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Final Design and Procurement of Divertor Operational Instrumentation Remote Handling Connectors

Call for Nomination (CFN)

Summary of the Technical Specification

1 Purpose

This Call for Nomination is the first step for the eventual Call for Tender on the development of the final design, the manufacturing, the testing and the delivery of the Divertor Operational Instrumentation Remote Handling Connectors (DOI RHCs). The DOI RHCs are components located inside the Vacuum Vessel of the ITER machine having the function to allow the connection and disconnection of DOI cables during the maintenance of the instrumented Divertor Cassettes by Remote Handling tools.

2 Background

The ITER Project aims to demonstrate the scientific and technological feasibility of fusion power for peaceful purposes and to gain the knowledge necessary for the design of the next-stage DEMOnstration fusion power plant.

ITER is a joint international research and development project for which the construction activities have started. The seven Members of the ITER Project form the seven Domestic Agencies (DA) and include: European Atomic Energy Community (EUDA), Japan (JADA), People's Republic of China (CNDA), Republic of India (INDA), Republic of Korea (KODA), Russian Federation (RFDA) and United States of America (USDA).

ITER is being constructed at St Paul Les Durance, in southern France, where the ITER Organization (IO) has its headquarters.

ITER is identified in France as a Nuclear Facility according to the INB Order of 7th February 2012 ("Installation Nucléaire de Base").

ITER is based on the "tokamak" concept of magnetic confinement, in which the plasma is contained in a doughnut-shaped Vacuum Vessel (VV). The fuel — a mixture of deuterium and tritium, two isotopes of hydrogen — is heated to temperatures in excess of 150 million °C, forming a hot plasma. Strong magnetic fields are used to keep the plasma away from the walls; these are produced by superconducting coils surrounding the VV, and by an electrical current driven through the plasma.

The VV is a hermetically-sealed steel container that houses the fusion reaction and acts as a first safety confinement barrier. It operates at 100°C and can be baked up to 200°C to guarantee a clean and ultra-high vacuum environment needed to operate the plasma.

Internal components such as the Blanket, Divertor and First Plasma Protection Components are located inside the VV. They are equipped with Operational Instrumentation for measurement of thermal, mechanical and electromagnetic parameters during operation. These measurements are performed by two types of sensors:

- Optical sensors to measure strains, displacements and temperatures;
- Electrical sensors like Rogowski coils, magnetic flux loops, thermocouples.

Among 54 Divertor Cassettes, three of them (#15, #33, #51) are installed in three VV Sectors #3, #6, #9 and are equipped with DOI (see Figure 1).

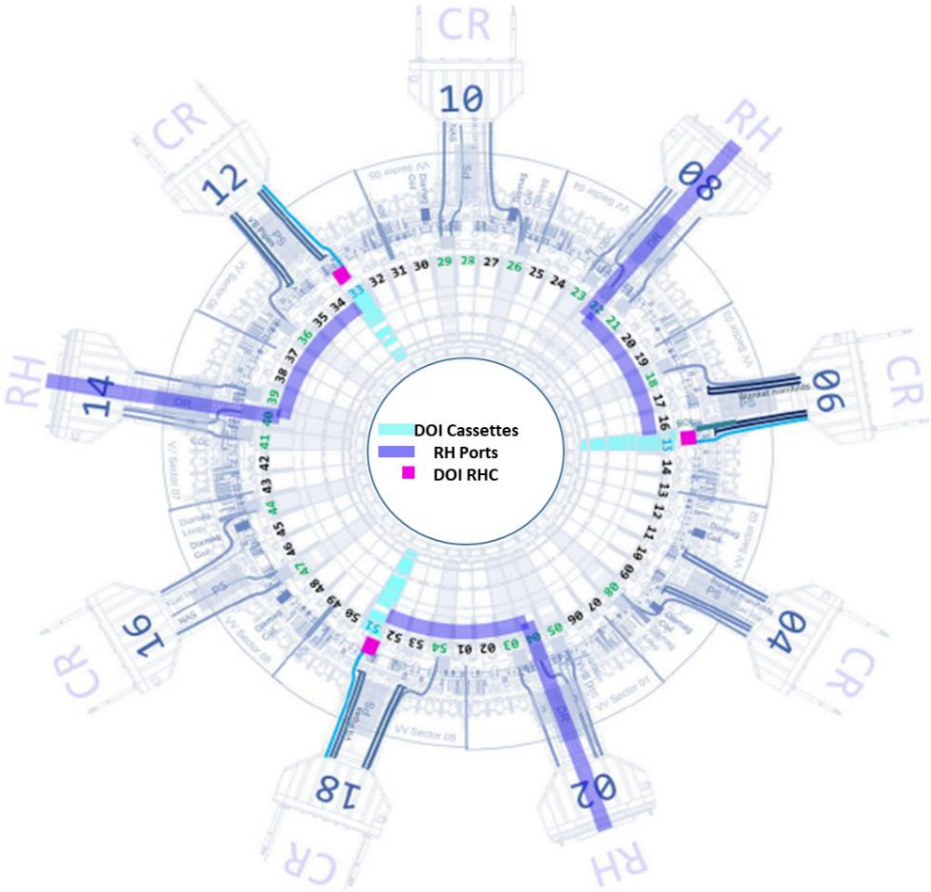

Figure 1 – Location of the 3 Divertor Cassettes equipped with DOI and with RHC on the tokamak layout.

The Divertor Cassettes will be handled by RH during installation and removal sequence.

It is planned to replace the Divertor cassettes a few times during the ITER operation. Unexpected maintenance could also occur, so that the connectors shall be designed to be used typically 10 times.

The DOI RHCs, as components located inside the VV of ITER machine, will be subjected to heat, inertial, electromagnetic and radiation loads (see Table 1 for indicative loads).

Table 1 – DOI Remote Handling Connector operating conditions

Configuration	Scenario	Temperature	Pressure	Heat Load	Nuclear Heat Load
Normal operations	Maintenance	20°C ± 5°C	1 atm	No	No
	Baking	350°C	< 10^{-5} Pa	No	No
	Start-up (D-D plasma)	100°C	< 10^{-5} Pa	~0.20 MW/m^2	No
	Pulse (D-T plasma)	350°C	< 10^{-5} Pa	~0.20 MW/m^2	Yes

The DOI RHCs connector shall comply with the following classifications as defined by the ITER project:

- Non Protection Important Component
- Quality Class 3
- Vacuum Quality Class 3
- Remote Handling Class 1

The above classification impose additional requirements for:

- Vacuum design compatibility;
- Electromagnetic compatibility;
- Compliance with Divertor Remote Handling tools.

3 Scope

3.1 Scope of work

The scope of the contract is broken down into five phases, split in tasks, as follow:

- **Phase I: Final Design Development**
  - Task 1.1: Development of the final design of the DOI RHCs starting from a preliminary design issued by ITER
  - Task 1.2: Prototype manufacturing and design qualification
  - Task 1.3: Technical support during Final Design Review
- **Phase II: Pre-Manufacturing engineering activities**
  - Task 2.1: Manufacturing Design development
  - Task 2.2: Manufacturing Readiness Review
- **Phase III: Hardware procurement**
  - Task 3.1: Procurement of raw materials
  - Task 3.2: Procurement of Components Off The Shelf (COTS) items necessary for manufacturing and assembly of the DOI RHCs
- **Phase IV: Manufacturing**
  - Task 4.1: Serial production of the DOI RHCs (3 + 1 spare)
  - Task 4.2: Factory Acceptance Test
- **Phase V: Delivery to IO site**
  - Task 5.1: Delivery to ITER site.
    - Batch 1: Delivery of the four DOI RHCs sub-assemblies (VV sockets) for ITER Assembly Phase I

- Batch 2: Delivery of the remaining four sub-assemblies of the DOI RHCs for ITER Assembly Phase II

The Contractor shall demonstrate its capability to reproduce the design of the DOI RH Connector delivered and tested during the previous R&D phase and for which IO has confirmed positive results.

Alternatively, in the case where the Contractor proposes a design significantly changed compared to that already qualified, the design shall be validated on sample products by the Supplier.

3.2 Scope of supply

Each DOI RHC assembly comprises at least the following components:

- VV Socket – the part of the connector permanently mounted on the inner wall of the VV;
- Divertor Cassette Socket – the part of the connector mounted of the Divertor Cassette body;
- Extending mechanism which allows connection and disconnection of DOI cables;
- Pins inserts for electrical and optical fiber cables, one DOI RHC shall accommodate ~100 optical fiber and ~80 electrical pin contacts;
- Guiding and motion tools, which allow manipulation of the DOI RHC by the Divertor Remote Handling System.

The DOI RHCs shall be pre-assembled with the optical fiber and Mineral Insulated (MI) cables at the Contractor's premises. The purchase of the cables is outside scope of the Contract. Optical fiber and MI cables will be supplied by IO as free-issued items.

In the frame of this contract, the following items shall be delivered to the ITER site:

Batch #	**Scope of delivery**	**Quantity**	**Due date**
Batch #1	DOI RHC sub-assemblies #1 - Vacuum Vessel sockets	4 (3 for installation + 1 spare)	By Assembly Phase I – January 2023
Batch #2	DOI RHC sub-assemblies #2 - Divertor Cassette sockets with extending mechanism	4 (3 for installation + 1 spare)	By Assembly Phase II – December 2025

Installation of the DOI RHC at the ITER site is out of the scope of this contract.

4 Experience Requirements

The ITER Organization is looking for Candidates with demonstrated experience in developing and manufacturing the remote handling connectors for optical fiber and electrical cables compatible for application in high vacuum.

The Candidates must prove its ability to provide in an organised way the competences specified in the Scope of Work above.

The Candidates should also have experience in working in a clean area, which shall only be operated by trained personnel to approved procedures.

The Candidates 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.

The detailed Selection Criteria will be disclosed to the nominated Candidates during Pre-Qualification stage.

5 Candidature

Participation is open to any legal entity either an individual or a group (consortium) which is established in an ITER Member State. 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 IO.

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 to be disclosed at the Pre-Qualification stage.

6 Timetable for the Tender Process

The tentative schedule for this tender process is as follows:

Call for Nomination	February 2021
Invitation for Pre-Qualification	March 2021
Pre-qualification submission	April 2021
Invitation for Call for Tender	May 2021
Tender Submission	July 2021
Contract signature	October 2021