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BH5587

VERSION CREATED ON / VERSION / STATUS
18 Oct 2024 / 1.0 / Approved

EXTERNAL REFERENCE / VERSION

Technical Specifications (In-Cash Procurement)

CFE for Mechanical Engineering Design and Manufacturing for the EC system

This Technical Specification defines the skills and capabilities required in a mechanical engineer expert candidate to provide technical support for the mechanical design and manufacturing of the different subsystems of the Electron Cyclotron (EC) System

Technical Specifications

CFE for Mechanical Engineering Design and Manufacturing for the EC system

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1 Preamble

This Technical Specification is to be read in combination with the General Management Specification for Service and Supply (GM3S) –[1] that constitutes a full part of the technical requirements.

In case of conflict, the content of the Technical Specification supersedes the content of [1].

2 Background

The EC system aims at delivering up to 20MW for plasma heating and current drive (H&CD) applications, with a capability of an additional 20 MW by future upgrade (40 MW in total). In order to achieve 20MW of delivered power, the EC system has an installed power of 24MW.

The EC system is comprised of seven main sub-systems:

- High Voltage Power Supplies (HV),
- High Power Microwave Sources (RF),
- Evacuated Transmission Lines (TL),
- Ex-vessel Waveguides (EW),
- Equatorial Launcher (EL),
- Upper Launchers (UL),
- EC Control system (CS).

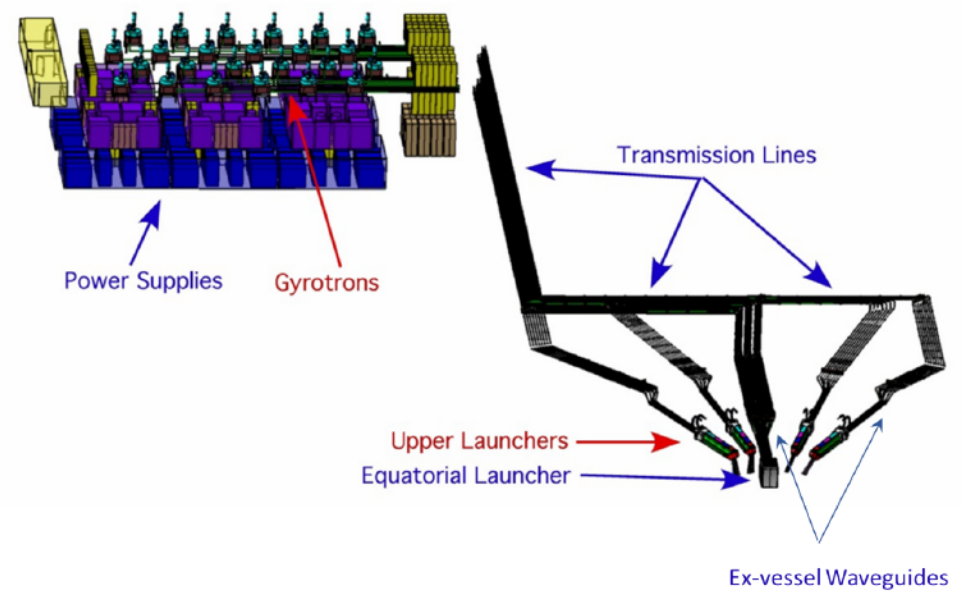

Figure 1: EC system main subsystems

The EC system is housed in three buildings: the RF Heating Building (B15), the Assembly Hall Building (B13), and the Tokamak Building (B11). Most of the power system is in the south side of B15, where the effects due to the stray magnetic field from the Tokamak are minimized. The TLs routing through the three buildings was chosen to minimize the number of miter bends, which are a principal source of power loss and mode conversion.

The EC system is equipped with four upper launchers (UL) of 8 MW microwave power input capable each with the main aim to provide NTM control and assist in the plasma breakdown and burn-through. It also contributes, together with the equatorial launcher (EL), to provide

pure heating. The EC system is equipped with an EL able to inject up to 24MW microwave power mainly for central heating and current drive.

The four ULs are installed in upper ports 12, 13, 15 and 16, the last one being used for first plasma. The EL is installed in equatorial port 14. See figure below.

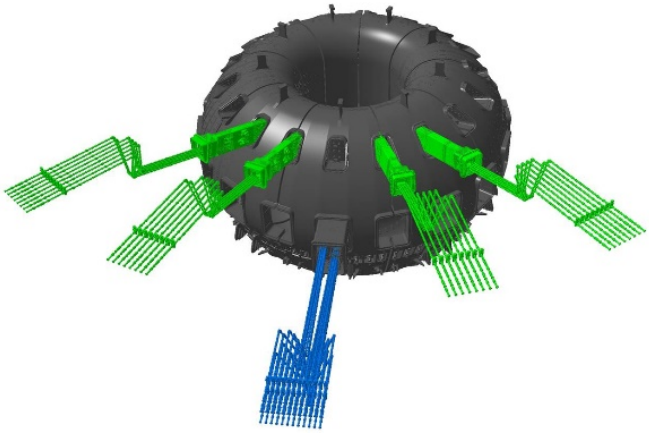

Figure 2: Location of EC launchers: UL12, 13, 15, 16 and EL14

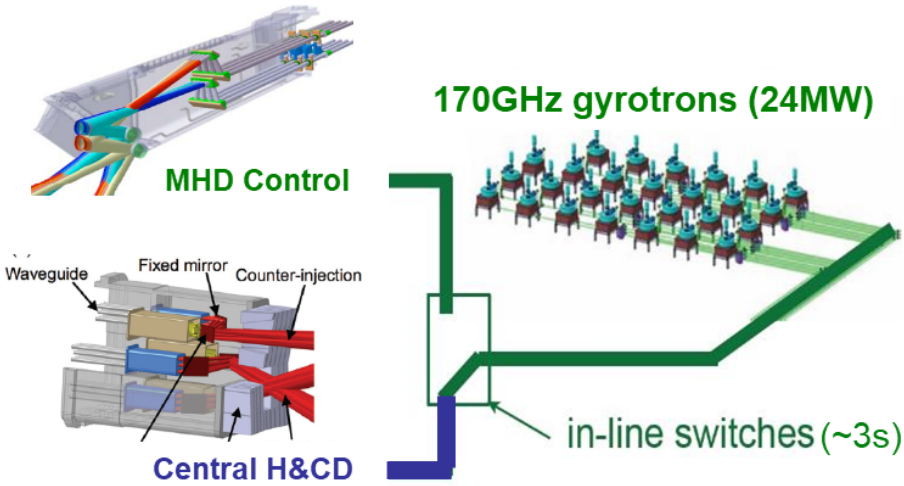

Figure 3: Overall view of power injection and functionality of EC launchers

The last portion of waveguides connecting to the launchers and forming part of the first confinement barrier mainly forms the Ex-Vessel Waveguides system. This system includes a series of RF components and the corresponding ancillaries. Being part of the first confinement barrier most of the EW components are PIC classified as SIC-1.

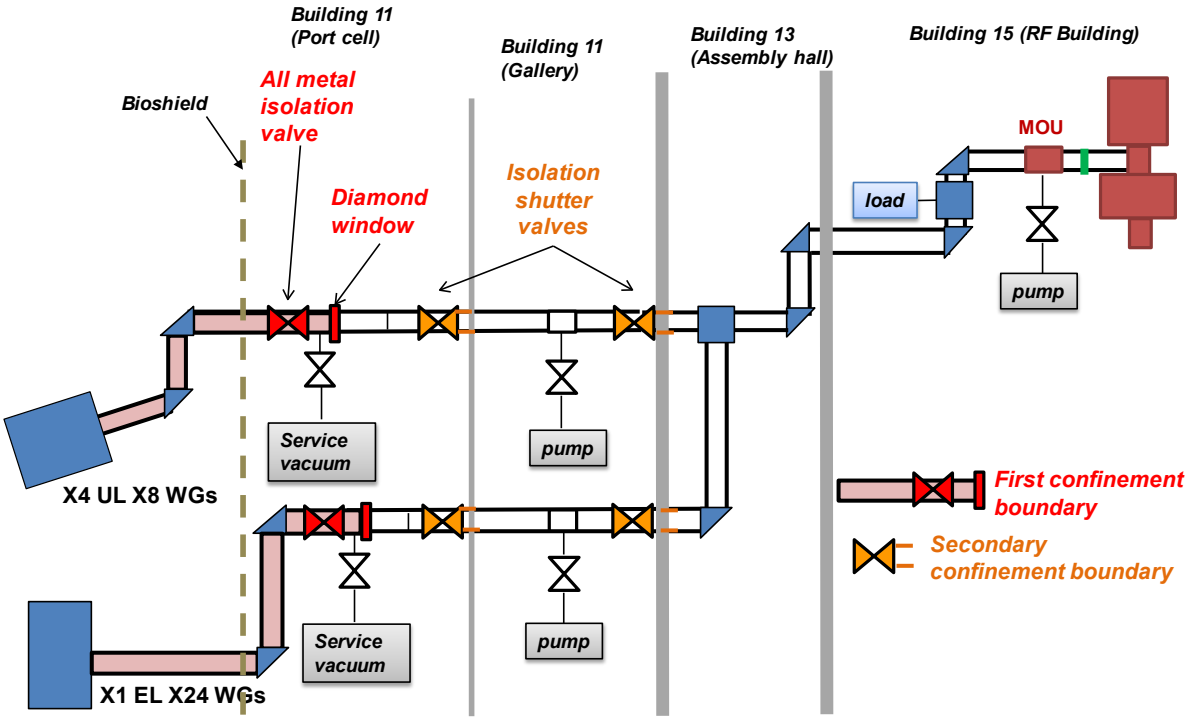

Figure 4: Overall layout and confinement strategy. First confinement barrier formed by EW system is highlighted in red. *Note that there are two miter bends that form part of first confinement barrier (from port plug up to the diamond window), and therefore SIC-1. They are represented in blue in the figure.*

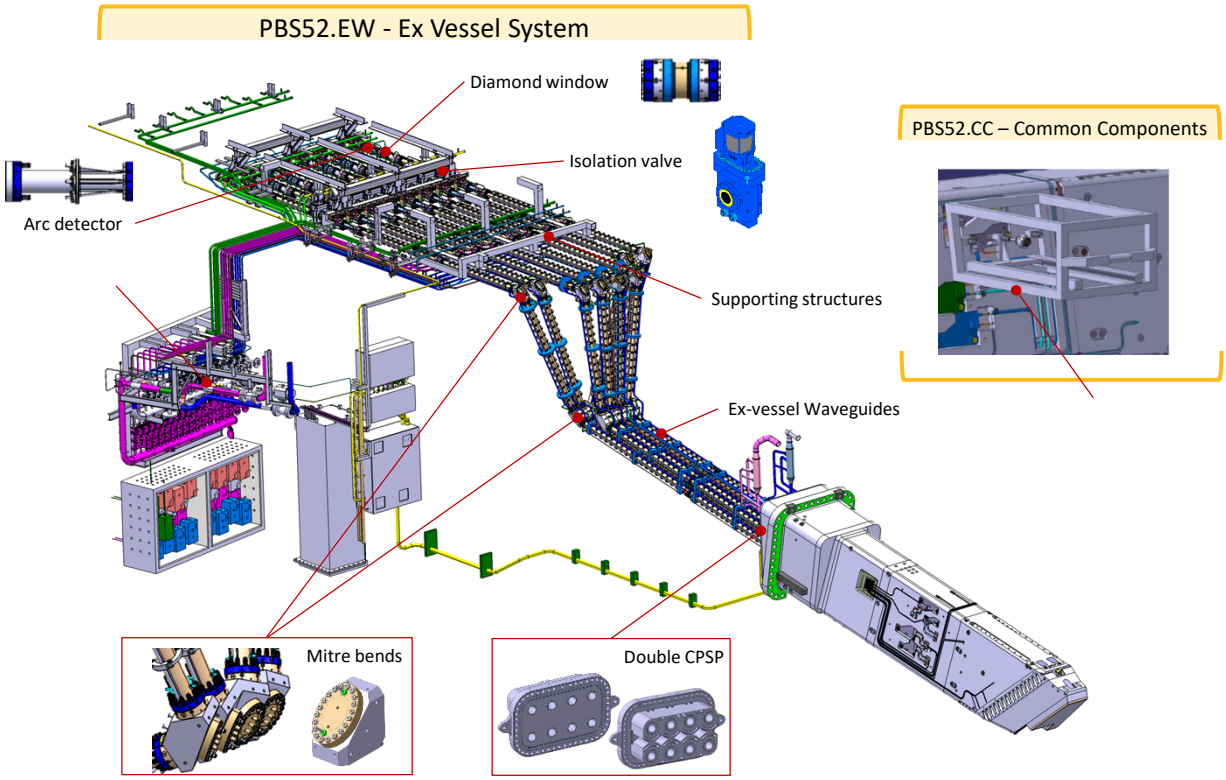

Figure 5: Overall architecture of EW and UL systems

More details about the design and status of development of different components can be found in the references [8][9][10][12].

3 Purpose

This Technical Specification defines the skills and capabilities required in a mechanical engineer expert candidate to provide technical support for the mechanical design and manufacturing of the different subsystems of the Electron Cyclotron (EC) System.

4 Acronyms & Definitions

4.1 Acronyms

The following acronyms are the main one relevant to this document.

Abbreviation	Definition
CAD	Computer Assisted Design
CRO	Contract Responsible Office
CS	Control System
DA	Domestic Agency
DCIF	Design Collaboration Implementation Form
EC	Electron Cyclotron
EL	Equatorial Launcher
EW	Ex-vessel Waveguides
EWP	Engineering Work Package
FDR	Final Design Review
H&CD	Heating and Current Drive
HV	High Voltage
IO	ITER Organization
JADA	Japanese Domestic Agency
PBS	Plant Breakdown Structure
PBS52	EC System
PBS 52.UL	Upper Launcher system
PBS 52.EL	Equatorial Launcher system
PBS 52.EW	Ex-vessel Waveguides system
PBS 52.TL	Transmission Lines system
PC	Port Cell
PIA	Protection Important Activity
PIC	Protection Important Component
PRO	Procurement Responsible Officer
QA	Quality Assurance
RF	Radio Frequency
SIC	Safety Important Class

Abbreviation	Definition
SLS	System Load Specifications
TL	Transmission Line
TRO	Technical Responsible Officer
UL	Upper Launcher
WP	Work Package

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

4.2 Definitions

Contractor: shall mean an economic operator who have signed the Contract in which this document is referenced.

5 Applicable Documents & Codes and standards

5.1 Applicable Documents

This is the responsibility of the Contractor to identify and request for any documents that would not have been transmitted by IO, including the below list of reference documents.

This Technical Specification takes precedence over the referenced documents. In case of conflicting information, this is the responsibility of the contractor to seek clarification from IO.

Upon notification of any revision of the applicable document transmitted officially to the contractor, the contractor shall advise within 4 weeks of any impact on the execution of the contract. Without any response after this period, no impact will be considered.

Ref.	Title	IDM DOC ID	Version
[1]	General Management Specification for Service and Supply (GM3S)	ITER_D_82MXQK	1.4
[2]	SRD-52 (ECH&CD) from DOORS	ITER_D_28B365	5.4
[3]	sSRD-52-UL Sub SRD Upper Launchers	ITER_D_YEWRRM	1.5
[4]	Sub SRD Ex-vessel Waveguides	ITER_D_YPZPKZ	1.1
[5]	sSRD-52-EL Sub SRD Equatorial Launcher	ITER_D_8SRU9K	1.0
[6]	Sub-system Requirements Document (sSRD) EC Transmission Line PBS 52.TL	ITER_D_SMZ5LK	2.4
[7]	EC H&CD Transmission Line Component Quality Classification	ITER_D_35R67C	3.3
[8]	52.UL_DDD_Upper Launcher Design Description Document	ITER_D_YSTY8W	1.4
[9]	Description of the input design of the Upper Launcher and Ex-vessel Waveguides systems	ITER_D_42CJSA	1.4
[10]	Draft of the 52.EW DDD	F4E_D_2MW3RK	2.3
[11]	EC EL Plug subsystem Load Specification	ITER_D_NNQAQG	3.7
[12]	ECH Transmission Line Subsystem Design Description Document (sDDD)	ITER_D_6YHNJB	2.1

Ref.	Title	IDM DOC ID	Version
[13]	Order dated 7 February 2012 relating to the general technical regulations applicable to INB - EN	ITER_D_7M2YKF	1.7
[14]	Provisions for Implementation of the Generic Safety Requirements by the External Interveners	ITER_D_SBSTBM	2.2
[15]	Software Qualification Policy	ITER_D_KTU8HH	2.0

5.2 Applicable Codes and Standards

Not applicable.

6 System Classification

Table 1 below summarizes the ITER Classifications of the EC Upper Launchers (UL) and Equatorial Launchers (EL) as per [3][5].

Table 1: ITER classifications of the EC Upper and Equatorial Launchers

Quality	RH	Safety	Seismic	Vacuum	Tritium	PE	NPE	Maintenance	Metrology
QC1	RHC3	SIC-1	SC1(SF)	VQC1A	TC1A	Cat. IV (Gr.2 Gases) See (A)	Cat. II (N2 Gases) See (B)	MC1-1, MC2-1	AMC-1

Note (A): The EC Launcher Plugs and their components are cooled by IBED PHTS (Integrated loop of Blanket, ELM-VS, and Divertor Primary Heat Transfer Systems) such that they are identified as PE (pressure equipment) and NPE (N2 nuclear pressure equipment) by the Environmental Code. The Launcher Port Plugs are designed for neutron shields, therefore they are likened to casings, not subject to their internal pressure of the cooling water. It has been confirmed by the French ministry that these components using IBED PHTS water can benefit from the exclusion provided for in j) of Art. R. 557-9-2 since pressure is not a significant factor in their design. High pressure He feeding system for SMA (steering mirror assembly) with He bottle will be Group 2 – Cat. IV (max. 200 bar).

Note (B): The Launcher Plug external components concerning IBED PHTS, comprising pipes and manifolds, are identified as NPE (Nuclear Pressure Equipment). According to the Environmental Code and Ministerial order dated 30 December 2015 on nuclear pressure equipment and certain safety accessories intended for their protection, those components fall into N2 – Groupe 1 (Gases) Cat. II NPE as their DN ≤ 100 mm and PS ≤ 50 bar. According to Art. R. 557-12-1.-I of the Environmental Code, the Launcher Plug internal components are out of scope of NPE.

Table 2 below summarizes the ITER classification for the Ex-vessel Waveguides subsystem as per [4].

Table 2: ITER classifications for the EW subsystem

Quality	RH	Safety	Seismic	Vacuum	Tritium	PE	NPE	Maintenance	Metrology
QC1	N/A	SIC-1	SC1(SF)	VQC1A	TC1A	Cat. 0 (Gr.2 Gases) See (A)	N/A See (B)	MC1-1, MC2-1	AMC-1

Note (A): A part of the equipment is cooled by the CCWS (Component Cooling Water System) which operates above 0.5bar, therefore components under the fluid pressure are identified as PE (Pressure Equipment). According to the Environmental Code [R40], as long as the maximum allowable pressure of CCWS remains below 10 bar and fluid temperature below 110°C, therefore, these components are under Art. R. 557-9-3. –III.

Note (B): The CCWS-1 cooling circuit (PBS 26) is not NPE classified (SRD-26-CC). The CCWS-1 loop associated to the EW components will have the same classification providing that the maximum activity due to potential tritium leaks or water activation are below 370MBq.

IO shall inform to the contractor to any modification in the above information.

7 Scope of Work

7.1 Scope of work

The work involves supporting the ITER Electron Cyclotron (EC) System Team in activities related to the design of the systems, contribute to the management and finalization of the interfaces, verification of the final design of launchers and transmission lines and provide dedicated expertise for manufacturing and vacuum compatibility for EC Launchers and Ex-vessel waveguides systems

The candidate is intended to:

- Work with CAD designers on the development of final design components bringing preliminary designs to final designs.

- Provide structural assessment expertise (stress evaluation and code compliance) according to nuclear codes (ASME III, RCC-MR) and conventional codes (ASMEVIII, EN-13445)

- Provide manufacturing and welding assessments according to nuclear codes (ASME III, RCC-MR) and conventional codes (ASMEVIII, EN-13445)

- Participate in design reviews.

7.2 Work description

The work description assigned to the candidate appointed may be summarized as:

- Verification of mechanical design configuration of EC components and arriving at an acceptable design solution.
- Supports the EC system Technical Responsible Officers (TROs) with the final design of their subsystems including participation to design reviews (presenting design solutions, analysis, etc).
- Assessing the design solutions and review design documentation from all the involved parties (e.g. DA or suppliers).
- Reviewing manufacturing documentation from all the involved parties (e.g DA or suppliers), assessment of manufacturing feasibility, and follow-up of special manufacturing process qualifications.
- Provides support to the integration of the EC system and associated interface management documentation.
- Contributes to the documentation preparation and review for design and manufacturing reviews.
- Cooperates to the development of assembly process for EC system and then for its documentation.
- Manages the documentation in accordance with the ITER process (IDM and PLM).
- Prepare and review of technical specifications.

7.3 Service Duration

The duration of the Contract is 1 year. The contract would be subject to conformity with performance and quality of deliverables as per section **Error! Reference source not found.**. All work to be performed in collaboration with relevant TROs, involved parties and relevant departments.

8 Location for Scope of Work Execution

The work will be developed off-site. The contractor will be able to attend meetings on-site as needed (estimated frequency between once per month and once per two months).

9 IO Documents

No input is expected from IO.

10 List of deliverables and due dates

The Contractor shall provide IO with the documents and data required in the application of this technical specification, the GM3S [1] and any other requirement derived from the application of the contract.

The deliverables associated to this task are the activities reports generated in a quarterly basis, describing the QC and manufacturing follow-up activities performed with reference to the records and evidences generated. The list of deliverable packages is described in Table 8.1.

Note: Content of deliverables and time schedules could be modified as a function of the project needs by mutual agreement between the IO and the Contractor.

Table 8.1: List of deliverable packages and their estimated due date.

D01	Quarterly activities report #01	T0 + 3 months
D02	Quarterly activities report #02	T0 + 6 months
D03	Quarterly activities report #02	T0 + 9 months
D04	Quarterly activities report #04	T0 + 12 months

T0: is considered the initial day when the resources as available to start the work.

Contractor is requested to prepare their document schedule based on the above and using the template available in the GM3S appendix II (click here to download).

11 Quality Assurance requirements

The organization conducting these activities should have an ITER approved QA Program or an ISO 9001 accredited quality system. Alternatively, the contractor may opt to follow the IO QA processes. In this case, the requirement to prepare a Quality Plan is not applicable. Specific training shall be provided by IO.

Documentation developed as the result of this Contract shall be retained by Contractor for a minimum of 5 years.

The contractor must perform the Verification and Validation of all the software used within this contract according to Software Qualification Policy [15]. When Verification and Validation records are already existing for the intended software, they can be directly provided to the IO with no need of further justification.

12 Safety requirements

ITER is a Nuclear Facility identified in France by the number-INB-174 ("Installation Nucléaire de Base").

Components and activities intended for ITER Basic Nuclear Installation shall observe French Regulation in application of 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 [13].

The contractor must comply with all the requirements expressed in "Provisions for implementation of the generic safety requirements by the external actors/interveners" [14].

13 Special Management requirements

Requirement for [1] GM3S section 6 applies amended with the below specific requirements.

13.1 Contractor Responsibilities

The Contractor shall appoint a single Contact Responsible Officer (CRO) for all matters of the contract.

In order to successfully perform the tasks in these Technical Specifications, the Contractor shall:

- Provide suitably experienced and trained resources (an Engineer) to complete all aspects of deliverables and associated documentation;
- Strictly implement the IO procedures, instructions and use IO templates, where provided;
- Organise work in an efficient way according to the workload, commitments and objectives;
- Report to the TRO any issues during the performance of the Contract which require IO intervention or decision including potential delays in the submission of deliverables;
- 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;
- The Contractor acknowledges that all input information provided to perform the task remain property of IO and shall not be disclosed or used for any other activity than the one specified in this specification;
- The Contractor shall be in charge of the training and coaching of all its resources;
- The Contractor shall work in accordance with the QA plan accepted by IO;

- The Contractor shall perform the activities according to this specification taking into account all relevant additional documents and IO processes into account (hand books, export control, intellectual properties…);
- The Contractor shall use the ITER software platforms, for the management of all the documents, which are produced during the execution of this contract.

13.2 IO Responsibilities

The IO shall:

- Appoint a TRO for the Contract, who will be the point of contact for all technical matters, and a Procurement Responsible Officer (PRO) for all contractual and commercial matters.
- Organise periodic meetings with the Contractor on work performed.
- IO shall make available to the Contractor all technical data and documents which the Contractor requires to carry out its obligations pursuant to this specification in a timely manner. Should not all the needed input be available, the Contractor shall advise IO representative of the potential impact on the delivery of the Work Packages, to agree and define all the correction actions to take in place.

13.3 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.

Language

The official language of the ITER project is English. Therefore, all documentation relevant to this contract shall be in English.

Format of deliverables

The contractor shall submit all deliverables to the ITER Organization in the following format:

- All reports shall be provided in native electronic format (MS Word, Excel, PNG, JPEG (high resolution), MS PowerPoint, MS Project or other), as well as in PDF format.
- For all deliverables submitted in electronic format the contractor shall ensure that the release of the software used to produce the deliverable shall be the same as that adopted by the ITER Organization.

The deliverables and their format shall also take into account any specific rules and guidelines specified by the ITER Organization in writing during the execution of the contract.

13.4 Specific requirements and conditions

The Contractor is expected to assign one professional to this project, for the entire duration of this contract. Software and all data produced during the contract shall remain property of the ITER Organisation.

All work is to be performed in collaboration with relevant TROs, involved parties and relevant departments. The work will be developed 100% off-site. However, the contractor will be able

to attend meetings on-site as needed (estimated frequency between once per month and once per two months).

The Contractor's proposed profile shall meet the following requirements:

- MSc. In mechanical engineering or equivalent degree;
- Sufficient experience (more than 8 years) working in fusion engineering field with nuclear and vacuum components.
- Experience in Mechanical Engineering of complex system in different phases (design, manufacturing, assembly and integration) including the implementation of different codes and standards;
- Designing as per codes and standards (for example: RCC-MR, SDC-IC, ASME, EN, ASTM);
- Experience on writing and/or reviewing technical specifications for design and manufacturing contracts for nuclear components.
- Experience on designing and managing nuclear confinement barrier components such as port plugs, windows, pipping and feedthroughs together with its sealing and monitoring systems.
- Experience on following-up qualifications for nuclear and/or vacuum components through prototyping/testing, and analysis, to demonstrate compliance with requirements.
- Experience in manufacturing as per codes and standards (for example: RCC-MR, SDC-IC, ASME, EN, ASTM);
- Experience in management of deviations and non-conformances in the manufacturing of mechanical equipment;
- Experience on manufacturing QC, development and follow up of corresponding MIP for relevant components in the nuclear industry;
- Experience on developing or reviewing assembly strategies and its tasks for heavy components such as VV, ports and/or port plugs.
- Experience on developing and follow-up for assembly tooling for heavy components such as VV, ports and port plugs.
- Experience on designing, prototyping and testing for maintainability both remote handling and hands-on components in nuclear environment such as VV, port plug and port cell.
- Experience in follow-up of NDT & DT activities;
- Experience with CAD (2D and 3D) models for verification of design soundness and requirements implementation
- Knowledge of the nuclear French regulatory framework is advisable;
- Follow up of projects: Project manager; PMP and control suppliers in international projects;
- Capability to work in English language, both verbally and written.

To be considered as an advantage the following:

- Experience in large international projects (ability to work in multi-cultural Environment);
- Experience working on the ITER project and more specifically in the EC systems or similar in PC environment;
- Experience on development of optical systems and associated qualification

13.5 Work Monitoring / Meeting Schedule

The work monitoring will be performed by the deliverable packages of **Error! Reference source not found.**, remote periodic meetings with the TRO and remote participation in project meetings to report as requested.

13.6 CAD design requirements (if applicable)

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 (2F6FTX), and with the Procedure for the Management of CAD Work & CAD Data (Models and Drawings 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 GNJX6A - 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 (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.