FABRICATION AND ASSEMBLY/INTEGRATION OF VACUUM COMPATIBLE IN-VESSEL INSPECTION SYSTEM (IVIS) & RELATED ACCESSORIES FOR IVIS

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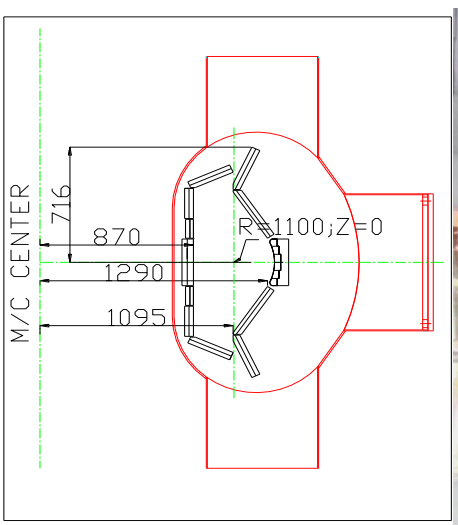
Contents:

1. Introduction:

SST-1 vacuum vessel (VV) houses many in vessel components (Fig 1A & 1B). Healthiness of these components is required to be checked on timely basis. Hence an in-vessel inspection system (IVIS) is proposed for viewing in vessel components remotely without breaking the vacuum environment of the SST-1 VV

A simple in-vessel inspection system (IVIS) is being designed, fabricated and integrated for in-situ visual inspection of around 3800 First Wall (FW) graphite (armour) tiles mounted on copper modules assembled inside the vacuum vessel of SST-1 tokamak.

This mechanism provides frequent, better, in-vessel viewing of the inside FW components and vessel wall surface of tokamak with simple engineering & operational effort, which limits the system to be small, simple, occupying minimum space and custom made with a minimum time for realization of the concept.



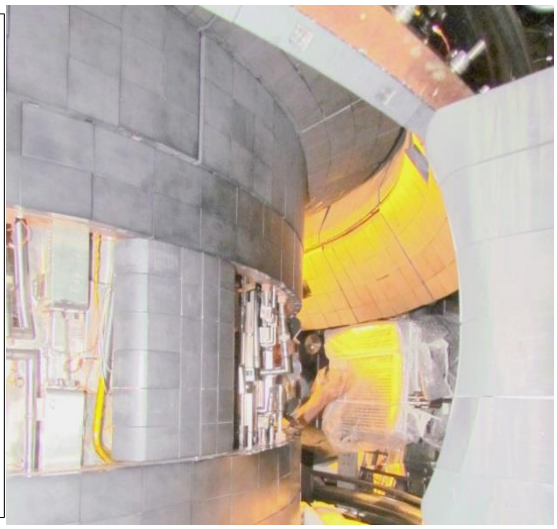


Fig 1A: Elevation view of SST-1 Fig 1B: Graphite tiles inside SST-1 VV

2. System description:

The IVIS is designed, to travel inside the SST-1 vacuum vessel for the purpose of viewing and inspection. The system can travel either in clockwise and counter clockwise during plasma campaigns (Fig 2A &2B).

IVIS have a snake like link configuration; consist of total six links (Fig. 2C) out of which five are articulated links providing rotary motion to the mechanism and one link, known as deployer, provides linear motion for the purpose of pushing and pulling the mechanism in and out of the VV by means oflinear drive actuator

IVIS will be initially positioned outside the VV, in a high level vacuum storage chamber separated by a gate valve barrier with the VV. During (one quarter i.e. + 90^{o}) viewing, the gate valve will opened so that the mechanism can be positioned inside the VV, complete the viewing procedureand return back to its initial position outside the VV. The process will then

be repeated for other quarter, i.e. -90^{o} viewingthus completing half of the toroidal (circumferential) span of the VV and final closing of the gate valve barrier.

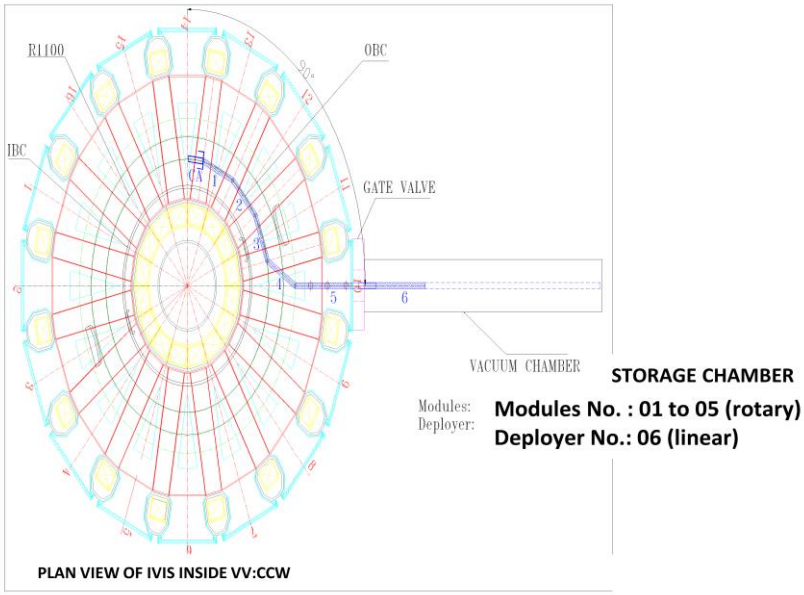


Fig 2A: Anti-clock wise, CCW direction (+90^{o})

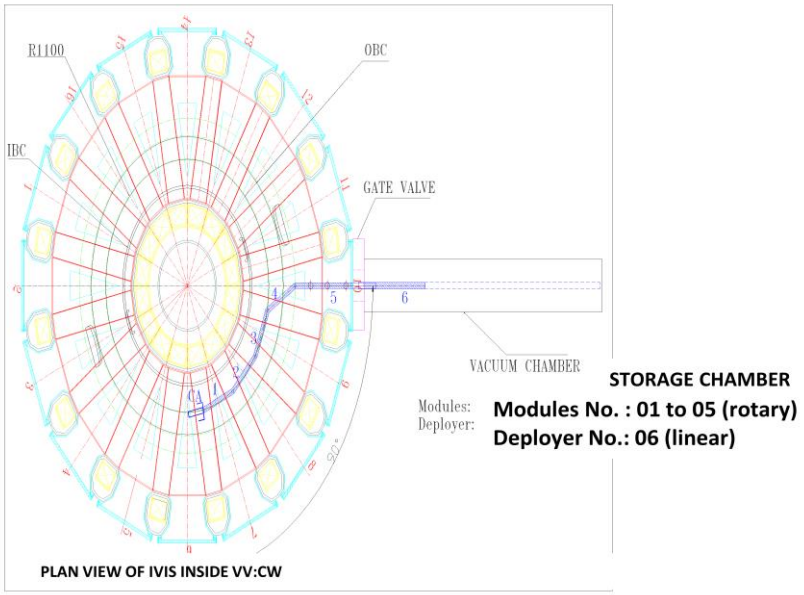


Fig 2B: Clock wise, CW direction (-90^{o})

IVIS are to be powered with high vacuum (HV) compatible programmable electrical servo motors providing all the rotary and linear motions.

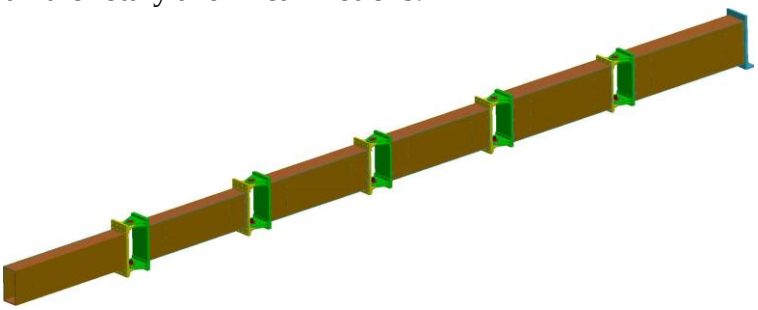


Fig 2C: 3D CAD model of IVIS

3. System Requirement:

IVIS is operated within very stringent environmental conditions as mentioned below. The system needs to be as light as possible in order to maximize payload. The material for the arm structure also needs to be strong and rigid. Total time of viewing cycle is 1800 seconds.

It is the vendor's responsibility to ensure that all the components fit together accurately with high precision and all the dimensions and tolerances, as mentioned in the drawings, are maintained. The vendor may include additional fabrication tolerance requirements after discussion and approval from IPR.

Vendor should ensure thatstructural components of IVIS arm i.e. articulation link, joints, support, flange, support base, bolts, screws etc. are made of material as per the engineering drawings supplied herewith and the assembly shall be performed in a clean environment. All materials used should be non-magnetic and should have low out-gassing properties (to be used in ultra-high vacuum (UHV). Any deviance from the specified materials, during fabrication, should be notified to IPR before proceeding.

The link and joint dimensions mentioned in this document have been decided after rigorous kinematic and structural analysis of the system as per the space limitation inside SST-1 tokamak. Thus any geometrical deviance from the specified dimensions in this tender, during fabrication, should be notified to IPR before proceeding.

The design of the system considers UHV compatible wet/dry lubrication. The vendor MUST ensure NOT to use any kind of grease or lubrication within the system without appropriate approval from IPR.

The vendor should ensure to maintain a clean room environment during fabrication of the system.

Post Fabrication, necessary surface treatment should be provided by the vendor to ensure vacuum compatibility of the system.

4. Scope of work: Scope of work for IVIS are listed below

The scope of work includes the below mentioned activities to be carried out by vendor.

- The vendor shall be responsible for material procurement, high precision fabrication, testing and supply of the IVIS as per specification & drawing attached herewith.
- Generation of 2D fabrication drawings, bill of materials (BOM), 3D CAD model from supplied enquiry drawings, write ups and approval of same from IPR.
- The vendor shall follow the design inputs from IPR and check for manufacturing feasibility and process for manufacturing as per detailed scope of work.
- Fabrication of UHV compatible rotary link and linear guide mechanisms and machine elements (like bushes, contact bearings, shafts, encoder mountings, motor mountings).
- Fabrication of UHV compatible guide rails/slides, linear drives, locking mechanisms etc.
- Fabrication of storage vacuum chamber with vacuum openings for pumps, openings for gate valve, viewports, vacuum feedthrough's etc.
- UHV compatible vacuum feedthroughs procurement for in-situ routing
- Vendor shall be responsible for supply of UHV compatible linear guide mechanisms and providing details of commercial off-the-shelf(COTS) components for UHV compatible linear guide like gears, ball screws, lead screw, base platform, linear guide way block,linear drives, locking mechanisms etc.prior to integration for approval from IPR.
- Vendor shall be responsible for fabrication of joint assembly 01(Refer IVIS/DRG-03 in Annex-I) with vacuum compatible contact type bearings and test the same in vacuum environment, get approval from IPR before proceeding for the fabrication of other joint assemblies
- Measurement of the end deflection due to self-weight of the system and payload under fully unfolded extended configuration, and ensure that the total deflection is within the limits as specified in the acceptance criteria.
- Ground assembly, functionality demo of IVIS in atmosphere (at vendor site), with operational sequence detail (OSD).
- All necessary documentation of IVIS manufacturing phase, IVIS operation including OSD for preparation of final report
- Involvement, coordination and approval from IPR and supply of the assembled system at IPR and final testing are also included in scope of work.
- Vendor shall be responsible for providing details of commercial off-the-shelf(COTS) components for vacuum and storage chamber like view ports, gaskets, o-rings etc. prior to integration with the system for approval from IPR.

The work covers the following points, but not limited to:

- Evaluation of all design as per drawings of components, sub-assemblies & assembly for manufacturability, inspectibility, assembly & test requirement.

- Preparation of detailed manufacturing/fabrication drawings for components & assembly with tolerances included.
- Procurements of all necessary materials, items and equipment with test certificates, whenever applicable.
- Design, development and manufacturing of tools, jigs, fixtures and other accessories required for manufacturing of components &assemblies.
- Manufacture of all components, with high precision (±03 micron), according to fabrication drawings and procedures approved by IPR.
- Testing & Inspection of the materials, parts, components &sub-assembly at appropriate stages before the final assembly. Supply of appropriate test report to IPR
- Cleaning and testing of the components according to the specified procedures.
- Assembly of components and to test their mechanical integrity at factory site.
- Factory acceptance tests.
- Packaging and delivery of components to IPR with appropriate unloading instructions at IPR site.

IPR will provide the vendor with the design and the 2D drawings, as enclosed herewith. Vacuum compatible motors, gearboxes, UHV gate valve, vacuum compatible cables and encoders will be supplied as Free-Issue Materials (FIM).

The quantity and costing of the FIM is given in the table below:

Sr. No.	Item Description	Qty.	Cost in INR
1	Vacuum compatible motors & gearboxes	05	675000
2	Encoders	05	500000
3	UHV gate valve ISO 500	01	2700000
4	Vacuum compatible cables and connector pins	10	300000

NOTE:

- List of works mentioned above to be carried out by vendor as per technical specification/drawings under purchaser's supervision and guidance. For any required deviation from this procedure, prior permission of IPR is must.

- Vendor will discuss with IPR authority the fabrication methodology, and will give complete breakup of activities, facilities to be used and time schedule. Periodical review of work progress/status with IPR is mandatory.

- Procurement of bought out items (bearings, bushes, vacuumfeedthroughs etc.) should be from original equipment manufacturer OEM or their authorized agents.

5. Technical Requirements

A. Articulated Robotic In-Vessel Inspection System (IVIS) with the following technical specifications:

Description	Specifications
Mechanical structure	Horizontally Articulated
Degree of Freedom	05 rotational axes and 01 translational at base
Number of Links	06
Payload Capacity at Tool Center Point (TCP)	1 kg
Maximum TCP Linear Speed	10 mm/sec
Repeatability at TCP	<2 mm (for integrated mechanical assembly)
Link and Joint Dimensions	Refer Drawing for Details
Motion	Motorized (To Be Supplied as FIM)
Material	All materials used should be UHV compatible, light weight and Non-Magnetic *(Refer Drawing for Details)*
Tolerance	Accurate finish and alignment with ±10microns for all components, sub-assembly & Assembly *(Refer Drawing for Details)*
Bearings	All bearings used should be UHV compatible, light weight and Non-Magnetic *(Refer Drawing for Details)*
UHV Condition	The system should work in a vacuum environment of $<10^{-7}$ mbar
Temperature Condition	The system should work in high temperature environment of 80°C
Magnetic Field Condition	The system should work in a stray magnetic environment of 10 Gauss
Mounting Stand	Mounting Stand for Testing the system at a stationary position
Physical Storage Space	Radial space of equipment ~ 4m length outside VV port (vacuumstorage chamber$<10^{-7}$ mbar for housing IVIS in idle time)Refer Drawing for Details
Machining	Machining of upper and lower lugs and shaft interface with bearings should suite the bearing OEMs tolerances recommendations No welding on IVIS link assembly
Environment Requirement	IVIS components should not pollute vacuum environment inside VV during in-vessel viewing

B. StorageVacuum Chamber

Description	Specifications
Vacuum Chamber	Material:SS304L and vacuum environment of $<10^{-7}$ mbar Surface condition : electro-polished inside only Surface finish of inner side of chamber should be 2∇
Flanges	Material:SS304L

	Flange Type:UHV compatible knife edge type (rectangular) Hardness: >80 Rockwell Surface finish of UHV side of flange should be 3∇ **All the flanges should be as per standards and should have interchangeability.** *(Refer Drawing for Details)*
Ports	Material:SS304L Surface condition: electro-polished inside only Surface finish of UHV side of flange should be 3∇ Inside TIG welding between chamber and ports **All the ports should be as per standards and should have interchangeability.***(Refer Drawing for Details)*
Support structure	To support the whole assembly, electrically insulated from whole vessel assembly Material : SS304
Temperature Condition	The system should be bake-able to 150°C
Leak tightness	Helium leak rate $1x10^{-9}$ mbar-litre/sec (Local) and $7x10^{-9}$ mbar-litre/sec (Global)
Weld joints	Non-magnetic, inside TIG welding, vacuum compatible and Local leak rate $1x10^{-9}$ mbar-litre/sec
Vacuum sealing	Gaskets compatible with the given vacuum level and leak rate (preferably Cu, Al or high grade viton) and fasteners (SS304) hexagonal type for leak tightness

C. Vacuum Compatible Linear Guide

Description	Specifications
UHV Condition	The system should work in a vacuum environment of $<1e^{-7}$ mbar
Temperature Condition	The system should work in high temperature environment of 80°C
Magnetic Field Condition	The system should work in a stray magnetic environment of 10 Gauss
Stroke length	~3.5 meter
Distance between two Rail	Compact
Mounting plate dimension	Compatible with Linear motion guide
Payload Capacity	100 Kg Cantilever type load
CoGpoint of Load	2 meter from Mounting Plate for fully extended configuration

Note: All dimensional details are included in the drawings. All the other fabrication related details have to be worked out by vendor and approval should be taken from IPR.

6. Deliverables:

The deliverables of sub components and phase timing are mentioned as below

Phase	Deliverable	Time from P.O (T0)
I	Submission of final fabrication drawings to IPR for approval	T1 = T0 + 04months
II	Material procurement, inspection, testing and submission of Material Test Certificates for compatibility to UHV, Temperature and Non Magnetic Properties as mentioned in Section 5.0 and 7.0	
III	Fabrication and testing of joint assembly 01 with bearings in vacuum environment as mentioned in Section 4.0 then proceed further for fabrication of other joint assemblies	
IV	Completion of fabrication of components as mentioned in Section 5.0	
V	Assembly of System and Integration of motors, UHV gate valve, cables and encoders (FIM)	
VI	PDI	
VII	Delivery of system at IPR	T2 = T1+ 07 months
VIII	Installation of system at IPR	T2 + 3 weeks

7. Standards, Material, Fabrication and Testing Process to be followed

a. Codes & Standards

1. For TIG welding procedure qualification, welder's qualification and all other welding details ASME-Sec-IX shall be followed.
2. For testing methods ASME-Sec-V shall be followed.
3. All welded/flange joints must be helium leak tested
4. Material should be according to relevant ASTM standard
5. Linear dimensional tolerances as per DIN ISO 2768 - m standard
6. ASME Section VIII shall be used for fabrication, inspection, testing and acceptance.

b. Material

1. The IVIS links, joints, vacuum storage chamber, flanges and other components should be made up of the material as indicated under technical specification section 5.
2. Any other material which needs to be used from vendor side should be UHV compatible.
3. Inside and outside surfaces of the vacuum chamber and other components shall have electro-polishingas indicated under technical specification section 5.

4. The material shall be tested by the vendor in procured condition for its chemical, physical and mechanical properties as well as for any internal defect.
5. Vendor shall submit these test certificates to IPR for approval before starting any fabrication work. Materials should be according to relevant ASTM standard.

The procurement of all the tools, fixtures, jigs, equipment's, material etc.; required for the fabrication, inspection, testing, supply and erection at IPR shall be in the scope of vendor.

c. Fabrication Procedure

All welding involved in the fabrication of the links, joints, high vacuum storage shall be carried out in accordance with applicable code or approved equivalent codes as mentioned in the section 7a of this document.
The following practice shall be followed for all welding/fabrication:-

1. Before welding all parts should be cleaned with acetone or 1:1:1 trichloroethane
2. As specified in the drawings all welds to be done on Material SS304L should be Tungsten argon arc welding (TIG) strictly, according to ASME - Sec. IX.
3. Trapped volume should be avoided during welding. Full penetration weld should be employed wherever it is possible. When welding is to be done on both sides of the wall, continuous welding on inner side [Ultra High Vacuum (UHV) side] and tack welding outside are to be done at required places.
4. Single pass weld up to a maximum extent is preferred. Interruption during welding should be reduced to a minimum possible extent.
5. If leak develops; weld should be ground off with the base metal and re-welded.
6. Filler material, if used, should be compatible with the parent material.
7. All welds should be ground smooth and flush with adjoining surfaces with convex curvature with adjoining wall everywhere prior to leak test.
8. The welding shall be carried out only by qualified welders
9. Pickling and passivation, of all the components shall be done with nitric acid or HF.
10. All surfaces specifically the inner ones exposed to UHV side shall be grounded to 2∇ surface finishes with a surface finish of 1.6 to 3.0 micron.
11. Abrasive cleaning of surface exposed to UHV is not allowed.

d. Inspection and Testing

1. All the fabrication drawings completed with dimensions and tolerances shall be checked and should be submitted to IPR for necessary approval.
2. After fabrication of joint assembly 01(Refer IVIS/DRG-03 in Annex-I) with vacuum compatible contact type bearings and testing of the same in vacuum environment will be carried out (it has to have free actuation under vacuum), vendor has to getapproval from IPR before proceeding for the fabrication of other joint assemblies.
3. After fabrication of all the components, they shall be inspected for dimensional accuracy as per approved drawings and specifications.
4. The vessel assembly globally and locally (specifically at joints)shall be Helium leak tested and the reports should be submitted to IPR for necessary approval.
5. IPR authority / representative shall have access to all manufacturing facilities, inspection and testing facilities, tools, drawings etc.; during all stages of manufacturing.

6. Vendor has to submit final fabrication and testing reports to IPR, based on which, IPR can decide to do or not to do the Pre-dispatch Inspection. Final fabrication and testing reports should include:
   - All the raw materials as mentioned in Section to be used for the fabrication shall be tested for their chemical composition, physical properties and mechanical properties. All the test certificates from authorized sources shall be submitted to IPR for approval.
   - The components manufacturing/fabrication and assemblies should be done within ±10 micron or better and vendor has to submit the dimensional check and surface report for components and assemblies.
   - All the components should be checked for surface finish.
   - Radiography Test (RT) shall be carried out on all the possible welds as per ASME Sec. V. and the reports needs to be submitted to IPR for approval.
   - Leak rate for individual weld joint (locally ~ $1x10^{-9}$ mbar litre/sec) for each components and assembly should be checked for their global helium leak rate $7x10^{-9}$ mbar litre/sec.
   - All the fabricated components should be checked for dimensional accuracy.
7. All the components shall be delivered only after shipment clearance from IPR.
8. Delivery acceptance shall be issued by IPR authority / representative after acceptance tests and verification of dimensions, testing, etc.; to one's satisfaction of compliance with drawings, specifications and functional requirements.

8. Installation and Testing

- Dimensional & alignment checks at IPR
- Visual inspection of components for any defects, flaws etc.
- Integrated leak testing of vacuum chamber at IPR
- Ground assembly, functionality demo of IVIS in vacuum environment at IPR
- Final Integration with at IPR and operational demo/validation of IVIS
- Final documentation report including all operation sequence.

9. Acceptance Criteria

1. After dispatch items received at IPR site will undergo dimensional measurement
2. The components, sub-assemblies and assemblies will be checked for their limits and tolerances as per the final drawing approved by IPR.
3. If the components, sub-assemblies and assemblies are not found as per the design limits, all components, sub-assemblies and assemblies will be rejected by IPR. New components, sub-assemblies and assemblies need to be freshly fabricated by vendor if the vendor fails to prove the inspection on mentioned above.
4. The supplied components and assembly will be checked for their global helium leak rate $7x10^{-9}$ mbar liter/sec, ultimate pressure of $<10^{-7}$ mbar and for baking at 150°C.
5. The vendor shall demonstrate the performance for articulated system's repeatability within <2mm for integrated mechanical assembly at IPR premises

All the above tests will be done at IPR site by IPR personnel though any discrepancy found should be rectified by vendor. If vendor desire to witness the said test, he has to intimate IPR at the time of supply.

10. List of Drawings being supplied with this Tender

Refer Annexure I

11. Insurance, Packing And Supply

1. Contractor will pack all the components with the proper material to avoid damages during transportation.
2. All components will be cleaned thoroughly with detergent and dried before packing.
3. Contractor will inform IPR authority before supply of the material to IPR.
4. The transfer Insurance of fabricated components and FIM will be in the scope of vendor.

12. Period of Work Completion

The essence of this work order is the completion of the work in time. The period of completion for the work contract is within 12 (twelve) months from the date of purchase order. All necessary arrangements should be made to guarantee the execution time period.

13. Guarantee:

Twelve months from date of final acceptance of the components, for poor workman ship/welding/fabrication, faulty material, malfunctioning COTS,components procured from OEMS, electronics items etc.During this period if any fault occurs/detected in contractor's services, contractor will rectify the same at no extra cost. In the event contractor fails to fulfil his guarantee obligations, IPR shall have the right to remedy or to have remedied the defect/fault, in both cases for contractor's account

14. Test Reports to be submitted

- Fabrication drawings generated by vendor and approval of the same by IPR, prior to start of fabrication activity
- Raw material test certificates of materials procured by vendor and approval of the same by IPR – QA, prior to start of fabrication activity
- Inspection/functionality report, vacuum compatibility certificate, guarantee card of bearings, bushes and vacuum feedthrough's
- Visual inspection of components for any defects, flaws etc. by IPR personnel
- Dimension metrology and alignment report of all fabricated components and assembled units carried out in presence of IPR personnel

- Helium leak testing for welded, flange joints (All joints must be helium leak tested for the sensitivity of $\leq 10^{-9}$ mbar liter/sec at 300K) in presence of IPR personnel
- Overall vacuum level of vacuum chamber should be $\leq 10^{-7}$ mbar at 300K
- Ground assembly, functionality demo of IVIS in atmosphere (at vendor site)
- Report on fabrication methodology of IVIS arm, vacuum compatible linear guide, vacuum compatible encoder mounting and vacuum storage chamber
- Dimensional & alignment checks at IPR
- Visual inspection of components for any defects, flaws etc at IPR.
- Integrated leak testing of vacuum chamber at IPR
- Ground assembly, functionality demo of IVIS in vacuum environment at IPR
- Final Integration at IPR and operational demo/validation of IVIS
- Interference checks with neighboring sub-systems at IPR
- Final documentation report including all operation sequence.

15. Facilities Available at Site

1. Water / compressed air / electric power supply
2. 10 ton overhead crane in SST-1 Hall.
3. Helium leak testing detector for vacuum leak testing

*Note:*Contractor shall engage all other necessary machinery equipment's, manpower etc. at site during execution of work contract if required.

16. Factory Acceptance Tests

Full-Power Test – The vendor should operate the system to its full power and Maximum Reach, Payload, Heat produced should be tested and test results to be submitted to IPR along with the delivery of the system.The vendor shall demonstrate the performance for articulated system's repeatability within <2mm for integrated mechanical assembly at vendor premises.
For further testing details refer Section 04, 07d and 08.

17. General Terms and Conditions

- Any deviation / discrepancy / change from the drawings shall be brought out in separate sheet by the vendor.
- Vendor shall submit to IPR a list of material, inspection plan, material procurement schedule, manufacturing schedule and release for fabrication approved by IPR.

- Fabrication of all the components shall be as per fabrication drawings supplied by IPR using precision machining.
- All components shall be checked for dimensions using and a detailed report for the same may be submitted to IPR
- Avoid welding at any stage of fabrication of the robotic articulated arm, unless approved by IPR.
- Procurement of all the tools, fixtures, jigs, equipment's, material, temporary blanks etc.; required for the fabrication, inspection and testing shall be in the scope of VENDOR.
- All the fabrication and assembly including all the components shall be carried out in accordance with applicable code or approved equivalent.
- IPR authority / representative shall have access to all manufacturing facilities, inspection and testing facilities, tools, drawings etc.; during all stages of manufacture.

ANNEXURE-I

Following conceptual drawings are being supplied by IPR along with this tender document.

A. IVIS ASSEMBLY

Sr. #	TITLE	DRAWING No.
1	IVIS ASSEMBLY	IPR/RHRTD/IVIS/DRG - 01
2	BASE	IPR/RHRTD/IVIS/DRG - 02
3	JOINT nASSEMBLY	IPR/RHRTD/IVIS/DRG - 03
4	JOINT 1 FEMALE LUG FLANGE	IPR/RHRTD/IVIS/DRG - 04
5	JOINT 1 MALE LUG FLANGE	IPR/RHRTD/IVIS/DRG - 05
6	JOINT 2 FEMALE LUG FLANGE	IPR/RHRTD/IVIS/DRG - 06
7	JOINT 2 MALE LUG FLANGE	IPR/RHRTD/IVIS/DRG - 07
8	JOINT 3 FEMALE LUG FLANGE	IPR/RHRTD/IVIS/DRG - 08
9	JOINT 3 MALE LUG FLANGE	IPR/RHRTD/IVIS/DRG - 09
10	JOINT 4 FEMALE LUG FLANGE	IPR/RHRTD/IVIS/DRG -10
11	JOINT 4 MALE LUG FLANGE	IPR/RHRTD/IVIS/DRG -11
12	JOINT 5 FEMALE LUG FLANGE	IPR/RHRTD/IVIS/DRG -12
13	JOINT 5 MALE LUG FLANGE	IPR/RHRTD/IVIS/DRG -13
14	FEMALE LOWER LUG	IPR/RHRTD/IVIS/DRG -14
15	FEMALE UPPER LUG	IPR/RHRTD/IVIS/ DRG - 15
16	MALE LUG	IPR/RHRTD/IVIS/ DRG - 16
17	LOWER SHAFT	IPR/RHRTD/IVIS/ DRG - 17
18	UPPER SHAFT	IPR/RHRTD/IVIS/ DRG - 18
19	MOTOR LUG INTERFACE	IPR/RHRTD/IVIS/ DRG - 19
20	LINKnASSEMBLY	IPR/RHRTD/IVIS/ DRG - 20
21	LINK 0 HORIZONTAL PLATE	IPR/RHRTD/IVIS/ DRG - 21
22	LINK 0 VERTICAL PLATE	IPR/RHRTD/IVIS/ DRG - 22
23	LINK 1 HORIZONTAL PLATE	IPR/RHRTD/IVIS/ DRG - 23
24	LINK 1 VERTICAL PLATE	IPR/RHRTD/IVIS/ DRG - 24
25	LINK 2 HORIZONTAL PLATE	IPR/RHRTD/IVIS/ DRG - 25
26	LINK 2 VERTICAL PLATE	IPR/RHRTD/IVIS/ DRG - 26
27	LINK 3 HORIZONTAL PLATE	IPR/RHRTD/IVIS/ DRG - 27
28	LINK 3 VERTICAL PLATE	IPR/RHRTD/IVIS/ DRG - 28
29	LINK 4 HORIZONTAL PLATE	IPR/RHRTD/IVIS/ DRG - 29
30	LINK 4 VERTICAL PLATE	IPR/RHRTD/IVIS/ DRG - 30
31	LINK 5 HORIZONTAL PLATE	IPR/RHRTD/IVIS/ DRG - 31
32	LINK 5 VERTICAL PLATE	IPR/RHRTD/IVIS/ DRG - 32
33	LINK 0 STIFFNER	IPR/RHRTD/IVIS/ DRG - 33
34	LINK 1 STIFFNER	IPR/RHRTD/IVIS/ DRG - 34
35	LINK 2 STIFFNER	IPR/RHRTD/IVIS/ DRG - 35
36	LINK 3 STIFFNER	IPR/RHRTD/IVIS/ DRG - 36
37	LINK 4 STIFFNER	IPR/RHRTD/IVIS/ DRG - 37
38	LINK 5 STIFFNER	IPR/RHRTD/IVIS/ DRG - 38

Storage Vacuum Chamber (SVC)

Sr.#	TITLE	DRAWING No.
1	STORAGE VACCUM CHAMBER ASSEMBLY	IPR/RHRTD/SVC-01
2	BASE PLATE ASSEMBLY	IPR/RHRTD/SVC -02
3	SIDE PLATE 1 ASSEMBLY	IPR/RHRTD/SVC -03
4	SIDE PLATE 2 ASSEMBLY	IPR/RHRTD/SVC -04
5	UPPER PLATE ASSEMBLY	IPR/RHRTD/SVC -05
6	500 ISO GATE VALVE (FIM)	IPR/RHRTD/SVC -06
7	VESSEL SIDE PORT ASSEMBLY	IPR/RHRTD/SVC -07
8	BASE PLATE	IPR/RHRTD/SVC - 08
9	SIDE PLATE 1	IPR/RHRTD/SVC - 09
10	SIDE PLATE 2	IPR/RHRTD/SVC - 10
11	UPPER PLATE	IPR/RHRTD/SVC - 11
12	RAIL SUPPORT STRUCTURE	IPR/RHRTD/SVC - 12
13	100 CF FLANGE	IPR/RHRTD/SVC - 13
14	100 CF BLANK FLANGE	IPR/RHRTD/SVC - 14
15	150 CF FLANGE	IPR/RHRTD/SVC - 15
16	150 CF BLANK FLANGE	IPR/RHRTD/SVC - 16
17	63 CF CASK SIDE FLANGE	IPR/RHRTD/SVC - 17
18	63 CF CASK SIDE BLANK FLANGE	IPR/RHRTD/SVC - 18
19	300 CF FLANGE	IPR/RHRTD/SVC - 19
20	300 CF BLANK FLANGE	IPR/RHRTD/SVC - 20
21	END FLANGE	IPR/RHRTD/SVC - 21
22	BLANK END FLANGE	IPR/RHRTD/SVC - 22
23	VESSEL SIDE END FLANGE CONNECTOR	IPR/RHRTD/SVC - 23
24	500 CF ROTATABLE FLANGE	IPR/RHRTD/SVC - 24
25	VESSEL PORT FLANGE CONNECTOR	IPR/RHRTD/SVC - 25
26	VESSEL PORT FLANGE	IPR/RHRTD/SVC - 26
27	63 CF PORT SIDE FLANGE	IPR/RHRTD/SVC - 27
28	SUPPORT STAND	IPR/RHRTD/SVC - 28