

## Report

# Technical Specification for Market Survey - Cryostat Lower Port Cell Bellows

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Approval Process			
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<i>Change Log</i>			
<b>Technical Specification for Market Survey - Cryostat Lower Port Cell Bellows (7HLGYL)</b>			
<i><b>Version</b></i>	<i><b>Latest Status</b></i>	<i><b>Issue Date</b></i>	<i><b>Description of Change</b></i>
v1.0	Signed	29 Mar 2022	
v1.1	Approved	30 Mar 2022	minor updating

## **Technical Specification for Market Survey of Cryostat Lower Cell Bellows**

This documents corresponds to the technical summary for the market survey for the ITER Cryostat Rectangular Bellows tender

## Purpose

The ITER organization is performing this market survey in order to identify potential suppliers for Cryostat Lower Port Cell Bellows as per IO final design. This document summarizes the requirements for the design, manufacturing, testing, transport & delivery and support to installation and commissioning. This market survey is not binding nor contractual.

## Background

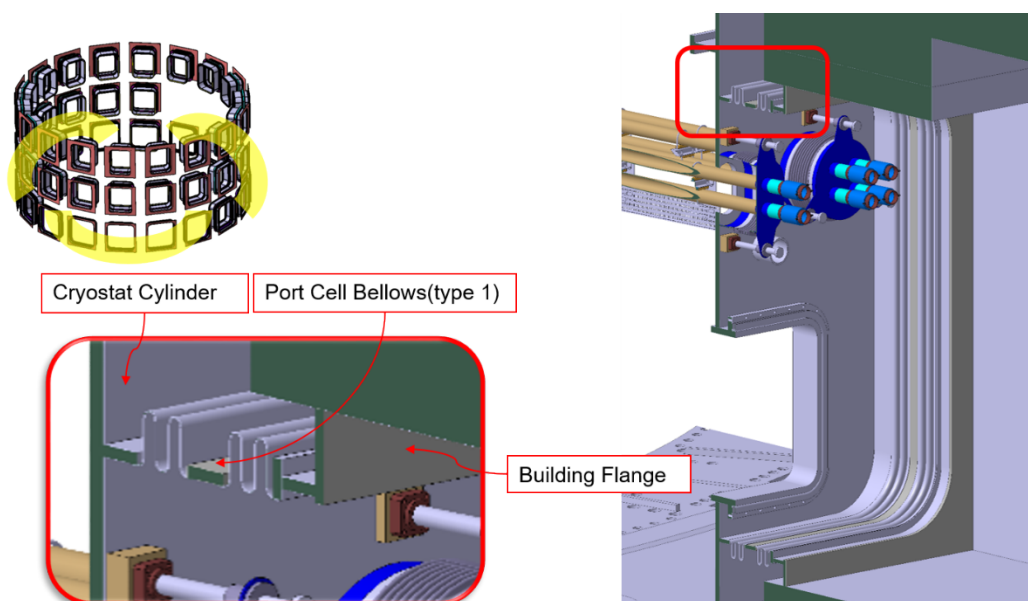
ITER (“The Way” in Latin) is one of the most ambitious energy projects in the world today. 35 nations are collaborating to build the world’s largest tokamak, a magnetic fusion device that has been designed to prove the feasibility of fusion as a large-scale and carbon-free source of energy based on the same principle that powers our Sun and stars.

For more information on the ITER project: <http://www.iter.org>

The Cryostat is one of the major components of the ITER machine. The Cryostat is a large, stainless steel structure surrounding the vacuum vessel and superconducting magnets.

Rectangular bellows is a Cryostat sub-system composed of expansion joints. The primary function of the ITER Cryostat rectangular Bellows is to keep pressure confinement. The bellows also compensate for relative displacements between the connected large components (the vacuum vessel, the cryostat, the building) induced by thermal, seismic and electromagnetic loading during operational, incidental or accidental regimes.

This survey is for Lower Port cell rectangular bellows. The design of Lower port cell bellows is frozen by IO as shown on Figure 1. There are 15 port cell (type 1) and 3 port cell (type 2) at divertor port level, both have same geometry of convolution part except the different connecting flange with Cryostat. The primary function of port cell bellows is to ensure leak tightness and relative movements during normal operation regimes and accidental events.



**Figure 1 – Location and geometry of Cryostat Lower Port Cell Bellows**

## Experience

The Contractor shall have adequate experience for the work and activities as detailed below.

- Compliance with codes and standards applicable for rectangular bellows (EJMA, ASME Section II/V/VIII/IX ...) and qualification for designing and manufacturing nuclear components
- Design development of large multiply rectangular bellows including use of advanced analysis capacities (Finite Element Analysis) for design justification
- Manufacture and testing of large multiply rectangular bellows including advanced forming (minimized stretching, no single roll or punch forming) and welding techniques (no circumferential weld in convolutions, no weld in convoluted corner area)
- Integration, installation and commissioning of large multiply rectangular bellows in complex plant environment

## Work description

The scope of this procurement covers the manufacture, testing and delivery of 18 rectangular Lower Port Cell Bellows. The material for lower cell bellows is ASME SA-240 304L for all the parts.

The scope of work has been summarized as follows:

- Final Design Development – Prototype Testing:  
The design of the rectangular bellows is already performed by IO and available. All integration and interface details have been defined. Based on the design Prototype testing is required in order to validate the compliance and performance of the rectangular bellows. The following tests are to be performed: axial and angular spring rate tests, tightness tests (via Helium leakage test), burst tests, fatigue life tests, in-plane squirm tests, and test for interspace pumping of metallic sealed pockets between the layers.  
(Contractor can propose his own design but need to meet the final delivery requirement)
- Manufacturing Design – Fabrication – Inspection/Examination – Factory Acceptance Testing: The manufacturing design and all the corresponding manufacturing documentation (drawings, material supplier documentation, weld data packages, manufacturing procedures, Non Destructive Examination procedures, Manufacturing Inspection Plans ...) shall be prepared. It shall be reviewed before the start of fabrication through a Manufacturing Readiness Review. The fabrication of all 18 rectangular bellows shall be performed and all the inspection and examination requirements shall be implemented. Factory Acceptance Testing shall also be conducted.
- Transport and delivery to the ITER Site: A proper packing and shipping plan shall be prepared and the transportation to the ITER Site shall be performed.
- Support to installation, Site Acceptance Testing and commissioning: The on-site installation, Site Acceptance Testing and commissioning activities are the responsibility of IO. However, during activities which are critical for the operational functionality of the bellows, expert advice will be requested.

## **Key Technical Requirements**

### *Applicable Codes and Standards*

The following Codes and Standards are applicable:

- ASME Boiler & Pressure Vessel Code (BPVC) - 2013 EDITION (or above) - Section VIII: Rules for Construction of Pressure Vessels - Division 2 : Alternative Rules
- ASME Boiler & Pressure Vessel Code (BPVC) - 2013 EDITION (or above) - Section II : Materials – Part A, B, C, D
- ASME Boiler & Pressure Vessel Code (BPVC) – 2013 EDITION (or above) - Section V : Non Destructive Examination
- ASME Boiler & Pressure Vessel Code (BPVC) - 2013 EDITION (or above) - Section IX : Welding and Brazing Qualifications
- EJMA – Expansion Joint Manufacturer Association - 10th Edition

### *Manufacturing requirements*

The applicable dispositions of ASME VIII Div.2 Part 6.1 shall be respected.

- Convolution forming shall be performed with a minimized degree of material stretching. Bellows material is to be adjusted during the forming process. NO welding is allowed on coevolution part after forming of convolution.
- Single roll or punch forming is not acceptable.
- No ferritic contamination shall be allowed during the rectangular bellows fabrication process.

### *Tolerances*

The fabrication tolerances specified in EJMA 10th Edition shall apply with the following conditions:

- Convolution pitch and inside diameter: same tolerances as values of figure D13 of EJMA 10th Edition
- Convolution height: more stringent tolerance with 75% of values of figure D13 of EJMA 10th Edition;

For flanges and duct ISO 2768 - mK tolerances shall apply

### *Material Requirement*

Produced materials shall be certified as per EN 10204:2004, Inspection Certificate type 3.1.

Materials requirements are defined in ASME II Part A, SA-240. Additional ITER requirements shall be taken into account in product procurements specifications:

- Requirements for relative magnetic permeability (Raw material  $\mu \leq 1.05$ )
- More stringent requirements for impurity elements P, S, Nb, B, and Co as specified below

Element	Max wt. %
P	0.030
S	0.015
Nb	0.10
B	0.0018
Co	0.10

### *Qualification requirements*

Prior to official production, the prototype for lower cell bellows shall be produced in order to demonstrate the manufacture feasibility of supplier. Prototype testing is also required in order to validate the compliance with functional requirement of the bellows.