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Technical Specifications (In-Cash Procurement)

Technical Specification-DMS PIS development

This document describes the activities, summarized in the listed deliverables, required to support the completion of the design, prototyping, coding, and integration to be performed for the DMS Plant Interlock System (PIS)

Table of Contents

1 Purpose

The purpose of this technical specification (ITER_D_ 7V88DM) is to outline and define how the development of the Plant Interlock System (PIS) for the Disruption Mitigation System (DMS) shall be supported towards the FDR.

2 Scope

This document describes the activities, summarized in the listed deliverables, required to support the completion of the design, prototyping, coding, and integration to be performed for the DMS PIS.

3 Definitions

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

Acronym	Meaning
ALARA	As Low As Reasonably Achievable
APS	Advanced Protection System
CIS	Central Interlock System
CODAC	Control, Data Access and Communication
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
PCS	Plasma Control System
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
RO	Responsible Officer
PIA	Protection Important Activity
PIS	Plant Interlock System

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_57W3MJ – Design Justification Plan
[7] ITER_D_56KDXG – HAZOP report
[8] ITER_D_6KJ5WS – DMS performance analysis
[9] ITER_D_6KJNHW – Issue or Risk or Opportunity Analysis Report
[10] ITER_D_WQFY54 – Maintenance, Test and Inspection Plan
[11] ITER_D_ 258LKL – Working Instruction for the Qualification of ITER safety codes
[12] ITER_D_ QUK6LF – ITER Human & Organizational Factors Policy
[13] ITER_D_2MU6W5 – ITER Abbreviations
[14] ITER_D_KTU8HH – Software Qualification Policy
[15] ITER_D_T97WNG – Technical note on the functional dependencies for disruption mitigation between PBS-18.DM, PBS-46, and PBS-47

5 Estimated Duration

The overall duration of this work is 12 months.

6 Work Description

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.

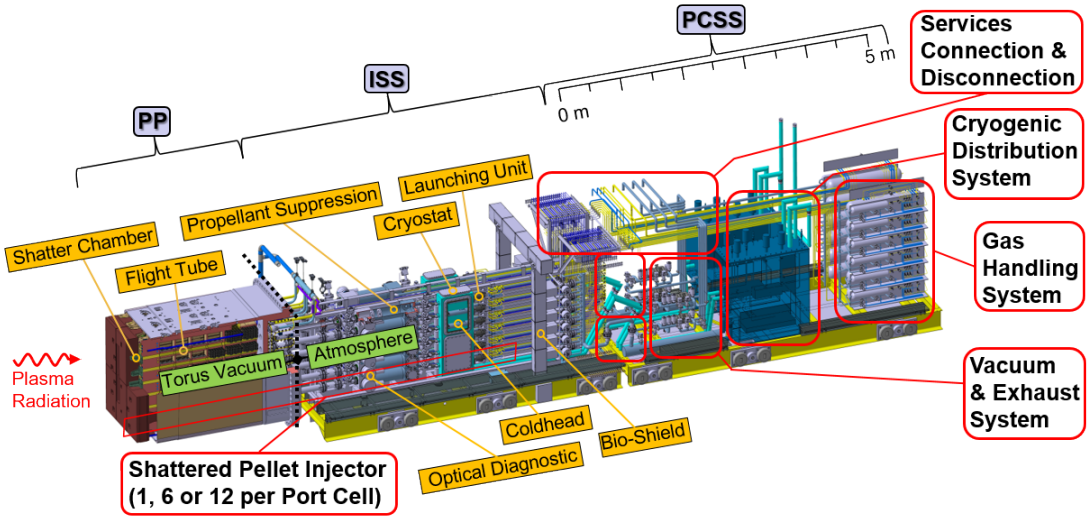

Figure 6-1 Typical DMS in EP integrated into the ISS and PCSS

6.2 Plant Interlock System

The Plant Interlock System (PIS) of the DMS is the control system in charge of the critical functions related to the investment protection. It interfaces directly the main indicators and actuators of the DMS Plant, and is in permanent communication with the upper layer of the protection systems, the Central Interlock System (CIS) and the Advanced Protection System (APS). Functionally, it is also interfaced with the Plasma Control System (PCS).

The APS calculates in real time, based on plasma and other tokamak parameters, the injector triggering sequence, and communicates it to the PIS where it is updated and stored. The PIS also monitors the status of the DMS injectors during a pulse, and communicates its status back to the APS as a parameter to evaluate both the sequence and the need to stop the ongoing pulse. Finally, the CIS centralizes all requests of the DMS trigger (which may come from CIS internally, following the execution of other protection functions, or from any of the APS modules) to issue a unique DMS trigger request to the PIS which implements the injector firing sequence based on the sequence previously stored.

In its design and conception, the DMS PIS follows a similar architecture to that of the CIS Fast Architecture, composed of a set of two cRIO chassis NI9159 based on Virtex FPGAs which communicate internally through Manchester coding to exchange internal diagnosis, and externally to CIS. During tokamak operation, the requirements of the system imply the use of components capable of performing control-cycles in the micro-seconds range to meet function input-response requirements. It is designed following the principles of the IEC-61508 standard on functional safety.

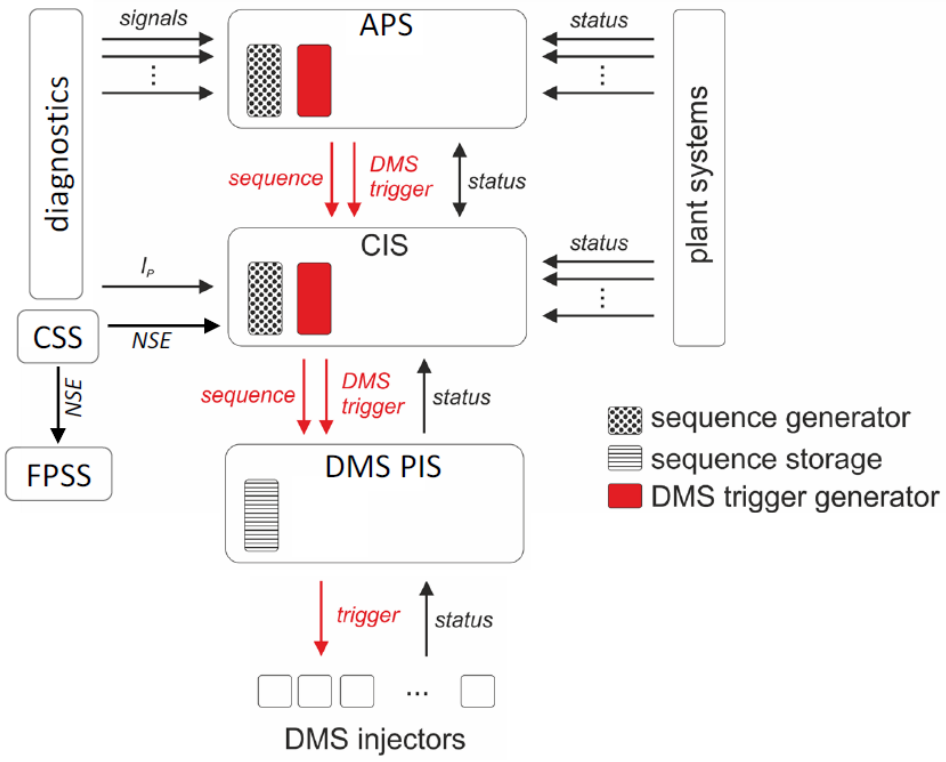

Figure 6-2

A prototype of the DMS PIS exists, which was developed in cooperation with the CIS. It was used to validate certain performance parameters and an initial concept of the sequence transmission/storage and CIS triggering.

6.3 PIS design and prototyping activities

Due to project schedule constraints, development of individual DMS subsystems are following a concurrent engineering approach. Due to the First-of-a-Kind (FOAK) nature of the DMS, this gives rise to significant known and unknown technical risks related to the interoperability of individual subsystems. Effective identification, management and retirement of these technical risks will be critical to successful subsystem integration and therefore to the delivery of DMS PIS.

The DMS PIS will have to operate within the overall DMS control system consisting additionally of a conventional control system and a plant safety system. Hence, the PIS work must be coordinated with those responsible for the integrated control system.

The list of specific and general activities expected to be performed by the Contractor is, non-exhaustively:

- Documenting and developing internal and external interfaces between DMS subsystems and with CIS/APS;
- Liaising with DMS and CIS design teams to ensure consistency of internal and external interface requirements, constraints and assumptions;
- Lead the prototyping activities, in continuation to the pre-existing work, in liaison with CIS team;
- Contribute to the DMS PIS design documentation dossier;
- Identifying key technical risks and unknowns related to the performance of individual subsystems, in particular those which could impact the internal interfaces;
- Carrying out other related requests, upon line management request.

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

#	Target date (months)	Deliverable description
D1	T0 + 3	Familiarise with the DMS design and PIS early prototyping activities Update interface control documents PBS 18 – PBS 46 and PBS 18 – PBS 47, for what concerns the PBS 18.DM scope Draft list of changes to be carried out on the DMS PIS prototype together with a test plan
D2	T0 + 6	Update functional and technical description document for the DMS PIS Update interface sheets and related documentation for what concerns the interfaces PBS 18.DM – PBS 46 and PBS 18.DM – PBS 47. Preliminary report on update of prototyping activities
D3	T0 + 9	Incorporate changes and updates of above deliverables based on inputs and review comments from DMS, CIS and PCS teams Report and presentation at Final Design Review summarising the status of this work and next steps
D4	T0 + 12	Incorporate changes and updates of above deliverables based on inputs and review comments from DMS team and after the Final Design Review

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 chapter 8, *List of deliverables and due dates*.

10 Specific requirements and conditions

The work involves technical expertise in computer science, Linux kernel software development, LabView development under NI c-RIO, as well as understanding and practical use of ITER procedures. Understanding of IEC 61508-3 to support the interlock control system lifecycle would be helpful.

- Expertise in computer science, Linux kernel software development;
- Experience in documentation management systems;
- Experience FPGAs and PCIe Specifications, and development under LabView;
- Experience with Linux PCI driver architecture;
- C/C++ development and software QA;
- Good interpersonal communication skills;
- Ability to facilitate dialogue with a wide variety of contributors and stakeholders to identify process requirements;

- Technical document generation;
- Interface management on large projects such as particle accelerators, fusion, fission, aerospace projects.

11 Work Monitoring / Meeting Schedule

Work is monitored through reports. See chapter 8, *List of deliverables and due dates*.

The Contractor will work predominantly work on the IO site.

12 Delivery time breakdown

T0 is the date of the contract signature. See chapter 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).

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 PIA. This general work covers the whole DMS system. Refer the Quality class and Safety Class as per the SRD document (BEJQWA).