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Technical Specifications (In-Cash Procurement)

Expertise support in the area of particle and surface interactions aiming to port plug design and integration

The objective of this work is to provide wide expertise support in the area of particle and surface interactions aiming to port plug design and integration.

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1 Purpose

The objective of this work is to provide wide expertise support in the area of particle and surface interactions aiming to port plug design and integration.

2 Scope

The scope of the work is preliminary refining of optical cutout(s) shape in Diagnostic First Wall aiming to minimization of deposition flux on first mirrors and assessment of hydrogen isotope retention in DSM materials based on results of MCNP calculations and following IO CT guidelines.

3 Definitions

CAD	Computer Aided Engineering
C-RO	Contractor Responsible. Responsible for the contract at the contractor's side. See Contract specifications for definition of duty.
C-TRO	Contractor Task Responsible Officer. Responsible for carrying out the technical work – as a contractor – within the scope of the contract.
DSM	Diagnostics Shield Module
DFW	Diagnostics First Wall
IO CT	ITER Organization Central Team
IO-RO	ITER Organization Responsible Officer. Responsible for the contract at the IO-CT side.
IO-TRO	ITER Organization Task Responsible Officer. Responsible for supervising and supporting the technical work carried out by the C-TRO within the scope of this contract.
FMU	First Mirror Unit
KOM	Kick-off Meeting
PBS	Plant Breakdown Structure
QA	Quality Assurance
RH	Remote Handling
SIC	Safety Important Class
SS	Stainless steel
TRO	Technical Responsible Officer

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

4 References

IDM Links put in the text directly.

5 Estimated Duration

The contract duration shall be up to 12 months and shall commence on the date of contract signature. It is envisaged that the main part of the services shall be performed OFF Site and regular short (2 – 4 weeks each) visits to IO CT shall be planned.

6 Work Description

The work will mainly focus on the tasks described below but not necessary be limited to. Expertise for a similar kind of task can be requested upon mutual agreement.

6.1 DSM materials

6.1.1 Introduction

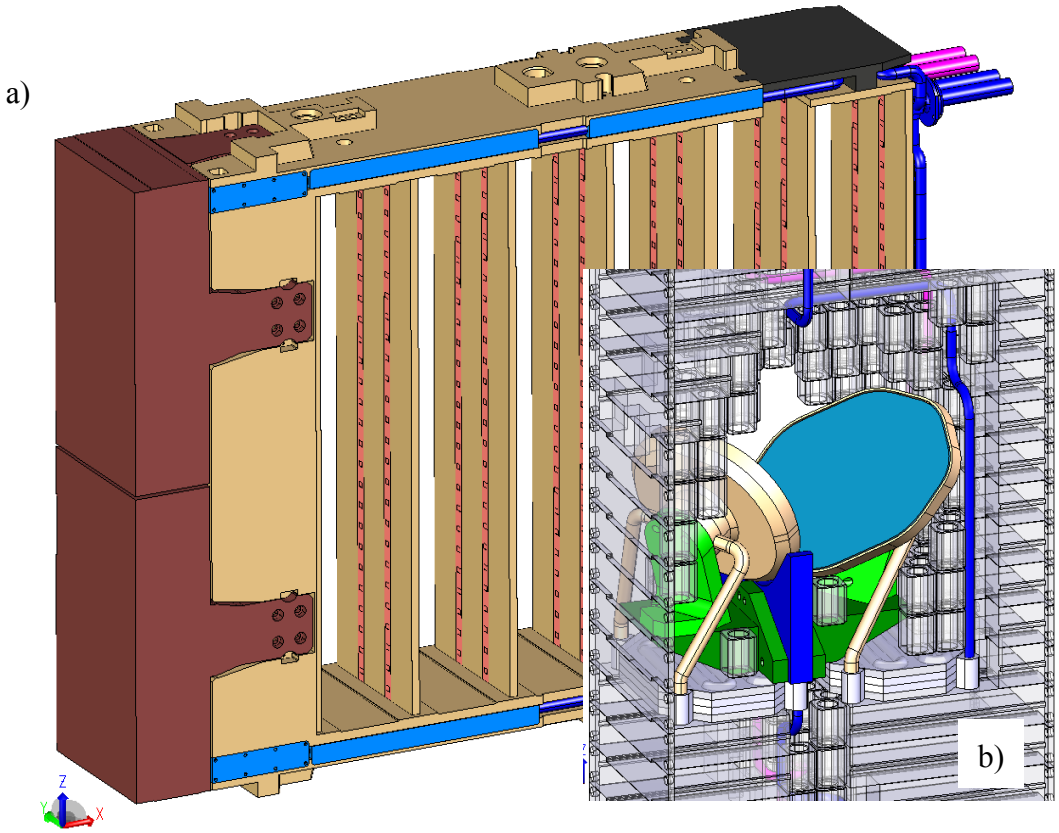

Figure 1. Modular DSM of the port plug (a). Diagnostic component surrounded by B4C shield blocks (b) within DSM.

Boron carbide (B4C) shielding blocks (SB) are foreseen to be employed in ITER diagnostic port plugs with a modular design of Diagnostic Shield Module (DSM, Figure 1). B4C is an attractive candidate for SB as a light weight and efficient neutron moderator material. B4C SBs are hidden from plasma; they should not be treated as a plasma facing component. These SBs are located behind DFW and forged part of the DSM. Neither plasma ions nor CXN can reach B4C SB in the line-of-sight direction. No direct plasma induced sputtering/redeposition will occur at B4C SB. However, there are still several possible mechanisms that might potentially lead to some T in-vessel retention provoked by B4C SB.

The concern is a presence of “ionizing radiation” which lead to tritium ionization. Ionized T atoms bombard surrounding surfaces (stainless steel, B4C) with a certain energy that

effectively results in T implantation and retention. Two cases shall be considered for comparison: stainless steel and B4C shield blocks. Results of existing β and γ emission MCNP calculations should be taken as a starting point and the range of ion flux to the walls should be estimated. Results of calculation should be used for T retention assessment following the methodology and guidelines from IO-CT. For example, some existing IO CT results of TMAP calculations on tritium accumulation can be interpolated to the given problem.

6.1.2 Expected outcome

The expected outcomes from this task are:

1) Engineering conservative assessment of tritium adsorption and retention in B4C shielding blocks;
2) engineering conservative assessment of tritium adsorption and retention in SS port plug structure and SS shielding blocks (backfilling);
3) comparison of tritium trapping in B4C and SS in port plugs;
4) recommendations on tritium retention/adsorption mitigation measures if needed.

The results of the work shall be delivered as a technical report or several reports. Delivered report(s) will be uploaded in IDM and reviewed. Reviewer's comments shall be taken into accounts and updated report delivered to IO CT.

6.2 Shape of DFW cutout

6.2.1 Introduction

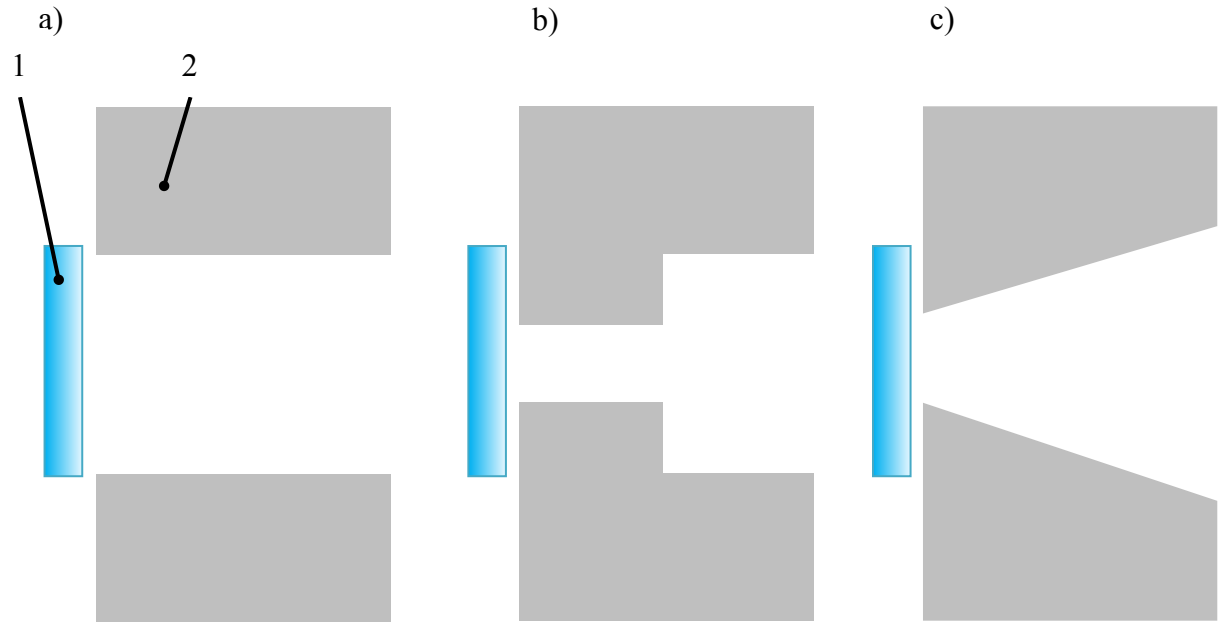

Figure 2. Shapes of the mirror duct (DFW cutout for optical path). 1 – first mirror, 2 – mirror duct (cutout in DFW).

One of the important mechanisms leading to first mirror reflectivity degradation is re-deposition on the mirror surface. Taking into account the very limited access to the port plugs, a number of passive and active measures will be taken in order to reduce re-deposition flux to mirrors. Re-deposition flux mainly originates from tokamak plasma and from mirror duct walls of the DFW (2). Re-deposition from tokamak plasma is unavoidable but the one originating from mirror duct can be at least partially mitigated via special shaping of the mirror duct.

Meanwhile, mirror duct shape is not only dictated by physics but mainly by engineering limitations. That is why, it is important to reveal the best and the worst mirror duct shape and provide engineers with recommendations on how mirror channel could be optimized in the given design and manufacturing constraints.

The work to be performed under this technical specification covers

- calculations on CXN (normal incidence angle) induced deposition on first mirrors;
- development of the model of angular and energetic dependence of CXN induced deposition on first mirrors, including mirror sputtering and redeposition and accounting of particle reflection;
- calculations of the deposition on first mirrors for the different shapes of DFW cutout;
- providing of engineering recommendations to diagnostic engineers on the shape of DFW cutout;
- providing of estimates on re-deposition on second mirror from erosion due to CXN of first mirror.

6.2.2 Expected outcome

The outcome of calculations shall demonstrate a level of deposition non-homogeneity on the mirror in the case of 1) angular variation of CXN flux; 2) angular orientation of the mirror.

Engineering values of deposition flux to first mirror in dependence on DFW cutout parameters shall be revealed. Recommendations to diagnostic engineers shall be given on optimization of cutout shape in the given DFW design constraints, cost limitations and schedule.

If modelling approach is used in the work, a comparison of results of the modelling *versus* analytical estimates shall be made.

The results of the work shall be delivered as a technical report or several reports. Delivered report(s) will be uploaded in IDM and reviewed. Reviewer's comments shall be taken into accounts and updated report delivered to IO CT.

7 Responsibilities

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;
- 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;
- Organise a monthly meeting(s) on work performed;
- Provide offices at IO premises.

8 List of deliverables and due dates

Deliverable	Description/content*	Due Dates**
D1	Engineering conservative assessment of tritium adsorption and retention in B4C and SS shielding blocks based on MCNP calculations of β and γ emission from port plug elements. Comparison of tritium trapping in B4C and SS in port plugs. Recommendations (on demand of IO CT) on tritium retention/adsorption mitigation measures.	T_0 + 3 months
D2	Assessment of mirror duct shape (DFW cutout) influence on deposition on first mirror. Revealing of the dependence of first mirror deposition non-homogeneity on mirror angular position. Produce dedicated technical report.	T_0 + 6 months
D3	Consideration of CXN and sputtered atoms reflection on the walls of mirror duct and its inclusion into report as by D2. Consideration of angular orientation (from 0 to 90 with respect to duct axis) of CXN flux. Provide parametric (angular, reflection, impurity concentration, sputtering yield, geometry) study of particle flux to the mirror. Providing engineering recommendations (put in the dedicated report) supported by conclusions from previously produced report(s) on mirror duct shape.	T_0 + 8 months
D4	Update report(s) produced in D1, D2, D3, D4 accordingly to reviewer's comments. Update first mirror related documents affected by results obtained in D1 – D4 and accordingly to reviewer's comments. Provide minutes of the progress and technical minutes.	T_0 + 8 months

* The reviewers of the reports need to be coherent with the ITER_D_2EXFXU - Sign-Off Authority for Project Documents

** The schedule of delivery dates may be updated to meet the IO-CT schedule requirements and upon mutual agreement between IO-RO and C-RO.

9 Acceptance Criteria

These criteria shall be the basis of acceptance by IO following the successful completion of the services. These will be in the form of monthly progress reports as indicated in section 8, table of deliverables and further detailed below:

- Reports as deliverables shall be stored in the ITER Organization's document management system, IDM by the Contractor for acceptance. A named ITER

Organization's Contract Technical Responsible Officer (TRO) is the Approver of the delivered documents;

- The reviewers of the reports need to be coherent with the ITER_D_2EXFXU - Sign-Off Authority for Project Documents.
- The reviewers of the DDD and StIR need to be coherent with the Document Production Plan.
- The Reviewer(s) can ask modifications to the report in which case the Contractor must submit a new version.
- The acceptance of the document by the Approver is the acceptance criterion.

10 Specific requirements and conditions

- Experience in analytical calculations and higher mathematics;
- Experience in photonic irradiation modelling (COMSOL, ANSYS);
- Experience in modelling of implantation and sputtering (TRIM code or similar);
- Experience in ion-surface interaction area;
- Knowledge in hydrogen retention in materials;
- Knowledge in material outgassing properties;
- Knowledge in low temperature plasma area (glow discharge, electron beam discharge, space plasma, etc);
- Understanding of ITER requirements and guidelines;
- Excellent skills in writing technical reports in English;

11 Work Monitoring / Meeting Schedule

The work will be managed by means of Progress Meetings and/or formal exchange of documents transmitted by emails. Progress Meetings will be called by the ITER Organization, to review the progress of the work, the technical problems, the interfaces and the planning. It is expected that Progress Meeting will be held weekly or biweekly or as needed. Progress meetings will involve C-TROs and IO-TRO. The minutes of these progress meetings shall be prepared by the C-TRO.

The main purpose of the Progress Meetings is to allow the ITER Organization/Diagnostics Division and the Contractor Technical Responsible Officers to:

a) Allow early detection and correction of issues that may cause delays;
b) Review the completed and planned activities and assess the progress made;
c) Permit fast and consensual resolution of unexpected problems;
d) Clarify doubts and prevent misinterpretations of the specifications.

In addition to the Progress Meetings, if necessary, additional meetings to address specific issues to be resolved may be requested by the ITER Organization.

It is expected that on occasion a presentation to Topical Technical Meetings either by videoconference or in person may be required.

For all Progress Meetings, a document (the Progress Meeting Report) describing tasks done, results obtained, blocking points and action items must be written by the Contractor. Each report will be stored in the ITER IDM in order to ensure traceability of the work performed.

12 Delivery time breakdown

See Section 8 – Deliverables and Due Date

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 (ITER_D_7M2YKF).

Compliance with Defined requirements for PBS 55 - Diagnostics (NPEVB6 v1.3) or its flowed down requirements in SRD-55 (Diagnostics) from DOORS (28B39L v5.2) is mandatory.