



ITER-India
(Institute For Plasma Research)



Title	GeM Bid for Manufacturing, Testing, Supply, Installation and Commissioning of Hot Helium Leak Test (HHLT) Vacuum Vessel
Sub Title	Scope of Supply, Work and Technical Specifications

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1. Introduction:

This document describes the definition and scope of work for Manufacturing, Testing, Supply, Installation and Commissioning of HHLT vacuum vessel that would be used for the Hot Helium Leak Testing of accelerator grids.

Description of Vacuum Vessel:

Cylindrical chamber of HHLT Vessel would be 1.5 m long with major diameter as 1 meter and 12 mm thickness. The cylindrical chamber would be made of stainless steel (SS304L). One end of cylindrical chamber would have rotatable type flange (without Viton O-ring) while another end would have fixed flange (With Viton O-ring). Chamber contains one no. of ISO 500 K type port, 7 no. s of straight (normal to wall surface) CF 100 ports and 3 nos. of inclined (inclined at 70 degrees & 40 degrees to wall surface) CF 100 ports. Cylindrical chamber would be mounted on structural steel-based support column (attached to it by welding) with base plate as shown below. Base plate would be further mounted on structural steel C- Channel. Support column are divided in two segment containing Teflon based isolation disk and washer for electrical isolation.

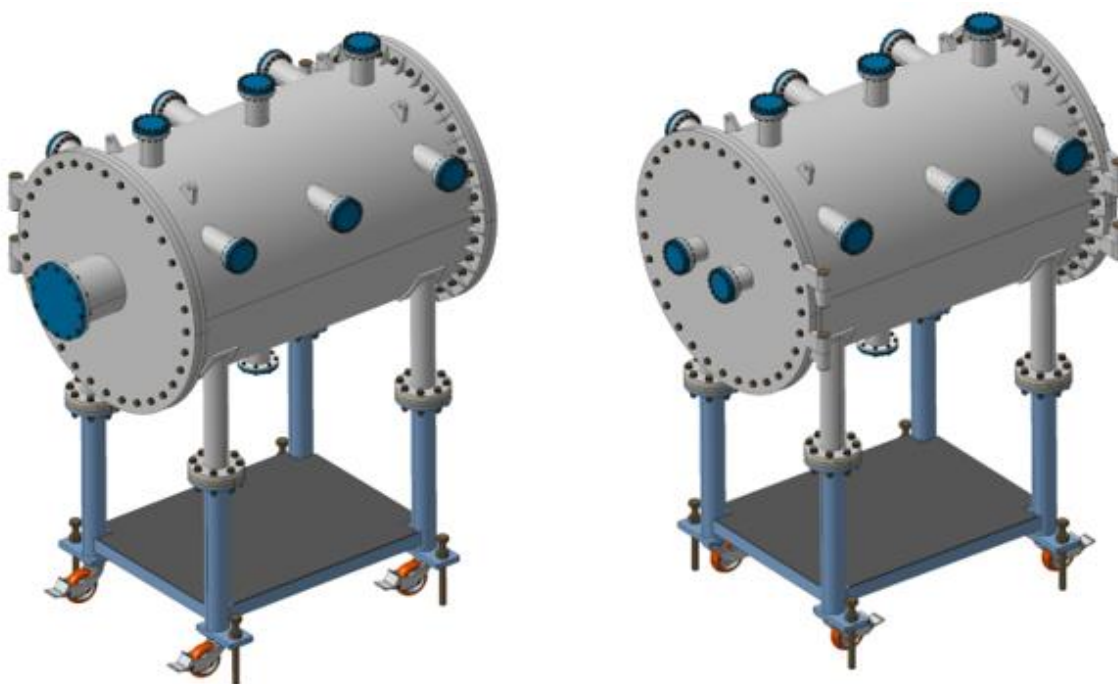


Figure 1: 3D View HHLT Vacuum Vessel

Functional Requirement of HHLT Vacuum Vessel:

- a. Provide vacuum confinement to the accelerator grid system.
- b. Sustain weight (~50 kg) of the accelerator grid segments and provide support to it.
- c. Sustain weight of end flange connection.

- d. Sustain weight and provide support to turbomolecular pump (~60 kg) through ISO 500 port.
- e. Provide access to vacuum feed through electrical/hydraulic/thermocouple through multiple CF ports.
- f. Provide accessibility for diagnostic ports.
- g. Provision of handling and lifting the vessel as per requirements.

Operational Requirement of Vacuum vessel:

S. No.	Requirement	Parameters
1.	Vacuum Requirement	5×10^{-06} mbar
2.	Leak Rate	$\sim 5 \times 10^{-09}$ mbar-lit/sec- Local $\sim 5 \times 10^{-07}$ mbar-lit/sec- Global
3.	Operating external Pressure	1 atm
4.	Operating Temperature	25-30 degree Celsius

2. Scope of Work:

1. **Review of engineering drawing provided with tender document and check the configuration for vacuum integrity (to comply with overall vacuum and leak rate requirements) and suggest changes if any.** Please note that carrying out the structural design is not in the scope of the bidder. Purchaser has the right to accept or reject the suggestion provided by the vendor/supplier. Vendor needs to review: O-ring groove dimension
2. Any change in engineering design shall be implemented after approval from ITER-India.
3. Preparation of manufacturing/fabrication drawings (including tolerances), manufacturing and quality documents such as Manufacturing and Inspection Plan (MIP), Quality Plan (QP), manufacturing process sheets, manufacturing procedures, welding procedures, inspection and testing procedures, packing, transportation and installation procedures. *Vendor shall submit all the drawings, manufacturing, and inspection plan to ITER-India for approval with proper documentation.*
4. Procurement of all the materials required for vessel manufacturing including materials required for all qualifications, tests, tools, jigs & fixtures until Site Acceptance Testing (SAT) at ITER India (Required material, non-exclusive to all manufacturing activities, handling, surface treatment, assembly, inspection, testing, packing, loading, unloading, transportation, installation and commissioning vessel at ITER-India)
5. Manufacturing of vessel as per the final approved drawings and approved Manufacturing Inspection Plan (MIP).
6. Manufacturing tools, jigs & fixtures and tooling required for all manufacturing activities, handling, surface treatment, assembly, inspection, testing, packing, loading, unloading, transportation, installation and commissioning of vessel is in the scope of supplier.

7. Inspection and testing's as per ITER India approved MIPs against the requirement. MIP shall enlist the stages of manufacturing along with the reference documents, intervention stages. MIP format shall be provided by ITER India.
8. Factory Acceptance Tests as listed in section 10.
9. The issuance of "Inspection Release Note" / "Dispatch Clearance" from the Purchaser or his authorized representative shall be considered as completion of "Factory acceptance test"
10. Packing, Loading / handling for safe delivery, transportation, unloading & placing at the place requested by Purchaser at ITER-India site.
11. Site acceptance test at ITER-India which shall consist of overall visual inspection for verification of transportation damages, dimensional inspection and leak testing in presence of Purchaser's representative. ITER-India shall provide the pumping system (vacuum pumps) and leak detection equipment (MSLD) for the site acceptance.

3. **List of Deliverables:**

(i) **List of Components to be delivered at ITER-India after dispatch clearance:**

S.No.	Particulars	Drawing No.
	VACUUM_VESSEL_&_SUPPORT_STRUCTURE_ASSY	VVSS-00-00
1.	VACUUM_VESSEL	VVSS-00-01
2.	BLANK_FLANGE_WITH_ISO250F_PORT	VVSS-00-02
3.	BLANK_FLANGE_WITH_DN100CF_PORT	VVSS-00-03
4.	ALUMINIUM_GRATING_PLATE	VVSS-00-04
5.	PIN	VVSS-00-05
6.	O-RING	VVSS-00-06
7.	100CF_BORED_FLANGE	STD
8.	100CF_GASKET_OFHC_COPPER	STD
9.	100CF_BLANK_FLANGE	STD
10.	ISO100_F_BORED_FLANGE	STD
11.	ISO100_F_BLANK_FLANGE	STD
12.	ISO100_F_HV_CENTERING_RING	STD
13.	ISO250_F_BLANK_FLANGE	STD
14.	ISO250_F_HV_CENTERING_RING	STD
15.	SUPPORT_STRUCTURE	VVSS-00-07
16.	ISOLATION_DISK_OD230	VVSS-00-08
17.	SUPPORT_STRUCTURE_PLATE	VVSS-00-09
18.	ISOLATION_BUSH	VVSS-00-10
19.	6_INCH_SWIVEL_CASTER_WHEEL_ASSY	STD
20.	ISO_4016_M8x55_BOLT_HEX_HEAD	STD
21.	ISO_7089_WASHER_8x16_PLAIN_SERIES	STD
22.	ISO_4034_NUT_M8_HEX_HEAD	STD
23.	ISO_4016_M8x40_BOLT_HEX_HEAD	STD

24	ISO_4016_M10x55_BOLT_HEXA_HEAD	STD
25	ISO_7089_WASHER_10x20_PLAIN_SERIES	STD
26	ISO_4034_NUT_M10_HEXA_HEAD	STD
27	ISO_4016_M16x90_BOLT_HEXA_HEAD	STD
28	ISO_7089_WASHER_16x30_PLAIN_SERIES	STD
29	ISO_4034_NUT_M16_HEXA_HEAD	STD
30	ISO_4016_M16x110_BOLT_HEXA_HEAD	STD
31	ISO_4018_M30x300_HEXA_HEAD_SCREW	STD
32	ISO_4034_NUT_M30_HEXA_HEAD	STD
33	ISO_4762_M8x12_HEXA_SCKT_CAPSCREW	STD
34	250CF_TO_ISO100F_FLANGE_ADAPTER	VVSS-EX-01
35	250CF_GASKET_OFHC_COPPER	STD
36	ISO_4016_M8x65_BOLT_HEXA_HEAD	STD
37	ISO_4762_M8x30_HEXA_SCKT_CAPSCREW	STD
38	METALLIC_HOSE_SS-FX4TM8TM8-100CM-SWAGELOK	STD
39	CF40_MULTI_PIN_BAYONET_FEEDTHROUGH	STD
40	35CF-40CF_GASKET	STD
41	100CF_BLANK_FLANGE+PIPE	VVSS-EX-02
42	100CF_TO_25KF_FLANGE_ADAPTER	VVSS-EX-03
43	100CF_TO_40KF_FLANGE_ADAPTER	VVSS-EX-04
44	100CF_TO_40CF_FLANGE_ADAPTER	VVSS-EX-05

(ii) List of documents to be submitted by supplier in phase-wise manner:

S.No.	Description
A. Before start of manufacturing process:	
1.	<ol style="list-style-type: none"> Deviation list (if any) in the engineering drawings. Initial follow-up documents (Quality Plan and Manufacturing & Inspection Plan) including Purchaser hold points. Material documentation (incl. Procurement specification, material certificates, test and examination results). List of Supplier's sub-suppliers. (if any). Manufacturing drawings and components part list. Check for the Materials (base and filler) identification and marking. Welding Procedure Specification (WPS), Procedure Qualification Record (PQR) and Shop Weld Plan (Shop weld plan can be prepared as a part of mfg. drawings) Leak Testing Procedures. Cleaning procedures. Packing and Transportation procedures. Format Non Conformance Report (If applicable)

B. Documents to be supplied before final acceptance:

2.	1. Inspection reports (dimensional checking, visual inspection, results of leak tests performed (including size and location of leaks found), NDE). 2. End of manufacturing report (Release Note) / Manufacturing dossier including as-built drawings.
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Note: Apart from the list mentioned in section 3 as deliverables, any other item required for factory testing, assembly to maintain mechanical, vacuum integrity and leak testing and to meet the requirements as mentioned in section 1.1 & 1.2. also comes under scope of supply.

4. Vendor's Scope of Work within design review:

Vendor's scope of work within design review is limited to following:

- a. Manufacturability and manufacturing design from the engineering design
- b. Check for O-ring groove dimension and positioning (PCD).

5. Installation requirement at ITER-India site:

Vacuum Vessel is to be located inside DNB lab situated at ground floor of ITER-India laboratory building.

Note: *Vendor may attach(weld) the support structure to Vessel cylindrical shell at ITER-India site (Or) support structure can be pre-attached to cylindrical shell at factory site based on material handling convenience as assessed by vendor himself.*

6. Material Specification:

S. No.	Component	Material	Equivalent grade*
1.	Cylindrical shell of vessel	SS-304L	ASTM A240
2.	Pipes	SS-304L	ASTM A-312
3.	Covering flanges	SS-304L/316L	ASTM A-240
4.	Bottom supports structure	Structural steel	ASTM A-36
5.	Bolts and studs	Stainless steel	ASTM A-193
6.	O-ring	VITON	E-60C grade
7.	Grid support frame	Aluminum	

*Variation in equivalent grade is permitted as per approval from ITER-India.

The dimensions mentioned in the drawings are finished dimensions and the supplier shall procure the raw material in sufficient quantities and appropriate size taking into account all the necessary allowances required for manufacture, qualification and testing.

The supplier shall submit material test certificate for all the raw materials. All material shall be free from all the kinds of defects like cracks, fissures, pits, lamination or any other defects which would make it incompatible with ultra-high vacuum environment.

Material Test Reports in accordance with EN 10204 3.1 shall be provided. The traceability of the same shall be established with the material.

In case of non-availability of test certificate / any test result required by the code, vendor must agree to perform the same in NABL accredited lab (if required, ITER India/Purchaser may witness the same)

Surface finish of material:

The inner surface finish must be more than 2 delta (R_a 6.3- 3.2). The region where O-rings are to be fitted must attain a surface finish of 3 delta (R_a 1.6-0.8) The outer surface may be as received. Components shall be suitably cleaned with alcohol/acetone.

7. Material Procurement:

All the material, welding consumable, proprietary items and brought out items including materials for trials, qualifications and test coupons etc., as required for manufacture of vessel shall be procured in accordance with relevant ASTM specification with appropriate test certificates. The supplier shall procure all the materials as per relevant applicable specification from reputed manufacturers. The source of material procurement may be indicated and got approved from the Purchaser. Material shall be procured along with the EN 10204 3.1 certification and the same shall be provided for review and approval.

8. Welding:

All weld joints shall comply with the specification laid down under the relevant Subsections of Article 1 of ASME standard for Boiler and Pressure vessels, section IX.

Latest edition (as on the date of tender) of the following shall be the applicable code / specification:

ASME Sec IX : Welding and Brazing Qualification

ASME Sec V : Non-destructive Examination

ASME Sec II Part C : Specifications for Welding Rods, Electrodes and Filler Metals.

Welding General Requirement:

Welding shall be done on the job, strictly following the approved welding procedures using approved welding consumables and qualified welders / welding operators. Suitable sequencing

of welds shall be carried out to avoid buildup of residual stress and distortion. WPS shall be displayed in manufacturer's shop during welding. The weld fit-up tolerance shall be as indicated in drawing. Clearance shall be obtained from Purchaser's inspector for fit-up before welding.

All the welding consumable shall be procured and stored as per the requirements of ASME Sec II Part C. The EN 10204 3.1 certificate shall be provided for welding filler material certificate

Welding process and control specification (Relevant subsection of article 2 under ASME standard for Boiler & Pressure Vessel Section IX):

Welding qualification samples shall be prepared by the vendor/supplier to qualify the welding and control specification for each type of weld to be used during manufacture.

9. Inspection and Testing:

- The supplier shall inspect all the parts, sub-assemblies, final assemblies etc., for full compliances as per approved drawings.
- All the tolerance dimensions / features in the individual parts and the completed vessel shall be inspected by suitable methods for compliance as per ISO 2768- mK.
- Dimensional check for the individual components and the completed vessel shall be carried out at a constant temperature as per the approved procedure and shall meet the requirements specified in the approved drawing.
- Before dimensional checks all the tools, gauges, instruments and measuring equipment's must be calibrated to ensure their proper range, type, accuracy & precision.
- All the dimensions given in the drawing are at room temperature.
- Inspection of welds must be as per criterion mentioned in section 9.
- Vacuum leak testing must be done on finally fabricated and cleaned vacuum vessel as per final acceptance criterion mentioned in section 10.
- The inspection shall be in compliance with MIP prepared by the supplier and approved by the purchaser. However, depending on the manufacturing procedure, quality assurance system of the company and manufacturing and inspection facilities available with the supplier, some additional checks may also be necessary on and above approved MIP. Such checks shall be incorporated and implemented by the supplier without any extra financial implications to the purchaser.
- Written reports to be reviewed and signed by authorized quality representative of the vendor for each test and inspection.
- ITER-India shall be given the opportunity of having an inspector present at any of these tests and shall be informed at least 2 weeks before any test takes place. All the acceptance tests (factory site) would be witnessed by ITER-India representative. Acceptance of any component will only be given when it has met the full requirements of the specification and/or drawings. In the event of a test failure, the vendor shall document the failure and submit a proposal for correcting the faults. Written approval from ITER-India shall be required before any corrective action is taken.

- Quality surveillance as well as quality audit by the Purchaser or his authorized representative shall not relieve the supplier from the responsibility of meeting the specification or the inspection duties.

10. Acceptance Criteria (applicable to Factory acceptance test and site acceptance test):

- a) Dimensions & Surface finish of fabricated components and vessel assembly must be as per the approved engineering/fabrication drawing.
- b) Helium Leak Test: The vessel shall be thoroughly cleaned before vacuum test following the standard vacuum protocols. He-leak test shall cover all the vacuum boundary weld joints.

For the leak testing, the vacuum vessel shall be placed along with the supports and flanges are to be closed with blanking flanges. The system shall be evacuated to a vacuum of 1×10^{-4} mbar, using appropriate vacuum pumps. All the joints including the weld joints shall be leak tested using helium leak detector for leak rate of less than 5×10^{-9} mbar-l/s. Following successful completion of the leak tests, the vessel shall be tested for integral leak rate of less than 5×10^{-7} mbar-l/s.

- The Supplier is responsible to provide all jigs, seals and equipment to for carrying out the leak tests.
- The Supplier is responsible for the supply of blanking flanges, seals, pumping and leak detection equipment for the tests. (ITER-India may provide pumping system and leak detectors for testing at ITER-India Site).
- Supplier shall submit the Leak testing procedure which describes how the leak test will performed and include configuration diagrams and full details of equipment to be used etc. to ITER-India for approval.
- Supplier shall prepare leak test report.

-For the integral leak tests, the test vessel should be covered with a plastic and the vessel is evacuated using a vacuum pumping system to a pressure $\sim 10^{-4}$ mbar. A leak detector is connected either to a separate port, or in the line connecting to the backing pump and is calibrated w.r.t a standard leak before starting the measurement of integral leak test. For the integral leak test, the space between the evacuated vessel and plastic cover must be filled with helium tracer gas at least 60% by volume. As helium enters through leak present in evacuated vessel it gets detected by helium gas leak detector. The detector indicates the total / global leak rate.

11. Cleanliness, Storage and Workmanship:

Prior to its helium leak test, the vacuum vessel shall be cleaned. All internal and external surfaces of the vacuum vessel, including all flanges shall be rendered free from fingerprints, contamination, welding flux, and any other substance that may impair the ability to establish and maintain the required vacuum. After cleaning, the vacuum vessel shall be closed with airtight covers and stored under clean polyethylene covers in a clean, dry and dust free area.

- Clean condition and good workmanship shall be maintained at all the stages of storing, handling, fabrication, inspection and packing as acceptable to purchaser.
- Care should be taken to avoid contact of stainless steel with carbon steel.
- SS fabrication area is to be shielded from neighboring areas by metallic screens to prevent contamination from the weld spatter, grinding dust etc.
- The raw material, subassemblies and finished components shall be sufficiently covered with polythene sheets to avoid contamination during storage.
- Separate storage facility for S.S material away from C.S material shall be used and identification of all material and off cuts (like heat no, plate no., rolling direction etc.) shall be maintained by transferring the same to other location before cutting.

12. Handling and Packaging:

- The supplier shall ensure that all the vessel parts / assemblies are protected against any corrosion or damage during all stages of manufacture, inspection, handling, storage and transport. The packing shall be suitable and rigid enough to ensure safety of vessel during all stages of shipping by road to site, loading, stacking and storage at plant site. Adequate number of silica gel packets along with a copy of shipping release shall be kept inside cart.
- All the openings shall be protected to prevent entrance of dirt and moisture during shipment, storage at site and erection.
- The package shall be stencilled in bold character with indelible paint, protected with shellac to indicate shipping mark, package numbers, dimensions and gross weight in kilos, the purchase order number and any other necessary data to identify the equipment and relate it to the contract.
- Packing list shall plainly show package number, kinds of package, contents, dimensions and net, legal and gross weight of each package. If different items are in a package, the net weight for each item shall be specified.
- The shipment of equipment shall not be affected until and unless written “Inspection Release Note” / “Shipping Release” / “Dispatch Clearance” is obtained. The same will be issued by the Purchaser or his authorized representative after satisfactory completion of “Factory acceptance test”. The supplier then only shall dispatch the vessel to Purchaser’s site.
- Transshipment in transit shall be avoided and supplier shall arrange specially hired conveyance for direct delivery at Purchaser’s site.

13. Drawings:

Engineering Drawings:

Engineering drawings & 3d xml/step files for the preparation of manufacturing drawings would be provided by ITER-India:

Manufacturing Drawing:

The supplier shall prepare manufacturing / shop drawing based on final design approved by Purchaser. The drawings prepared by the supplier shall require the approval of the Purchaser prior to start of manufacturing activities. The supplier shall take care to prepare detailed shop manufacturing drawings / sketches indicating all the dimensions with tolerances for all the individual components, sub-assemblies, final assemblies etc. The weld fit-up tolerance shall also be indicated in the drawings.

The vendor needs to prepare the 'as built' drawing after completion of all the manufacturing and testing activities and the same shall be submitted to purchaser for review and approval.