



**645MFD**

**06 Oct 2021 / 1.1 / Approved**

EXTERNAL REFERENCE / VERSION

### Technical Specifications (In-Cash Procurement)

## CFE - Lower Port Pipe RH Operations Engineering

This document describes the technical needs for expert specialists in engineering of Diagnostics. Specifically the technical needs of the Diagnostics Division with particular reference to design development and construction preparation,

## Table of Contents

<b>1</b>	<b>PURPOSE .....</b>	<b>2</b>
<b>2</b>	<b>SCOPE .....</b>	<b>2</b>
<b>3</b>	<b>DEFINITIONS .....</b>	<b>2</b>
<b>4</b>	<b>REFERENCES.....</b>	<b>2</b>
<b>5</b>	<b>ESTIMATED DURATION.....</b>	<b>2</b>
<b>6</b>	<b>WORK DESCRIPTION.....</b>	<b>2</b>
<b>7</b>	<b>RESPONSIBILITIES .....</b>	<b>7</b>
7.1	Contractor's Responsibilities .....	7
7.2	IO's Responsibilities .....	7
<b>8</b>	<b>LIST OF DELIVERABLES AND DUE DATES .....</b>	<b>7</b>
<b>9</b>	<b>ACCEPTANCE CRITERIA.....</b>	<b>8</b>
<b>10</b>	<b>SPECIFIC REQUIREMENTS AND CONDITIONS.....</b>	<b>8</b>
<b>11</b>	<b>WORK MONITORING / MEETING SCHEDULE .....</b>	<b>9</b>
<b>12</b>	<b>DELIVERY TIME BREAKDOWN.....</b>	<b>9</b>
<b>13</b>	<b>QUALITY ASSURANCE (QA) REQUIREMENTS.....</b>	<b>9</b>
<b>14</b>	<b>CAD DESIGN REQUIREMENTS.....</b>	<b>9</b>
<b>15</b>	<b>SAFETY REQUIREMENTS.....</b>	<b>10</b>

## 1 Purpose

This document describes the technical needs for expert specialists in engineering of Diagnostics. Specifically the technical needs of the Diagnostics Division with particular reference to design development and construction preparation, predominantly in the following areas:

- Mechanical engineering, integration and CAD (Enovia)

## 2 Scope

The objective of this Task Order is to boost the ITER Diagnostics team in the evaluation and establishment of diagnostics systems, providing mechanical engineering design, modelling, analysis and development of mock ups and prototypes required for design validation, and input to construction work descriptions.

## 3 Definitions

CAD	Computer aided design
CMM	Configuration and management model
DA	Domestic Agency
DM	Detailed model
DR	Diagnostic Rack
HC	Hot Cell
IO	ITER Organization
IO-TRO	ITER Organization Technical Responsible Officer
IV	In Vessel
MAM	Manipulator Arm
PIA	Protection Important Activity
RH	Remote Handling
UHV	Ultra High Vacuum
VV	Vacuum Vessel

For a complete list of ITER abbreviations see: [ITER Abbreviations \(ITER\\_D\\_2MU6W5\)](#).

## 4 References

Links inserted in text

## 5 Estimated Duration

The duration of the task is spread over 12 months, from the date of the Kick Off Meeting.

## 6 Work Description

This work relates to Lower Port Diagnostic systems (55.L2, 44.L8, 55.LE). These systems are present in 3 lower ports. The key component of these systems are the diagnostic racks (DR), which are 10.5 ton steel structures housing various diagnostic tenants and they also contribute to the nuclear shielding performance of the ITER machine. These DRs need to be fed with fluid (water and gas) pipes and electrical cables to actuate subsystems and observe plasma

parameters. Being inside the VV, these racks are fully RH compatible, human presence not allowed in this environment.

In addition to VV RH operations, the water/gas pipes shall also have to be welded with RH tooling in the Hot Cell. This connection is necessary between the diagnostic tenant and the rack routed fluid lines.

The present task aims at

- further developing the above described water-, gas supply connections, and to prepare and execute detailed design and testing campaign to verify concept.
- Verify the in-rack HC based RH connections

The basis for the studies is a series of studies developed for and after the PDR of the system (held in April 2021). The corresponding presentations (and documents) are found here

- [ITER\\_D\\_57RERN - 14 - Integration of services and FTs](#)
- [ITER\\_D\\_57RGTX - 23 - RH of Gas, Water services \(In vessel\)](#)
- And also the DDD: [ITER\\_D\\_UVMNYB - System Design Description \(DDD\) 55.L2/55.L8/55.LE Lower Port System](#)
- [ITER\\_D\\_4J7BYR - D02 - Pipe routing and attachment from FT to rack connection](#)
- [ITER\\_D\\_4HSN7F - D01- Review market and other ITER related options for pipe cut/weld tooling inside VACCUM VESSEL for water and gas pipe connection points between rack and VACCUM VESSEL mounted pipes](#)
- [ITER\\_D\\_4J7TWW - D04 - Pipe and electrical cable routing](#)
- 

In past studies the following areas have been worked on

- General layout of fluid lines and connection points
- Conceptual design of VV wall mounted supports and rack mounted supports
- Verification of space reservations for tooling (taking into account existing examples, ie EQ12 tooling)
- Main sequence of operations
- Pipe length reduction due to rewelding
- Gas pipe adaptations principles
- Engineering design of proposed structures, including
  - wall mounted pipe supports (active and passive), taking into account required range of motion and RH tooling interface and accessibility.
  - Alignment features for tooling (so that the tools can reliably be placed by the MAM into the correct position)
  - RH interface for tooling: this feature is a standardized component, so that the MAM can grip the tools
  - Rack based alignment and manipulation tools and their RH mechanism
- Kinematic studies, to verify that not only the final position, but the full range of motion is clash-free
- Detailed study and simple engineering analysis on how to handle pipe length management. Pipe length management can be important for many reasons
  - To handle differential thermal expansion due to coolant temperature difference between VV wall and pipes (200C vs 240C),
  - to handle pipe length change due to repeated cutting/rewelding. At this stage it is assumed that up to 5 cut/reweld operations shall be necessary, and each time the permanent pipe shall be 5mm shorter
  - to move pipes to clear space reservations for RH tooling for rack and divertor cassette removal

- to manage installation tolerances and repeatability

In addition to continuing work on these, the following specific areas need further study:

- Maximum possible synergies between gas and water pipe handling
- Length of HAZ (heat affected zone)
- Stress in components when manipulated
- Swarf production
- Tooling development/customization (NDT, cut, weld, etc)
- Verify the Hot Cell based fluid connections.

In the next phase of development this study shall focus on

- VV based RH tasks :
  - Tooling development/selection: welding/cutting/NDE tooling must be carefully selected to suit the specific requirements of the lower ports, and required customizations negotiated for RH interface, radiation requirement, swarf production, etc
  - Mockup activity: planned to start in the second half of 2022, with the aim of demonstrating feasibility of concept for the FDR of the system (planned June 2023). In the frame of this activity, testing work packages must be developed
  - Engineerign verifications, including input definition for structural calculation, kinematic studies, etc
  - Detailed list of all pipe manipulation activities to for a systematic overview of all possible states
  - Documentation update in preparation of FDR
- HC based RH tasks
  - Verify the used pipe diameter and tooling. Presently small pipe diameters are considered (6-10mm OD) for piping. However, there is no qualified operations for these concepts. A study is to be performed on the feasibility to increase pipe diameter in order to be able to use already qualified RH operations. Possible options include increasing diameter only at cut/weld zones, or, use a large diameter pipe entirely

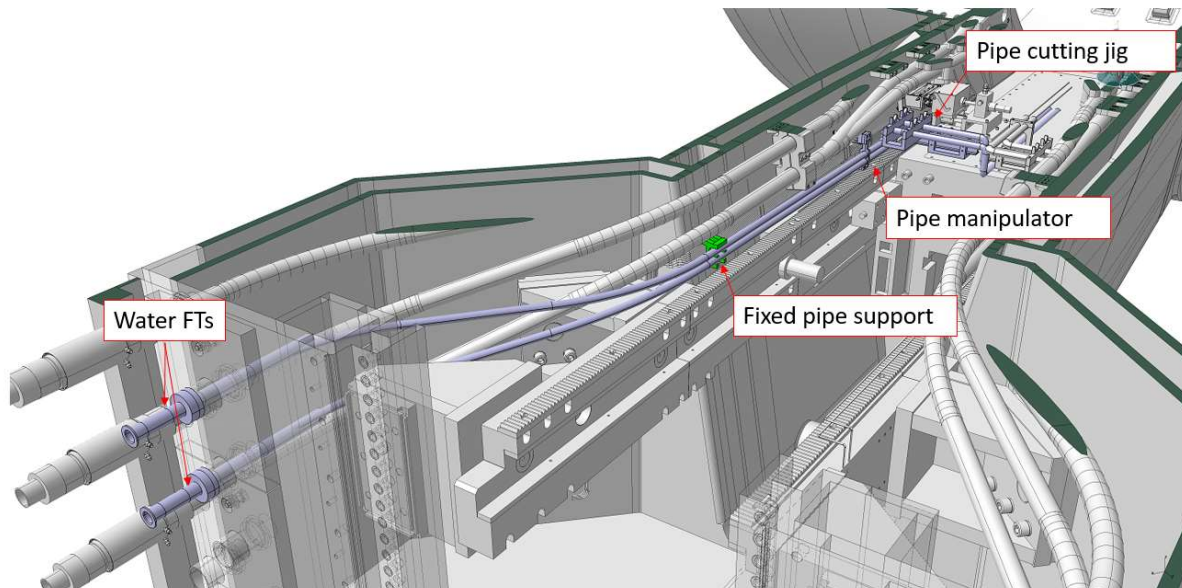


Figure 1: Elements of the in-vessel water system

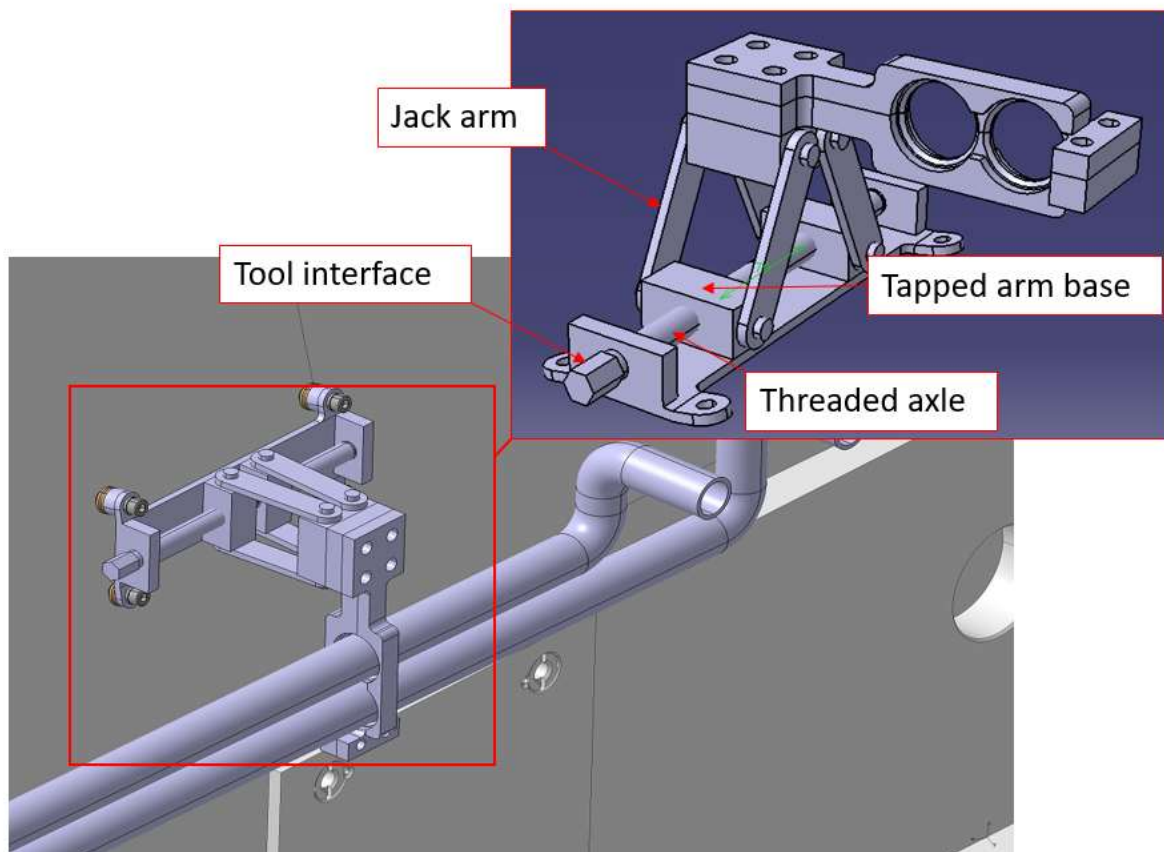
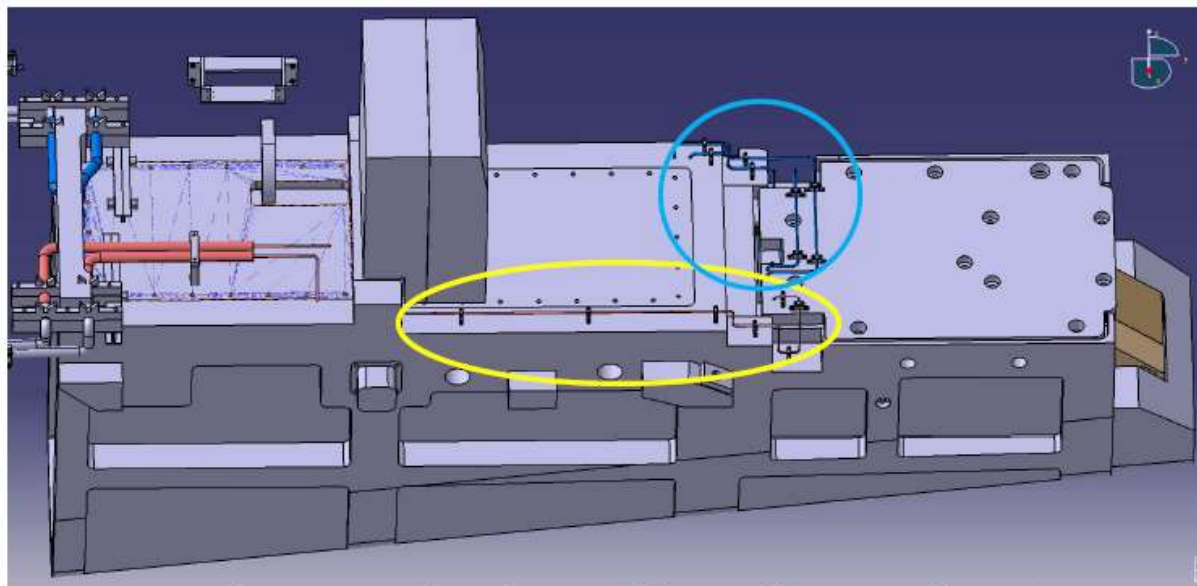
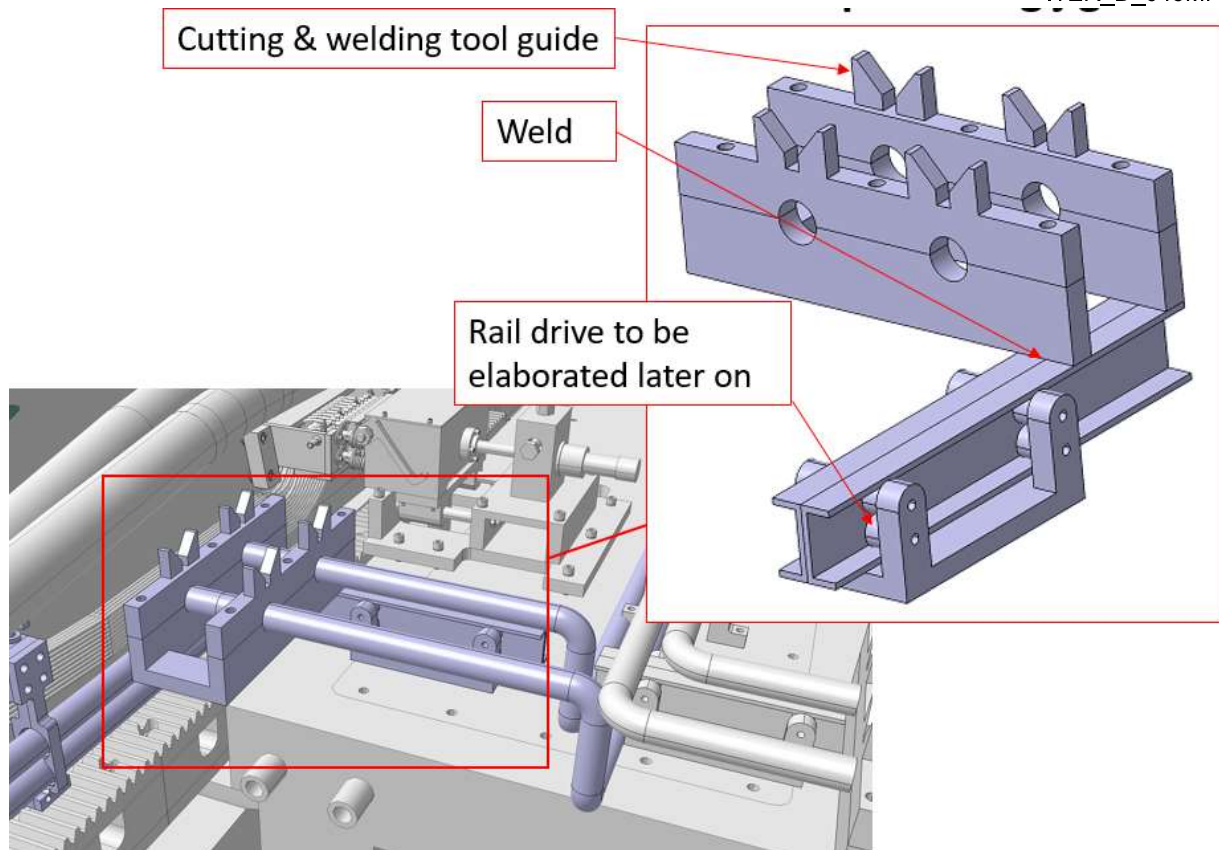


Figure 2: pipe active toroidal adjustable support





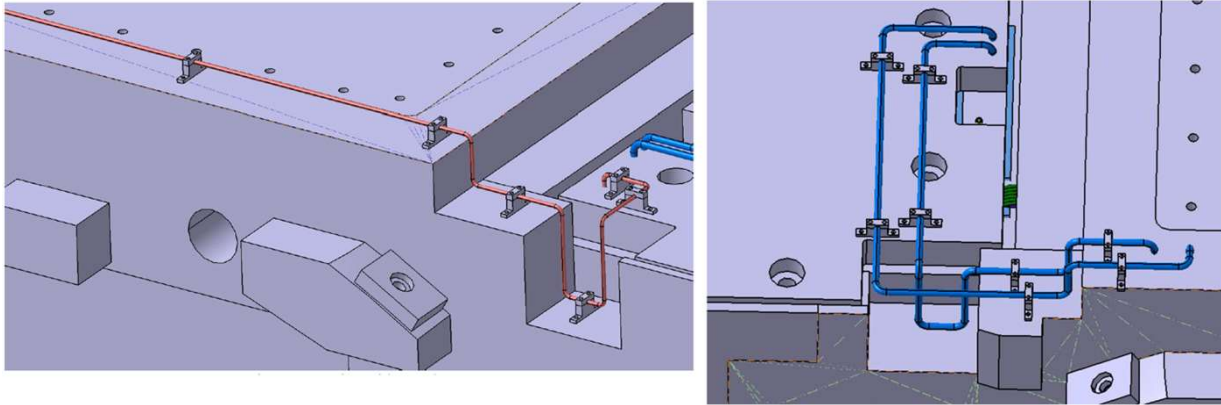


Figure 5: Cu/weld zone for water/gas pipes (HC based operation)

## 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;
- Provide monthly schedule updates for the tasks being worked on by the Contractor;
- 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 rules.

### 7.2 IO's Responsibilities

The IO shall:

- Nominate a Responsible Officer to manage the Contract;
- Organise a monthly meeting(s) on work performed;
- Provide offices at IO premises;
- Review documents in a timely fashion

## 8 List of Deliverables and due dates

Discrete deliverables are listed in **Error! Reference source not found.**, grouped by due dates. Some scope exists for re-ordering the dates of specific deliverables if priorities and scheduling requirements change.

D #	Description	Due Dates
-----	-------------	-----------



D #	Description	Due Dates
D1	Detailed sequence/list of all pipe handling maneuvers, from first installation (even on-site testing and commissioning/assembly) for gas and water connection (VV based). Particular attention to range of displacement of components, required interface loads for manipulation tooling. Work on detailed definition of required tooling (if necessary with supplier). Identify critical issues from previous contract. Study the alternative HC based RH operations concept using larger pipe diameters. Create CAD Enovia when applicable. Report to demonstrate.	T0 +3 month
D2	Detailed testing plan and development plan based on D1. Propose breakdown of testing work packages with definition of layout and observed parameters (technical specification of tests). Continue study other areas needing more engineering justification. Work on detailed definition of required tooling (if necessary with supplier) Create CAD/Enovia where applicable. Produce technical specification for testing.	T0 + 6 months
D3	Assist TRO in the oversight of the testing contract(s). Complete on all required engineering justification of key problems. Prepare a final plan for further mockup activity Output is Enovia CAD data, and final report.	T0 + 9 months
D4	Assist TRO in the oversight of the testing contract(s). Update all related documents, such as assembly plan, interface sheets, testing and commissioning plan, TDF, etc. Propose a configuration on the alternative HC based RH operations concept using (or not) larger pipe diameters.	T0 + 12 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.

## 10 Specific requirements and conditions

The personnel proposed by the Contractor to carry out the work described in Section 6 must have:

- It is foreseen that the work shall require approximately the effort of a single person full time (the work can also be split ie CAD designer/engineer/analyst)
- A professional qualification in engineering with relevant experience in engineering design in a complex technical environment; Experience in cabling and piping
- Facility and proven competence with modern 3D CAD design packages and related software;

- Good technical writing skills;
- Good inter-personal skills;
- The ability to be consistent and work well under pressure with good attention to detail;
- Capability to work in English language, both verbally and written;
- Able to work with partners and the ITER host to define critical needs;
- Ability to align work priorities with overall project schedule;

Experience in any or all of the following areas is required:

- Knowledge of diagnostic systems;
- Design of mechanical components for vacuum environments;
- Experience, knowledge of attachment method for piping,
- Previous experience of working on an international project;
- Experience in working with CATIA v5.0/ ENOVIA and adaptation of models for analysis in ANSYS workbench;
- Experience in following French nuclear safety regulations (see Section 15)

## **11 Work Monitoring / Meeting Schedule**

As summary progress report shall be provided on a monthly basis for acceptance by the IO Responsible Officer.

The progress report shall include the detailed status of each Deliverable.

## **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 \(ITER\\_D\\_22MFG4\)](#).

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 Software qualification policy ([Software Qualification Policy \(ITER\\_D\\_KTU8HH\)](#)).

## **14 CAD Design Requirements**

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 ([ITER\\_D\\_2F6FTX](#)), and with the Procedure for the Management of CAD Work & CAD Data (Models and Drawings [ITER\\_D\\_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\\_D\\_GNIX6A](#) - 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 ([ITER\\_D\\_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 ([PRELIMINARY ANALYSIS OF THE IMPACT OF THE INB ORDER - 7TH FEBRUARY 2012 \(AW6JSB v1.0\)](#)).

Compliance with [Defined requirements for PBS 55 - Diagnostics \(NPEVB6 v2.0\)](#) or its flowed down requirements in [SRD-55 \(Diagnostics\) from DOORS \(28B39L v5.2\)](#) is mandatory.

**NOTE:** There are no Protection Important Activities (PIAs) within the scope of this work but there is monitoring/oversight of Third Parties performing PIAs as part of Work Package A tasks.



