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Technical Specifications (In-Cash Procurement)

Thermal hydraulics design of Diagnostic Port Plugs components

CFE for:

This document describes technical needs of for specialist work relating to the cooling design and engineering analyses aimed to customize the generic DFWs (Diagnostic First Walls) and DSMs (Diagnostic Shielding Modules) to the configurations derived from the integration of diagnostic Port Plugs.

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1 Introduction

Diagnostics are a critical part of the operation of ITER. They provide the means to observe, control and sustain the plasma performance over long timescales. ITER will operate with a plasma current in the region of 15 MA and toroidal fields of 5 T. The pulse lengths will be in the region of 500 s typically and will extend up to several thousand seconds during more advanced operation. A key objective of this device is Q=10 operation. This means that a typical fusion power of 500 MW will be provided for 50 MW input.

Many diagnostics, as well as systems line DMS (Disruption Mitigation System) and GDC (Glow Discharge Cleaning), shall be integrated into ports and their infrastructure, which hold these diagnostics in place. Figure gives an overview of the typical integrated diagnostic port in ITER.

The Diagnostic Port Plugs serve as common platforms for a variety of diagnostics systems. Diagnostic equipment and shielding are integrated together into cassettes known as "Diagnostic Shielding Modules" (DSM) which, in turn, are attached to the Port Plug structure that is part of the ITER VV confinement barrier. Refer to Figures 1 and 2 for the details of a typical Equatorial Port Plug Assembly and Upper Port Plug Assemblies respectively.

There are 25 diagnostic ports in ITER, and one more port, Equatorial Port #2, is also hosting diagnostic systems. Each equatorial and upper diagnostic port consist of the port plug structure with three integrated Diagnostic Shield Modules and Diagnostic First Walls (see Fig. 2), Interspace Support Structure and Port Cell Support Structure.

Figure 1: Example of diagnostics inside integrated port (top) and integrated port interspace structure (bottom).

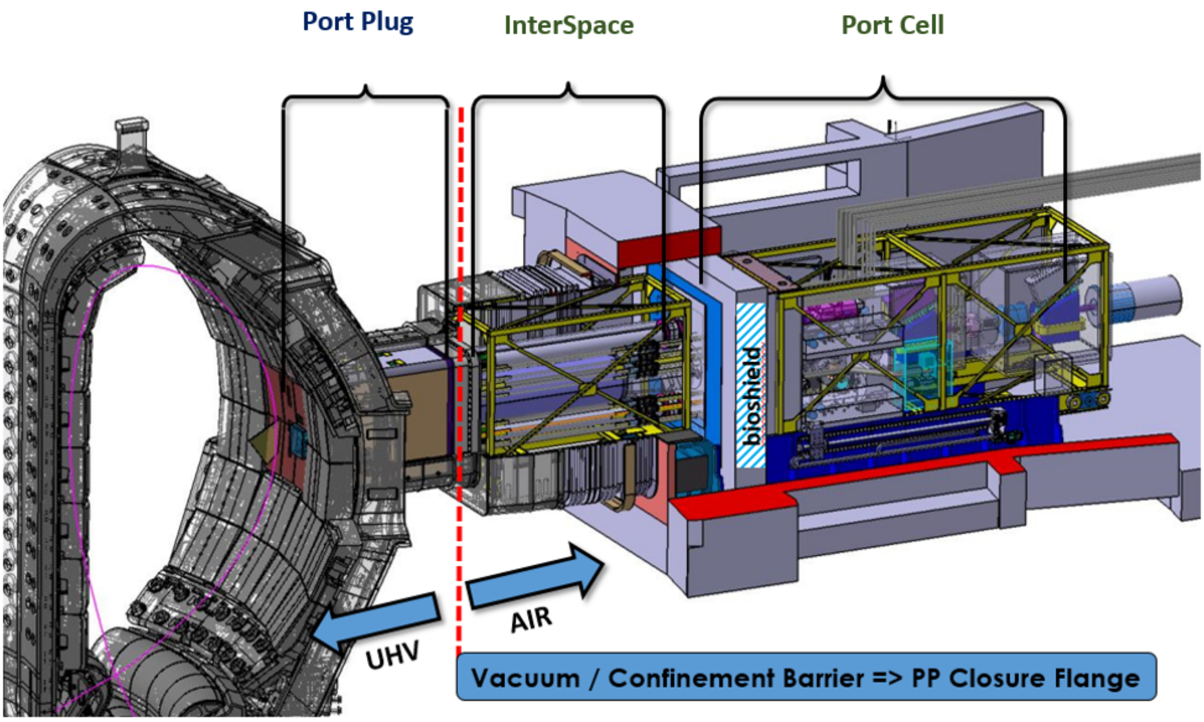

Figure 1: Example of diagnostics inside integrated port (top) and integrated port interspace structure (bottom).

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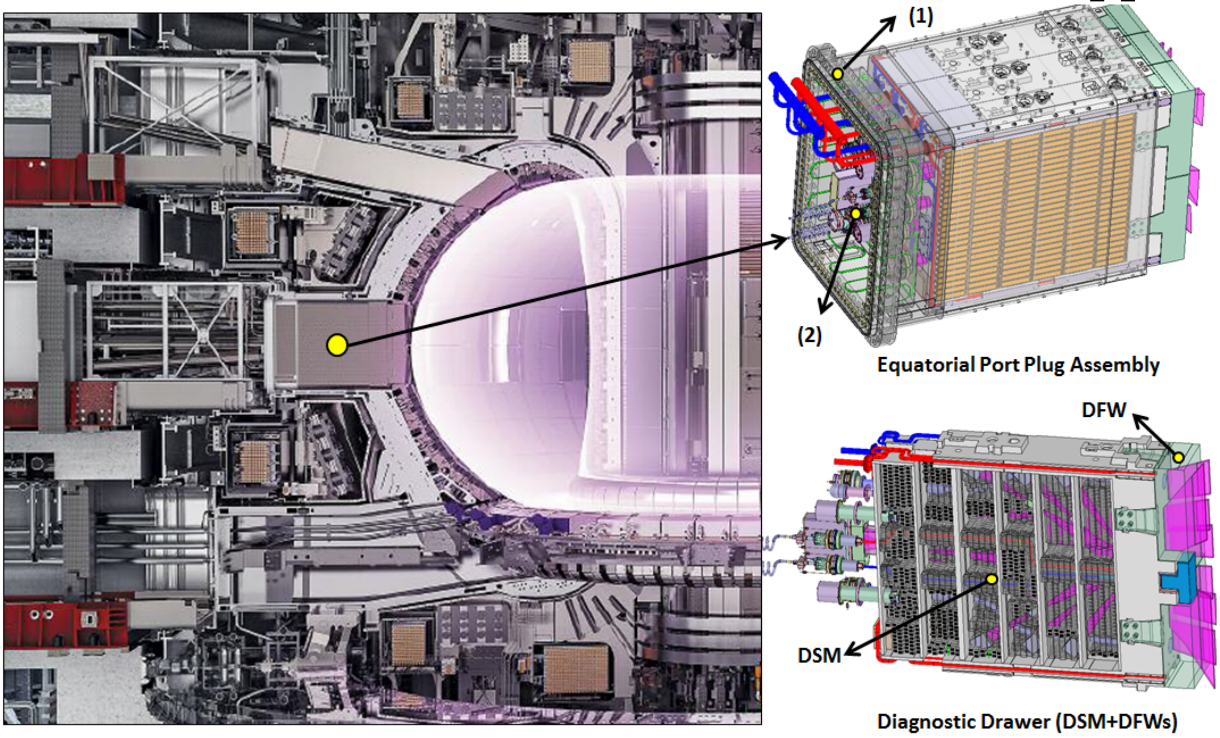

Figure 2: Example of in-vacuum port assembly (DSM/DFW) for equatorial ports.

2 Purpose

This document describes technical needs of for specialist work relating to the cooling design and engineering analyses aimed to customize the generic DFWs (Diagnostic First Walls) and DSMs (Diagnostic Shielding Modules) to the configurations derived from the integration of diagnostic Port Plugs.

3 Scope

In ITER, many diagnostics are inserted through port plug to diagnose the plasma temperature, density, radiative properties, first-wall resilience, etc. The diagnostic instruments and components are sensitive to high heat load, neutron damage, coating by dust and metallic vapour deposition, etc. On each port a DFW is installed to protect diagnostic instrumentation and components. The DFW is an assembly of FW and shielding elements that attaches to the diagnostic port plug. On the other hand, the Port Plug integration comprises the design of the diagnostic containers, the DSMs. Several activities covering from the design of a DSM infrastructure itself to the detailed integration of shielding, diagnostic components and common services (cooling, electrical network…) have to be developed jointly in order to achieve an integrated design able to meet design requirements. A key aspect of this integration work is the thermal hydraulic performance of the DSM.

The scope of this activity is on one side, to develop customized design configurations of six DFWs belonging to upper and equatorial diagnostic Port Plugs. On the other side, it also comprises the hydraulics design and assessment of DSMs for one of the IO equatorial ports (EQ#17). The work comprises integration and design of the cooling scheme compatible with the techniques and methods assessed for the generic component and the analyses required for assessing the design feasibility and thermal performance justification of DSMs and DFWs. Finally, development and integration of DSMs and DFWs in a customizable hydraulic dynamic model of the whole Port Plug is also part of the scope. This model will permit the correct hydraulic balancing of the cooling network of the whole Port Plug.

4 Definitions

DFW: Diagnostics First Wall

DR: Design Review

DSM: Diagnostics Shielding Module

EDFW: Equatorial Diagnostics First Wall

FEA: Finite Element Analysis

IO: ITER Organization

IO-TRO: ITER Organization technical Responsible Officer

PP: Port Plug

SLS: System Load Specification

For a complete list of ITER abbreviations see: ITER Abbreviations (ITER_D_2MU6W5).

5 References

The following reference documents compile the design information of the current status of the generic DFW designs.

[1] ITER_D_2D7VZA - 04 Manufacturing Oriented DFW Mechanical Design Overview – DFW-DSM interfaces

[2] ITER_D_2DGRMJ - 05a System Load Specification

[3] ITER_D_2DGWH6 - 05b Supporting Analyses

[4] ITER_D_UZU8CU - 55.QC - Thermal hydraulics analyses DSM-1 (FINAL VERSION)

[5] Analyses Check Lists (RT2NKT)

6 Estimated Duration

The duration shall be for 12 months from the starting date of the task order. Services shall be provided on-site.

7 Work Description

The work involves the components and related tasks:

- Thermal design and integration of the cooling scheme for a DFW compatible with the manufacturing approach followed in the design of the generic DFW. Evaluation of thermal performance (thermal hydraulic coupled analysis) of the designed item. This activity is extended to 6 DFWS belonging to upper and equatorial ports.
- Thermal design and integration of the cooling scheme for 3 DSMs compatible with the manufacturing approach followed in the design of the generic DSM (thermal hydraulic coupled analysis). Evaluation of thermal performance of the designed item. This activity is extended to 3 DSMs belonging to EQ#17.
- Customizable (macro, script…) hydraulic dynamic model of the whole Port Plug including DSMs, DFWs, diagnostics and PP structure cooling circuits. These elements can be treated as blocks for which flow and pressure drop characteristics are known. This model will permit the correct hydraulic balancing of the cooling network of the whole Port Plug and the simulation of the different hydraulic conditions. The simulation of specific conditions is not part of the scope, just the development of the dynamic model.

All analyses report will follow the templates provided by the IO either for thermal-hydraulics and structural analyses.

Along with the report, the Acceptance Data Package for each deliverable (ADP) shall contain the analysis dbs and input files. Technical checks and reviews records of the analyses as per ITER quality procedures [5] and made by SQEP other than those who took part in the original analysis will be performed internally in IO.

7.1 Contractor's Responsibilities

In order to successfully perform the tasks in these Technical Specifications, the Contractor shall:

- Strictly implement the IO procedures, instructions and use templates.
- Provide experienced and trained resources to perform the tasks, profiles must be accredited by CVs and background summary.
- Contractor's personnel shall possess the qualifications, professional competence and experience to carry out services in accordance with IO rules and procedures.
- Contractor's personnel shall be bound by the rules and regulations governing the IO ethics, safety and security IO rules.

7.2 IO's Responsibilities

The IO shall:

- Nominate the Responsible Officer to manage the Contract.
- Manage the on-site day to day work performed by the contractor consistently to the scope and deliverables of this Task Order.

8 List of Deliverables and due dates

The main deliverables are provided in the table below.

D #	Description	Due Dates
D01	Cooling design (CAD models) and Supporting analyses results justifying the performance of DSM#01 – EQ#17. Thermal hydraulics report using template provided by IO.	T0 + 1 months
D02	Cooling design (CAD models) and Supporting analyses results justifying the performance of DSM#02 – EQ#17. Thermal hydraulics report using template provided by IO.	T0 + 2 months
D03	Cooling design (CAD models) and Supporting analyses results justifying the performance of DSM#03 – EQ#17. Thermal hydraulics report using template provided by IO.	T0 + 3 months
D04	Cooling design (CAD models) and Supporting analyses results justifying the performance of DFW#1. Thermal hydraulics report using template provided by IO.	T0 + 4 months
D05	Cooling design (CAD models) and Supporting analyses results justifying the performance of DFW#2. Thermal hydraulics report using template provided by IO.	T0 + 5 months

D06	Cooling design (CAD models) and Supporting analyses results justifying the performance of DFW#3. Thermal hydraulics report using template provided by IO.	T0 + 6 months
D07	Cooling design (CAD models) and Supporting analyses results justifying the performance of DFW#4. Thermal hydraulics report using template provided by IO.	T0 + 7 months
D08	Cooling design (CAD models) and Supporting analyses results justifying the performance of DFW#5. Thermal hydraulics report using template provided by IO.	T0 + 8 months
D09	Cooling design (CAD models) and Supporting analyses results justifying the performance of DFW#6. Thermal hydraulics report using template provided by IO.	T0 + 9 months
D10	Advance progress report describing the customizable (macro, script…) hydraulic dynamic model of the whole Port Plug including DSMs, DFWs, diagnostics and PP structure cooling circuits.	T0 + 10 months
D11	Advance progress report describing the customizable (macro, script…) hydraulic dynamic model of the whole Port Plug including DSMs, DFWs, diagnostics and PP structure cooling circuits.	T0 + 11 months
D12	Final report describing the customizable (macro, script…) hydraulic dynamic model of the whole Port Plug including DSMs, DFWs, diagnostics and PP structure cooling circuits.	T0 + 12 months

9 Acceptance Criteria

The deliverables will be posted in the Contractor's dedicated folder in IDM, and the acceptance by the IO will be recorded by their approval by the designated IO TRO. These criteria shall be the basis of acceptance by IO following the successful completion of the services. These will be in the form of reports as indicated in section 8, Table of deliverables.

10 Specific requirements and conditions

- Experience in Mechanical Engineering;
- Advanced capabilities on using FE codes (submodelling, fields interpolation between physics) with emphasis in ANSYS Code (classic) and associated programming tools (APDL…);
- Advanced capabilities on using CFD codes (CFX, Fluent, Open-Foam).
- Experience in the use of clusters (High Performance Computing Systems) for extensive CFD calculations.
- Extensive experience of programing in Phyton.
- Extensive experience using postprocessing tools like Paraview.
- Understanding of schematics and 3D models and use of 3D modellers aimed to FEA (Spaceclaim, ANSYS prep…);
- Knowledge of ITER requirements and guidelines;
- Excellent skills in writing technical reports in English Language;

11 Work Monitoring / Meeting Schedule

Work is monitored through reports on deliverables (see List of Deliverables section) and at monthly project meetings.

12 Delivery time breakdown

See Section 7 "List Deliverables section and due dates".

13 Quality Assurance (QA) requirements

The organisation conducting these activities should have an ITER approved QA Program or an ISO 9001 accredited quality system.

The general requirements are detailed in ITER Procurement Quality Requirements (ITER_D_22MFG4).

Prior to commencement of the task, a Quality Plan must be submitted for IO approval giving evidence of the above and describing the organisation for this task; the skill of workers involved in the study; any anticipated sub-contractors; and giving details of who will be the independent checker of the activities (see Procurement Requirements for Producing a Quality Plan (ITER_D_22MFMW)).

Documentation developed as the result of this task shall be retained by the performer of the task or the DA organization for a minimum of 5 years and then may be discarded at the direction of the IO. The use of computer software to perform a safety basis task activity such as analysis and/or modelling, etc. shall be reviewed and approved by the IO prior to its use, in accordance with Quality Assurance for ITER Safety Codes (ITER_D_258LKL).

14 CAD Design Requirements (if applicable)

For the contracts where CAD design tasks are involved, the following shall apply:

The Supplier shall provide a Design Plan to be approved by the IO. Such plan shall identify all design activities and design deliverables to be provided by the Contractor as part of the contract.

The Supplier shall ensure that all designs, CAD data and drawings delivered to IO comply with the Procedure for the Usage of the ITER CAD Manual (2F6FTX), and with the Procedure for the Management of CAD Work & CAD Data (Models and Drawings 2DWU2M).

The reference scheme is for the Supplier to work in a fully synchronous manner on the ITER CAD platform (see detailed information about synchronous collaboration in the ITER GNJX6A - Specification for CAD data production in ITER Contracts.). This implies the usage of the CAD software versions as indicated in CAD Manual 07 - CAD Fact Sheet (249WUL) and the connection to one of the ITER project CAD data-bases. Any deviation against this requirement shall be defined in a Design Collaboration Implementation Form (DCIF) prepared and approved by DO and included in the call-for-tender package. Any cost or labour resulting from a deviation or non-conformance of the Supplier with regards to the CAD collaboration requirement shall be incurred by the Supplier.

15 Safety requirements

ITER is a Nuclear Facility identified in France by the number-INB-174 ("Installation Nucléaire de Base").

For Protection Important Components and in particular Safety Important Class components (SIC), the French Nuclear Regulation must be observed, in application of the Article 14 of the ITER Agreement.

In such case the Suppliers and Subcontractors must be informed that:

- The Order 7th February 2012 applies to all the components important for the protection (PIC) and the activities important for the protection (PIA).
- The compliance with the INB-order must be demonstrated in the chain of external contractors.
- In application of article II.2.5.4 of the Order 7th February 2012, contracted activities for supervision purposes are also subject to a supervision done by the Nuclear Operator.

For the Protection Important Components, structures and systems of the nuclear facility, and Protection Important Activities the contractor shall ensure that a specific management system is implemented for his own activities and for the activities done by any Supplier and Subcontractor following the requirements of the Order 7th February 2012 (PRELIMINARY ANALYSIS OF THE IMPACT OF THE INB ORDER - 7TH FEBRUARY 2012 (AW6JSB v1.0)).