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Technical Specifications (In-Cash Procurement)

IDFI Installation contract - Technical Summary

This document provides a technical summary of the scope of work and contract plan for the In-vessel Diagnostic, Instrumentation & Fuelling (IDFI) Installation.

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1 Purpose

The purpose of this document is to provide technical summary of the scope of work, planning and required competences for the In-vessel Diagnostic, Instrumentation & Fuelling (IDFI) Installation IO procurement.

2 Abbreviations

The following table lists and defines the abbreviations used in this document.

Abbreviation	Definition
ASN	Autorité de Sûreté Nucléaire
IWP	Installation Work Package
MI	Mineral Insulated
PIA	Protection Important Activity
PIC	Protection Important Component
UHV	Ultra High Vacuum
VV	Vacuum Vessel

Table 1: Abbreviations and Acronyms

3 The ITER Project

For a complete description of the ITER Project, covering both organizational and technical aspects of the Project, visit www.iter.org.

3.1 The ITER Facility

The ITER Facility is currently under construction in Cadarache area, in the south of France. Central to the facility is the Tokamak Complex, a nuclear rated structure in reinforced concrete that comprises three integrated buildings, Figure 2. The Complex has a footprint of 118 x 81 m, extends vertically from -15 m to +40 m relative to ground level, and contains the plant systems that service (power, heat, cool, condition, fuel, monitor and control) the Tokamak.

To support the assembly of the Tokamak machine there is a steel-framed Assembly Building and Cleaning Facility, arranged to form a continuous working space.

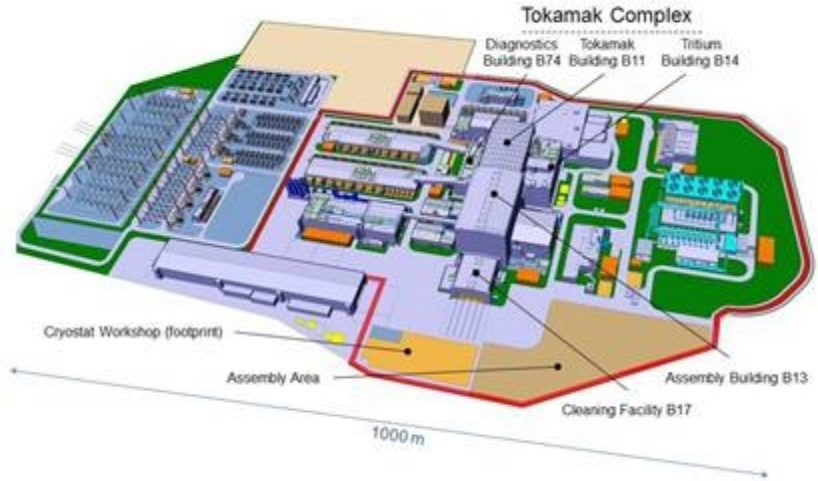

Figure 2: Layout of the ITER Site

3.2 ITER Machine Assembly Process

The overall assembly process is illustrated at the highest level in Figure 3.

The Tokamak is assembled from nine (9) sectors, each encompassing a toroidal angle of 40°, and comprising a 40° VV sector, two TF Coils, a 40° VV Thermal Shield sector, and the associated interconnections and supports. The components are delivered to the site individually, and sub-assembled into sectors using purpose-built jigs and fixtures in the Assembly Building *(Assembly Sequence A2)*.

Prior to the sector installation in the Tokamak pit, the gravity supports, lower cryostat sections, and the components which cannot be installed following final assembly of the sectors, principally the lower poloidal field coils, lower correction coils, the lower and side correction coil feeders, and the lower pre-compression rings, are installed or temporarily stored within the cryostat base *(Assembly Sequence A1)*. In parallel, components of the feeders for the superconducting magnets are installed in the lower level gallery of the Tokamak Building.

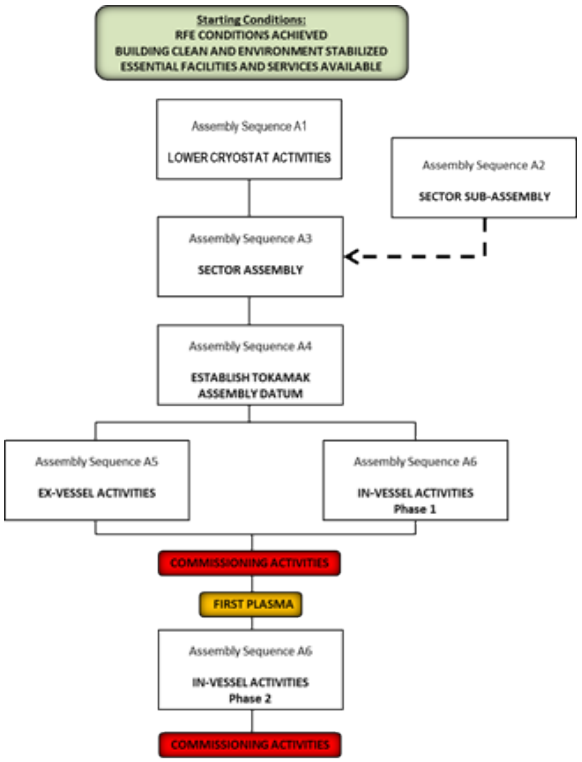

Figure 3: Tokamak Assembly Process

The sectors are then transferred to the pit sequentially where, following alignment, the TFC's are attached to their permanent supports and connected sequentially, the VVTS sectors are also connected sequentially, whereas the VV sectors are joined (welded) according to a plan which aims to minimise deformations, and the associated technical risk. Following installation of the final sector the VV is closed toroidally with the simultaneous welding of the last 2 sectors field joints (*corresponding to the end of Assembly Sequence A3)*

The permanent VV Gravity Supports are positioned and attached to the VV and Cryostat. The TFC pre-compression rings are then installed in their final position, and the preload applied to each of the coils. A detailed dimensional survey at this stage provides the geometrical estimate of the magnetic datum for the as-built TF magnet, and this is used as reference for all subsequent alignment operations. The major Sector Assembly Tools are disengaged and removed from the pit to allow the subsequent assembly sequences to proceed *(corresponding to the end of Assembly Sequence A4).*

The completion of the installation of the ex-vessel components proceeds with completion of the Cryostat in parallel (*Assembly Sequence A5).*

Internal VV access is via selected horizontal ports at the lower (divertor) and equatorial levels. Clean conditions are established inside the vessel, and the installation of the Phase 1 in-vessel systems is performed *(Assembly Sequence A6)* in parallel with A3/A4 and A5 sequences. **The scope of work of this Procurement is part of A6 Assembly process.**

4 Procurement Description

The present description only applies to In-Vessel Diagnostic, Instrumentation & Fuelling (IDFI) scope.

The IDFI scope falls into A6 Assembly process and covers around one-third of the full A6 scope of work.

4.1 Scope of Procurement

The scope to be performed under this Procurement will consist of the preparation, qualification, execution, control and documentation of the permanent works, plus any temporary works required to achieve the permanent works.
The Contractor shall demonstrate experience and compliance with the highest standards in project and contract management ensuring that the objectives for schedule, cost and quality related to the contract scope execution are met. The Contractor shall comply with all instructions and requirements during the execution of the contracts and shall put in place an accurate quality management system.

The Scope of Works of this Procurement includes:

- Project and Contract Management;
- Development of Installation Work Packages (IWPs) from the documentation provided by IO;
- Identification, definition and provision of any required temporary works required to complete the permanent works, such as, lighting, protection, temporary access, safety equipment, standard tooling, etc.;
- Design, procurement and maintenance of purpose-built tooling, including the maintenance of IO supplied tooling;
- Provision of offsite, custom machining facilities; custom machining of IO supplied components;
- Qualification of works and methods as a result of a contractor's IWP development including the necessary mock-ups;
- Provision of all consumables and accessories required to complete the works;
- Execution of the permanent works on site in accordance with the Project schedule;
- Performance, and documentation of all required installation tests and verifications;
- Preparation and issue of detailed as-built drawings, specifying dimensions achieved.

The Contractor's personnel shall have access to the ITER facilities as allowed by the IO.

4.2 Contracting strategy

The IDFI scope is split into four different work packages :

1. Process development and qualification of the In-Vessel Diagnostics cable looms assembly and clips welding (off-site preparatory activity);
2. Development and implementation of a full-size assembly mock-up into the ITER Trial Test and Training Facility (TTTF) (on-site preparatory activity);
3. On-site installation at Vacuum-Vessel (VV) Sector level (IDFI Phase 1);
4. Completion of on-site installation scope, after the VV Sectors welding is completed (IDFI Phase 2).

The current contracting strategy is to proceed through progressive contracting via different tender procedures (which can be Restricted Tenders based on Market Survey outcomes) resulting into different successive contracts. The IO intent is to narrow the competition based on demonstrated competences and capacities until the selection of one Industrial Partner for the award and the delivery of works packages #3 and #4.

4.3 Procurement Periods and Duration

The summary schedule is based on activities executed with 2 shifts per day of 7.5 productive hours per shift, 6 days per week. The night shift is considered to be used for hazardous activities like Radiographic Testing (generating exclusion zones).

The main execution periods to be considered are the following (precise scope and duration of each period will be confirmed at the related tender stage):

Work Packages	Scope of work	Expected start date	Provisional duration
1	Process development and qualification (off-site preparatory activity)	Q1-2025	6 months
2	Full-size assembly mock-up in ITER TTTF (on-site preparatory activity)	Q3-2025	3 months
3	IDFI Phase 1 – Installation at VV Sector level	Q4-2025	24 months
4	IDFI Phase 2 – Installation completion after VV Sectors welding (*)	Q3-2030	16 months

(*) VV Sectors welding will be happening between IDFI Phase 1 and IDFI Phase 2.

4.3.1. Process development and qualification

An overall description of the work is presented (but not limited to) below:

- Specification and preparation of tests for diagnostic cable looms installation.
- Execution of cable looms installation in the chosen configurations including dimensional and functional verification at the end of each cable installation cycle.
- Preparation of related documentation: test set up description, test programme, operating manuals of the tools, test reports etc.

The above mentioned work is to be carried out in full at the Contractor's premises.

4.3.2. Development and implementation of a full-size assembly mock-up

The scope of work will cover the entire development and implementation of a full-size assembly mock-up of the In-Vessel Diagnostic cable looms and In-Vessel Instrumentation into the ITER Trial Test and Training Facility (TTTF).

This activity will be carried out at ITER premises, in south of France.

An overall description of the work is presented (but not limited to) below:

- Preparation of the TTTF for the individual cables and cable looms installation tests. Note: IO will procure and install in TTTF the hardware mimicking the VV and port areas in the most challenging configuration(s).
- Execution of cable looms installation in the chosen configuration(s), dimensional and functional verifications.
- Preparation of the related documentation: test set up description, test programme, detailed cable looms installation procedures, operating manuals of tools etc.

4.3.3. IDFI Phase 1

This package will start once the first two (2) Vacuum Vessel Sectors are installed and aligned in the ITER pit. At that time, the corresponding Vacuum Vessel inner area is accessible to the Contractor with a minimized co-activity for proceeding with the works.
The IDFI Phase 1 covers the installation work happening on each individual VV Sector and primarily In-vessel Diagnostic systems, such as looms, flux loops, magnetic sensors, and In-Vessel Instrumentation, such as Rogowski coils, optical sensors and thermocouples.
The Contractor will proceed to the installation of IDFI equipment progressively, whenever new VV Sectors are installed and aligned into the pit.
The main type of activities to be carried out during this Phase are (but not limited to): MI cables and optical fibres pulling and bending, welding and crimping of metallic clips, welding of optical sensors, non-destructive testing, assembling of supports for cables and sensors, etc.

4.3.4 IDFI Phase 2

This package will start once all the nine (9) VV Sectors are welded together.
The IDFI Phase 2 covers the installation work happening on the complete VV torus and in the ports, primarily waveguides, micro-fission chamber, neutron activation system, as well as pellet and gas injection systems and in-service inspection. This work constitutes the completion of the full IDFI installation scope,
In-Port assembly work will start after the first Lower Port extensions welding are being completed and will progress in parallel and following the sequence of Port extension welding sequence from Lower Ports to Upper Ports and then Equatorial Ports. Multiple teams working in parallel on several ports are considered and work is performed in co-activity with the Port extension welding but also with the installation of the In-Vessel Coils works.

5 Required Competences

The tokamak fusion reactor system integrates a uniquely extensive variety of high technologies in its design. The competence and experience of the Contractor, and the ability, experience, and training of their engineering and construction team will have a direct influence on quality, re-work, and schedule. The Contractor will be required to demonstrate competence and experience in a number of key areas including the engineering capacity to develop and qualify fit-for-purpose assembly processes.
Core competences are:

- Assembly Tooling
- Clean Conditions Working
- Mechanical and Electrical Codes and Standards
- High Vacuum and Ultra-High Vacuum
- Occupational Safety
- Bending, forming and precision Assembly of Mineral insulated cables
- Process Development and Qualification
- Quality Assurance / Quality Control
- Regulated Construction
- Welding
- Inspection and Non-Destructive Examination
- Instrumentation Installation
- Metrology
- Lifting and Handling, up to 1000 kg

- Reverse Engineering, Customisation and Precision Machining, Workshop
- Tooling Maintenance, Storage and Preservation

The remaining competencies may be obtained by sub-contracting subject to the limit which will be specified at the tender stage, in which case the Contractor or Consortia will be required to identify staff members for the area of competence sub-contracted to guarantee adequate technical supervision.

Important note: ITER is classified as a nuclear facility (INB-174), thus is subject to strict regulation of work and quality. The ITER Project is under the jurisdiction of the Autorité de Sûreté Nucléaire (ASN).

Activities identified as Protection Important or Safety Relevant (French Order of 7 February 2012) will be subject to additional surveillance. Relevant experience to the French Order is a requirement.

It is important to note that not all Tokamak Assembly activities will be Protection Important or Safety Relevant, and the level of surveillance for these activities will be as indicated by the Quality Classification System. The Contractor shall ensure at any point in time and throughout the whole assembly and installation process that the IO requirements are properly propagated and verified including the complete chain of sub-contracted services and works.