Technical Specification

Technical specification - Engineering analysis 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 engineering analysis activities performed for the entire DMS.

It is intended to hire engineering support on a Call for Expertise contract basis.

Table of Contents

1 Purpose

The purpose of this technical specification (ITER_D_5GWNB4) 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 engineering analysis activities performed for the DMS.

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 45P8YK - Defined requirements PBS 18 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

[10] ITER D PSTTZL - List of ITER-INB Protections Important Activities

5   Estimated Duration

The overall duration of this work is 12 months.

6   Work description

The work involves provision of technical expertise and to work together with the IO-TRO and the DMS design team primarily. It involves many areas of activity that have to be supported.

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. A typical injector design for the equatorial ports can be seen in fig. 1.
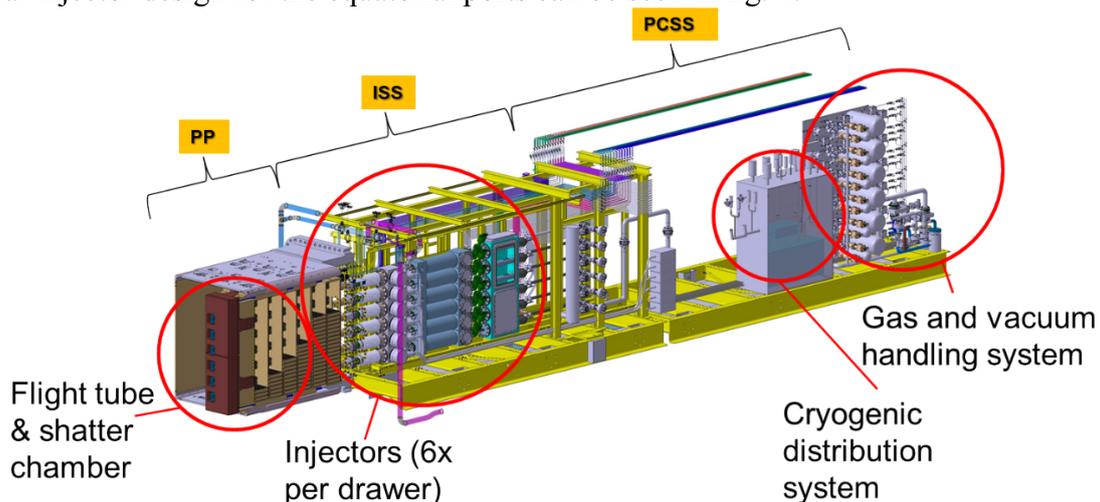

Figure 1 Typical DMS in EP integrated into the ISS and PCSS.

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. 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.

6.2   Engineering analysis

The objective is to continuously support the DMS design. The list of specific and general activities expected to be performed is

- Preparation of Load Specification documents for DMS In-vessel component and Ex-vessel components, in strict compliance with ITER General Load specification

- Preparation of Structural Integrity Reports for DMS In-vessel and Ex-vessel components, in strict compliance with ITER MQP standards
- Performing thermal assessment of DMS In-vessel and Ex-vessel components
- Performing linear/non-linear excessive deformation analysis of DMS In-vessel and Ex-vessel components
- Performing linear/non-linear progressive deformation analysis (fatigue etc.) of DMS In-vessel and Ex-vessel components
- Performing elastic/elastoplastic instability analysis (buckling) of DMS In-vessel and Ex-vessel components
- Performing Seismic assessment of DMS In-vessel and Ex-vessel components
- Performing fatigue assessment of bolts/welds in accordance with analysis codes
- Carrying out other related engineering tasks, upon line management request.

6.3   Engineering documentation

Some of the technical documentation which maybe expected to be prepared are

- Load specifications
- Analysis reports
- Presentations

Furthermore it may be expected
- to participate in regular DMS group meetings
- to participate in design and integration reviews

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	Perform initial analysis tasks in preparation of the PDR. Provide a report on IDM summarising the work of this deliverable.
D2	T0+6	Perform detailed analysis tasks in preparation of the PDR and support the DMS design team in chit resolution. Provide a report on IDM summarising the work of this deliverable.
D3	T0+9	Perform initial analysis task in preparation of the FDR. Provide a report on IDM summarising the work of this deliverable.
D4	T0+12	Perform detailed analysis task in preparation of the FDR. Provide a report on IDM summarising the work of this deliverable.

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 experiences are required:

- Experience in Mechanical Engineering;
- Sound experience in FEA analysis;

- Experience in using ANSYS Classic & workbench v.15 or higher (and associated packages for CFD (CFX or FLUENT), EM (Maxwell or ANSYS) analysis and pre-processing (SpaceClaim / DesignSpace)).
- Experience in FEA pre-processing, mesh generation and model's quality assessment;
- Experience in Mechanical (linear/non-linear/static/dynamic);
- Experience in thermal-hydraulic analysis (single and coupled);
- Experience in electromagnetic analysis; if particularized to ITER related loads defined from primary inputs (DINA) is considered as an advantage;
- Experience in ParaView and post-processing tool (interface with ANSYS to be developed);
- Experience in advanced Finite Element Analysis techniques (sub-modelling, interpolation, contact technologies, programming (APDL) and coupled field analysis);
- Experience in structural assessment Code post-processing techniques (linearization and categorization of stresses, fatigue, limit analysis);
- Experience in application of appropriate industrial Codes and Standards of nuclear/non-nuclear equipment (e.g. ASME VIII Div 2, ASME III, RCC-MR);
- Experience in creation of Load Specifications for ITER complex integrated systems and management of interface loads between upper level components and tenant systems following an integrated analysis approach;
- Monitoring and reporting of status of projects;
- Communication with international local and remote teams in context of nuclear fusion research or similarly complex research and engineering environment;
- Organization, taking minutes and action tracking of international meetings;
- Understanding of schematics and 3D models.

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 (as per *ITER D PSTTZL*) 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 45P8YK Defined requirements PBS 18 DMS* is mandatory.

Note: DMS Design Activities are PIAs