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SUMMARY

Call For Nomination IO/19/CFT/1-17174/LLJ

Contract
for Beryllium windows assemblies to ITER Diagnostics

Purpose

The primary objective of ITER is to show fusion could be used to generate electrical power, and to gain the necessary data to design, construct, and operate the first electricity-producing plant. It will generate 500 MW of fusion power for extended periods of time, ten times more than the energy input needed to keep the plasma at the right temperature. It will therefore be the first fusion experiment to produce net power. It will also test a number of key technologies, including the heating, control, diagnostic and remote maintenance that will be needed for a full-scale fusion power station.

Background

ITER is a joint international research and development project for which initial construction activities have recently started. The project aims to demonstrate the scientific and technological feasibility of fusion power for peaceful purposes. The seven Members of the ITER Organization are the European Union (represented by EURATOM), Japan, the People 's Republic of China, India, the Republic of Korea, the Russian Federation and the USA. ITER will be constructed in Europe, at Cadarache, in southern France, where the ITER Organization (IO) has its headquarters.

ITER will install circa 40 diagnostic systems. Among the spectroscopic diagnostics, most of the X-ray diagnostics under design/construction for ITER require the use of a Beryllium window as an x-ray filter in some cases acting as well as a vacuum boundary.

Scope of work

The objective of this call is to collect the interest and capability of the applicants to manufacture the Be windows assemblies for the X-ray diagnostics. These assemblies are composed of an interfacing SS sub-frame (SS316LN(IG) or equivalently 316 LN with low Cobalt content < 0.05%) to which the Beryllium is welded (e.g. diffusion, or brazed). Each Beryllium window sub-frame assembly is meant to be welded to a SS receiving flange support by the diagnostic tenant (illustrative example in Fig. 1).

This call is aimed at the provision for:

- Implement design following ITER design concepts
- Manufacture

- Qualification tests as per ITER requirements

The vacuum metal flanges that receive the Beryllium window SS sub-frame are out of the scope of this call.

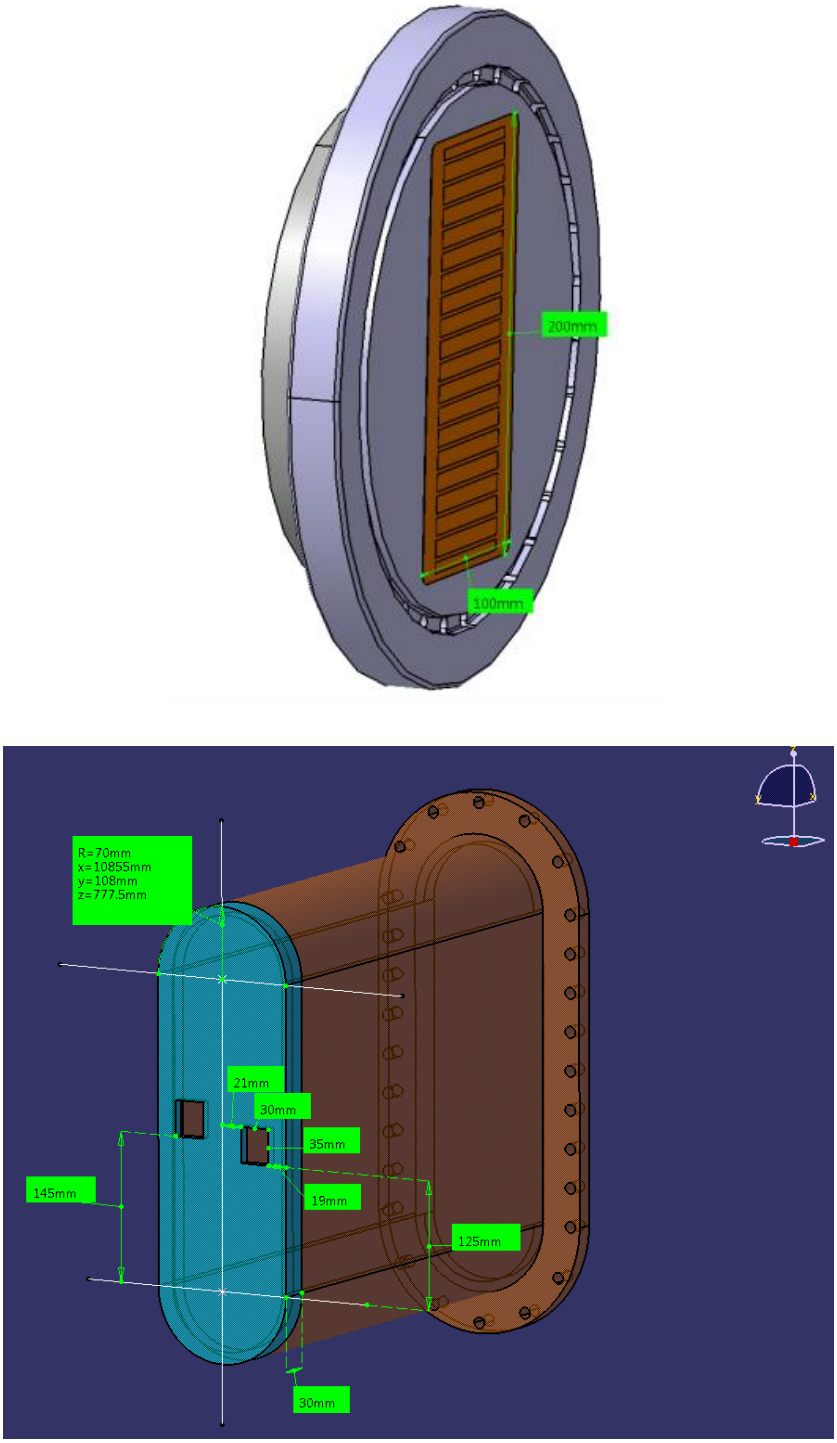

Fig.1 – Illustrative example of Beryllium windows assemblies (below in blue: SS sub-frame plus Beryllium window aperture)

Technical framework

The pressure resistance requirements (tests up to 3 bar differential, both sides) may imply that the Beryllium window is supported on both sides either by a permanent supporting frame and/or a removable supporting mesh in order to avoid plastic deformation. This solution would require the mesh to have a X-ray transparency of 80% or higher. In addition, Beryllium windows shall be able to resist to water vapour corrosion near 100 ^{o}C (specific test diagram is indicated below). To that end Al_2O_3 (preferably) or Al coating shall be applied with thickess around 3 -5 micrometer.

The outline technical requirements and tests to be performed are drafted below for information only.

Technical Requirements (Table I)

Quantity	10 < Q < 15
Material	Be / purity 99% or greater
Dimensions	Various (eg. 100x40 mm^2)
Thickness	200 micrometer
Bake to	250°C
Leak rate (air equivalent) Leak rate test (He)	10^{-10} $Pa.m^3/s$ $2.69x10^{-10}$ $Pa.m^3/s$
Outgassing rate (100°C)	10^{-7} $Pa.m^3.s^{-1}.m^{-2}$ (H isotopes) 10^{-9} $Pa.m^3.s^{-1}.m^{-2}$ (impurities)
Surface Roughness	0.8 µm (R_{max})

Tests to be performed (supplier to indicate clearly which tests cannot cover):

1. Prior to leak testing it must be demonstrated that the window assemblies can withstand, and remain unaltered by, a 0.3 MPa pressure differential in either direction. Proof tests to 0.3 MPa differential are required to qualify the window assemblies. The requirements are for no change in leak tightness and no plastic deformation (dimensional changes).
2. Leak rate tests as per table I.
3. Rapid vent tests for 1.5 atm on the air/gas side and <0.001 atm on the UHV side (50 cycles to simulate detector chamber gas refill)
4. Vibration tests, accelerations and frequencies: 15g at 9 Hz all directions (1000 cycles)
5. Test chemical resistance to internal H_2O flooding/vapor: what effect has on Beryllium surface and window capability to pass the required 1-4 tests.
   The demineralized water for the tests should respect the following concentrations (take the most conservative case in the perspective of window performance testing):

Table II - Cooling Water Chemistry Specification for Plasma Operation (2823A2)

Parameter	VV PHTS**	IBED PHTS	NBI PHTS
Conductivity @25ºC, µS/ cm	<= 1.0	<= 0.2	<= 0.1
pH @25 ºC	6.5 - 8.0	7.0 - 9.0	6.5 - 7.5
Sodium, ppb	<= 25	<= 5	<= 5
Cloride, ppb	<= 25	<= 5	<= 5
Hydrogen***, ppb	-	<= 350	<= 100
Catalyzed Hydrazine****, ppb	-	<= 30	-
Ammonia****, ppb	<= 300	<= 1,000	-
Oxygen, ppb	<= 100	<= 10	<= 10
ORP@25 ºC, mV	Info	(-400) - (-100)	(-400) - (-100)
Iron*****, ppb	<= 12	<= 10	<= 10
Copper*****, ppb	<= 10	<= 10	<= 10

Thermal and humidity tests:

6. Thermal shock testing of the window bonded elements must exhibit no change in helium leak rate when sprayed with water at 100˚C while at the window normal operating temperature
7. Window assemblies to be baked out in vacuum at 250˚C for 36h. After cool down the assembly shall be re-tested as per requirements in table 1.
8. Thermal test (stresses). Temperatures from 25-250˚C at a rate of 5K/h (or faster) and cool down at 7 K/h (or faster) until 70˚C and number of cycles = 500

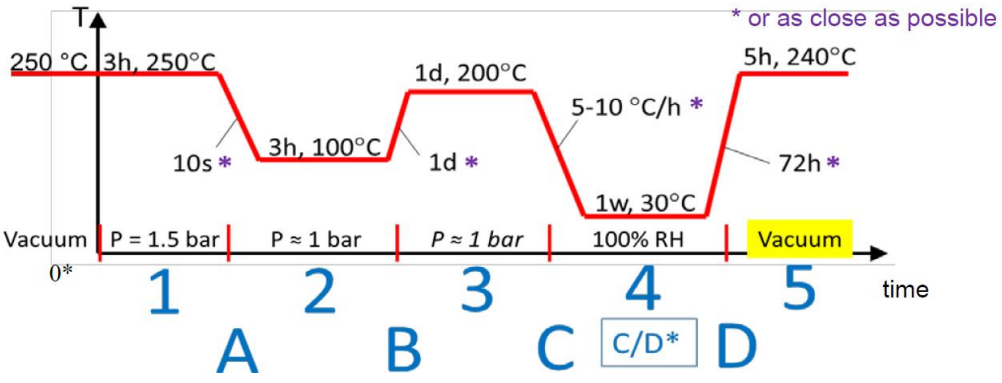

Fig. 2 – Thermal and relative humidity cycling tests diagram

9. Perform He leak test as per table 1.
10. Leak test under gamma and neutron irradiation for Beryllium to SS bonding. This test requirements depends on the supplier capability (to discuss) and may be done somewhere else.
11. Test for T permeability or calculation under high temperature. An equivalent test can be to measure the partial pressure of H inside a evacuated (UHV) chamber closed by the Be-window immersed in a chamber containing an hydrogen atmosphere.

Overview of documentation to be delivered regarding the manufacture process:

The following documents need to be reviewed, approved, and accepted before pre-manufacturing activities commence:

- Window Joining Plan (i.e., welding, brazing)
- Quality Plan (including test plan /schedule)

- Window Joining Processes and Qualification Tests
- Dimensional Drawings
- Qualification test plan

The following documents need to be reviewed, approved, and accepted before manufacturing commences:

- Type of test report

On completion of manufacturing, two sets of the following documents should be supplied as data books:

- Signed-off Quality Plan
- Window Joining Processes and Worker Qualifications
- Radiographic Reports (if applicable)
- Production Proof Sample Reports (if applicable)
- Material Certificates, traceable to assemblies, in accordance with EN 10204 2.2 ,3.1 or 3.2 (if applicable or equivalent) (https://www.bssa.org.uk/topics.php?article=195)
- Dimensional drawings identifying attachments (the locations and dimensions of joint, the dimensions of Beryllium and SS)
- Type of test report (s)
- Dimensional Inspection Report

As a general statement, the details of the services to be provided by the contractor will be defined in the task order technical specification document.
The technical specifications will be defined specifically for each diagnostic depending on the actual requirement and will include a technical scope, the organization of the task and a description of the deliverables.

Duration of services

The contract will be carried out over an initial period of four (4) years with an option to extend the services for a further two (2) years. The contract is scheduled to come into force in October 2019.

Procurement Time table

A tentative time table is outlined as follows:-

Call for Nomination	1st week April 2019
Pre-Qual. Submissions	2nd week May 2019
Pre-Qual. evaluation	2nd week June 2019
Call for Tender	end July 2019
Evaluation	2nd week August 2019
Clarification questions related to this Call for Tender / Report	end September 2019
Estimated Contract Award Date:	mid October 2019

Estimated Contract Start Date:	Early November 2019

Experience

Companies experienced in providing a significant contribution in handling, manufacturing and testing Beryllium windows These companies shall have proven experience in the following areas:

- Experience on Beryllium material treatment-cutting and welding
- Experience in manufacture of Beryllium window assemblies is mandatory, knowledge and experience in fusion and/or nuclear design industry is highly desirable.
- Project handling of similar manufactured systems
- Basic vacuum, mechanical and thermal analysis
- Design and analysis of Nuclear systems (desirable), and application of codes and standards to Beryllium windows designs (mandatory)
- Knowledge of the ITER X-ray diagnostics (desirable)
- Demonstration of manufacture of technically sound similar commercial products.

Experience in relevant physics experiments will be considered as a major asset for the contractor's selection.

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. 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 cannot be modified later without the approval of the ITER Organization.

Legal entities belonging to the same legal grouping are allowed to participate separately if they are able to demonstrate independent technical and financial capacities. Bidders's (individual or consortium) must comply with the selection criteria. IO reserves the right to disregard duplicated references and may exclude such legal entities form the tender procedure.