Technical Specifications

For

Project, integration of ITER Neutron Diagnostics

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1 Purpose

This document describes technical needs of ITER/TED/PPD Division, with reference to the technical oversight of design, engineering, project and integration design and follow up activities of the-**Neutron Diagnostics systems**.

2 Background and Objectives

ITER is a major new device that is under construction at Cadarache, near Marseille, in the South of France.
The ITER Organization (IO) is bringing together people from all over the world to be part of this unique project and to contribute to building the ITER device which requires the best people from many disciplines. The work environment is flexible and dynamic with opportunities to work closely with many people and cultures from around the world. The device (figure 1.) will study the potential of controlled nuclear fusion to provide energy for the future of mankind. In order to study the behaviour of this device, a set of monitoring systems (called Diagnostics) are required.
The success of ITER will come through its ability to produce large amount of high energy neutrons, i.e. fusion power, for long time.
These measurements are carried out by means of the Neutron Diagnostics systems.
In particular, measurements of neutron emission and fusion power are essential for achieving ITER goals, in particular the fusion gain factor, Q, related to the reactor performance as well for plasma control, machine protection and for plasma optimization.
The work described below is related to the project, integration, engineering support needed for the Neutron diagnostics.

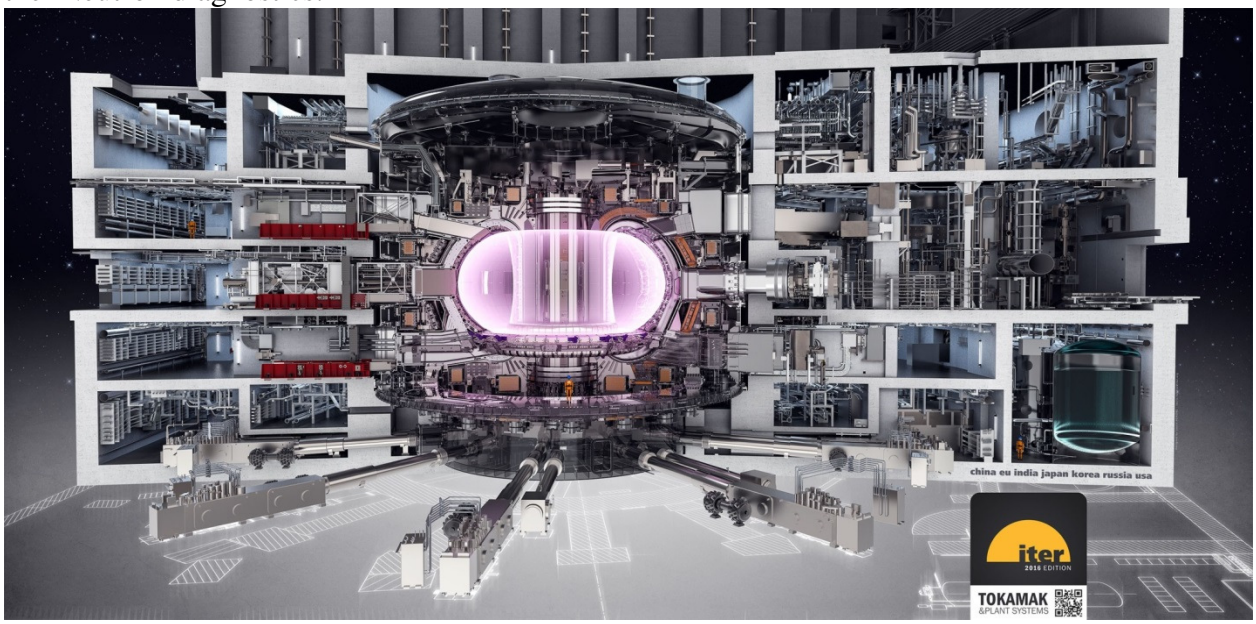

Figure 1. ITER Tokamak

The Neutron Diagnostics will provide important information on ITER DD and DT plasmas performance like fusion power, neutron/gamma emission and related energy distribution functions as well total neutron flux and fluence on the First Wall, fuel ratio, core ion temperature.

The neutron emission in ITER is expected to span a range of 7 orders of magnitude – from 10^{14} with DD plasmas up to 10^{21} neutrons per second with DT plasmas. The accuracy required for the measurement of the neutron emission is 10% with temporal resolution of 10^{-3} seconds.

An extensive set of neutron diagnostic systems are installed on ITER: neutron flux monitors, Activation system, Neutron Cameras and Spectrometers.

Fig 2 shows the neutron complex, i.e. the parameters to be measured by means of different neutron detection techniques.

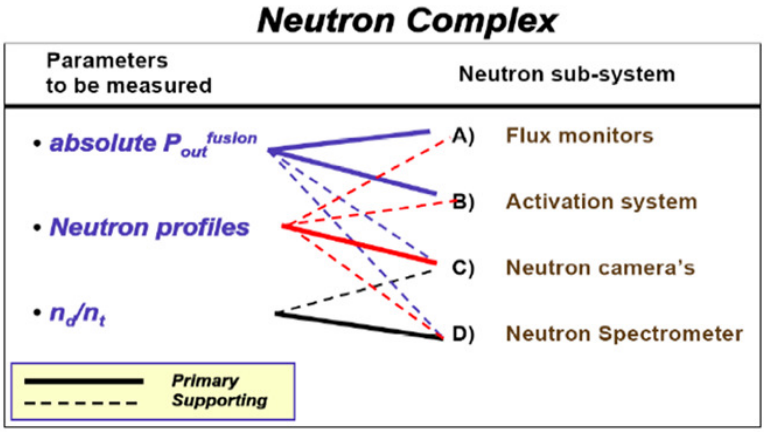

Figure 2. Neutron Complex

In designing the diagnostics systems one has to take into account the quite challenging ITER environment with high neutron flux (up to 10^{14} n/cm^{2}s with 14 MeV neutron energy), high temperatures due to plasma radiation and nuclear heating (up to 1000 C) and magnetic field (up to 6 T) as well high transient magnetic field causing large forces and significant electromagnetic noise due to the auxiliary heatings.

In fig.3 are shown all Neutron Flux Monitors (NFM) positioned in different Tokamak locations, for the measurement of the fusion power/total neutron yield.

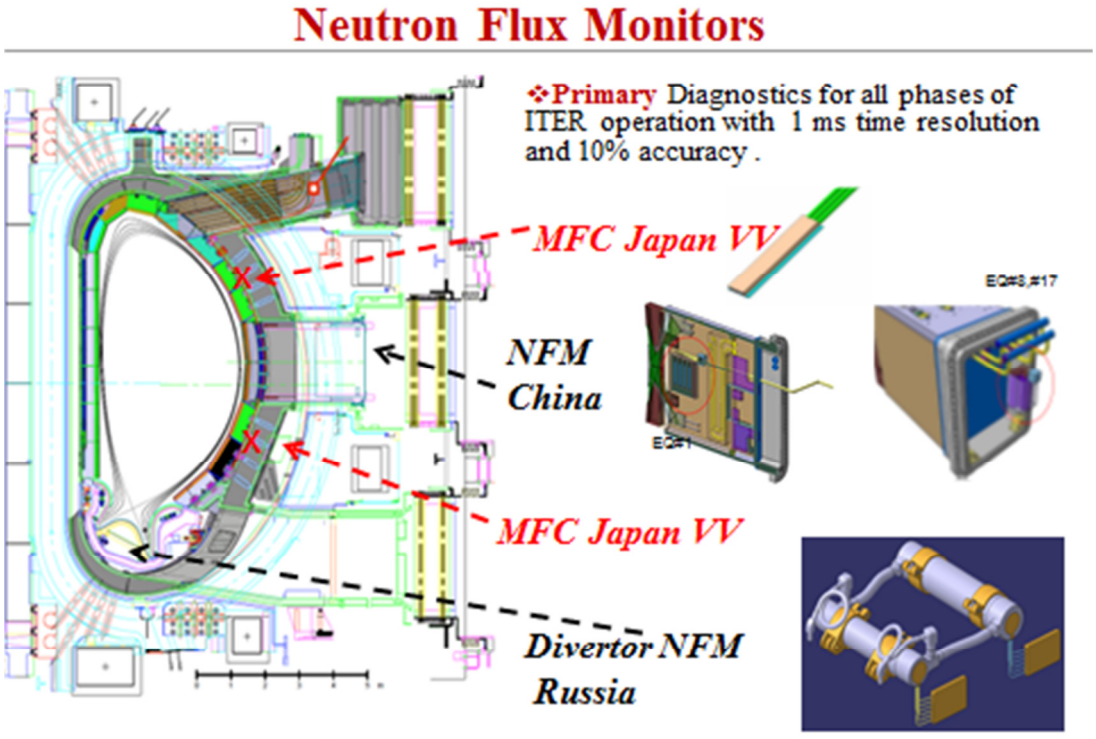

Figure 3. Neutron Flux monitors at ITER

An important diagnostics is the Neutron Activation System (NAS) which is the unique neutron diagnostic able to measure the whole neutron emission range with a dynamic range of 10 orders of magnitude due to appropriate selection of mass and foils materials.

An essential activity is the integration of the diagnostics with the other ITER Systems like Vacuum Vessel, VV(see fig. 4) and Diagnostics ports.

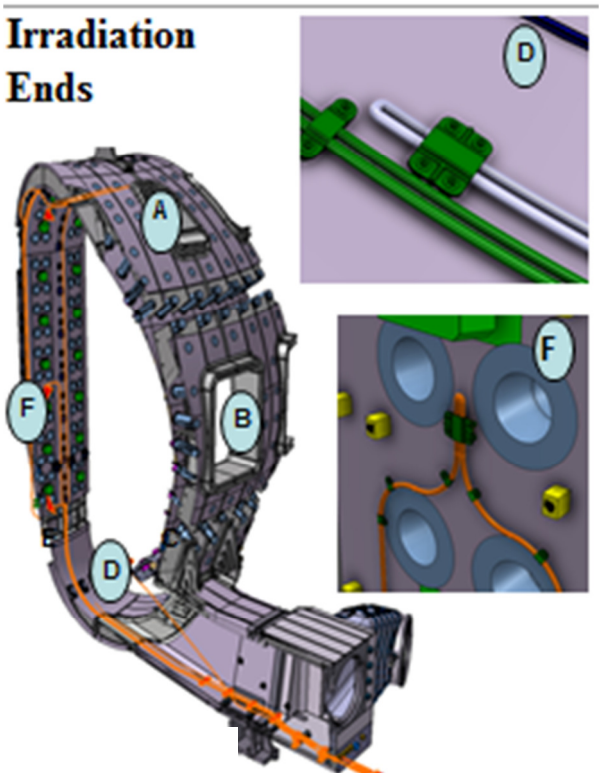

Fig. 4 NAS Irradiation Ends in the VV

3 Scope

The primary objective of this engineering activity is to provide expertise on the ITER Neutron Diagnostics in the technical oversight of design -engineering, project and integration design, including preparation of design reviews and their follow-up. Other elements of design and R&D work are also likely.

The objective of this contract is:

- Lead the design development of neutron diagnostics;
- Support the Diagnostics IO and DA teams in the evaluation and development of neutron diagnostics from design phases up to their delivery to IO site;
- Preparation (from both technical and organizational perspective) and associated follow up work, of design reviews, including all follow- up and documentation activities as appropriate;
- Coordinate Design Reviews;
- Lead risks identification and management
- Work on interfaces with the Construction teams and Port Integration teams to ensure implementation of the systems as required.

- Coordinate in the interfaces management of Neutron diagnostics with all other ITER PBS
- Advise the procurement of the neutron diagnostics systems.
- Lead the activity of assembly and installation of neutron/gamma diagnostics systems;
- To contribute to the development and realization of the neutron calibration strategy;

There will be a requirement to liaise with IO personnel and particular external teams over the period of the contract. It will be necessary to collect inputs from these teams and use them to generate internal IO documentation.

4 Definitions

IO: ITER Organization

DA: Domestic Agency

TRO: IO Technical Responsible Officer

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

5 References

Links inserted in text.

6 Duration

The duration of the contract is 1 year from the contract start date.

7 Work Description

The work involves technical knowledge particularly for neutron diagnostics and Port integration projects. The work to be done is in collaboration with the IO Technical Responsible Officer (TRO). It involves many areas of activity that have to be documented

- To facilitate Design Reviews activity concerning Radial Neutron Camera (RNC), Microfission Chambers (MFC), Radial Gamma Spectrometers (RGRS), Neutron Activation System (NAS), High Resolution Neutron Spectrometers (HRNS)and other systems as required
- To develop technical design of the interfaces and integration of the neutron diagnostics with the tokamak, particularly for the systems above mentioned;
- To develop accurate interface documentation, schematics plans and databases;
- To contribute with the design and reviews activities of Neutron Diagnostics
- To review technical designs/models and reports from Domestic Agencies
- To maintain commitment to the Protection Important Activities and to requirements of the INB order 7th February 2012 and to propagate them to the Domestic Agencies;
- Document work as required: reports of the activity carried out, conferences reports and documentation required by STAC, MAC, TED/PPD Diagnostic division
- Promote safety and quality at all times in all job site activities.
- Ability to provide and deliver documentation in appropriate way

- Contribution of own ideas and proposals aiming to support the Diagnostic advancement

IO will provide all IO IDM, CAD (Enovia, SSD) and all other relevant database/documents for performing the above mentioned activity.

8 Responsibilities

Services to be provided 100% at IO site.

The ITER Organization may request Contractor to travel and work at places other than ITER site.

8.1 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;

• 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.

8.2 IO's Responsibilities

The IO shall:

• Nominate the Responsible Officer to manage the Task Order;

• Organise meetings on work performed;

9 List of Deliverables and due dates

Based on Sections 3 and 7 following deliverables will be provided:

Deliverable		Due date
1	Support DA on PDR-2 Preliminary Design Review of the NAS Port Plug Components (EQ11, EQ17 and U11) and FDR-1 Final Design Review of Ex vessel lines: Provide Input Package list; Manage and Complete Interfaces documentation; organize and coordinate the safety records and provide safety documentation update; contribute to the Factory Acceptance Test and provide the requirements doc for Site Acceptance Test Phase. Provide final update of Input Package list for DR close-out; Provide the Close-out reports of the PDR-2 and FDR1 meetings reviews.	T.0 +3 months
2	Support DA on the FDR-2 Final Design Review of MFC in-vessel (end termination and connector) and on the FDR-3 of MFC in-vessel (clamps and feed-out). Support DA for the related Manufacturing review activity:	T.0 + 6 months

	Provide Input Package list; Manage and Complete Interfaces documentation; organize and coordinate the safety records and provide safety documentation update; contribute to the Factory Acceptance Test and provide the requirements doc for Site Acceptance Test Phase. Provide final update of Input Package list for DR close-out; Provide the Close-out reports of Design reviews (FDR2 and FDR3 and MRR) .	
3	Lead the Tangential Neutron spectrometer (TNS) Conceptual Design Review: Provide Input Package list; Manage and deliver Interfaces documentation; organize and coordinate the safety records and provide safety documentation update; deliver reports on the TNS project along the Input package list; contribute to the Port Plug Integration of EQ#8 Provide final update of Input Package list for DR close-out; Provide the Close-out report of TNS of meeting review.	T.0 + 8 months
4	PDR of the Radial Neutron Camera (RNC): Manage the progress of the design of the RNC in cooperation with DA. Prepare and support DA on Preliminary Design Review: Provide Input Package list; Manage and complete Interfaces documentation; organize and coordinate the safety records and provide safety documentation update; contribute to the Factory Acceptance Test and provide the requirements doc for Site Acceptance Test Phase. Provide final update of Input Package list for DR close-out; Provide the Close-out report of the RNC PDR meeting review.	T.0 + 11 months
5	Executive summary of the performed activities and to draft next steps of engineering, project and integration design, for support to the Port Plug Diagnostics Division	T.0 + 12months

*The acceptance criteria for each of the deliverables shall be a report submitted to IO for approval by the IO TRO and uploaded into IDM.

The reports shall have appendix with a complete list of all relevant IO IDM, CAD (Enovia, SSD) and all other relevant database references with version number.

10 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, Table of deliverables.

11 Specific requirements and conditions

- Education to a PhD degree level or equivalent
- Knowledge and experience of neutron/nuclear diagnostics;
- Demonstrated Experience on nuclear, plasma or high energy physics facilities;
- Demonstrated Experience on engineering aspects and interfaces / integration of neutron diagnostics on tokamak;
- Demonstrated experience in managing tokamak diagnostic projects
- Demonstrated Knowledge of ITER neutron diagnostics systems
- Knowledge of ITER requirements and guidelines;
- Experience in working with CAD/ENOVIA models and Schematic diagrams;
- Experience in specifications for procurement and System requirements management;
- Demonstrated Experience in working within international organizations;
- Ability to Technical documents generation;

12 Work Monitoring / Meeting Schedule

Work is monitored at monthly project meetings and through the acceptance of ach of the four deliverables.

13 Delivery time breakdown

See List of Deliverables section.

14 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).

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

[ITER_D_7GJHSE - Order dated 7 February 2012 relating to the general technical regulations applicable to INB - FR].