Technical Summary

Contract for Procurement of TCWS expansion joint assemblies at L3 and closure flanges

Purpose

The purpose of this Contract is to design, fabricate, test and supply expansion joints and closure flanges for ITER project / Tokamak Cooling Water System (TCWS).

Background

ITER will be the largest and most complex nuclear fusion system yet to be built. Situated in Southern France, adjacent to the French CEA Cadarache site, the ITER facility covers approximately 190 hectares and is designed to study the fusion reaction between hydrogen isotopes, tritium and deuterium.

The ITER Organization requires bellow assemblies and closure plates for the construction of the Tokamak Cooling Water System (TCWS) in the cryostat.

Scope of work:

System	Item	Material of construction	Bellow nominal size, DN	Quantity
TCWS	VV PHTS bio shield expansion joint	304L (Co 0.05%, Nb 0.1% and Ta 0.01)	500	18
TCWS	IBED PHTS bio shield expansion joint	304L (Co 0.05%, Nb 0.1% and Ta 0.01)	600	36
TCWS	VV PHTS cryostat expansion joint	304L (Co 0.05%, Nb 0.1% and Ta 0.01)	500	9
TCWS	IBED PHTS cryostat expansion joint	304L (Co 0.05%, Nb 0.1% and Ta 0.01)	600	36
TCWS	VV PHTS bio shield closure flanges	304L (Co 0.05%, Nb 0.1% and Ta 0.01)	TBD	9
TCWS	IBED PHTS bio shield closure flanges	304L (Co 0.05%, Nb 0.1% and Ta 0.01)	TBD	36

Expansion joint classification:

S.N.	Category	Class
1	Safety Classification:	SIC-1
2	Vacuum Classification:	VQC-2A
3	Remote Handling classification:	N/A
4	Tritium classification:	N/A
5	Quality Classification:	QC1
6	Seismic Classification:	SC-1 (S)

Particular requirements

The bellow elements should be protected on the outside from damage during stages of future maintenance and other related actions which might inflict the damage to them.

All bellow assemblies shall undergo thru a set of tests which include:

- Helium leak test
- Pressure test
- Dimensional inspection

Pressure testing shall follow the requirements of ASME B31.3 and supplemented by requirements of IO, which will be detailed in “Technical Specification for Bellows”. The most stringent amongst the two codes shall apply for determining the pressure test value.
As per ITER Vacuum Handbook It shall be demonstrated that the below assemblies displaced at a maximum value radially and axially (if applicable) and subjected to a 0.2 MPa of pressure differential applied internally or externally on the assembly can survive and remain unaltered when the bellows interspace is at the following pressures:

- $<10^{-3}$ MPa (evacuated interspace)
- 0.05 MPa (interspace normal operation)
- 0.2 MPa (interspace over pressure)

In all cases pressure testing shall be followed by leak testing.

Helium leak testing shall be performed in accordance with ASME B31.3 and supplemented by requirements provided by IO which can be found in “Technical Specification for Bellows” and detailed in “Appendix 12” for requirements. The ITER Vacuum Responsible Officer (RO) will nominate a Vacuum Specialist to witness the acceptance leak tests and any other leak test deemed necessary as part of a manufacturing process. In no circumstance shall any vacuum equipment be installed without an accepted pre-installation leak check being performed at the ITER site, without the express permission of the ITER Vacuum Responsible Officer. This applies to all Vacuum Quality Classifications.
For an acceptance of helium leak tests the helium concentration around the test piece shall be at a minimum of 50% for the duration of the test. The helium concentration shall be measured and recorded. The helium shall be maintained for a period calculated to be sufficient to identify leaks at the acceptance level.

The supplier is responsible for all jigs, seals and equipment to allow the leak tightness to be proven across all vacuum boundaries, unless otherwise stated in the contract. The supplier is responsible for the supply of tooling and methodologies for the subsequent removal of jigs, seals, temporary closure plates, etc., which have been fitted to components to facilitate the leak testing of such components.

Leak tests shall be performed:

- During manufacturing to confirm soundness of joining processes and sub-components and to reduce the risk of Incorporating leaks in a system that are subsequently difficult to locate or to repair.
- As an acceptance test at the supplier's site to show that completed assemblies meet the acceptance leak criteria.
- When a component arrives at the ITER site, to confirm that there has been no damage during packaging and transport. This test, which is under the control and at the discretion of ITER, will be designed to be as simple and fast as possible.
- During installation, under the control of ITER, when testing is implemented to reduce the risk of newly made joint leaks only being detected at the completion of the total installation.
- On pumping down of the completed installation as part of the final commissioning.

Requirements for vacuum class VQC-2A of leak rate is provided by IO and stated in the table below:

System/Component	Maximum leak rate (Pa.m^3/s air equivalent*)
VQC-2A	$1x10^{-9}$
* - Helium equivalent Leak Rate (LR) = Air equivalent x 2.69 at the same temperature.	

Table 3: Maximum acceptance Leak rate for VQC-2A

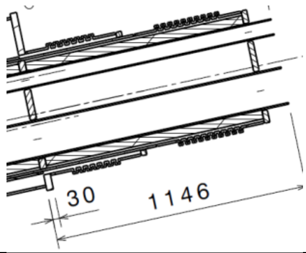
Any leak rates greater than specified value in table 3 shall be discussed for acceptance or rejection with ITER vacuum responsible officer.

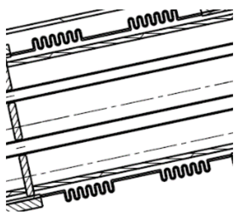
Dimensional inspection shall be performed by the Supplier of bellow convolutions to conform the compliance to the technical specification. The results shall be supplied to IO for the acceptance.

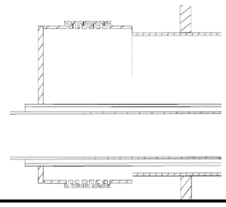
An x-ray of bellows inner ply longitudinal weld seam (only) and longitudinal weld seam of pipe section shall be performed as well.

Below is required to have more than one ply and future tests for leaks with the use of small bore thru the flange to the first layer of ply shall be implemented.

The following technical data I applicable to these bellow assemblies:

VV PHTS bio shield side expansion joints		
Expansion joint type	Depend on the final design (initially a universal type, two in a row), tie rods possible.	
Bellow ply	Double	
End connection	Depend on the final design and loads	
Material	304L (Co 0.05%), Nb (0.1%) and Ta(0.01)	
Unit number, pcs.	18	
Diameter (mm)		DN500
Flow medium	Inside	Vacuum
	Outside	Air
	Flow Rate (kg/s)	N/A
	Flow direction	N/A
Design	Pressure (Bar)	26
	Temperature (˚C), internal	220
Operating (PLASMA)	Pressure (Bar)	1
	Temperature (˚C), internal	115
	Axial displacement, (mm)	21
	Transversal displacement, (mm)	3
	Number of cycles	30000
Operating (WATER BAKING)	Pressure (Bar)	1
	Temperature (˚C), internal	195
	Axial displacement, (mm)	46
	Transversal displacement, (mm)	5
	Number of cycles	500
Accidental (Loca)	Pressure (Bar)	23
	Temperature (˚C), internal	195
	Axial displacement, (mm)	46
	Transversal displacement, (mm)	5
	Number of cycles	1

IBED PHTS bio shield side expansion joints		
Expansion joint type	Depend on the final design (initially a universal type, two in a row), tie rods possible.	
Bellow ply	Double	
End connection	Depend on the final design and loads	
Material	304L (Co 0.05%), Nb (0.1%) and Ta(0.01)	
Unit number, pcs.	18	
Diameter (mm)		DN600
Flow medium	Inside	Vacuum
	Outside	Air
	Flow Rate (kg/s)	N/A
	Flow direction	N/A
Design	Pressure (Bar)	50
	Temperature (˚C), internal	270
Operating (PLASMA)	Pressure (Bar)	1
	Temperature (˚C), internal	136
	Axial displacement, (mm)	N/A
	Transversal displacement, (mm)	N/A
	Number of cycles	30000
Operating (WATER BAKING)	Pressure (Bar)	1
	Temperature (˚C), internal	240
	Axial displacement, (mm)	N/A
	Transversal displacement, (mm)	N/A
	Number of cycles	500
Accidental (LOCA)	Pressure (Bar)	40
	Temperature (˚C), internal	240
	Axial displacement, (mm)	N/A
	Transversal displacement, (mm)	N/A
	Number of cycles	1
Accidental (CrICE)	Pressure (Bar)	1
	Temperature (˚C), internal	240
	Axial displacement, (mm)	22
	Transversal displacement, (mm)	36
	Number of cycles	1

VV PHTS cryostat side expansion joints		
Expansion joint type	Depend on the final design (initially a universal type, two in a row), tie rods possible.	
Bellow ply	Double	
End connection	Depend on the final design and loads	
Material	304L (Co 0.05%), Nb (0.1%) and Ta(0.01)	
Unit number, pcs.	9	
Diameter (mm)		DN500
Flow medium	Inside	Vacuum
	Outside	Air
	Flow Rate (kg/s)	N/A
	Flow direction	N/A
Design	Pressure (Bar)	26
	Temperature (˚C), internal	220
Operating (PLASMA)	Pressure (Bar)	1
	Temperature (˚C), internal	115
	Axial displacement, (mm)	21
	Transversal displacement, (mm)	3
	Number of cycles	30000
Operating (WATER BAKING)	Pressure (Bar)	1
	Temperature (˚C), internal	195
	Axial displacement, (mm)	46
	Transversal displacement, (mm)	5
	Number of cycles	500
Accidental (CrICE)	Pressure (Bar)	1
	Temperature (˚C), internal	-74
	Axial displacement, (mm)	58
	Transversal displacement, (mm)	25
	Number of cycles	1

IBED PHTS cryostat side expansion joints		
Expansion joint type	Depend on the final design (initially a universal type, two in a row), tie rods possible.	
Bellow ply	Double	
End connection	Depend on the final design and loads	
Material	304L (Co 0.05%), Nb (0.1%) and Ta(0.01)	
Unit number, pcs.	36	
Diameter (mm)		DN600
Flow medium	Inside	Vacuum
	Outside	Air
	Flow Rate (kg/s)	N/A
	Flow direction	N/A
Design	Pressure (Bar)	50
	Temperature (˚C), internal	270
Operating (PLASMA)	Pressure (Bar)	1
	Temperature (˚C), internal	136
	Axial displacement, (mm)	13
	Transversal displacement, (mm)	19
	Number of cycles	30000
Operating (WATER BAKING)	Pressure (Bar)	1
	Temperature (˚C), internal	240
	Axial displacement, (mm)	29
	Transversal displacement, (mm)	44
	Number of cycles	500
Accidental (CrICE Event)	Pressure (Bar)	1
	Temperature (˚C), internal	-74
	Axial displacement, (mm)	65
	Transversal displacement, (mm)	66
	Number of cycles	500

All vacuum components are assigned a Vacuum Classification to point the service area on ITER. Bellow sub-assemblies are given a Vacuum Classification as VQC-2A. This are is classified as cryostat primary vacuum component which is connected to the cryostat vacuum through an opening. Joints which separate the classes shall be classified according to the requirements of the more demanding class. The surface finish requirements according to each class are also to be applied. The VQC class shall be marked on any produced drawings. Materials which are used in vacuum are specified in the Technical Specification.

Cleanliness is required during the whole manufacturing process and the preservation of cleanliness is good practice for any component to achieve the necessary vacuum standards and to minimize the time required to recover from any contamination incident. All components shall be subjected to a rigorous cleaning procedure, consistent with the Vacuum Classification of that particular component. A detailed Clean Work Plan shall be submitted for acceptance to the ITER Vacuum RO before any cleaning operations are performed. The plan shall specify how cleanliness will be maintained throughout the manufacturing process. It shall state when specific cleaning procedures will be applied and all of the controls which will be in place to maintain cleanliness, including handling.

A guide to cleaning and handling of components for use on ITER vacuum systems shall be found in “Technical Specification for Bellows”.

Experience requested

The Supplier shall demonstrate an experience to be able to produce manufacturing documentation (e.g. drawings) as per design inputs provided, fabricate, test and assemble the required goods as per ASME B31.3 Category M fluid [1], and the bellow standards as per [4]. Assembly parts, as will be stated more precisely in the Technical Specification shall comply for bellows with ASTM A240M for grade type T304L [6] and for flanges with A182M for grade T304L [5]. The Supplier shall be able to provide Quality Assurance level and Supply Chain Management System required for manufacturing of nuclear components, as per procedure [7] and shall comply with the French Order of 7th February 2012 establishing the general rules for basic nuclear installations [2].

All Codes & Regulatory Requirements will be provided in the Call of Tender stage.

Timetable

Tentative timetable for tendering process is stated below:

- Call for Nomination launch………………………June 2021
- Pre-Qualification……….…………………......... July 2021
- Call for Tender………..…………………………..Q3 2021
- Contract award …………………………………. Q4 2021

- Delivery to ITER Site.………………………… Q3 2022 (bio shield)

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

Candidature

Only ITER Member States are eligible for tendering, either individually, as part of a consortium or being included as a subcontractor:

- European Union including, provisionally, the UK. UK entities may only be awarded a contract upon the successful ratification of the UK's EURATOM membership before the contract award date, or by exceptional recommendation of the award of contract by the ITER council. Note that Switzerland is no longer a member of EURATOM and cannot be awarded a contract either individually, as part of a consortium or be included as a subcontractor therein.
- Republic of India,
- Japan,
- People's Republic of China,
- Republic of Korea,
- Russian Federation,
- United States of America.

Entities can participate either individually or in a consortium. A legal entity cannot participate individually or as a consortium partner in more than one application or tender. 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 groupings shall be presented at the pre-qualification stage. The tenderer's composition cannot be modified without the approval of the ITER Organization after the pre-qualification.

Legal entities belonging to the same legal grouping 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.