VACUUM VESSEL LOWER PORT PENETRATIONS & IN VESSEL VIEWING PORT EXTENSION

Call for Nomination (C4N)
Ref. IO/CFT/18/15702/JPK
Summary of Technical Specifications

1. Purpose

The purpose of the contract is to execute design, prototyping, qualification, manufacturing, acceptance test, delivery support to installation & commissioning of the Lower Penetrations and In Vessel Viewing (IVV) Port Extension to the ITER Organization (IO) in Saint Paul Lez Durance, France. The procurement of is divided in in two Lots:

- **Lot 1** corresponding to Lower Penetrations made of expansion joints, (including the 6 ones for IVV Port), penetrations and their supporting structure.
- **Lot 2** corresponding to the procurement of the IVV Port Extension with associated electrical heaters.

2. Background

ITER ("The Way" in Latin) is one of the most ambitious energy projects in the world today. 35 nations are collaborating to build the world's largest Tokamak, a magnetic fusion device that has been designed to prove the feasibility of fusion as a large-scale and carbon-free source of energy based on the same principle that powers our Sun and stars. For more information on the ITER project: http://www.iter.org/

The main function of the ITER Vacuum Vessel (VV) is to provide a high quality vacuum for the fusion plasma, while shielding external components. The cryostat is to provide the vacuum environment to avoid excessive thermal loads from the hot vacuum vessel to magnets operating at cryogenic temperature within the tokamak. There are many penetrations to allow the passage of components and systems through the cryostat and VV that are needed to operate and maintain the tokamak.

The lower penetrations, located in the lower cylinder area of the tokamak are primary vacuum extensions through the cryostat to the port cell area. Three types of lower penetrations are identified: odd port penetrations, even port penetrations (RH ports and cryopump ports) and IVV penetrations, see picture bellow.

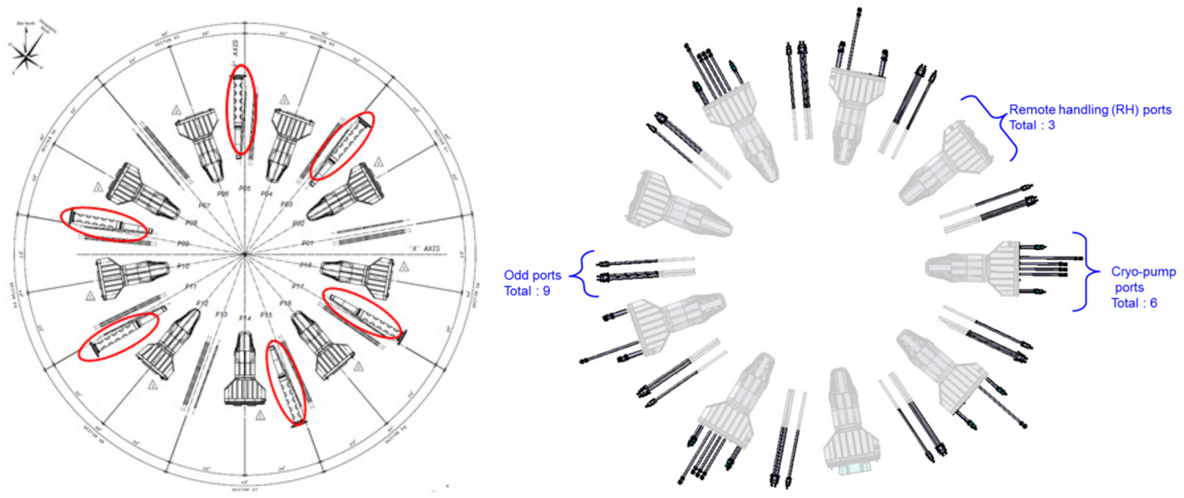


Figure1: Lower cylinder area, with lower ports. Left: The distribution of the 6 IVV Ports is circled in red. Right: Distribution of Lower penetrations.

Lot 1:

The lower penetrations, located in the lower cylinder area of the tokamak are primary vacuum extensions through the cryostat to the port cell area Two types of lower penetrations are identified: odd port penetrations and even port penetrations (RH ports and cryopump ports). Lower penetrations are housing components crossing the cryostat:

- Cooling and baking pipes
- Diagnostic electrical cables and feedthrough
- Other sensors

A penetration is as follow:

- A vacuum pipe, guarded in the specific case of cooling/baking pipes in stainless steel 1.4404 (316 L).
- A multiply below interfacing with the vacuum pipe and the cryostat, designed following EN 14917 and/or EJMA.
- A flange to fix the penetration onto the cryostat (designed following ASME III and made of SS 304)
- A flange to interface with the client rooted inside the penetration
- Supports limiting the degree of freedoms of the penetration, fixed onto the cryostat to be designed following the RCC-MR Ed. 2007 when required.

As example the design of a penetration is as shown below (conceptual design for divertor penetrations).

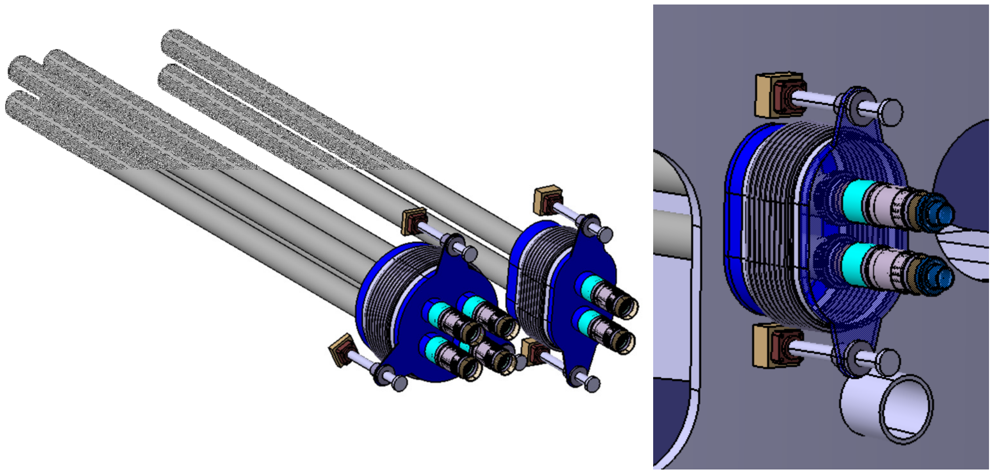


Figure 2: Divertor odd penetration. Left picture is showing the full penetration made of vacuum and gurd pipes, expansion joints and supports.

The following table summarizes the number of expansion joints to be designed and qualified as well as quantities and preliminary dimensions. As a whole, 282 bellows will be procured.

	Dimensions and general requirements					**Environment normal operation**		
#	**flange diameter**	**Safety important component**	**Shape**	**Type**	**Quantity**	**Flowing medium**	**Inside**	**Outside**
1	408mm x 606mm	non SIC	oblong	Multiply	9	Vacuum	cryostat vacuum	air
2	DN650	non SIC	circular	Multiply	9	Vacuum	cryostat vacuum	air
3	DN125	non SIC	circular	Multiply	54	Vacuum	interspace vacuum	cryostat vacuum
4	DN200	non SIC	circular	Multiply	36	Vacuum	cryostat vacuum	air
5	DN201	non SIC	circular	Multiply	18	Vacuum	cryostat vacuum	air
6	DN202	non SIC	circular	Multiply	3	Vacuum	cryostat vacuum	air
7	DN203	non SIC	circular	Multiply	3	Vacuum	cryostat vacuum	air
8	DN204	non SIC	circular	Multiply	6	Vacuum	cryostat vacuum	air

9	DN205	non SIC	circular	Multiply	6	Vacuum	cryostat vacuum	air
10	DN125	non SIC	Circular	Multiply	4	Vacuum	cryostat vacuum	air
11	450mm x 250 mm	non SIC	Oblong	Multiply	8	Vacuum	interspace vacuum	air
12	DN125	non SIC	Circular	Multiply	4	Vacuum	cryostat vacuum	air
13	450mm x 250 mm	non SIC	Oblong	Multiply	8	Vacuum	interspace vacuum	air
14	DN125	SIC1	circular	Multiply	108	Vacuum	Primary vacuum	air
15	DN400	SIC1	Circular	Double	6	Vacuum	Primary vacuum	cryostat vacuum

The primary function of the ITER Bellows is to keep pressure confinement between the Vacuum vessel and the Cryostat. The bellows also compensate for relative displacements between the connected large components (the vacuum vessel, the cryostat) induced by thermal, seismic and electromagnetic loading during operational, incidental or accidental regimes. They shall be designed to comply with strict requirement to ensure low leak rate, low risk of failure, high reliability and periodic testing of their performances to prevent failures. Bellows shall be designed to withstand temperatures from -65°C and 200°C, absolute internal and external pressure of 0.15 MPa and 0.16 MPa respectively. Displacements will be provided in the detailed technical specification.

In addition, bellows used on all divertor penetrations, type 14, are confinement barrier and safety important components. These bellows shall be designed to allow stretching by 175mm providing double confinement is limited space available. They shall be designed for 5MPa internal pressure at 270°C and 4MPa internal pressure at 400°C in accidental case.

Lot 2:

The IVV system penetrates the VV and the cryostat extending the primary vacuum outside of the cryostat. There are a total of six IVV Ports located at the lower port # 3, 5, 9, 11, 15, 17, each port is divided in two main parts IVV Port Stub Extension, connecting with the VV sub, and IVV Port Extension connecting the Port with the cryostat, both parts are mechanically connected by an intermediate bellows. These bellows have a circular shape and are made of stainless steel. Bellows are integrated in the penetration to provide a primary vacuum tight boundary between the cryostat and the VV and allow for relative deformations. Notice that these bellows are described as part of the IVV Port, but are included in the scope of Lot 1 for arrangement of the bellow procurements.

Both the VV and Cryostat are normally operated under vacuum conditions, but due to the presence of high temperature and water cooled components, there is a possibility for pressurization during the leaking accident.

The IVV Port Extension feature external heater bands. These are used to heat up the structures to 100deg C during operation, and 200deg C during VV baking.

The IVV PE main function is to provide primary vacuum boundary as well as tritium confinement. The VV is a PIC-1 component and therefore the IVV Ports are PIC-1 components as well. As a PIC-1 component, the seismic class is SC1 (S and F). This means that structural stability and required functional seismic safety performance has to be maintained in the event of an earthquake. This is the main design driver.

The materials used to manufacture the penetration shall comply with ITER requirement in terms of low Cobalt content and be compatible with interface materials.

Penetrations are part of the Vacuum Vessel design. As such their design and manufacturing shall for the French nuclear code RCC-MR Ed. 2007. This code is driving all the stages of the design justification, material purchase and traceability, welding and NDE including volumetric control of welds, leak testing etc. In the specific case of bellows, EN14917 has been chosen for the justification of the design of multiply bellows.

All welds shall comply with supplementary vacuum requirements as per ITER Vacuum Handbook.

The geometrical context for this procurement is shown on Figure 3 and the physical boundary of the procurement is delineated in red.

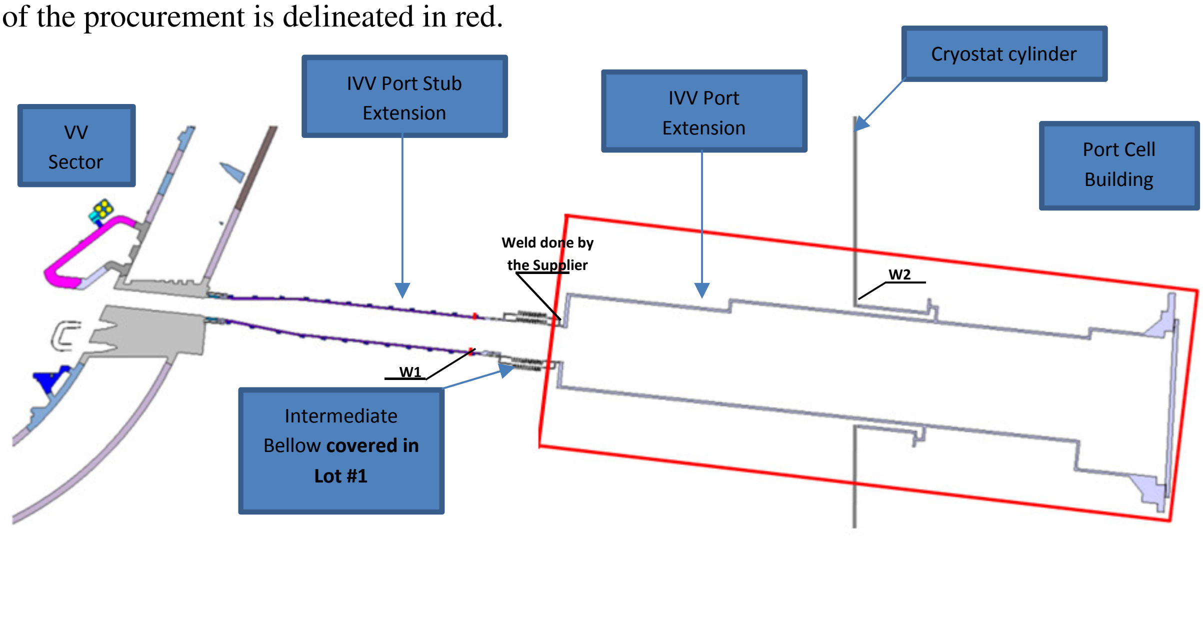


Figure 3: IVV Port components and interfaces (Poloidal cross section view)

Typical thickness of the IVV Port Extension is 20mm.

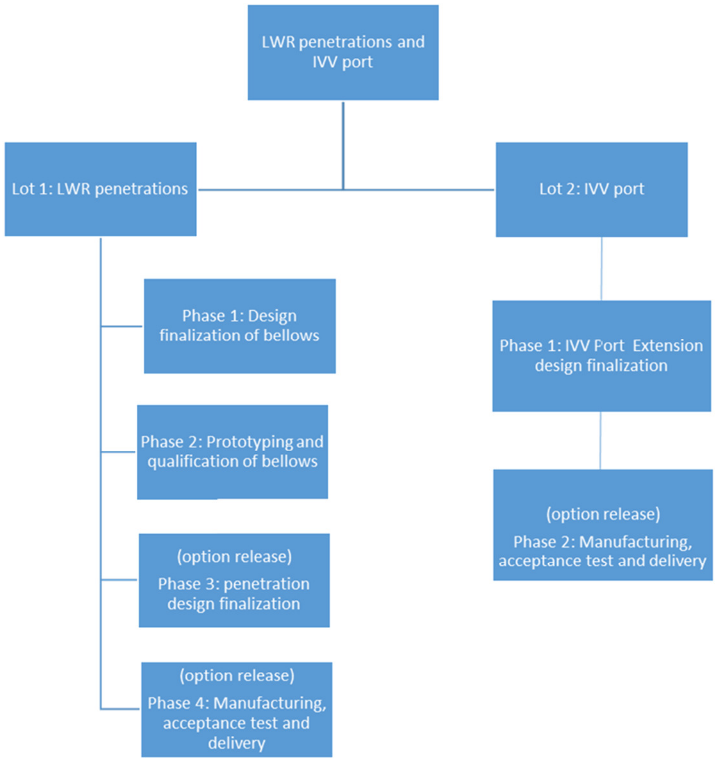
3. Scope of work

A Technical Specification will be issued for each lot.

The outline of contract implementation can be summarized as follows:

- Final Design Development and Prototype Testing
- Manufacture and Factory Acceptance Testing
- Transport and Delivery to the ITER Site
- Support to Installation, Site Acceptance Testing and Commissioning

The schematic below provides more information related to each lot:



The Lot 1 is composed of 4 phases:

- Phase 1: Design finalization of bellows
- Phase 2: Prototype and qualification of bellows
- Phase 3: Penetration design finalization (Option to be released after closure of phase 2 and integrability check of bellows in environment)
- Phase 4: Manufacturing, acceptance test and delivery of penetration (Option to be released after closure of phase 3 and validation of design)

The Lot 2 is composed of 2 phases:

- Phase 1: Design finalization of IVV port extension
- Phase 2: Manufacturing, acceptance test and delivery of penetration (Option to be released after closure of phase 1 and validation of design)

4. Time Schedule

The contract shall start in December 2018 / January 2019 and its estimated duration is 5 years.

The tentative timetables is shown below, nevertheless the Supplier shall produce a Detailed Schedule showing all phases of the Contract and showing how the overall IO Schedule will be complied with.

Call for Nomination	June 2018
Prequalification	August 2018
Tender submission date	September 2018
Award date of contract	December 2018 / January 2019
Contract start date	February - March 2019
Contract end	March 2023

This is given for information only and may be subjected to change.

5. Experience

The Contractor and its personnel shall demonstrate a technical and engineering capability and relevant experience in:

- Using codes and standards applicable for bellows (EJMA, EN14917 …)
- Codes and standard applicable for support Vacuum Vessel (RCC-MR) and Cryostat (ASME) and qualification for designing and manufacturing nuclear components.
- Design, structural integrity analysis, fabrication, examination, quality control and testing of the IVV Port Extension in line with RCC-MR ed.2007.
- Manufacture and testing of multiply bellows including advanced forming and welding techniques.
- High vacuum technology
- Prototyping, qualification and testing of multi ply bellows and safety important components.
- Integration, installation and commissioning of large assemblies with multiply bellows in complex plant environment
- Development of the mechanical components for Remote Handling (RH) maintenance.

The Contractor is expected to provide direct evidence of this work in their submissions. Previous experience and knowledge of the ITER project is not required, however, the companies need to be self-sufficient in seeking out detailed information in order to accomplish the contract successfully.

In addition, during the tendering process the Supplier will have to provide evidence of:

- QA system: The Tenderer shall have and maintain a valid ISO 9000 certification and shall have the duty to verify and document the equivalent quality level of all its subcontractors and consultants.
- Professional Software: The Tenderer shall provide a list of the professional software available and used, e.g. for structural (static, dynamic, seismic), thermal and thermo-mechanical analyses, electromagnetic analyses (such as ITER conventional multi-physic analysis software ANSYS), CAD software (such as ITER conventional CAD software CATIA V5 and/or V6, if it is applicable) etc.

6. Nuclear and Quality Requirements

The ITER Organization is the nuclear operator of the ITER nuclear fusion facility (INB 174, ("Installation Nucléaire de Base") under French nuclear law. For Protection Important Components (Safety Important Class) (PIC/SIC), the French Nuclear Regulation must be observed, in application of the Article 14 of the ITER Agreement. Therefore the Contractor and its subcontractors must comply with the following:

- The Order 7th February 2012 applies to all the PIC components and Protection Important Activity (PIA)
- The compliance with the INB-order must be demonstrated in the chain of external contractors
- In application of article II.2.5.4 of the Order 7th February 2012, contracted activities for supervision purposes are also subject to a surveillance done by the Nuclear Operator.

For the Protection Important Components, structures and systems of the nuclear facility, the Contractor shall ensure that a specific management system has to be implemented by any Contractor and its subcontractor working on Protection Important Activities, following the requirements of the Order 7th February 2012 and ITER Provisions for Implementation of the Generic Safety Requirements by the External Interveners. The Contractor will have to provide an evidence of implemented Quality Assurance System required for design, manufacturing, testing, qualification and shipping of nuclear components.

7. **Candidature**

Participation is open to all legal persons participating either individually or in a grouping (consortium) which is established in an ITER Member State. A legal person cannot participate individually or as a consortium partner in more than one application or tender of the same contract. A consortium may be a permanent, legally-established grouping or a grouping, which has been constituted informally for a specific tender procedure. All members of a consortium (i.e. the leader and all other members) are jointly and severally liable to the ITER Organization. The consortium grouping shall be presented at the Pre-Qualification stage. The Candidate's composition cannot be modified without the approval of the ITER Organization after the Pre-Qualification. Legal entities belonging to the same legal group are allowed to participate separately if they are able to demonstrate independent technical and financial capacities. Candidates (individual or consortium) must comply with the selection criteria. The IO reserves the right to disregard duplicated reference projects and may exclude such legal entities from the Pre-Qualification procedure.

8. **Reference**

Further information on the ITER Organization procurement can be found at: **http://www.iter.org/org/team/adm/proc/overview**