production for full batch will be provided. Refer Clause No. 1.7.1 of Section-B of Part-II Clearance for Bulk production and Dispatch Clearance Note.

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5.0. List of Deliverables:

5.1. List of Components to be delivered at ITER-India:

- a. vacuum feed through assembly – 10 nos(5 pair). (As per approved manufacturing drawing)

5.2. List of documents to be submitted by supplier:

Table 1: List of documents

<u>Sr.No.</u>	<u>Description</u>
<u>A. Before start of manufacturing process:</u>	
1.	1. Design report (for approval to ITER-India) 2. Manufacturing drawings and components part list (for approval to ITER-India). 3. Initial follow-up documents (Manufacturing & Inspection Plan) including Purchaser hold points. 4. Material documentation (inclusive material certificates, test and examination results (if any)).
<u>B. Documents to be supplied before final acceptance:</u>	
2.	1. Inspection reports (dimensional checking, visual inspection, results of leak tests, High voltage test performed - including size and location of leaks/ defects found), NDE(if applicable).


6.0. Technical Specifications:

6.1. Material Specification:

- a. Pure Ceramic (Glazed) is requested, with Al_2O_3 content > 99%. Relevant test certificate must be provided to ITER-India for approval prior to start of manufacturing.
- b. Stainless steel (304L) conforming to ASTM specification A240/A312/A314 / equivalent Indian standard.
- c. Kovar material conforming to ASTM Specification ASTM F15 alloy / equivalent / equivalent Indian standards.

6.2. Brazing Requirements:

- a. Brazing shall be carried out in a vacuum atmosphere.
- b. For ceramic to metallic brazing, either metallization of ceramic can be used followed by Nickel plating or active metal brazing can be used.
- c. Leak testing of braze joints: All vacuum sealing braze joints shall be 100% leak tested. Acceptance criteria for local leak tightness (by vacuum method) is less than 5×10^{-9} mbar-lit/sec.
- d. The use of LPT shall be prohibited on braze joints. In case LPT is inevitable during any stage of manufacturing, a proper cleaning procedures shall be implemented, after approval from ITER-India.

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6.3. Welding Requirements: Welding requirements are applicable as per ASME rule section IX.

Welding:


- a. Suggested Welding procedure is TIG welding.
- b. Welding shall be done on the job, strictly following the approved welding procedures.
- c. *Weld Plan:* The Supplier shall submit a Weld Plan to ITER-India for approval prior to start fabrication. The weld plan is a drawing which cross references of each welded joint to a supporting weld procedure specification (WPS). Weld Plan, in conjunction with the following documents shall be submitted to ITER-India before start of welding activity:
 - i. Welding Procedure Specification
 - ii. Procedure Qualification Record
 - iii. Welder Qualification Record
- d. *Acceptance test for Production weld on actual components:* 100 % volumetric examination (LPT, Radiographic testing, Ultrasonic testing & Visual examination- as applicable shall be done on the welded joints).
- e. The build-up of internal stresses shall be avoided as far as possible.
- f. The selected welding technique shall produce a clean, pore free weld with minimal oxidation.


7.0. Inspection and Testing:

The following test and inspection procedure shall apply to components during manufacturing and to finished components of capacitor assembly:

Table 2: *Inspection and Testing*

Test Description	Components	Acceptance Criteria/Reference Document
Visual Inspection	End Flanges, Ceramic cylinder, final brazed assembly	Free from all kinds of surface defects.
Dimensional Inspection- Using conventional tools like dial gauge and vernier.	End Flanges, Ceramic cylinder, final brazed assembly	Approved manufacturing
Geometrical Tolerances- Flatness, parallelism	End Flanges, Ceramic cylinder, final brazed assembly	Approved manufacturing

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<p>MSLD –Leak testing shall be performed at room temperature. Leak testing must be performed by following two methods:</p> <p><u>Local Leak testing (Vacuum method):</u> Vacuum feed through must be evacuated below 10^{-03} mbar using MSLD. After background is stabilised at less then 5×10^{-09} mbar-lit/sec, helium should be sprayed near all the brazing joints and vacuum sealing area.</p> <p>Note: - For evacuating the feed through, both the ends shall be covered with end flanges. <u>For covering the elongated side of ceramic cylinder, stainless steel pipe with end covering flange shall be considered.</u> Proposal/ Procedures for vacuum leak testing shall be approved by ITER-India prior to start of manufacturing and testing.</p> <p>All the tools, components, vacuum flanges, leak testing equipment's shall be supplied by Bidder during factory site testing.</p>		<p><u>Leak Rate of less than or equal to :</u></p> <p>$\sim 5 \times 10^{-09}$ mbar-lit/sec for Local leak rate.</p>
NDE –Examination –	As applicable	100% as per ASME sec VIII, Div. I, UW52.

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High Voltage test.	Test Voltage of 60 kV DC for the duration of 30 minutes in atmospheric condition.	No breakdown shall occur .
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8.0. Final Acceptance Test:

8.1. Factory Acceptance Test(FAT):

The Supplier is responsible for checking that all items conform to the technical requirements as set out in the technical specifications. The Supplier shall ensure that the items are in line with requirements. The Supplier shall make all components and parts available for Factory Acceptance Tests at the Supplier's site for ITER-India.

Factory Acceptance Test aims and criteria are to check:

- Compliance with the Technical Requirements specified in this Technical Specification and drawings.

For final FAT following test shall be done.

1. Visual Inspection
2. Dimensional tests
3. He leakage rate tests

Acceptance of the tests results and certificates does not relieve the Supplier of the responsibility for compliance with all the contractual requirements. If any of the Factory Acceptance Tests prescribed in the present specification reveals a defect or a fault of the components, the Supplier shall perform a timely and effective repair or shall guarantee the replacement the faulty deliverable free of charge, managing the repair or replacement by means of a proper non conformity management procedure.

8.2. Site Acceptance test (SAT):


After delivery of item(s) at purchase site, purchaser will inspect every component and check the physical state and condition of the packing for possible damage during transportation (Bidder may witness SAT at it's own discretion).

Acceptance Test at site includes

-Checks of the physical state and condition of the packing for possible damage during transportation (Bidder may witness SAT at it's own discretion).

-Successful completion of all the tests as per below, which may or may not be witnessed by Bidder's representative:

1. Visual Inspection
2. Dimensional tests
3. Helium leakage test

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If any of the Site Acceptance Tests prescribed in the present specification reveals a defect due to a fault or damage during transport or unloading, the Supplier shall perform an urgent and effective repair or shall guarantee the replacement of the faulty component at no cost to the purchaser, managing the repair or replacement by means of a proper non-conformity management procedure.

9.0. Warranty

12 months from date of site acceptance at ITER-India.

10.0. Delivery period

Table 3: Delivery Schedule

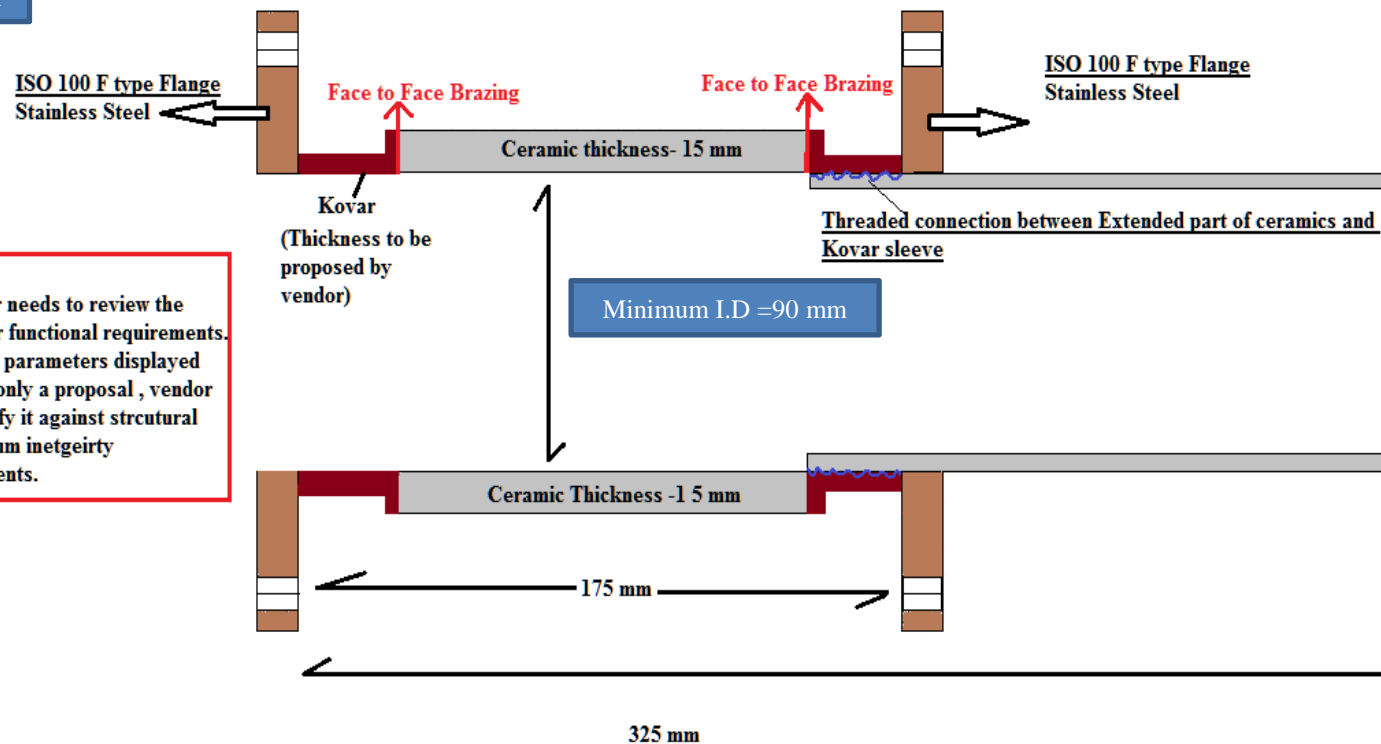
Release of Purchase order by ITER-India	T_0 (days*)
Submission of design report and manufacturing drawing with manufacturing and inspection plan(MIP) by Bidder	$T_1(\text{days}) = T_0 + 30 \text{ days}$
Approval of design, manufacturing drawing and MIP by ITER-India	$T_2(\text{days}) = T_1 + 7 \text{ days}$
Submission of material test certificates(TC)	$T_3(\text{days}) = T_2 + 7 \text{ days}$
Approval of TC by ITER-India	$T_4(\text{days}) = T_3 + 7 \text{ days}$
Pre- Qualification (PQ) of one number of vacuum feed through , witness and approval by ITER-India	$T_5(\text{days}) = T_4 + 120 \text{ days}$
Manufacturing and testing of remaining feed through	$T_6(\text{days}) = T_5 + 180 \text{ days}$
Factory acceptance test at Bidder site (FAT)	$T_7(\text{days}) = T_6 + 15 \text{ days}$
Delivery at ITER-India Site	$T_8(\text{days}) = T_7 + 15 \text{ days}$
Total time required for delivery at ITER-India site	381 days from release of purchase order.
Time required by ITER-India for completion of site acceptance test	60 days from date of material receipt at ITER-India site.

*- Calendar days only

Annexure-A: Detailed View- Proposed manufacturing route, functional requirement and testing

Detailed View- Proposed manufacturing route, functional requirement and testing

Sketch



Functional Requirement:
Water feed through must be able to withstand a isolation volatage of 50kV


Structural Integrity Requirement:
Proposed Braze joint design, ceramic thickness must be able to withstand the cantilevered load of mounting flange, SS pipe(1 inch and water load)

Vacuum Integrity requirement:
Leak rate of less than 5×10^{-9} mbar-lit/sec at inside vacuum of less than 10^{-5} mbar

Note:
a. Vendor needs to review the design for functional requirements.
b. Design parameters displayed here are only a proposal, vendor must verify it against structural and vacuum integrity requirements.

Design proposal has been worked out taking face to face brazing option at both the ends. The minimum lap length provided on Kovar sleeve for this brazing is 10 mm. Vendor needs to confirm, if it would be sufficient to take the required structural load of mounting flange, SS pipe with water load flowing inside it.

Above dimensions are only suggestive. As scope of work includes the design, Bidder must calculate these dimensions, satisfying the load requirements mentioned in section 3.2. While designing Bidder needs to maintain the limits of design on minimum I.D of feed through as 90 mm and end connection flanges should be of ISO 100 F type.

	ITER-India
	Indent document for item name

Annexure-B: Technical Compliance Format

The supplier must fill, sign, and stamp the below table as part of compliance to the requirements. If the item under procurement is a COTS product the following clause may be added.

As an evidence of offered specifications the supplier shall submit appropriate documentary evidences such as product data sheets, catalogues, manuals etc. Simply specifying Comply / Yes etc. without proper verifiable evidences may not be considered.

Section No.	Description	Bidders Compliance (Yes/No)	Remark (to be filled by the Supplier)
1	Introduction:		
2	Scope of Work		
3	Design Requirements		
4	Manufacturing Requirement		
5	List of Deliverables:		
6	Technical Specifications		
7	Inspection & Testing		
8	Final Acceptance Test		
9	Warranty		
10	Delivery		
Annexure-A	Detailed View- Proposed manufacturing route, functional requirement and testing		

Bidders Stamp & Signature