

Technical Specification

Technical specification - Mechanical engineering support for the disruption mitigation system design

The purpose of this technical specification is to outline and define how the development of the Disruption Mitigation System (DMS) shall be supported towards the FDR.

This document concerns DMS tenant integration and mechanical design activities performed in all DMS ports which includes the following areas: Port plugs, closure plates, port interspaces and port cells. It is intended to hire engineering support on a Call for Expertise contract basis.

The main focus of this technical specification is on the in-vessel design.

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1 Purpose

The purpose of this technical specification (ITER_D_YQRPA6) is to outline and define how the development of the Disruption Mitigation System (DMS) shall be supported towards the FDR.

2 Scope

This document concerns DMS tenant integration and mechanical design activities performed in all DMS ports which includes the following areas: Port plugs, closure plates, port interspaces and port cells.

3 Definitions

For a complete list of ITER abbreviations see: [ITER Abbreviations \(ITER_D_2MU6W5\)](#).

Acronym	Meaning
ALARA	As Low As Reasonably Achievable
CAD	Computer Aided Design
HoF	Human Organizational Factor
HFE	Human Factors and Ergonomics
DET	Data Exchange Transfer
DFW	Diagnostic First Wall
DIR	Design Integration Review
DSM	Diagnostic Shielding Module
FDR	Final Design Review
EP	Equatorial port
FDR	Final Design Review
FP	First Plasma
HIRA	Hazard Identification and Risk Assessment
ORE	Occupational Radiation Exposure
PCSS	Port Cell Support Structure
PDR	Preliminary Design Review
PFPO-1	Pre-Fusion Plasma Operation 1
PP	Port Plug
ISS	Interspace Support Structure
SDDR	Shutdown Dose Rate
SIC	Structural Integrity Component
RO	Responsible Officer
PIA	Protection Important Activity

4 References

- [1] ITER_D_27ZRW8 - Project Requirements
- [2] ITER_D_BEJQWA - SRD 18.DM
- [3] ITER_D_QDLQBD - Defined requirements PBS 18 PIS DMS
- [4] ITER_D_2NC6CB - 18.DM System Design Description for DMS.
- [5] ITER_D_RUGWUK - Safe Access for Maintainability
- [6] ITER_D_258LKL - Quality Assurance for ITER Safety Codes
- [7] ITER_D_QUK6LF - ITER Human & Organizational Factors Policy

[8] ITER_D_2MU6W5 - ITER Abbreviations

[9] ITER_D_KTU8HH - Software Qualification Policy

5 Estimated Duration

The overall duration of this work is 12 months.

6 Work description

The engineering support as listed here may include the following activities

- Support the DMS tenant mechanical integration EP#02, EP#08, EP#17, UP#02, UP#08, UP#14;
- Propose and develop adequate mechanical solutions for the DMS and its integration in the ITER environment;
- Help in preparation of the CAD models, design reviews technical documentation and presentations.

The scope of the work is limited to the DMS tenant areas. This includes components in and on the Port Plug (PP) (see fig.1), closure plate, Interspace and Port Cell areas (Fig.2) in EPs and UPs.

6.1 Introduction

The purpose of the ITER Disruption Mitigation System (DMS) is to provide machine protection in order to reduce the detrimental effects of plasma disruptions and to ensure the appropriate lifetime of all affected ITER components. It utilises cryogenic hydrogen and neon pellets which are generated inside the injectors which are located in the ISS. These pellets are pneumatically propelled in the time frame of milliseconds towards the plasma and just before entering the plasma are shattered into small fragments to enter the plasma and to reduce damage to the plasma facing components and other structures inside the ITER tokamak.

The DMS is located in ITER ports on the equatorial level and the upper levels (see system for equatorial systems as an example in fig. 1). All DMS units on the equatorial share a common design and so do the units on the upper ports. Since most of the ports are home to various diagnostics and other systems, each port environment can differ and the common DMS design solutions may have to be adapted. The DMS units are located in Equatorial Port (EP) #02, EP#08, EP#17 and Upper Port (UP) #02, UP#08, UP#14

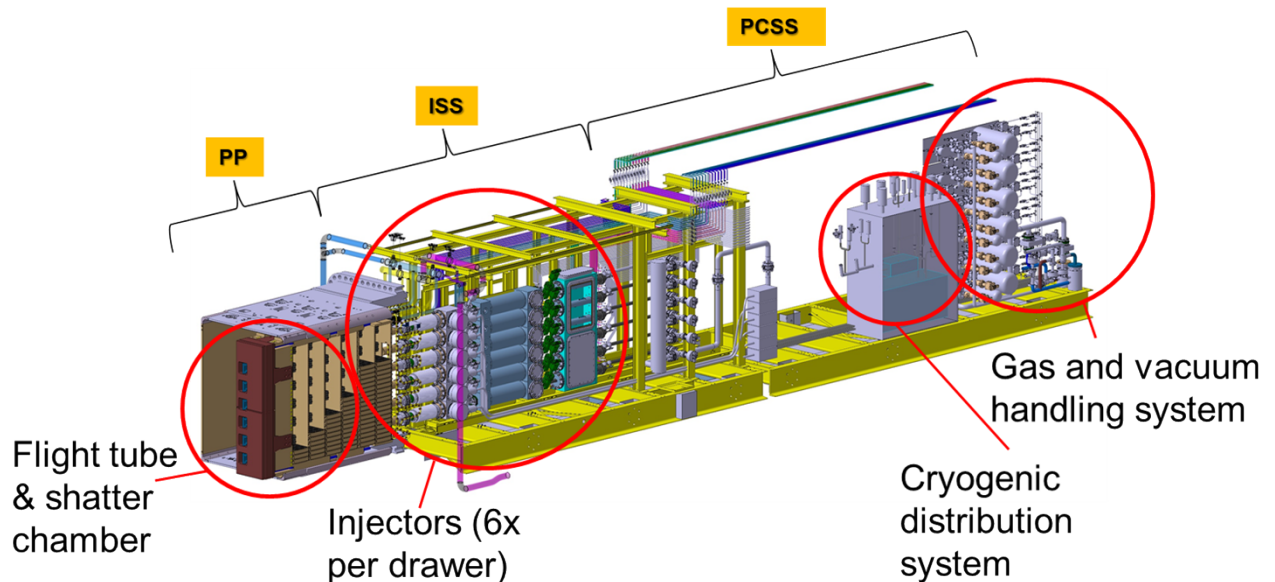


Figure 1 Typical DMS in EP integrated into the ISS and PCSS.

6.2 Mechanical design and integration

The objective is to continuously support the DMS design and the integration of the design into this highly constraint environment and to develop solutions appropriate for the DMS. The list of specific and general activities expected to be performed is

- Providing recommendations and following up adaptation needed in the iterative process of tenant integration;
- Development of PP elements and the integration of solutions necessary for integration:
 - Define, design, and implement the DMS interface with the DFW. Implement R&D results on the shattering geometry in a timely manner.
 - finding adequate space for the DMS components and shielding trays and developing of the fixation elements as per integration needs;
 - identifying and advising the PI on routing and service integration solution using standard solutions (clamps) for modular DSM structure;
 - continuously support the interfaces and keep them up-to-date
 - delivery of the relevant CAD models;
- Development of the closure plate elements and integration solutions:
 - finding proper arrangement of the flanges appropriate for inspection and maintenance,
 - support the development of services (SVS, cables), their routing and their integration,
 - participation in the development of the connection bridge between closure plate and building,
 - delivery of the relevant CAD models;
- Development of ISS and PCSS structural elements and integration solutions:
 - finding adequate space for the DMS components and shielding blocks, appropriate for inspection and maintenance,
 - support the development of services, their routing and integration,

- participation in the development of the connection of the services between ISS and PCSS, between ISS and building, between PCSS and building,
- delivery of the relevant CAD models,
- Development of shielding blocks for ISS and PCSS (if required)
- Delivery of CAD models of integrated ports in preparation for
 - Neutronics analysis,
 - Maintenance, ORE and inspection assessments,
 - HFE analysis,
 - Design reviews (e.g. PDR),
 - Integration reviews (DIR);
- Support of maintenance operations development in the ISS and PCSS areas including area in between closure plate and ISS;
- Support of the development of human occupational factor analysis;
- Launch CAD Data Exchange Transfer (DET) tasks following IO CAD rules;

The Disruption Mitigation System (DMS) 18.DM is a rapidly growing system at post-CDR development level. The most critical areas for integration area is the shatter chamber in the DFW and its interfaces with the DFW and the DSM. In addition the vacuum extensions and the services (vacuum, gas, cryogenic) in the ISS and PCSS require attention and engineering support. The work on vacuum extensions is ongoing with support of maintenance and ORE assessments, and HOF analysis, provided by PBS-55 which bears the port integration in most DMS ports. A close collaboration with PBS 55 and continuous information exchange is therefore expected. Since the DMS design is evolving the vacuum extension integration is being changed respectively. When the results of DMS neutronics analysis is available (from PBS-18 either PBS-55), the integration shall be adopted accordingly (doglegs modification , adding/removal of shielding blocks, etc);

6.3 Engineering documentation

Some of the engineering documentation which maybe expected to be prepared is

- Bill of Materials;
- documents to be used to define interfaces
- interface sheets
- design descriptions as input for neutronic analyses;
- input to any other required ITER design documentation

Furthermore it may be expected

- to participate in regular DMS group meetings;
- to participate in design and integration reviews;
- contribute or provide presentation related to mechanical design, integration and assembly;

7 Responsibilities

7.1 Contractor's obligations

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.

The official language of the ITER project is English. Therefore, all input and output documentation relevant to this Contract shall be in English. The Contractor shall ensure that all the professionals in charge of the Contract have an adequate knowledge of English, to allow easy communication and adequate drafting of technical documentation. This requirement also applies to the Contractor's staff working at the ITER site or participating in meetings with the ITER Organization.

7.2 Obligations of the ITER Organization

The ITER Organization shall

- Nominate the Responsible Officer to manage the Contract;
- Organise regular meeting(s) on work performed;
- Provide offices at IO premises.

The ITER Organization shall in addition give the possibility to the contractor to review documents on the ITER documents database (IDM). Furthermore the IO shall make all technical data and documents available to the Contractor which will be required to carry out its obligations in a timely manner.

8 List of deliverables and due dates

N°	Target date (months)	Deliverable description
D1	T0+3	<p>Develop a conceptual shatter chamber for the equatorial ports. The chamber needs to consider thermal as well as DMS related constraints. The shatter chamber shall preferably be passively cooled via an interface with the DSM. Alternatively an actively cooled concept shall be developed.</p> <p>Provide input to update the interfaces with the surrounding DFW and the DSM. Discuss with the IO RO and upload supporting description document in the IDM as per request. Assess the impact the design solution will have on the overall DMS in the ISS and the integration with other tenants.</p> <p>Provide a report on IDM summarising the work of this deliverable.</p>
D2	T0+5	<p>Develop a conceptual shatter chamber for the upper ports. The chamber needs to consider thermal as well as DMS related constraints. The shatter chamber shall preferably be passively cooled via an interface with the DSM. Alternatively an actively cooled concept shall be developed.</p> <p>Provide input to update the interfaces with the surrounding DFW and the DSM. Discuss with the IO RO and upload supporting description document in the IDM as per request. Assess the impact the design solution will have on the overall DMS in the ISS and the integration with other tenants.</p> <p>Provide a report on IDM summarising the work of this deliverable.</p>
D3	T0+7	<p>Progress the design of the shatter chamber and the DMS in-vessel components for the equatorial ports incorporating R&D results to a preliminary design stage.</p> <p>Define the interfaces with the surrounding DFW and the DSM. Discuss with the IO RO and upload supporting description document in the IDM as per request.</p> <p>Provide a report on IDM summarising the work of this deliverable.</p>
D4	T0+9	<p>Progress the design of the shatter chamber and the DMS in-vessel components for the upper ports incorporating R&D results to a preliminary design stage.</p> <p>Define the interfaces with the surrounding DFW and the DSM. Discuss with the IO RO and upload supporting description document in the IDM as per request.</p> <p>Provide a report on IDM summarising the work of this deliverable.</p>
D5	T0+12	<p>Prepare documentation and models in preparation of upcoming design reviews. Contribute to presentation on PP, closure plate, ISS and PCSS integration activities.</p> <p>Provide a report on IDM summarising the work of this deliverable.</p>

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 the approval of 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

In order to complete the tasks in a timely manner the following skills are required:

- Ability to work with CATIA V5,
- Ability to work with the ENOVIA database,
- Ability to work with ANSYS,
- Experience with ITER port plug design and tenant integration based on the IO integration approach (Equatorial ports as well as upper ports)
- Experience with design and integration of systems with vacuum extensions in ITER port plugs
- Experience with the DSM design and integration
- Experience with PP water cooling pipe routing and remote cutting and welding considerations
- Experience with the skeleton concept enrolled for the ITER port cell design
- Experience with the shielding concept for port plug based on the IO integration approach
- Experience in manufacturability of components
- Experience in mechanical engineering

11 Work Monitoring / Meeting Schedule

Work is monitored through reports (see List of Deliverables section).

The Contractor will work predominantly work on the IO site.

12 Delivery time breakdown

T0 is the date of the contract signature. See Section 8 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 Requirements (if applicable)

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

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](#)).

Drawing Registration in the IO system shall be performed according to the Procedure for the Management of Diagrams and Drawings in pdf Format Using the SMDD Application ([KFMK2B](#)).

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 [P7Q3J7](#) - Specification for CAD data Production in ITER direct 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 (PIC) 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 \(AW6JSB v1.0\)](#)).

Compliance with *ITER_D_QDLQBD Defined requirements PBS 18 PIS DMS* is mandatory.