

# Technical Summary

## Qualification and manufacturing of ITER diagnostic windows.

Ref: IO/21/CFT/70000771/LLU

### 1. Purpose

This Framework contract has three main objectives, which are:

1. Develop and qualify the Anti-Reflective Coating for the different windows
2. Pre-Qualification R&D
3. Qualification of window assemblies
  - a. Development of techniques and equipment for the qualification
  - b. Testing of components to demonstrate compliance with nuclear safety
4. Final Manufacturing of Diagnostic windows
  - a. Procurement of blank disks
  - b. Coating of disks
  - c. Machining of metallic parts (ITER grade SS will be free-issued)
  - d. Manufacturing and FAT of windows

### 2. Background

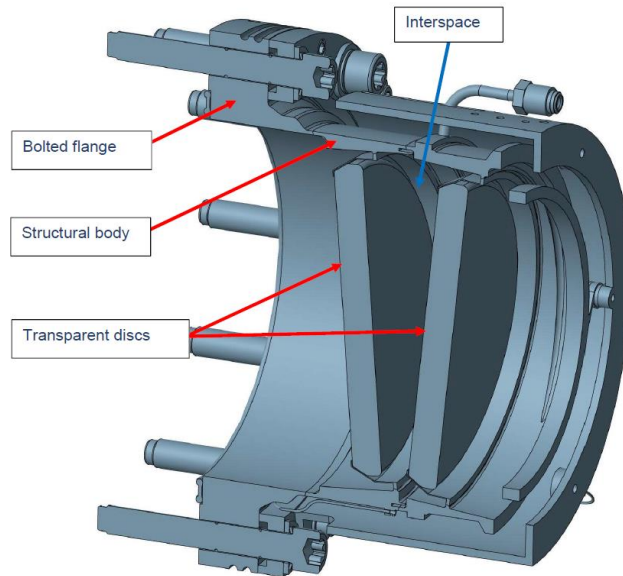
The purpose of this document is to provide the technical summary for a framework contract for the qualification and manufacturing of Diagnostic's windows.

The Safety function achieved by the diagnostic window assemblies is the confinement of toxic and radioactive products inside the vacuum vessel and attached vacuum extensions.

Each window assemblies is composed by:

- A structural body provided with a bolted flange, for the mechanical and vacuum tight attachment on a vacuum extension also called “mating flange”.
- Two transparent discs assembled into metallic ferrules by aluminium diffusion bonding.
- An interspace volume between both discs, whose pressure is permanently monitored by the Service Vacuum System (SVS).

An example of a Fused Silica window can be seen in Figure 1.



*Figure 1: Section of Window Assembly*

The design of the bolted flanges is similar to the one of the ITER standard vacuum flange. The size of the bolted flange is tailored to the clear aperture.

- DN 100 mm → Ø70, Ø82 mm clear aperture,
- DN 150 mm → Ø110, Ø130 mm clear aperture,
- DN 200 or 250 mm → Ø160 mm clear aperture.

### 3. Scope of Work

The scope of work covered in this planned Contract is to:

1. Development and Qualification of AR coating
  - a. Development of AR coating for Fused Silica, Quartz, Sapphire and ZnSe
  - b. Qualification of AR coating against bonding of windows, 500°C for 4 hours (300°C and 2 hours for ZnSe)
  - c. Qualification of AR coating against environmental conditions such as thermal cycling and LOCA events (validation against radiation damage will be assessed by IO)
2. Pre-Qualification R&D
  - a. Optimization of manufacturing process of window assemblies
  - b. Standard and Aggressive aging of window assemblies
  - c. Push-out tests to assess the effect of the optimizations and aging mechanisms on the windows
3. Qualification of window assemblies
  - a. Q&A compliance with nuclear safety standards
  - b. Development of manufacturing procedures
  - c. Aging of window assemblies (thermal aging, vibration testing, overpressure and fire events)
  - d. Helium leak test after aging of samples
4. Final Manufacturing of Diagnostic windows (ITER grade SS will be free-issued by IO)
  - a. Manufacturing and FAT of Quartz windows

- b. Manufacturing and FAT of Sapphire windows
- c. Manufacturing and FAT of ZnSe windows
- d. Manufacturing and FAT of Fused Silica windows

As a general statement, the details of the task to be provided by the future Contractor will be defined in the Task Order Technical Specification

These Technical Specifications will be defined specifically for each Task Order depending on the actual requirement and will include a technical scope, the organization of the Task Order within IO and a description of the deliverables.

## **4. Work Description**

### **4.1 AR Coating development**

Several diagnostic systems incorporating window assemblies plan to make use of anti-reflection (AR) coatings to improve the transmission performances of the optics. Organic AR coatings are not allowed.

The supplier shall develop and qualify for ITER environment the following AR coating systems:

1. Four coating systems for Fused Silica windows
2. Two coating systems for Sapphire windows
3. Two coating systems for ZnSe windows

Each one of these coating systems will be optimized for a given wavelength.

Furthermore the future contractor shall qualify the coating against ITER's environment, demonstrating that the coating does not impact the structural integrity of the disk, is compatible with water leak events and it does not suffer from delamination after a certain number of thermal cycles.

### **4.2 Pre-Qualification R&D**

During the R&D carried out for the development of ITER's diagnostics windows it was discovered that minor optimizations in the manufacturing process could have a large and positive impact on the resistance of the windows against aging mechanisms.

The future contractor shall manufacture mock-up windows as per the current design and with minor modifications, measure key dimensions on the windows and expose them against aging mechanisms (mainly thermal cycles) in order to provide a robust design and reduce the risk of failure during the qualification program.

### **4.3 Qualification of Window assemblies**

The qualification is aimed at proving that the window assemblies will ensure their safety function in all the normal, incidental or accidental situations for which their use is required.

The Safety function achieved by the diagnostic window assemblies is the confinement of toxic and radioactive products inside the vacuum vessel and attached vacuum extensions

The qualification of the window assemblies is tailored to the different natures of the components and assemblies forming part of a whole window assembly. A general overview of the qualification strategy can be seen in Figure 2.

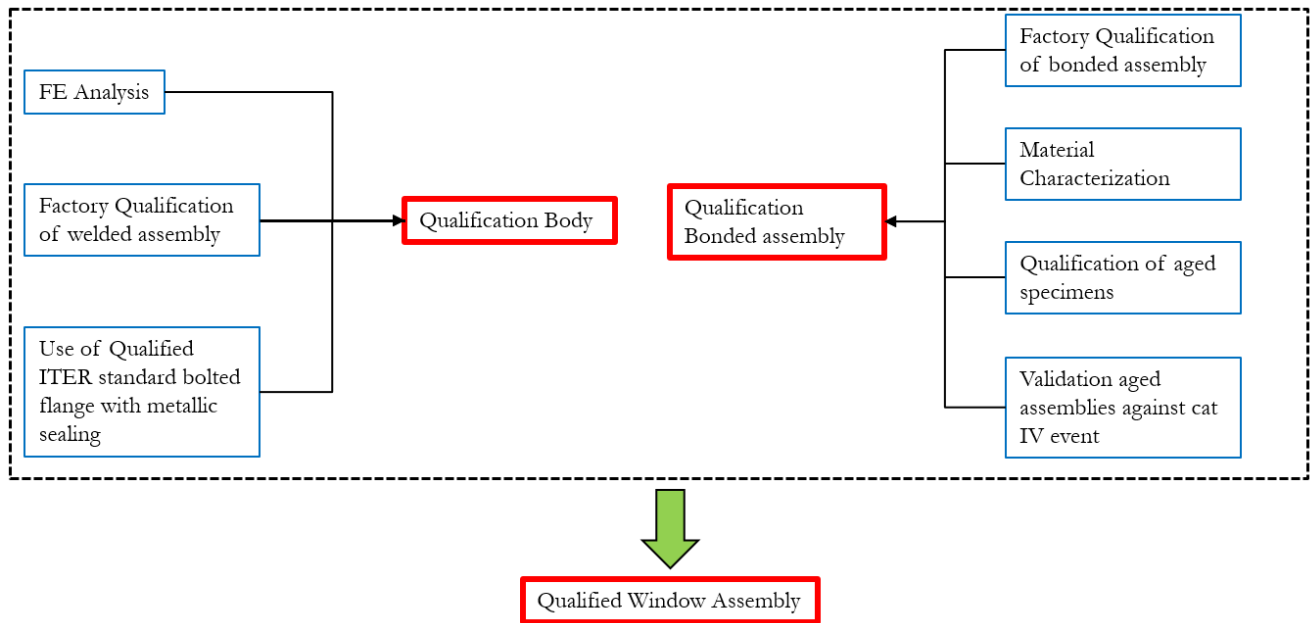


Figure 2: Overall Qualification strategy for the Window assembly

The future contractor shall focus on the qualification of the bonded window assembly and not the metallic body, which will be qualified by IO.

The main aging mechanisms to be considered for these qualifications are:

- Thermal cycling and thermal aging (long exposure to high temperature)
- Vibration tests
- Chemical aging

While the validation against Cat IV events can be summarized as fire events and quick increases of pressure (up to 4 bar)

## 4.4 Final manufacturing of diagnostics' Windows

An order of magnitude for the total number of windows to be provided to ITER can be seen in Table 1. The exact number of windows to be manufactured will be defined within the task orders.

Table 1: Expected Number of Windows

Material	# of windows
Fused Silica	60
Quartz	25
Sapphire	25
ZnSe	4

The future contractor shall manufacture and deliver all these windows following the same manufacturing process as per the qualified windows and with all the documentation required as per a Safety Important Component.

## 5. Required Experience and Facilities

The candidate shall have facilities and experience such that they can perform:

- AR coating
- Manufacture of test rigs
- Leak tightness measurements
- Mechanical testing of components
- High precision manufacturing
- Diffusion bonding of ceramics to metal

## 6. Duration of Service

The contract will be carried out over an initial firm period of four (5) years and an optional period of two (2) years. The contract is scheduled to come into force in end of 2022.

## 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. 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.

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. Bidders' (individual or consortium) must comply with the selection criteria. IO reserves the right to disregard duplicated references and may exclude such legal entities from the tender procedure.

## 8. Tentative schedule

The indicative Call for Tender milestones are:

- |   |                               |
|---|-------------------------------|
| • Call for Nomination                     | end of 2021/beginning of 2022 |
| • Issuing of Prequalification Invitations | Mid of February 2022          |
| • Issuing of Call for Tender              | End of April, 2022            |
| • Submission of Tenders                   | End of May 2022               |
| • Award of Contract                       | End of August 2022            |

## 9. Reference

Further information on the ITER Organization procurement can be found at:

<http://www.iter.org/org/team/adm/proc>