

RADIO-FREQUENCY QUADRUPOLE (RFQ)

**Tender Document
For**

**FABRICATION, INSPECTION, TESTING, SUPPLY, INSTALLATION &
COMMISSIONING**

OF

“RADIO-FREQUENCY QUADRUPOLE (RFQ)”

*Installation & Commissioning Site
Institute for Plasma Research, Gandhinagar*

PART-A (I)**Technical Terms, Conditions & Instruction to Bidders**

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INTRODUCTION

1.1 Requirement of Radio-Frequency Quadrupole (RFQ)

The RFQ Accelerator is being developed under the project “Development of RFQ for Accelerators” for Ion Irradiation Facility. In Irradiation Facility, an ECR ion source is used to produce ion beam which is further accelerated by Radio Frequency Accelerator to few MeV energies. These high energy ions can be used to study the material properties of first wall components like tungsten, copper, ferrous etc. of a fusion reactor.

In RFQ, basic structure is 4 electrodes, which generate RF electric field in its channel to accelerate and focus ion beams simultaneously. The RF field also plays the role of transverse matching and longitudinal bunching functions according to dynamics design. RFQ ingeniously integrates the above four basic functions in a compact RF cavity. The practical range of operation of RFQs goes to low velocities as compared to conventional linac. The RFQs bunch the beam adiabatically, which increases the capture efficiency and transmission. Because of these remarkable properties, the RFQs are well suited as a first unit of all high current RF linear accelerators in many advanced applications.

4 electrodes of RFQ are housed in vacuum vessel. For our design, this vacuum vessel will be made up of Aluminum 6061-T6 Grade to achieve a base pressure $\sim 10^{-8}$ Torr. The vacuum vessel will have different ports for RF feed, vacuum components and diagnostics etc. Figure 1(a) and 1(b) give two detailed views of vacuum vessel.

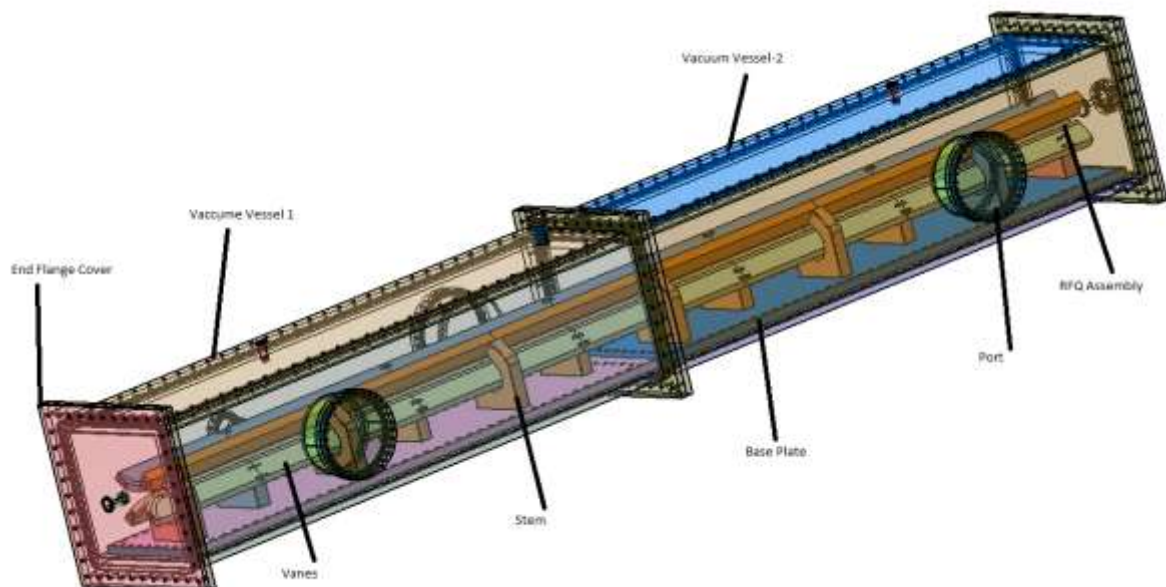


Figure 1(a) : Conceptual Assembly View of RFQ with Vacuum Vessel.

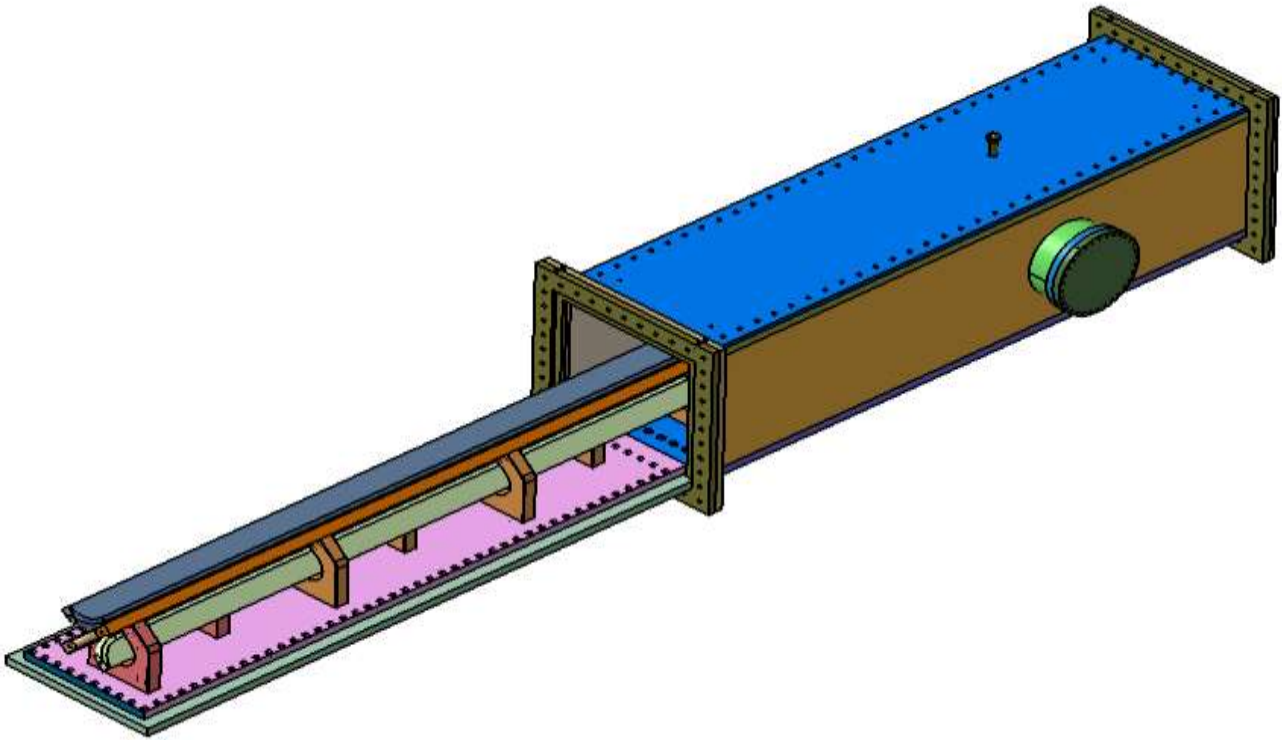


Figure 1(b) : Another View of RFQ with Vacuum Vessel.

1.2 The parameters of RFQ

1 MeV RFQ was designed @60 MHz to accept a 50 KeV, 5 mA DC proton beams from the ion source with a length of ≈ 4.2 m. The resonant frequency of RFQ is sensitive to the vane tip displacement within order of 2.5 MHz/mm. A photograph of a typical RFQ is shown below in Figure 2 and Figure 3.

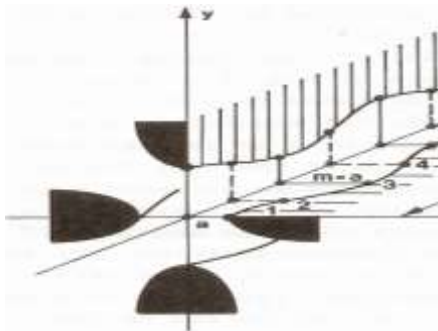


Fig.2: Schematic of RFQ cross section and modulations

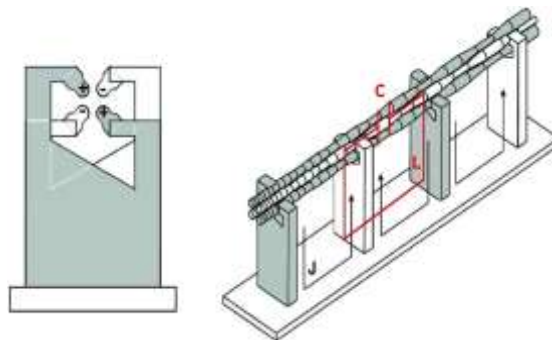


Fig.3: Typical cross section of a Rod Type RFQ

The RFQ consists of four ‘vanes’ that are positioned in such a way that the ion beam passes through the central region between the tips of the vanes, as shown in the figure 4. In this region alone the ion beam will see an accelerating field that will accelerate it to the desired energy and hence this region is most important part of the RFQ fabrication and needs very tight accuracies during the fabrication process.



Fig.4: Bunching and acceleration of the beam between the pole tips

Table 1 below summarizes the parameters and accuracy requirements of RFQ.

Table 1: Parameters of RFQ

Physical	Beam line height from the floor	1.5 m
	Overall width	≤ 1.3 m
	Overall length (flange-to-flange)	4.5m (approximately)
	Overall height (from floor)	≤ 2.00 m
Beam	Particle Type	Proton
	Input beam parameters	Match to LEBT at 5 mA
	Nominal Input energy (kinetic)	50 (+/- 0.5%) keV
	Nominal output energy (kinetic)	1 (+/- 0.15) MeV
	Physical beam aperture, $2 \cdot R_0$, beginning-to-end	30 mm (Approx.)
	Nominal Beam Current	5 mA
	Transmission efficiency	>97%
Alignment/ machining precision	Transverse emittance (normalized, rms)	< 0.2 mm mrad
	Vane Machining Accuracy	20-50 μ m
	RFQ Vane Alignment Accuracy	Better than ± 50 μ m
	Inter-segment Alignment Accuracy	Better than ± 50 μ m
	Max transverse position error (X,Y)at upstream and downstream beam flange	Better than ± 100 μ m
RF	Max longitudinal position error (Z)	Better than ± 100 μ m
	Frequency	60 MHz
	Duty factor (CW)	1%
	Total RF power for resistive losses and beam loading	<100 kW
Vacuum	RFQ operating temperature	Less than 30 $^{\circ}$ C
	Operating pressure	$\leq 4 \times 10^{-7}$ torr

2. SCOPE OF WORK

Scope of work contains preparation of manufacturing/fabrication drawings, manufacturing and quality documents (such as Manufacturing and Inspection Plan (MIP), Quality Plan (QP), manufacturing procedures, welding procedures etc.), inspection, assembly, testing procedures (at vendor site and at IPR site) and commissioning.

As per the topology of RFQ, the assembly tolerances are very tight – of the order of 100 microns, so proper machining of vanes and stems should be carried out strictly as per drawings. It is very critical as these vanes and stems are joined by bolting and dowelling only. In order to ensure that the tight tolerances mentioned above are actually achieved, at each stage precision metrology using a Coordinate Measurement Machine (CMM) is essential.

The vanes have to be machined to tight tolerances, of the order of few 10s of microns. Since vanes are exposed to high electric fields, the surface finish of the vanes has to be better than 0.4 μm R_a and 2 μm R_t .

Also, as the RFQ operates at ultra-high vacuum (UHV), the surface must be free of adsorbed molecules and other contaminants. Therefore, cleaning and handling procedures are very important, and the procedures given in this document should be strictly followed, failing which acceptance may not be given.

The detailed scope of work is given in this tender document.

- a. The drawings of the RFQ and vacuum chamber issued with this tender are offered as a reference. Detailed fabrication drawings for the vacuum chamber and RFQ shall be prepared by vendor and to be approved by the purchaser before starting any fabrication process. Therefore, although the reference drawings and associated data are available for use by vendor, vendor shall be finally responsible for the designs meeting the performance requirements as mentioned in this specification. Vendor is free to cross verify the design to meet the required specification.
- b. Vendor shall submit all the drawings and relevant documents in soft copy as well as in hard copy for IPR approval.
- c. Inspection and testing at various stages before / after / during manufacturing as mentioned in the various sections and annexures of specification and drawings. **IPR reserves the right to define/select the third party Inspection (TPI) agency. All the instruments required for testing (vendor site / IPR site) has to be arranged by vendor.**
- d. Completion of all factory acceptance tests as listed in section 4 of this document.
- e. The issuance of “Inspection Release Note” / “Dispatch Clearance” from the purchaser or his authorized representative shall be considered as “Factory acceptance test”.
- f. Proper packing, Loading, safe delivery, transportation, handling, unloading & installation at IPR site.
- g. The vendor will be required to supply the entire blank off flanges, good quality SS.304 (socket head cap screws, hexagonal nuts and i-bolts) of the required quantity and sizes.

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- h. Vendor can suggest any change in the design for vacuum vessel with can avoid the welding distortion with prior approval of IPR. IPR may suggest any minor modification in the vacuum vessel design which has to be incorporated by the vendor without any extra cost.
- i. Site acceptance test at IPR which consists of overall visual inspection for verification of transportation damages, dimensional inspection, leak testing, Hydro testing, RF Testing, High Vacuum testing, in presence of purchaser's representative. Vendor shall arrange the pumping system, valves and leak detection equipment, required for testing at the vendor's site.
- j. IPR shall provide the pumping system and leak detection equipment for the IPR site acceptance.
- k. Minor changes in the drawings may be incorporated at a later stage at no extra cost.
- l. Deviation from the given tolerances will not be permitted; the manufactured items will be checked / inspected with CMM at the supplier's inspection Centre to ensure compliance with the supplied set of drawings and also at IPR after delivery to check for any damage during transportation.
- m. The supplied components should have excellent workmanship in all aspects of fabrications. All the Jigs and Fixtures required for the fabrication, assembly, testing (at vendor site / IPR site) and commissioning are under the scope of vendor.
- n. The vendor will be required to send the inspection report of each and every stage of fabrication of all components. IPR reserves the right to send his personnel to vendor's works and get the components inspected in front of him during any or all stages of fabrication for final approval.
- o. Proper cleaning (mechanical / chemical) of components and system is under the scope of vendor.
- p. Vendor is responsible for safe storage of all components in all intermediate stages, particularly with a view to avoid nicks and scratches on the surfaces of the vanes, stems and vacuum vessel, and also to avoid surface contamination of the internal surfaces of the vanes and stems.
- q. Vendor will be required to make strong wooden boxes with proper packing's like thermocol etc. with hinged top cover to keep the fabricated/machined all the individual components e.g. each vane and each stem individually and safely i.e. one vane / stem per box, the separate base plates etc.
- r. Terminology / units in consistency must be followed in all documents.

List of Components to be delivered at IPR after dispatch clearance:

Sr. No.	Particulars	Qty.	Material	Drawing No.
1	Base Plate	02	ETP Copper	19020003 19020004
2	Typical RFQ vanes	24	Oxygen Free Electronic (OFE) copper	19020010 TO 19020036
3	Stems	12	Oxygen Free Electronic (OFE) copper	19020007 19020008 19020009
4	Vacuum Vessel assembly	01	Al 6061-T6	19030001
5	RFQ Assembly Prototype	01	Oxygen Free Electronic (OFE) copper	19010002
6	Full Assembly	01	Variable	19010001
7.	Spares – 10% extra for the consumables like gaskets, bolts, nuts, washers, dowels, O-rings etc.			

Table 2: List of deliverables of Components

NOTE: A prototype (part of actual RFQ) will be fabricated first and tested. **THIS PROTOTYPE HAS TO BE FABRICATED WITHIN 4 MONTHS AFTER RECEIVING THE PURCHASE ORDER FROM IPR.** In case accepted, Prototype will be a part of RFQ structure. Successful testing would lead to manufacturing of complete RFQ (as mentioned above). **The Vendor can sub-contact any part of the tender to authorised manufactures/representatives. Vendor has to submit the name of vendor during the technical quotation for sub-contract. IPR reserves the right to accept / reject the sub-contracted vendor.**

2.1 ENGINEERING SCOPE OF WORK OF COMPONENTS**2.1.1 BASE PLATE:**

Base plate is bottom part of the RFQ assembly that holds the full assembly of stem and vanes. Flatness and dimensional accuracy of the base plate is very much critical and essential to achieve the total RFQ dimensional accuracies. Base plate of RFQ is sitting inside of the bottom of the vacuum vessel (plate having rectangular cut out). Base plate itself rests on bottom of vessel all along its perimeter which is sealed by O ring to provide vacuum integrity to the vacuum vessel.

Fabrication steps of Base Plate:

- a. Vendor should prepare jig plate for the holes required for base plate and slots for the stem location, baseplate and bottom plate hole should be machined accordingly.

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- b. For All the O-ring grooves, inside surface of the vacuum vessel and stem covered area of the base plate, flatness should be within $\pm 0.02\text{mm}$.
- c. Slot of the base plate should be measured with respect to the reference of the face. The entire slot should be machined with respect to reference so that error should not be accumulated. Go/No Go Gauge should be developed for the slot of stem.

Inspection of Base Plate:

- a. All the holes should be checked with reference to the edge face of the base plate.
- b. All the slots for the stem should be checked with Go/No Gauge, Slot center distance should be as per drawing.
- c. Flatness should be checked for the full length of the plate and also sagging of the plate is not accepted.
- s. **NOTE: All the bolts used for base plate to bottom plate should be drilled from Center to evacuate the trap volume of bottom plate. The screws used to clamp base plate should have 3mm through hole for the escape of trapped air.**

2.1.2 VANES:

Vanes are the main important part of the RFQ Assembly. There are four vanes assembled 90 degree apart from each other.. These vanes are made in six pieces length and aligned with each other by fixing and levelling on stems. These vanes are having a modulation throughout its length that (Face profile) varies in dimension along the entire vane length (Six segments). The vanes also have are have internal cavities for water flow.

Fabrication steps of Vanes:

All the vanes will be made in two phases:

a. Pre Welding Machining:

1. The vendor will be required to prepare the pre-welding drawings and to machine the job as per the pre welding set of drawings.
2. Vendor will complete plug welding/brazing of cooling holes.
3. After welding, successful leak checking and hydro test vendor should go for final machining.

b. Post Welding Machining:

The vendor will be required to do final machining of all the Vanes as per the post welding set of drawings.

Following point has to be taken care while fabrication of Vanes.

- i. Not even a minor scratch/dent is permissible/allowed on the modulated profile surface and other surfaces shown in the drawings.
- ii. None of the water entry/exit hole should be chamfered and the surface around these holes has to scratch free as 'O' ring sits around for vacuum as well as water sealing locations.

- iii. Digital copy of “Co-ordinated of the Profile” i.e. a text file containing x, y, z coordinates of the points on vane profile data will be provided by IPR for each and every vane **to the eligible vendors.** A sample of the co-ordinates is given below:

x	y	z
0.00	-6.60	0.00
0.20	-6.60	0.00
0.40	-6.63	0.00

.....and so on.

Inspection/Metrology of VANE:

- All Component and Assembly inspection should be done using high precision measuring instrument CMM, Laser Tracker or Articulated Arm.
- Profile measurement of the Vane should be measured with reference to the two face of the VANE. It is evident that establishing datum using two face of the Vane, profile measurement can be done.
- Profile should be checked for the full length of vanes from the datum using CMM scan method. Measured point and machining data should be accepted within error of ± 20 micron.
- Length of the Vane should be measured between end faces of the vane. Sagging of VANES should not exceed the tolerance limit of 20 micron.
- All O-Ring and Dowel pin should be measured with reference to datum.

2.1.3 STEMS:

Stems are intermediate structure between the vane and base plate. Stems (twelve numbers) are sitting on the base plate and hold the vanes. All assembly references should be taken from the stem for the assembly of the vanes. Stems are having internal cavities for cooling on top surface of the stem.

Fabrication steps of Stems:

Following point has to be taken care during fabrication of Stems.

- Consider reference point i and ii of the section 2.1.2 (post welding machining) for the fabrication of the stems.
- Stems should be machined using CNC wire cut machine preferably.
- Flatness of the inside base surface and top surface of the stem should be ± 20 **Microns.**

Inspection of Stems:

- Profile measurement of stem is to be done using reference of bottom face surface which is joined with base plate.
- Flatness should be checked with in limit of ± 20 Microns at bottom face & top face at vane sitting location.
- Perpendicularity should be checked with reference to bottom face of the stem.
- All the measurement should be checked with the imaginary axis of the RFQ assembly.

2.1.4 VACUUM VESSEL ASSEMBLY: (REF DRG.NO:IPR/17/A3/RFQ/-19030002)

RFQ Assembly will be enclosed inside a vacuum vessel made of Al 6061 T6. Vacuum of the order of 1×10^{-8} mbar is required to operate the RFQ. RFQ base plate becomes part of bottom of vacuum vessel. RFQ assembly sits on the bottom plate of the Vacuum vessel and joined through bolting to vacuum vessel. There is O-ring Sealing between bottom plate of the vessel and base plate of the RFQ Assembly. Vessel assembly is made in two parts; these two parts shall be joined through bolting and O-rings to form the full length assembly. End Flange of the Vessel Assembly is fitted with the help of Viton O-ring and bolts. There are port/Nozzles on Vessel for different and are required to be welded with vessel. The vacuum vessel is closed with end flange covers using O-ring seal or gasket as shown in the drawings.

Fabrication Steps of Vacuum Vessel:

- a. All the plates (side plate, bottom plate and top plate) shall be welded together to make one single high vacuum chamber such that the mating flanges i.e. end flanges, remain perpendicular to inside surface of the bottom plate to an accuracy of ± 0.05 Degree.(REF.DRG.NO:IPR/17/A3/RFQ/19030002 ,ITEM NO:2,3,4)
- b. Bottom Plate: It is most important component of the chamber, because it holds the RFQ assembly on it. The bottom plate should be kept flat to an accuracy of ± 0.25 mm after welding. The inside surface of bottom plate and outside face of end flanges may require machining even after final welding to maintain the required flatness and perpendicularity. (REF.DRG.NO:IPR/17/A3/RFQ/19030002 ,ITEM NO:01)
- c. Tapping/threading trial should be carried out on a piece of Aluminum material first and only after successful trial and approval vendor shall go ahead in bottom plate assembly. The vendor shall ensure the proper tightening torque required to achieve the required vacuum levels. All the tapping on the bottom plate should be carried out using jig plate that has been used for the base plate.
- d. Vendor should ground the weld surface in vacuum vessel where assembly of bottom plate and base plates are mating. No weld protruding inside of vessel will be accepted from assembly point of view.

Following points have to be taken care during fabrication of Vacuum Vessel:

- I. Only TIG welding is allowed and should be done on all plate of vessel from inside. Tack welding should be given only from outside.
- II. All the plates should be fine machined from all the sides i.e. surface roughness of N4-N5 grade should be achieved.
- III. No dent or scratch will be permissible on inside surface of the chamber, knife edges of CF flanges, O ring grooves and the surfaces where sealing is done using the rubber O rings.
- IV. Overall length of the chamber has to be maintained within the accuracy of ± 2 mm.
- V. Overall perpendicularity requirement is within ± 0.2 Degree.
- VI. The vendor shall get all the components inspected from IPR personnel before welding and before dispatch.

- VII. **Vacuum testing:** Leak testing of vacuum chambers shall be carried out in presence of IPR personnel at vendor's site as well as at IPR site after delivery and leak rate should be better than 1×10^{-9} Torr-lit./sec. Ultimate vacuum of the chamber should be better than 1×10^{-8} Torr.
- VIII. Machining of the vacuum vessel should be done in two steps. In first step, extra material should be kept for End flanges and bottom plate, next step should be welding and only after that final machining should be carried out because of the possibility of developing distortions in these components during welding.

Inspection of Vacuum Vessel:

- All the measurement should be carried out with reference to the face of the outer flange so it remains parallel and perpendicular with respect to back flange of the vessel within ± 0.05 mm.
- Measurements on the Bottom plate, for flatness and perpendicularity, should be carried out with respect to outer flange face.
- All the tapping should be checked using thread gauges.
- All the O-ring surface areas of the vacuum vessel should be kept dent free and scratch free i.e., no dents and scratches are allowed on surfaces of End flanges, bottom plate, top plate near the O-rings.

2.2. RFQ PROTOTYPE ASSEMBLY:

RFQ prototype is basically a small part of vacuum vessel, which consists of one octant of four vane, four stem along with base plate as shown in the drawing (IPR/17/A3/RFQ/19010002). It is for validation of vane profile perfectness, vacuum and hydraulic sealing between stem and vane interface and also for the vacuum sealing between all the flanges at ports, sealing between vessel and baseplate as well as between stem and base plate. Final testing will be carried out in assembly condition with one part of vacuum vessel. The ultimate vacuum of the chamber should be better than 1×10^{-8} Torr.

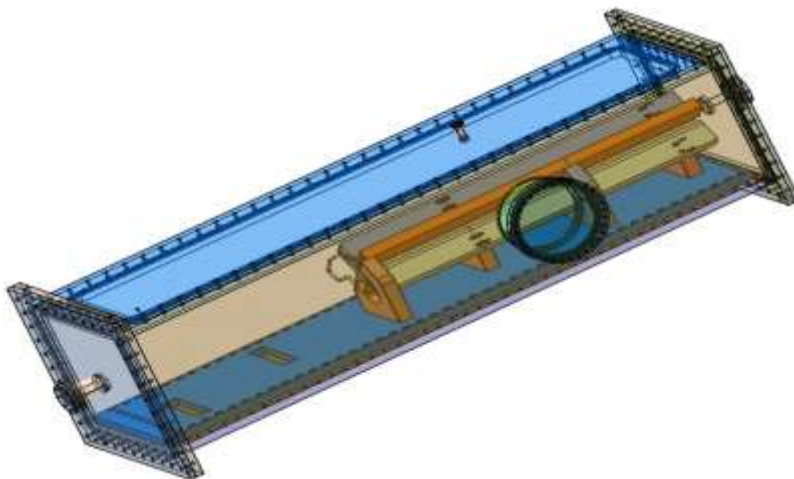


Fig 5: Isometric View of Prototype Assembly

Note: Vendor is required to fabricate Prototype strictly within 4 months after getting the order from IPR and perform the prototype assembly as per the above mentioned details. After taking

prior approval from IPR after successful assembly and testing of the prototype, fabrication of the rest of the components should be carried out.

Inspection/Metrology:

- a. Dimensional inspection shall be carried out as per full assembly procedures.
- b. Vendor should carry out the Hydro test up to a pressure of 5 bar and vacuum leak testing of the prototype for 1×10^{-8} Torr.
- c. Vendor should prepare set up to carry out RF testing for the RF acceptance procedure, as given in Full assembly section.

2.3 Final Assembly of RFQ components and Vacuum Vessel:

RFQ Assembly consists of two sub-assemblies of twelve Vane & six stem.

Full assembly of RFQ is the assembly of vacuum vessel (with all nozzles/ports with all their closing flanges with gasket / O-rings) and RFQ assembly (with all stems (12Nos), Vanes (24Nos), Baseplates (02Nos) with O-rings, Bolts, Nipples). Once Assembly of Vacuum Vessel is finished then base plates will be assembled on the bottom plate of the vessel and tightened with bolt. Stem will be inserted from the bottom side of the base plates through the cut outs made for the stems. After that vanes will be assembled on the stems. Finally End flanges covers will be mounted to close the chamber.

Metrology/inspection of the assembly:

- a. All the dimension of the vessel assembly should be checked with respect to outer flange
- b. Both end flanges should be checked for the parallelism to each other and side plates should be perpendicular to each other as per drawings.
- c. Both the bottom plates should be checked for perpendicularity w.r.t the outer flanges.
- d. Vendor should fabricate a temporary structure for the Assembly and testing.
- e. The vendor will be required to plan for jigs & fixtures for the assembly of RFQ inside the vacuum vessel.
- f. First base plate should be installed with reference to vacuum vessel outer flanges; perpendicularity and flatness should be checked with reference to outer flanges with in ± 20 Micron.
- g. All the stem slot centers should be checked with reference to the vessel outer flange and the distance of stem center should be with in tolerance defined as per drawings.
- h. All the stem assembly should be checked for the perpendicularity with respect to the baseplate and center distance with respect to vessel outer flange.
- i. All the distance of the stem dowel should be checked before starting assembly of Vane with stems.
- j. After assembly of the entire Vanes, Centre of RFQ axis should be measured with reference to stem datum point.
- k. RFQ assembly should be measured with reference to vacuum vessel face to the distance of VANE face and center axis of vessel and center of RFQ should be measured.

3 PRELIMINARY DESIGN FOR RFQ & VACUUM VESSEL (External Pressure Vessel)

Based on functional and operational requirement of the RFQ assembly & Vacuum Vessel, the Assembly has been divided into following parts:

- a. Vanes segments (total twenty-four Number) with different modulations.
- b. Three Types of Stems (total twelve numbers).
- c. Base Plates (total two numbers).
- d. Vacuum Vessel in two identical rectangles.
- e. End Flanges
- f. Covering Flanges for all CF Standard ports with Gaskets & O RINGS
- g. Bolts, Studs, Nuts, Washer, Dowel pins

3.1. LIMITS OF DESIGN:

Vendor is required to give suggestions or modifications if required, during the design review phase and get the approval for the same from IPR.

While suggesting any modifications or alternate design proposals, vendor must satisfy the following conditions listed under “Limits of Design”:

3.1.1 Vacuum Vessel:

- i. **Length of Vacuum vessel:**

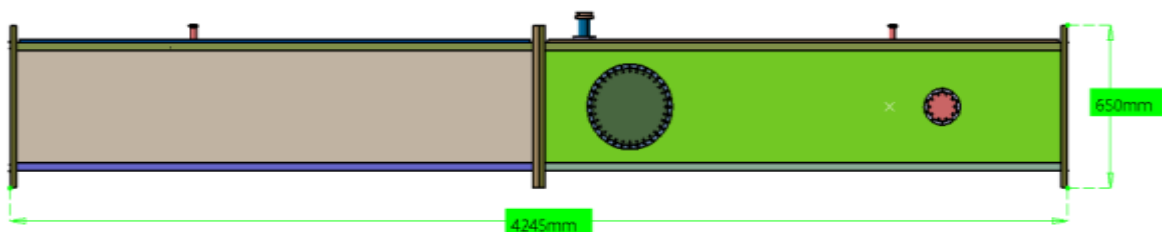


Fig 6: Elevation (front) View of vacuum vessel

Length of vessel (all two part vessel) must be limited to 4245 mm as shown in figure 6 and END flange height and width to 650 mm & 700 mm as shown in figure 7. All parts of chamber will be assembled together to make one single vacuum chamber.

Precaution: Mating flanges i.e. end flanges, should be perpendicular to the inside surface of the bottom plate to an accuracy of ± 0.05 Degree.

ii. **Size of the Vacuum vessel:**

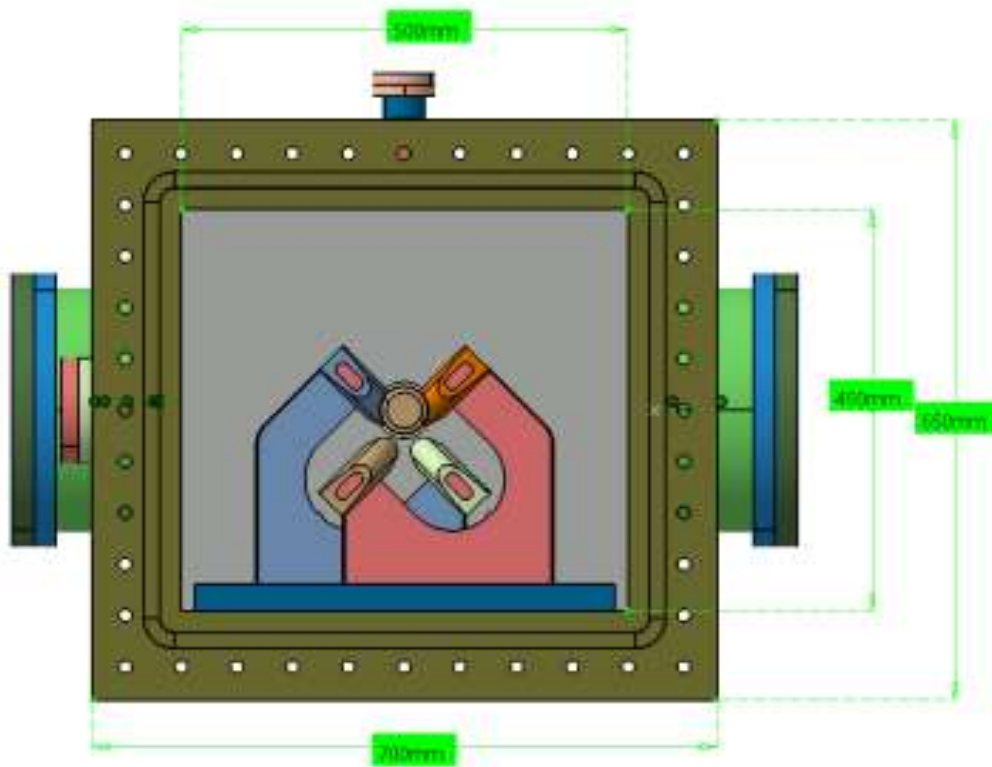


Fig 7: Side View of Vacuum vessel

As shown in figure 6, Outer width and Inner width of Vacuum vessel must be limited to 700 mm and 500 mm respectively. Outer height of vessel is 650mm and inner height is 450 mm.

iii. **Locations & projection of Standard CF openings/ports:**

Location and projection of all the standard CF openings/ports must be as per the attached drawings and all the covering flange must be standard CF compatible as mentioned in drawings. In case vendor finds lack of information in the drawings 3D model of the vacuum vessel can be referred which is self-explanatory.

iv. **Location & Projection of Non Standard Openings/ ports:**

Location and projection of Non Standard ports must be as per the drawings. Vendor may suggest some provision for local strengthening of these ports in the design to have the induced stress within allowable limit near the opening area. The port openings of nonstandard ports are shown in figure 8.

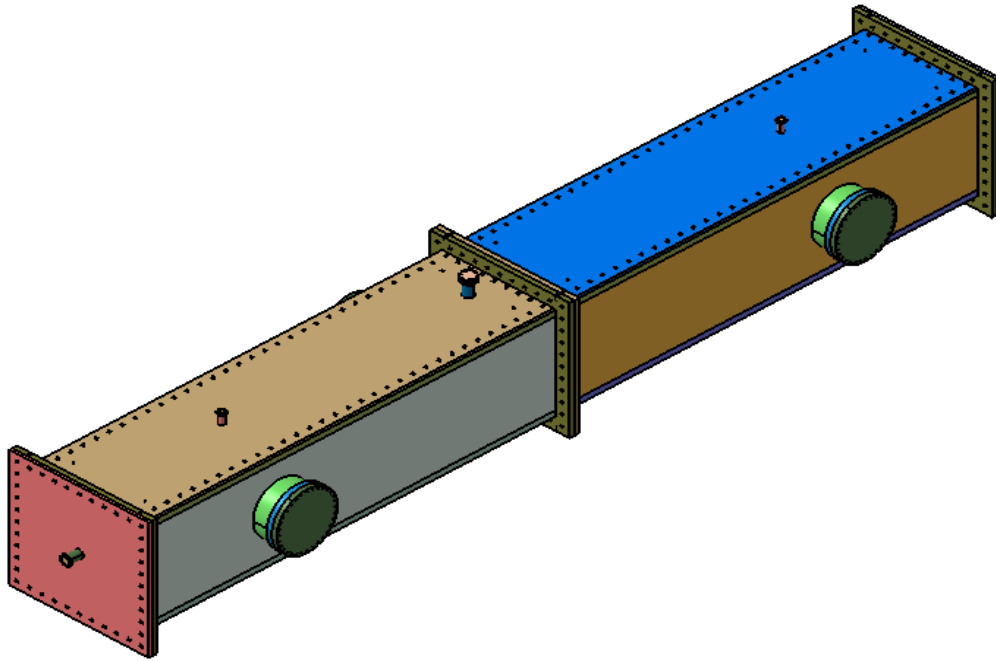


Figure 8: Projection for Non Standard Ports as Small, Circular port.

v. Thickness of End flange cover & Nonstandard ports of Vacuum Vessel:

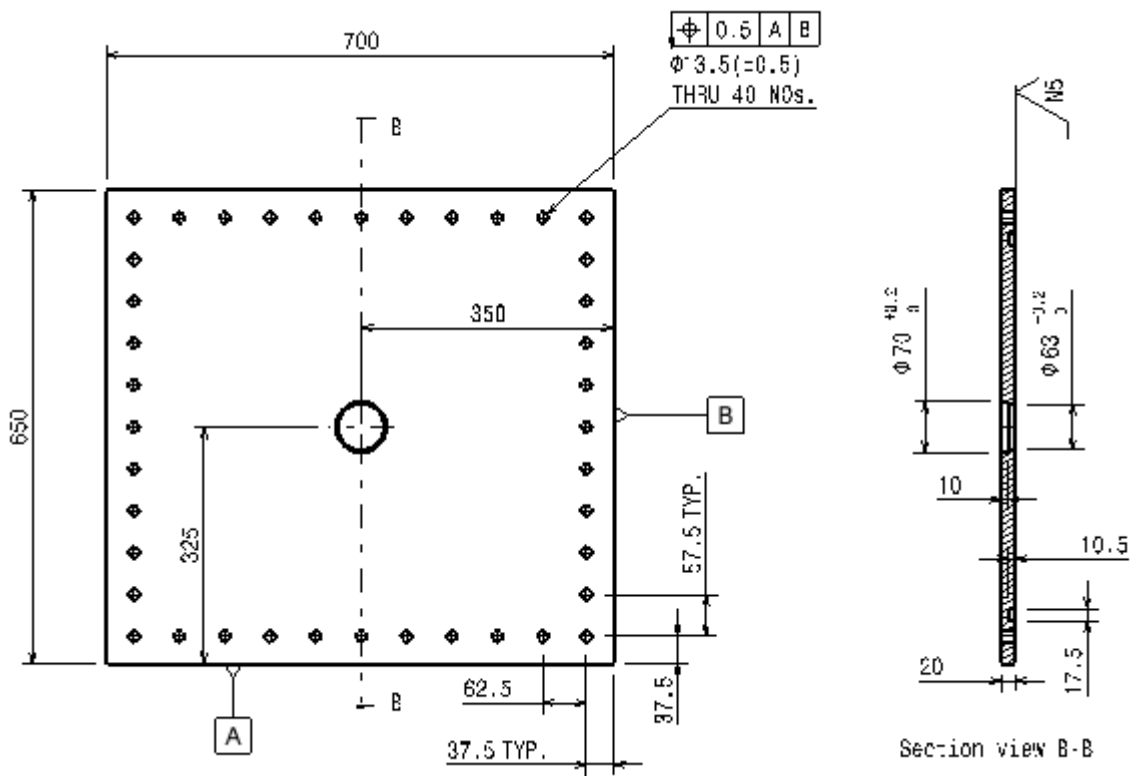


Fig 9: End Flanges cover for Vacuum Vessel

vi. Design of port flanges of Vacuum Vessel:

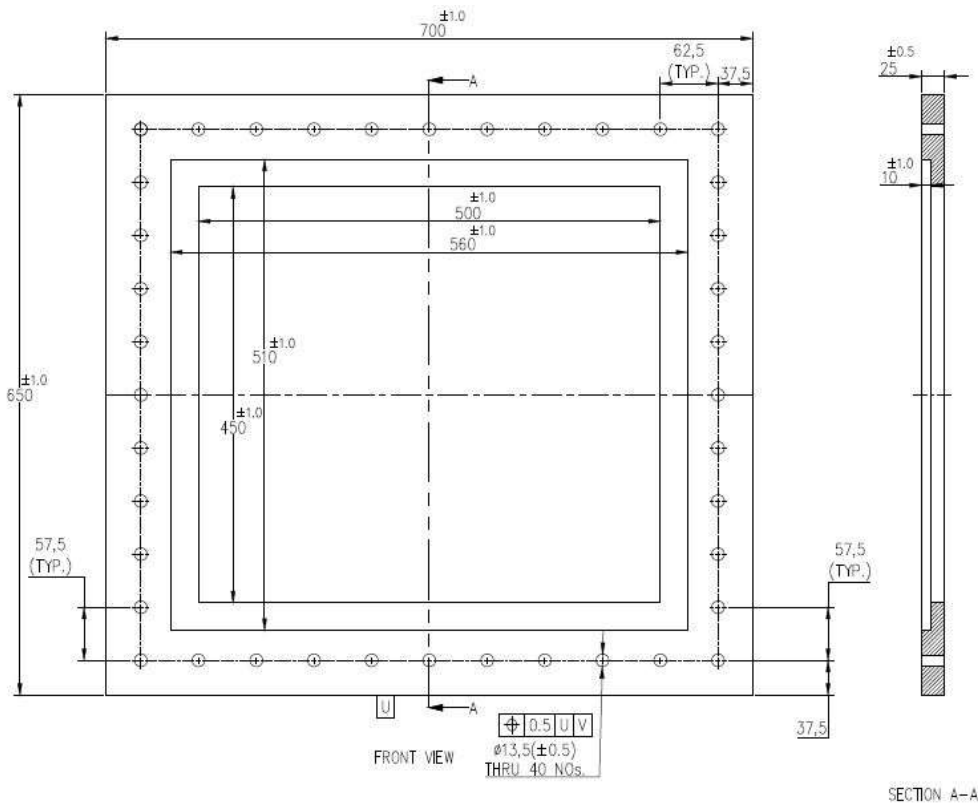


Fig 10: End Flanges for Vacuum Vessel

Connecting end flanges of Vacuum Vessel are having some specific design features as highlighted in drawings. Out of two End flanges of the vessel, one end flange surface will have single groove for placing Viton 'O' rings and other end flange surface will have flat ~ 3 micron finishing. (For details please refer to engineering drawings and the CAD model). While designing the end flanges vendor must preserve these features as it meets the experimental requirement refer fig 10 and drawings.

- vii. **Bottom Plate:** It is most important component of the chamber as it holds the RFQ assembly. The bottom plate should be flat to an accuracy of ± 0.25 mm after welding. The inside surface of bottom plate and outside face of end flanges may require machining after welding to maintain required flatness and perpendicularity refer figure 11.

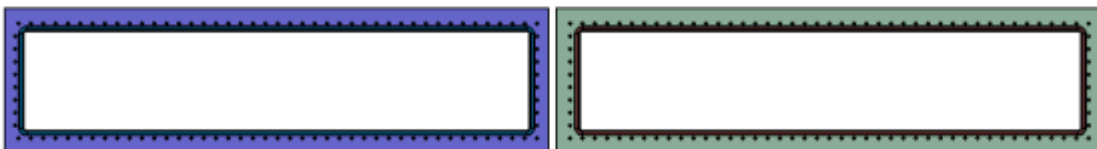


Fig 11: Bottom plate

3.1.2 RFQ Assembly:

i. Height of RFQ Assembly (Assembly of Vane, Stem, Base plate):

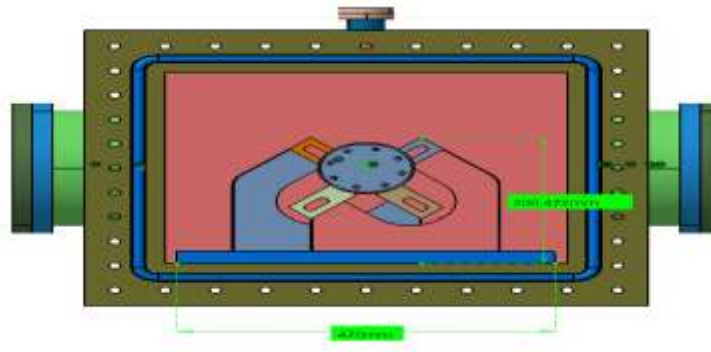


Fig 12: Elevation (front) View of RFQ Assembly

Length of RFQ (assembly of Vane and stem with Base plate) must be limited to 4160.19 mm. In figure 12, Assembly height shown as height is 300.473mm from inside of vessel base plate.

ii. Size of the RFQ Assembly:

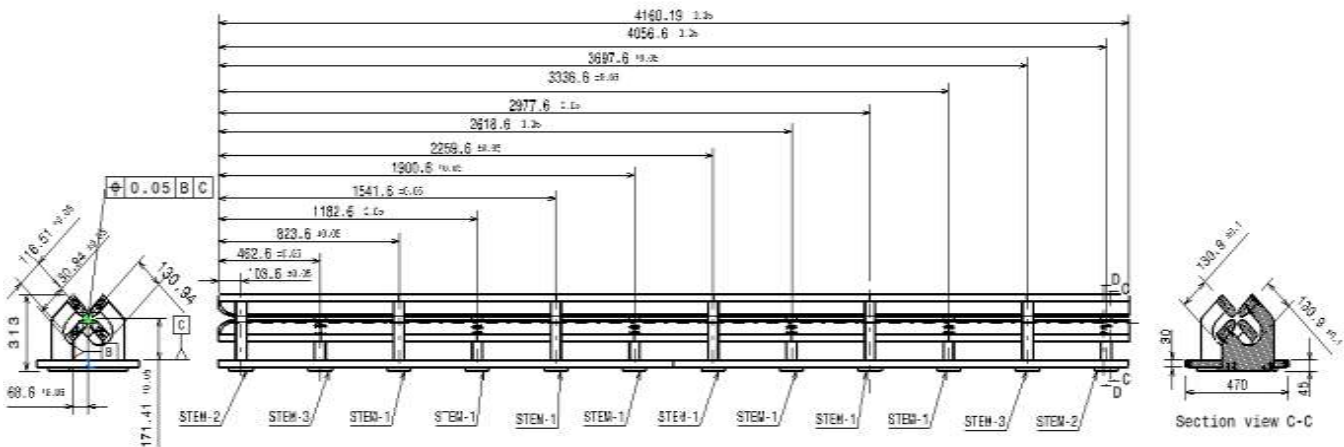


Fig 13: Front View of RFQ Assembly

As shown in figure 13, Outer width of RFQ Assembly must be limited to 470mm. and Length of the RFQ Assembly to 4160mm.

iii. Base Plate of RFQ Assembly: Base plate length should be limited to 2122.5 mm. and width of the base plate to 470mm.

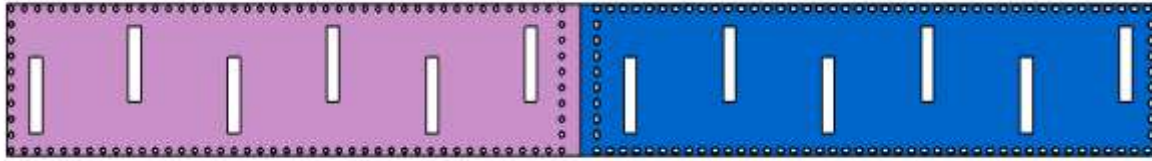


Fig 14: Elevation (front) View of Base Plate Assembly

Base plate surface should have flat ~ 3 micron finishing due to matching surface with "Viton" O-Ring.

iv. **Vane of RFQ Assembly:**

Six number of Vane should be machined precisely (~ 3 micron finish) as per drawing specification and section length should be 823.57 mm, 717.99 mm, 717.96 mm, 717.99 mm, 718.14 mm, 464.51 mm respectively. Vanes having modulations and cooling holes are required to be matched precisely as per reference drawings.

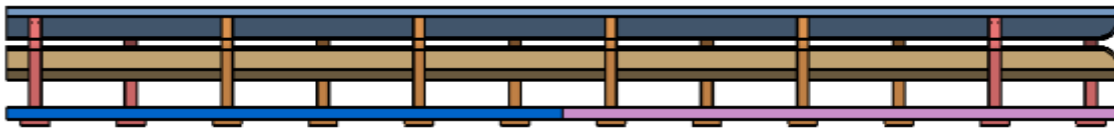


Fig 15: Elevation (front) View of VANE Assembly

v. **Stem of RFQ Assembly:**

Three types of stem with different cooling channel should be machined as per drawings. "O-Ring" Groove should be machined as per required drawings and surface finish.

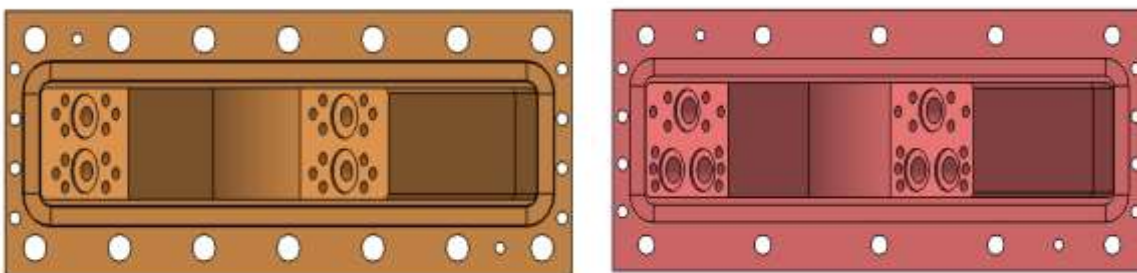


Fig 16: Top View of STEM for type of cooling channel

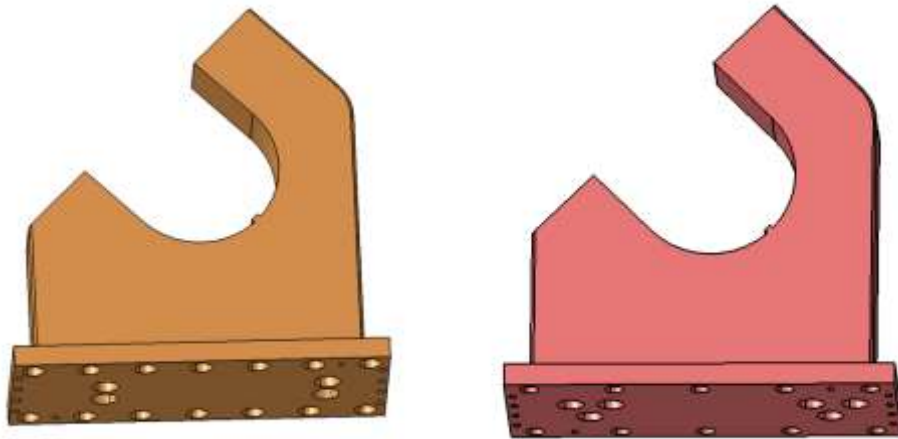


Fig 17: Front View of STEM

vi. **Full RFQ Assembly:**

RFQ Assembly consists of two sub-assemblies of twelve Vane & six Stems. This sub-assembly is assembled with two base plates. Vendor has to establish assembly sequence and get it approved from IPR.

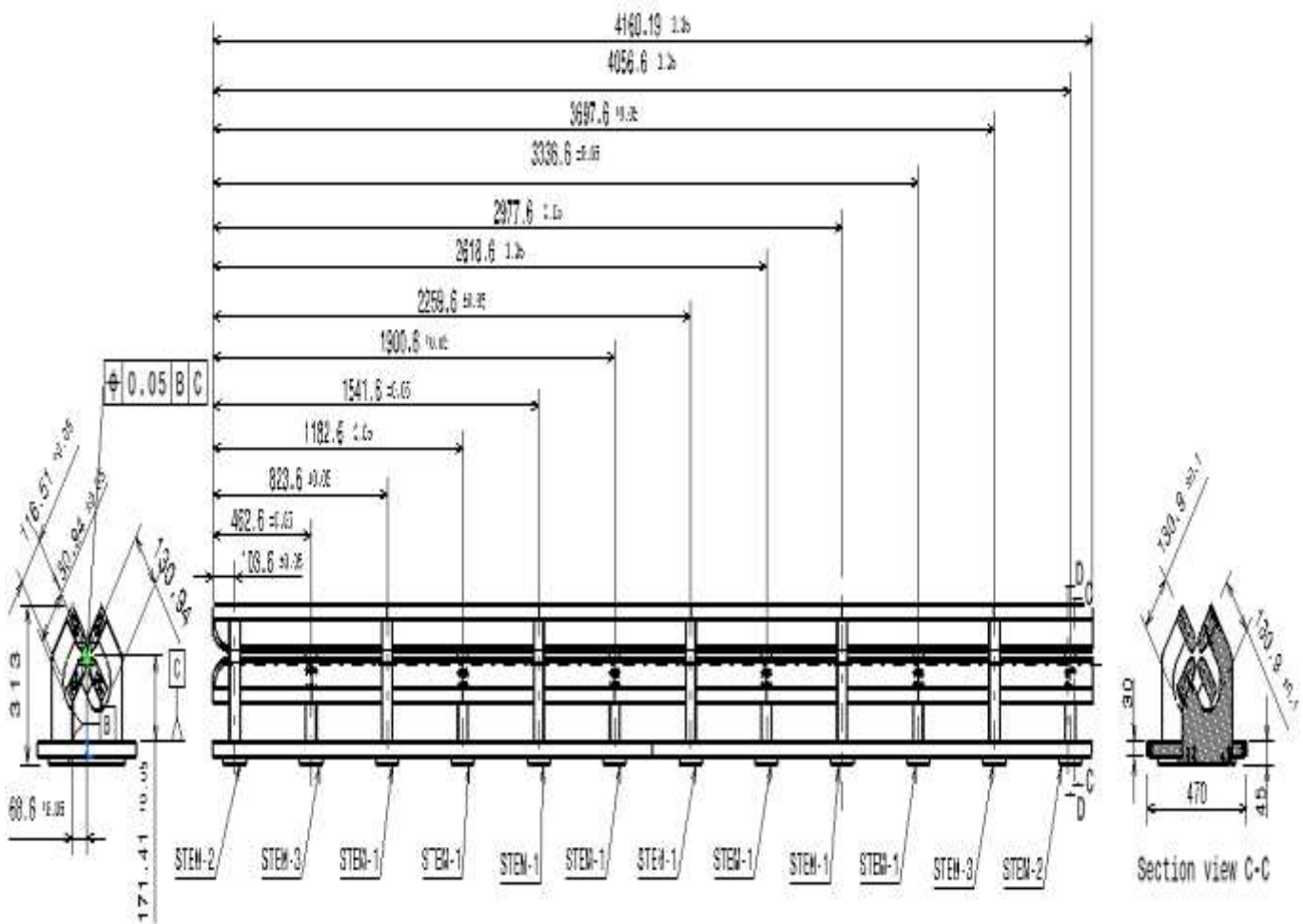


Fig 18: Elevation (front) View of VANE Assembly

4 Acceptance criteria:

A. Dimensional Acceptance & Visual Inspection Test:

- a. Dimensions & Surface finish of all fabricated components and assembly (RFQ + Vacuum Vessel) must be as per the approved engineering/fabrication drawing.
- b. Structural Integrity of vacuum vessel assembly must be ensured.
- c. Trial component shall be subjected to Dimensional inspection according to IS 2102 (Part 1) / ISO 2768-1 with precision measuring instrument i.e CMM, Laser Tracker, Articulated Arm.

B. Helium Leak Test:

Helium Leak test shall be carried in presence of IPR representatives.

The vessel shall be thoroughly cleaned before vacuum test following the standard vacuum protocols. 100% weld must be tested for helium leak testing.

It is considered that all other Non-Destructive examination (RT/UT) shall be completed before the Helium leak test.

For the leak testing, vacuum vessel will be leak tested separately using aluminum covering flanges. The vacuum vessel shall be placed at sufficient height at a temporary structure so that bottom of the baseplate can be accessed easily for testing. All the ports of vessel are required to be closed with blank flanges before testing. The system shall be evacuated to a vacuum 1×10^{-7} torr or less, using appropriate high vacuum pump. All the joints including the weld joints shall be leak tested using helium leak detector for leak rate of less than 1×10^{-9} Torr-l/s.

The Supplier is responsible to arrange all jigs, tools, seals and equipment to for carrying out the leak tests.

The Supplier is responsible for arrangement of required pumps and leak detection equipment for the tests.

Supplier shall submit the Leak testing procedure, which describes how the leak testing will be performed and include configuration diagrams and full details of equipment to be used etc. to IPR for approval. If required IPR team can help them in finalizing the leak testing procedures.

Supplier shall prepare leak test report for IPR approval.

C. RF acceptance tests

RF test is the most important functional requirement for operation of the RFQ. These RF tests will include the following:

- a. Measurement of quadrupole (60 MHz +/- 0.2 MHz with flush tuners) resonant frequencies of the vane assembly

- b. Measurement of quality factor (> 5000) of the vane assembly
- c. Bead-pull test or any other test to measure electric fields in the vane assembly.
These tests will be performed by the indenter, using a Vector Network Analyser, to be provided by the indenter. Supplier will facilitate any additional requirements needed to perform these tests at Vendor's site. Vendor should clearly mention if he can arrange for these tests. This test is essential for the proper functioning of RFQ. This is also basis for the further actions to be taken in case the above parameters are not achieved, but it does not lead to rejection in case the fabrication and assembly tolerances are achieved as per approved drawings.

D. Hydraulic Test

Supplier will arrange for water pressure tests on all the cooling channels drilled in the RFQ vanes and stems, to ensure that the required pressure specifications are met (up to 5 bar), and also to ensure that the plugs brazed into the channels are able to sustain the water pressure of 5 bar.

Clean and filtered water/Distilled water must be used for the hydrostatic test.. The test pressure must be maintained for 1 hour with no visible leaks or drop in pressure. The cause of any leaks in the system must be identified and rectified to the satisfaction of the indenter. During this test, in parallel, helium leak test may also be performed.

After the pressure tests and their acceptance, supplier should ensure that the cooling channels are thoroughly dried, and no water remains in them (otherwise this could lead to corrosion of the water channels).

E. List of documents to be submitted by supplier in phase-wise manner

A. Before start of manufacturing process	
Sr. No.	Description
1.	Material documentation (incl. Procurement specification, material certificates, tests including conforming to AL 6061-T6, Ultrasonic testing of plates and examination results)
2.	List of Supplier's sub-contractors –Should be approved with committee IPR
3.	Manufacturing drawings and components part list
4.	Materials (base and filler) identification and marking procedure
5.	WPS, PQR and Shop Weld Plan
6.	Fabrication procedures
7.	Assembly procedures with equipment / tools
8.	Cleaning procedures
9.	RF Testing Procedures (By IPR)
10.	Leak Testing Procedures
11.	High vacuum testing Procedure

12.	Hydro Testing Procedures
13.	List and status of equipment / instruments / tools for QC setup
14.	List and status of equipment / instruments / tools for QC setup with subcontractor
15.	Packing and Transportation procedures
16.	Non Conformance Report (If applicable)
B. Documents to be supplied before final acceptance in the factory	
Sr. No.	Description
1.	Description
2.	Inspection reports (dimensional checking, visual inspection, results of leak tests performed (including size and location of leaks found), Pressure/Vacuum Testing, Hydro testing, NDT,RF testing.
3.	End of manufacturing report (Release Note) including as built drawings. (Soft Copy-as per the desired & approved format Preferably CATIA V5 mutually agreed with IPR and Hard Copy).

Table 3: List of deliverables of Documents

Note: Apart from the list mentioned above as deliverables, any other item required for testing, assembly to maintain mechanical integrity and to meet the requirements as fabrication of RFQ Assembly & vacuum vessel with required covering flanges also comes under scope of supply.

F. MACHINING & WELDING

CRITERIA FOR MACHINING OF RFQ VANES AND STEMS

All machining shall comply with the specification laid down under the relevant Indian standard for general tolerances.

- Latest edition of the following shall be the applicable code / specification:
- IS 2102(Part 1)/ISO 2768-1: Tolerances for Linear and Angular dimensions without individual tolerance indications.
- IS 6838: Dimensions for 'O' Rings and Grooves for Vacuum Flanges.
- IS 3073: Assessment of Surface Roughness.
- IS 2709: Guide for selection of FITS.

Machining General Requirement:

Machining shall be done on the job, strictly following the approved Manufacturing and Inspection Plan (MIP) using approved machining tools, fixtures and qualified machinist / machine operators. Suitable sequencing of machining shall be carried out to avoid buildup of residual stress and distortion.

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The manufacturer shall prepare written procedure for distortion control for each typical operation giving the sequence of machining; machine feed, speed to machining etc. and shall submit the same to purchaser before taking up manufacturing. The same shall be displayed in manufacturer's shop during machining. Clearance shall be obtained from the purchaser's inspector for further machining. The sagging and distortion of the machined component shall be measured and recorded. The required accuracy as per qualified Procedure should be maintained by properly controlling speed, feed and usage of fixtures.

The machining processes shall be carried out using the base material and precise machines, tools and fixtures.

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.

The manufacturer shall prepare written procedure for distortion control for each typical joint giving the sequence of welding; heat input to weld etc. and shall submit the same to purchaser before taking up manufacture. The same shall be displayed in manufacturer's shop during welding. Clearance shall be obtained from the purchaser's inspector for fit-up before welding. The shrinkage and distortion of the welded joints shall be measured and recorded. The average heat input as per qualified Procedure Quality Record (PQR) shall be maintained by properly controlling voltage, current and welding speed during welding to meet the mechanical and metallurgical properties.

All the welding consumable shall be manufactured, inspected, tested, packed, supplied and stored as per the requirements of ASME Sec II Part C. Each batch of welding consumable is required to be qualified at vendor's shop as per the requirements of ASME Sec II Part C.

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 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 Vanes, Electrodes and Filler Metals.

Acceptance tests for welds:

The welding processes shall be carried out using the same base material and filler materials.

Radiographic inspection:

Weld samples shall be subjected to radiographic inspection according to QW191 of ASME standard for Boiler & Pressure vessels section IX.

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The welding quality shall be checked on welding samples produced during fabrication under identical conditions for, and in parallel with, the actual fabrication welding. The number of samples will be agreed in writing between the vendor and IPR. The vendor shall initiate manufacturing only after receiving the written approval of IPR related to the acceptance tests.

G. INSPECTION and TESTING

- i.** The supplier shall inspect all the parts, sub-assemblies, final assemblies etc., for full compliances as per approved drawings.
- ii.** All measurement should be carried out with highly precise measuring instrument i.e. CMM (Co-ordinate Measuring Machine), Laser Tracker, Articulated Arm.
- iii.** All the tolerance dimensions / features in the individual parts and the completed vessel shall be inspected by suitable methods.
- iv.** 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.
- v.** Before dimensional checks all the tools, gauges, instruments and measuring equipment's must be calibrated to ensure their proper range, type, accuracy & precision.
- vi.** Inspection of welds must be as per criterion mention in section 9.
- vii.** Helium leak test with vacuum must be done on finally fabricated and cleaned vacuum vessel as per final acceptance criterion mentioned in section 11.
- viii.** High Vacuum (HV) Test must be done after the successfully completion of helium leak testing as per acceptance criterion mentioned in section 11.
- ix.** The supplier shall provide details of all the inspection and testing facilities. The inspection and testing shall be done in a manner acceptable to purchaser. If deemed necessary purchaser will have right to specify additional inspection / testing other than specified in this specification and cost of such test / inspection will be borne by the purchaser. The records of all the tests and inspection shall be maintained by the supplier and the same will be submitted to the purchaser.
- x.** 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.
- xi.** 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.

- xii.** Written reports to be reviewed and signed by authorized representative of the vendor for each test and inspection.
- xiii.** IPR should be informed before planning of any test well in advance. IPR representative will witness these tests. Acceptance of any component will only be given once full requirements of the specification and/or drawings are achieved. In the event of a test failure, the vendor shall document the failure and submit a proposal for correcting the faults. Written approval from IPR shall be required before any corrective action is taken.
- xiv.** The vendor shall verify the work at various steps/check points as described in the specifications. The work shall be inspected and tested at each stage of manufacture to ensure conformity with the requirements specified therein and to enforce quality control measures.
- xv.** The quality control tasks shall be carried out by a unit of the vendor's organization that is independent of the production/manufacturing unit and reports directly to the management.
- xvi.** The entire documentation for the inspection and tests shall be recorded suitably with date, supporting data of the observations and duly certified with the signature of the quality control personnel. These records shall be easily and freely accessible to the authorized representative of IPR and he will also witness quality control activities for critical processes and operations.

5. MATERIAL PROCUREMENT

Complete list of free-issue-material is shown in the Annexure-A. The materials undergoing fabrication procedures shall be protected against damage/distortion by mishandling, scratches, denting or effects of weather.

An essential functional requirement for internal surface of RFQ structure is high quality surface finish, free of any embedded particulate contamination such as abrasive particles. Otherwise also, the OFE copper is a very soft material, which must be protected from any sort of surface damage specially on inner cavity walls of RFQ.

After completion of the work as per the drawings, Left over material should be returned to IPR.

All the material, welding consumable, proprietary items and brought out items including materials for trials, qualifications and test coupons etc., as required for manufacturing of the vacuum 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 and not through agents. The source of material procurement shall also be indicated and got approved from the purchaser. MIP, QP, testing procedure, Non Destructive Examination (NDE) procedure etc. submitted by the suppliers of raw materials, welding consumables, and proprietary items and brought out items shall be submitted to the purchaser for approval before procurement of material. Approved MIP and QP shall be strictly followed thereafter during procurement.

5.1 MATERIAL SPECIFICATION

Sr.No.	Component	Material	Equivalent grade
1.	VACUUM VESSEL IN TWO IDENTICAL RECTANGLES	AL 6061-T6	ASTM B209M – 14,AL 6061-T6
2.	Covering Flanges of Vacuum Vessel with O ring Grooves	AL 6061-T6	ASTM B209M – 14,AL 6061-T6
3.	Ports on vacuum vessel	AL 6061-T6/SS316	ASTM B209M–14,AL 6061-T6/ASTM A-240
4.	Vane/Stem material	Oxygen Free Electronic (OFE) copper	ASTM B170-99, grade 1 UNS C10100
5.	Base Plate	ETP Copper	ASTM B 152/ B152 M, Copper C11000
6.	Filler wire for AL 6061-T6	ER 4043	AWS A5.10/A5.10M:2017
7.	Brazing foils for end plugs	BAg-8	AWS A5-8
8.	Bolts , studs, insert & Nuts ,washer, Dowel pins	Stainless steel	ASTM A-193 non magnetic

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

Testing of material to meet the specification of equivalent ASTM Grade is to be carried out by vendor and certification for all the material tests is to be provided to IPR. All material shall be free from all the kinds of defects like porosity, cracks, fissures, dents, pits, lamination or any other defects which would make it incompatible with ultra-high vacuum environment. Following test must be performed to comply with specification:

1. Chemical Analysis test
2. Tensile strength test

Vendor must agree for a laboratory test in govt. approved test laboratories in presence of IPR representatives.

Surface finish of material:

The inner surface (expose to Vacuum) must be ~3 micron and it must be dent and scratch free. The region of the flanges, where wire seals, CF seals and O-rings are to be placed, must attain a surface finish of ~ 3 micron and should be free from any scratch. The outer surface must be free from sharp edges. Components shall be cleaned with NaOH and water to remove traces of acid left after electro-polishing.

6. CLEANINESS, 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. Remove oil, grease, and water vapor using an organic solvent such as acetone or a mild alkaline solution like a strong soap. Remove surface oxides with a stainless steel wire brush (used only for aluminum) or strong alkaline or acid. shall be followed by detergent cleaning.

Suggested Procedure for cleaning of copper component:

1. Cleaning using citric acid dilute solution, rinsing with fresh water, again cleaning with isopropyl alcohol and packing
2. **Chemical Cleaning in stages as listed below:**
 - a. First Etching with dilute sulphuric or nitric acid solution (Ratio 20: 100) for about 1min or less.
 - b. Second rinsing with clean water
 - c. Cleaning with detergent powder thoroughly
 - d. Again rinse with clean water
 - e. Dip in dilute chromic acid solution (Ratio 20: 100) for about half to 1 minute based on trial.
 - f. Rinse with fresh water
 - g. Drying with hot air
 - h. cleaning with isopropyl alcohol and packing

Note: Second method is just like as passivation, in which copper surface get fine chrome layer, which can last for months or years if it protected well means air tight.

7. HANDLING, PACKAGING and TESTING

The procedures for the handling and storage of Copper and Copper alloys are very similar to those used for Aluminum and Stainless Steel. It should be noted that the products are heavy, but relatively soft and can thus be easily damaged through poor or inappropriate handling.

- i. Copper bars should remain in their packaging until required and should be kept separated by protective material to avoid abrasion between the bars. Equally, the products must be protected from water, dampness and condensation.
- ii. Where Necessary, Finished component and bars should be stored in covered racks.
- iii. The bidder shall give details of floor space and suitable handling facilities available at the place of manufacture, assembly and testing of vacuum vessel parts and assemblies at the time of bidding.
- iv. The supplier shall ensure that all the vessel parts / assemblies / surfaces of the material are protected by proper covering 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,

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stacking and storage at plant site. Adequate number of silica gel packets along with a copy of shipping release shall be kept inside cart.

- v. All the openings shall be protected to prevent entrance of dirt and moisture during shipment, storage at site and erection.
- vi. The package shall be stenciled 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.
- vii. 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.
- viii. The shipment of equipment shall not be effected 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 at contractor’s work after satisfactory completion of “Factory acceptance test”. The supplier then only shall dispatch the vessel to purchaser’s site.
- ix. Transshipment in transit shall be avoided and supplier shall arrange specially hired conveyance for direct delivery at purchaser’s site.

8. DRAWINGS

8.1. Engineering Drawings:

The drawings for the preliminary design, prepared by CATIA, would be provided by IPR and are applicable as per annexure-D.

8.2. 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 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.

9. DELIVERY

The RFQ assembly and Vacuum vessel covered by this tender document should be supplied, delivered and unloaded at IPR site within nine months from the date of approval of fabrication drawings by IPR. Prototype should be ready for testing within 4 months from the date of approval of fabrication drawings. The vender should submit fabrication drawings for IPR approval within 5 weeks from the date of LOI.

10. INFORMATION REQUIRED WITH BID PROPOSAL

1. Technical Bid Format and Bidder's Confirmation as per Annexure-C enclosed with this document is to be furnished in full along with above requirements asked.

Annexure-A: Free Issue Material

Oxygen Free Electronic (OFE) copper extruded bars, conforming to ASTM B170-99, grade shall be supplied by IPR as free issue items. This material is guaranteed for freedom from hydrogen embrittlement and tested according to method D of ASTM B577-93

Sr. no.	Description	Quantity
1	OFE Copper Bars for Stems: 140 mm x 270 mm x 920mm or bigger	04 approx
2	OFE Copper Bars for Vanes: 140 mm x 100mm x 920mm or bigger	07 approx

NOTE: As the material will be supplied by IPR and it is costly material (Aprox.Rs.900/-per kg) in case of rejection, a maximum of 25% of total raw material, if required from vendor's side, will be issued free, against the rejected components. Over and above will be deducted at the rate of Rs.900/ (Rupees Nine Hundred) per Kg from the final bill.

Total value of FIM is approx. Rs.1,600,000/-

ANNEXURE-B (Mandatory Conditions)

Preliminary Information:

The fabrication of 4-Rod Radio Frequency Quadrupole (RFQ) is very intricate process in terms of precision and shape. The rods/vanes tips are having irregular modulations. These modulations take the special curved shape. This shape should be maintained within the précised tolerance of 10-20 μm because the resonant frequency of RFQ cavity is very sensitive to mechanical deformation, specially, on vane tips. Similar kinds of tolerances are required to be maintained during assembly of vanes and stems of RFQ. The fabrication of vanes and stems requires high precision CNC machines, CMM etc.

Mandatory Conditions:

Note: As part of technical acceptance, bidder must comply with following conditions for this tender:

1. Bidder must have good fabrication facilities which include C.N.C 5- AXIS MILLING MACHINE, CNC wire cut machine, Surface/Universal grinding machine, Universal milling & boring machine with D.R.O. The vendor must provide the list of machinery along with its technical specifications that are required and their availability to execute the job.
2. Bidder should possess or arrange at a 3rd party premises the metrology required for the measurement and testing like including CMM machines, linear height master, Surface roughness tester in their workshops. Documentary proof for the same must be provided. Consent letter from 3rd party shall be furnished wherever applicable.
3. In case the Bidder is sub-contracting the fabrication and test of vacuum system, consent letter from the sub-contract shall be furnished as applicable.
4. List of bidder's sub-contract suppliers with their undertaking for this tender to be submitted.
5. The bidder should submit a declaration with regard to **Projects on-hand** with cost details for the next Three (3) years.

ANNEXURE-C: Technical Bid Format

A. Bidder's Experience: (to be provided by Bidder)

B. Required Infrastructure to execute the job: (Bidder has to list down all the required machines / metrology / infrastructure etc.). If the bidder don't have the required infrastructure then he should mention clearly the name of sub-contractor.

Sr. No.	Required to execute the job	Availability with bidder / Sub-contractor
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		

C. Quality System and Assurance: (Bidder has to provide the details to maintain the QA / QC during the execution of job)

D. Codes and Standards: (Bidder has to mention the name of codes and standards to be followed)

E. Technical Compliance Sheet for RFQ assembly & Vacuum Vessel:

RFQ assembly & Vacuum Vessel to be delivered as follows:

Sr. No.	Scope of Supply	Bidder's confirmation
1	Evaluation and analysis of design to meet the specified design and operation condition, suggest changes if required, implementation of those changes in concurrence with the purchaser	
2.	Preparation of shop drawings for manufacture in shop, manufacturing and quality documents such as Manufacturing and Inspection Plan (MIP), Quality Plan (QP), manufacturing process sheets, manufacturing procedures, welding procedures, assembly procedures, inspection and testing procedures, packing & transportation procedures, etc.	
3.	Procurement of all the materials required for the job including those for qualifications (welding and forming) and for production test coupons (if required) etc, as per the specification and manufacture, assembly, inspection, testing, surface treatment, packing.	
4.	Manufacture the equipment as per the drawings and specification with the optimum and efficient method of manufacturing to meet the design and operational requirements.	
5.	Design and manufacture (with supplier's material) of dyes, punches, jigs, fixtures and tooling required for manufacture, handling assembly, inspection and testing of vessel is in the scope of supplier.	
6.	Design, manufacture (with supplier's material), supply and guarantee of special transportation structure and handling tools / fixtures for handling vessel at purchaser's site. The design of packing / transportation structure shall be such that, when lifted by crane at site, alone gets lifted leaving behind the packing structure.	
7.	Carry out inspection and tests at various stages before / after / during manufacturing as asked by the various sections and annexures of this specification and drawing.	
8.	The issuance of "Inspection Release Note" / "Shipping Release" / "Dispatch Clearance" from the purchaser or his authorized representative shall be considered as "Factory acceptance test"	
9.	Loading, safe delivery, transportation, handling, unloading at identified location at IPR site, installation and vacuum testing at IPR site. The vessel shall be handled in such a	

	manner that it remains horizontal all the time and no load acts upon it.	
10.	Carry out site acceptance test which may contain overall dimensional inspection, visual inspection for verification of transportation damages, and leak testing in presence of purchaser's representative.	
11.	Responsibility of vessel functionality	

F. Compliance sheet for RFQ fabrication

Compliance Sheet For RFQ Fabrication			
S.No	Parameter	IPR Requirement	Vender Specification
1.	Vane Machining Accuracy	20 μm	
2.	RFQ Vane Alignment Accuracy	Better than $\pm 50 \mu\text{m}$	
3.	Inter-segment Alignment Accuracy	Better than $\pm 50 \mu\text{m}$	
4.	Max transverse position error (X,Y)at upstream and downstream beam flange	Better than $\pm 100 \mu\text{m}$	
5.	Max longitudinal position error (Z)	Better than $\pm 100 \mu\text{m}$	
6.	Leak rate for Vacuum vessel and RFQ Assembly	$< 1 \times 10^{-9} \text{ mbar lt/sec}$	
7.	Surface Flatness of all components as mentioned in the respective drawings e.g Base Plate	Within $\pm 0.02\text{mm}$.	
8.	Alignment of all components	as per respective drawings	

G. Spares to be supplied for RFQ assembly and Vacuum Vessel:

Spare to be supplied by the bidder:

Any other spares which are needed for functioning of vessel as per the design and Operation requirements are to be supplied along with the vessel.

H. Bidder's deviations from technical specifications, terms and conditions, if other than specified in part-A and associated appendices:

Bidder may specify his deviation from technical specifications, terms and conditions, if other than specified in Part-A & its appendices. However these changes will become applicable on technical merit after discussion with purchaser and acceptance of the same by purchaser. Any noncompliance shall be unambiguously highlighted by the bidder.

I. Any additional information bidder wants to give in support of his bid.

K. Delivery schedule along with project execution milestone chart.

K. Confirmation letter from bidder:

Bidder will attach a confirmation letter with Part-A of the bid confirming that vendor has have studied all documents and drawings of Tender notice for Manufacturing, Inspection, supply, installation and final acceptance at IPR site of “**RFQ assembly and Vacuum Vessel**”. And also must confirm that Price Bid is in-line with the terms and conditions, management specifications and technical specifications given in this tender.” Vendor should put his authorized signature and official stamp on the confirmation with date and place of signing.

ANNEXURE -D: List of Drawings

List of drawings:

DR NO.	DRAWING DESCRIPTION	DRAWING NO.	SHEET NO.	DR NO.	DRAWING DESCRIPTION	DRAWING NO.	SHEET NO.
01	RFS ASSEMBLY	19020001	01 OF 01	26	TOP PLATE	19020020	01 OF 01
02	WAVE STEM BASE PLATE ASSEMBLY	19020001	01 OF 01	26	TOP PLATE COVER-1	19020021	01 OF 01
03	BASE PLATE-1	19020004	01 OF 01	27	TOP PLATE COVER-2	19020022	01 OF 01
04	BASE PLATE-2	19020005	01 OF 01	28	KF25 PORT	19020023	01 OF 01
05	STEM-1	19020007	3 SHEETS	29	CF 40 PORT	19020024	01 OF 01
06	STEM-2	19020008	3 SHEETS	30	DROSS VACUUM PORT	19020025	01 OF 01
07	HORIZONTAL ROD LEFT SEGMENT (1 TO 6)	19020011 TO 19020016	01 OF 01	41	DN 75 RF PORT	19020026	01 OF 01
08	HORIZONTAL ROD RIGHT SEGMENT (1 TO 6)	19020017 TO 19020022	01 OF 01	42	RF40 PORT	19020027	01 OF 01
09	VERTICAL ROD LOWER SEGMENT (1 TO 6)	19020023 TO 19020028	01 OF 01	43	CF63 PORT	19020028	01 OF 01
10	VERTICAL ROD UPPER SEGMENT (1 TO 6)	19020029 TO 19020034	01 OF 01	44	COOLING ARRANGEMENT-1 PROTOTYPE	19020029	01 OF 01
11	RFS ASSEMBLY PROTOTYPE	19020002	01 OF 01	45	COOLING ARRANGEMENT-2 PROTOTYPE	19020030	01 OF 01
12	WAVE STEM BASE PLATE ASSEMBLY PROTOTYPE	19020003	01 OF 01	46	VACUUM CHAMBER SECTION	19020031	01 OF 01
13	VERTICAL ROD LOWER SEGMENT-6 PROTOTYPE	19020028	01 OF 01	47	DETAILS OF FLANGE WELDING FOR VAVES	19020037	01 OF 01
14	VERTICAL ROD UPPER SEGMENT-6 PROTOTYPE	19020034	01 OF 01	48	STEM SLOT COVER FOR PROTOTYPE	19020040	01 OF 01
15	VACUUM CHAMBER ASSEMBLY	19020001	01 OF 01	49	CF FOR WAVE PROFILE DATA	19020041	01 OF 01
16	VACUUM CHAMBER-1 ASSEMBLY	19020002	01 OF 01	50	BILL OF MATERIAL	19020050	01 OF 01
17	VACUUM CHAMBER-2 ASSEMBLY	19020003	01 OF 01	51	DRAWING LIST OF RFS	19020051	01 OF 01
18	END FLANGE-1	19020006	01 OF 01				
19	END FLANGE-2	19020008	01 OF 01				
20	END FLANGE COVER-1	19020007	01 OF 01				
21	END FLANGE COVER-2	19020009	01 OF 01				
22	END FLANGE COVER-PROTOTYPE	19020010	01 OF 01				
23	O-RING-1	19020008	01 OF 01				
24	O-RING-2	19020010	01 OF 01				
25	O-RING-3	19020011	01 OF 01				
26	O-RING-4	19020001	01 OF 01				
27	O-RING-5	19020002	01 OF 01				
28	O-RING-6	19020006	01 OF 01				
29	BOTTOM PLATE-1	19020012	01 OF 01				
30	BOTTOM PLATE-2	19020013	01 OF 01				
31	SIDE PLATE-1	19020014	01 OF 01				
32	SIDE PLATE-2	19020015	01 OF 01				
33	SIDE PLATE-3	19020016	01 OF 01				
34	SIDE PLATE-4	19020017	01 OF 01				

ITEM NO	PART NAME	QUANTITY	DESCRIPTION	ITEM NO	PART NAME	MATERIAL	DESCRIPTION	QTY
01	BASE PLATE-1	AS PER DWG.	DWG.#19020003	01	TOP PLATE	SS 304	19020020	02
02	BASE PLATE-2	AS PER DWG.	DWG.#19020004	01	TOP PLATE COVER-1	SS 304	19020021	01
03	STEM-1	AS PER DWG.	DWG.#19020007	09	TOP PLATE COVER-2	SS 304	19020022	01
04	STEM-2	AS PER DWG.	DWG.#19020008	02	KF25 PORT	SS 304	19020023	02
05	STEM-3	AS PER DWG.	DWG.#19020009	02	CF 40 PORT	SS 304	19020024	01
06	HR. ROD LEFT SEGMENT (1 TO 6)	AS PER DWG.	DWG.#19020011 TO 19020016	06	DROSS VACUUM PORT	SS 304	19020025	03
07	HR. ROD RIGHT SEGMENT (1 TO 6)	AS PER DWG.	DWG.#19020017 TO 19020022	06	DN 75 RF PORT	SS 304	19020026	01
08	VER. ROD LOWER SEGMENT (1 TO 6)	AS PER DWG.	DWG.#19020023 TO 19020028	06	RF40 PORT	SS 304	19020027	01
09	VER. ROD UPPER SEGMENT (1 TO 6)	AS PER DWG.	DWG.#19020029 TO 19020034	06	CF63 PORT	SS 304	19020028	01
10	VER. ROD LOWER SEGMENT 5-PROTOTYPE	AS PER DWG.	DWG.#19020028	01	1/4"-19 BSF 304L ALLEN BOLT,WASHER	SS 304	FOR BASE PLATE TO VACUUM VESSEL, BOTTOM PLATE	218
11	VER. ROD UPPER SEGMENT 5-PROTOTYPE	AS PER DWG.	DWG.#19020034	01	1/8"-28 BSF304L ALLEN BOLT,WASHER	SS 304	FOR BASE PLATE TO STEM	288
12	END FLANGE-1	AS PER DWG.	DWG.#19020006	03	M8x35L BOLT,WASHER	SS 304	FOR BASE PLATE TO STEM	106
13	END FLANGE-2	AS PER DWG.	DWG.#19020008	01	M8x50L ALLEN BOLT,WASHER	SS 304	FOR ROD TO STEM	106
14	END FLANGE COVER-1	AS PER DWG.	DWG.#19020007	01	#6 DOWEL PIN	SS 304	FOR STEM TO BASE PLATE	30
15	END FLANGE COVER-2	AS PER DWG.	DWG.#19020009	01	#6 DOWEL PIN	SS 304	FOR ROD TO STEM	33
16	END FLANGE COVER-PROTOTYPE	AS PER DWG.	DWG.#19020010	01	M12x70L BOLT WITH DUAL NUT , WASHER	SS 304	FOR FLANGE TO FLANGE	128
17	O-RING-1	AS PER DWG.	DWG.#19020008	03	1/4"-19 BSF 304L BOLT WITH WASHER	SS 304	FOR TOP PLATE COVER TO TOP PLATE	188
18	O-RING-2	AS PER DWG.	DWG.#19020010	02	DOWNEY SEAL	VITON WITH 60 RING	FOR STEM TO WAVE	50
19	O-RING-3	AS PER DWG.	DWG.#19020011	01	COOLING ARRANGEMENT OF ROD TO STEM-1, PROTOTYPE	COPPER CHFC	19020029	01
20	O-RING-4	AS PER DWG.	DWG.#19020001	01	COOLING ARRANGEMENT OF ROD TO STEM-1, PROTOTYPE	COPPER CHFC	19020030	01
21	O-RING-5	AS PER DWG.	DWG.#19020005	03	END PLUG FOR VAVES	COPPER CHFC	19020037	---
22	O-RING-6	AS PER DWG.	DWG.#19020008	04	STEM SLOT COVER FOR PROTOTYPE	COPPER CHFC	19020040	02
23	BOTTOM PLATE-1	AS PER DWG.	DWG.#19020012	01	HELICOFLER SEAL FOR 40CF	AS PER STD	TOP PLATE TO 40CF PORT	01
24	BOTTOM PLATE-2	AS PER DWG.	DWG.#19020013	01	HELICOFLER SEAL FOR 63CF	AS PER STD	END COVER PLATE TO 63 CF PORT	01
25	SIDE PLATE-1	AS PER DWG.	DWG.#19020014	01	HELICOFLER SEAL FOR 75CF	AS PER STD	SIDE PLATE TO 75CF PORT	01
26	SIDE PLATE-2	AS PER DWG.	DWG.#19020015	01	HELICOFLER SEAL FOR 250CF	AS PER STD	SIDE PLATE TO 250 CF PORT	03
27	SIDE PLATE-3	AS PER DWG.	DWG.#19020016	01				
28	SIDE PLATE-4	AS PER DWG.	DWG.#19020017	01				

