IDM UID
2KL73P

VERSION CREATED ON / VERSION / STATUS
28 Nov 2019 / 1.0 / Approved

EXTERNAL REFERENCE / VERSION

Technical Specifications (In-Cash Procurement)

Technical Specifications for Thermal Shield flow and thermal analysis update

Requirements for performing the update of the flow and thermal analyses of the ITER Thermal Shield.

Table of Contents

1 Purpose

The purpose of this contract is to perform an updated flow and thermal analysis of the ITER Thermal Shield considering the last design features as well as the last interfaces with the surrounding components.

2 Scope

ITER is a large experimental Tokamak device being built to research fusion power. The Thermal Shield (TS from now) is a critical system that aims to provide an appropriate thermal barrier to the superconducting magnets, avoiding heat exchange by thermal radiation between magnets and the surrounding warm surfaces. In order to achieve its function, the TS minimises its thermal radiation heat exchange with magnets and warm components by keeping a very low surface emissivity (less than 0.05) and cooling the panels with helium gas at 80K.

The TS is cooled by DN8 cooling tubes welded to every panel and fed by a piping system connected to the cryoplant (Thermal Shield Manifold - TSM), whereas the low emissivity is fulfilled by silver coating all the stainless steel panels.

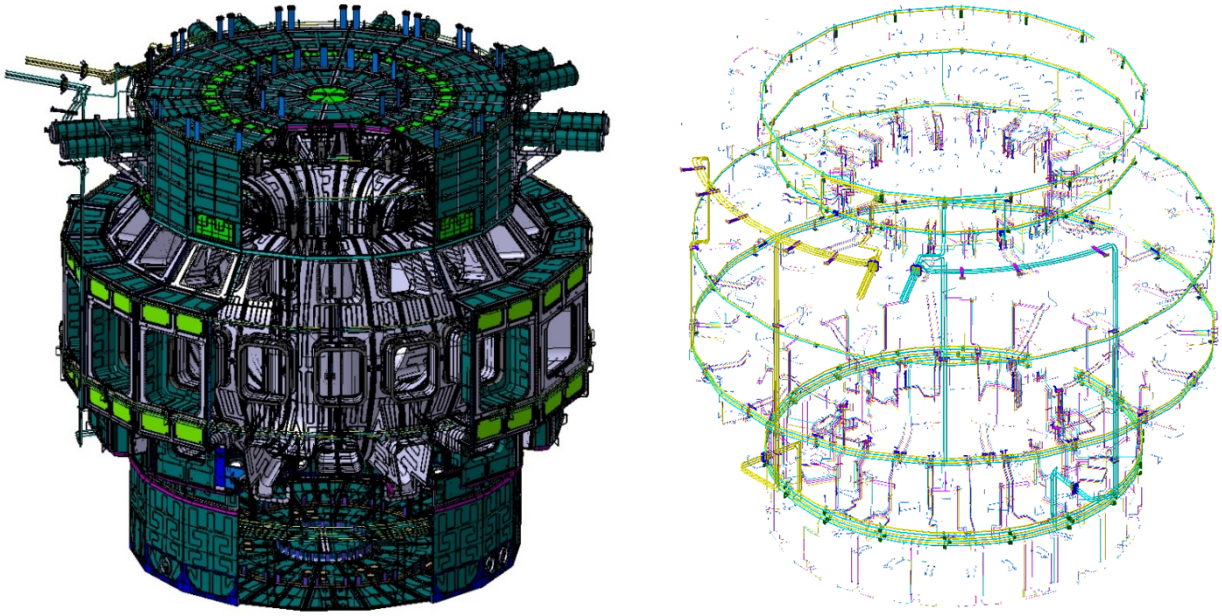

Figure 2-1: ITER Thermal Shield (left) and its cooling system TSM (right)

The scope of the work to be done by the Contractor and specified with this document includes:

1. An update of the flow network analysis of the full cooling system including the TSM and the cooling tubes welded to the panels. Thermo-hydraulic considerations may be required considering temperature rise and change of coolant properties due to heat input to the panels.
2. An update of the thermal analysis based on the updated flow analysis (from previously mentioned scope) and the heat input provided by IO, getting as a result a precise temperature map of the full Thermal Shield and the heat exchanged with the Magnet system.

3 Definitions

Here is the main terminology and acronyms used in this document:

FE	Finite Element
IO	ITER Organization

KODA	Korean Domestic Agency
KoM	Kick off Meeting
IO task TRO	IO task Technical Responsible Officer
TS	Thermal Shield
TSM	Thermal Shield Manifold

4 References

[1] System Design Description (DDD) 27 Thermal Shield; ITER_D_355MXB

[2] Flow analysis of the TS Manifold; ITER_D_P794KD

[3] Thermal Analysis of the TS; ITER_D_6TEDT2

[4] Memorandum about preliminary results of the updated heat load input estimation into the Thermal Shield; ITER_D_WWGB38

[5] Integrated simulation 80K TS; ITER_D_YC382Z

[6] ITER Procurement Quality Requirements; ITER_D_22MFG4

[7] Requirements for Producing a Quality Plan; ITER_D_22MFMW

5 Estimated Duration

The duration shall be for 9 months from the starting date of the task order. Services are to be provided off-site. However periodic attendance to meeting on-site (IO premise) of the staff undertaking the work may be required in a monthly basis.

6 Work Description

The work involves the following tasks:

- Review of the existing documentation and existing flow and thermal models;
- Flow static analysis of the final Thermal Shield design. Heat input shall be considered when thermo-hydraulic consideration is recommended (most loaded panels) and the last TSM design shall be included in the model. The results shall show a proper hydraulic balance on all the cooling circuits, the mass flow rate shall be collected for every panel and the orifices sizes checked suggesting possible changes if needed;
- Thermal FE analysis of the final Thermal Shield design. The radiative heat input shall be provided by IO under different scenarios. The model developed by the Contractor shall include an update cooling performance based on the mass flow rates calculated with the updated of the flow analysis (performed by the Contractor as previously mentioned). The model shall also represent the heat transferred to the Magnet system and shall be run under different scenarios selected by IO. The Contractor shall post-process the results checking that the heat transferred to the Magnets and every possible hot spot are under allowable values;
- If a change of the design flow is suggested as a solution to possible hot spots, the Contractor shall assess the impact of that change by updating the flow and thermal analysis;
- Preparation of the analysis assessment reports.

The exact list of input references, models and documents for preforming the activities shall be delivered to the Contractor during the KoM of this task.

Geometrical models shall be delivered to the Contractor through the official DET procedure.

7 Responsibilities

The technical responsibilities are distributed as following:

7.1 ITER Organization, IO:

IO shall:

- Nominate the Responsible Officer to manage the Contract;
- Organise a monthly meeting(s) on work performed (minutes and agendas shall be prepared by the Contractor);
- Provide the needed information and access to the appropriate ITER files for executing this work when needed. In particular, IO will make available any required technical information;
- Provide the list of heat load input on the TS model for every explored scenario;
- Provide the CAD model as designed and with some level of simplification to be used for analysis;
- Provide the currently existing flow and FE models to be considered by the Contractor if desired.

7.2 Contractor:

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;
- Possess the qualifications, professional competence and experience to carry out services in accordance with IO rules and procedures;
- Be bound by the rules and regulations governing the IO ethics, safety and security IO rules;
- Provide the computational resources to complete the activity (hardware and software);
- Develop a flow analysis model with EcosimPro considering the design features of the TS and all the relevant information provided by IO. An existing EcosimPro model currently available in IO can be considered for its update after its proper review (if desired by the Contractor);
- Develop a thermal FE analysis with Ansys (modelled with APDL or Workbench) with the goal of getting as a result its temperature map and heat output transferred to the ITER Magnet system. An existing Ansys-Workbench model currently available in IO can be considered for its update after its proper review (if desired by the Contractor);
- Consider the different loading scenarios to be defined together with IO.

8 List of deliverables and due dates

D #	Description	Due Dates
D01	TS flow analysis update	T0 + 3 month
D02	TS thermal analysis update	T0 + 7 months
D03	Report summarizing the flow analysis results and possible consequences for the orifice sizing	T0 + 8 months
D04	Report summarizing the thermal analysis results	T0 + 9 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 flow analysis codes with emphasis in EcosimPro;
- Advanced capabilities on using FE codes (submodelling, fields interpolation between physics) with emphasis in ANSYS Code (classic/workbench) and associated programming tools (APDL…);
- Experience in advanced thermal FE evaluations including combined heat transfer by conduction, convection and thermal radiation;
- 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 8 "List of Deliverables 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) [1].

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) [7].

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

n/a

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 [20].