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Technical Specifications (In-Cash Procurement)

Technical specifications EC electrical feedthoughs (2018-2019)

This technical specification is to describe the scope of work to be provided by the supplier to the ITER Organization (IO) Electron Cyclotron Section.
The purpose of this contract is the continuation of the final design of the electrical feedthroughs for the EC launchers.

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1 Purpose

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The purpose of this contract is the continuation of the final design of the electrical feedthroughs for the EC launchers.

These components will perform a safety function so they are classified as Protection Important Components (PIC). As a result, specific quality assurance requirements must be applied as described in Sections 12 and 13.

2 Background and Objectives

The electron cyclotron (EC) system is one of the four auxiliary plasma heating systems to be installed on the ITER tokamak. The ITER EC system consists of 24 gyrotrons with associated 12 high voltage power supplies, a set of evacuated transmission lines and two types of launchers. The whole system is designed to inject 20 MW of microwave power at 170 GHz into the plasma. The primary functions of the system include plasma start-up, central heating and current drive, and magneto-hydrodynamic instabilities control.

There are two type of antennas (or launchers) used to inject the Electron Cyclotron power into the plasma, one is in the equatorial port (EL) and the other occupy four upper ports (UL). The power from a given gyrotron can be directed to either launcher with the choice depending on the physics objectives.

Each of the launchers are also called port plugs as they form the first confinement boundary acting as "plugs" to the vacuum vessel ports. Each plug includes in-vessel waveguides, mirrors, shielding blocks, sensors etc. The back end of each port plug should be equipped with electrical feedthroughs to bring signals (thermocouples, strain gauges, angle measurement system, etc) or electrical power as needed.

The objectives of this contract are to provide the ITER Organization with the mechanical design of electrical feedthroughs for equatorial and upper launchers and associated engineering services regarding structural and thermal analyses.

3 Definitions

ECS: Electron Cyclotron Section

FEA: Finite Element Analysis

IO: ITER Organization

IO-TRO: ITER Organization Technical Responsible Officer

SLS: System Load Specification

StIR: Structural Integrity Report

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

4 Estimated Duration

The duration shall be for a period of 12 months days starting from the Kick-off Meeting (KOM). No work shall be carried our prior to this date. Services can be carried out at the supplier work site with regular visits at IO site (in the order of 10 weeks) or at IO site.

4.1 Work Package 1: In vessel cabling integration

A critical study of the current concepts and main technologies for the EC electrical feedthroughs have been done and described in [1]. In this work package is requested to develop a sound concept of the in vessel integration of cabling including connectors, selection of hardware and assembly strategies. During this period, all requirements pertaining to the launchers feedthroughs and 3D models will be provided by the IO.

4.2 Work Package 3: Component Load Specification

The contractor should update the EC feedthroughs load specification, [3], to include any possible update coming from the interface loads or other required update as per work package 2.

4.3 Work Package 2: Mechanical design of EC feedthroughs

A detailed 3D model of a particular feedthrough design for upper launcher can be seen here [2]. This work package consists in the modification of this concept to different sizes able to be compatible with the different modules of the equatorial launcher or other heating and current drive systems (e.g. neutral beam).

It also include the possible modifications to the feedthrough design coming from the ITER Vacuum Handbook requirements together with safety requirements and functional requirements from EC perspective (signals, etc.), provided by IO.

4.4 Work Package 4: Structural Integrity Evaluation and Qualification Plan

The purpose of the work has two main parts:

1) The demonstration, through detailed ANSYS analyses, that those components do not experience certain types of structural damage when subjected to the postulated loading conditions and that their performance is maintained. The analyses should be done using ANSYS Mechanical (Classical or Workbench) software for all structural assessments. It includes thermal and structural analysis.
2) For the core of the electrical feedthrough (e.g. standard ultrahigh vacuum feedthrough and connections) a full qualification is not possible though analysis. Therefore, as result of this phase, it is expected to have a comprehensive qualification plan that describes the testing plan for the future prototype towards the full qualification of the feedthrough.

4.5 Work Package 5: Technical Specification

The final outcome of this work is the update of the technical specification that can be considered as a specification for a prototype design.

5 Responsibilities

5.1 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.

5.2 IO's Responsibilities

The IO shall:

• Nominate the Responsible Officer to manage the Contract;

• Provide all the required information and access to the appropriate ITER files for executing this work. In particular, IO will make available any technical information, including 3D models, layouts and drawings, input data for the loads, references, etc. as needed for the Contractor to perform the work.

6 List of Deliverables and due dates

As described, the scope of work is contained within the 5 work packages described above. The following table describes the deliverables required within each work package and their due dates.

Work Package		Description	Due Dates
1	In-vessel integration	Descriptive report with recommendations and solutions for the in-vessel integration. A market survey to identify suitable ultrahigh vacuum components is also part of this deliverable.	T0 + 3 months
2	Component Load Specification	The contractor should update the EC feedthroughs load specification, [3], to include any possible update coming from the interface loads or other required update as per work package 2.	T0 + 5 months
3	Mechanical design of EC feedthroughs	The objective of this phase is to integrate an ultrahigh vacuum electrical feedthrough into a standard ITER flange for different EC systems configurations. It includes the incorporation of ITER Vacuum Handbook requirements together with safety requirements and functional	T0 + 5 months

		requirements from EC perspective (signals, etc.). This should be done from the work described in [1][2]. A descriptive report and 3D data is part of this deliverable.	
4	Structural Integrity Evaluation and Qualification Plan	According to the loads and the different feedthroughs designs identified in the previous work package, this phase deals with the analysis of the structural behaviour of the feedthroughs. The work should start with a failure mode analysis of the components (e.g. Plastic collapse, excessive deformation, fatigue, etc.). After, a FEA analysis by ANSYS is expected in order to provide the safety demonstration of the feedthroughs. In parallel, and also considering the loads identified in the previous work a testing program for the feedthrough should be developed. The main outputs shall be: • An Structural Integrity Report (StIR) which include the methodology and all the results of the analyses including tables and figures illustrating the mechanical reactions and the distribution of stresses, strains and displacements in the analysed part at all applied loads and load combinations. The guideline to perform this report is [5] and [6]. • A qualification plan to cover the additional tests required for the core of the feedthrough in order to have the complete qualification of the component.	T0 + 10 months
5	Technical Specification	The final work package for this contract is a technical specification where the main technical requirements of the different feedthroughs are collected towards the prototype manufacturing (built to print).	T0 + 12 months

7 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.

8 Specific requirements

- Experience in Mechanical Engineering.
- Base knowledge of the use of CATIA is required.
- Good and demonstrable skills in structural (linear/non-linear, static/transient) analysis using ANSYS (classic and/or workbench): analysis pre-processing, solution setting-up and advanced post-processing procedures.

- Demonstrable experience on mechanical (pressure vessel) Codes assessment procedures applied to FEA results (design by analysis) like stress linearization and fatigue.
- Experience in nuclear Codes (RCC-MR 2007 / ASME III) is highly desirable.
- Experience in the preparation of analysis reports is required.
- Experience in the analysis of nuclear components is highly desirable.
- Experience in similar activities is highly desirable.
- Sufficient experience to deliver the scope of work with independent autonomy.
- Fluency in English both verbal and written is required.
- Organization, taking minutes and action tracking of international meetings.

9 Work Monitoring / Meeting Schedule

Work is monitored through completed reports (see List of Deliverables section) and progress meetings (at IO and videoconference).

10 CAD Design Requirements

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).

11 Quality Assurance (QA) requirements

The ITER QA Programme is based on IAEA Safety Standard GS-R-3 and on conventional QA principles and integrates the requirements of the INB Order [7] on the quality of design, construction and operation of licensed nuclear installations. For this purpose, the Supplier shall ensure that any subcontractors carrying out work placed under the prime contract are in compliance with the QA requirements under the relevant QA classifications.

The general requirements are detailed in ITER Integrated Safety, Quality and Security Policy [10], and ITER Procurement Quality Requirements [11]. The specific requirements for the supervision of all subcontractors in the supply chain for Protection Important Components, Structures, Systems and Activities are detailed in the next section.

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 [12]).

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 [13].

All documentation related to this contract must be provided to the IO.

12 Regulatory requirements

ITER is a licensed nuclear facility as defined in the Decree of Authorisation of Creation of ITER-INB-174 [7] and consequently IO, the Nuclear Operator, must comply with the French Order of 7th February 2012 which provides the regulatory framework for licensed nuclear installations (INB-Order) [9].

As required by the INB Order, and notably its article 2.2.1, the nuclear operator (IO) must notify the external interveners of the necessary provisions for application of the INB order.

Certain components, structures and systems of ITER are classified as important for the interests of public safety as defined under Article L 593-1 of the French Environmental Code and are further classified according to the area or service (i.e. their function).

In the framework of IBN order, a *defined requirement (DR)* is a requirement assigned to a protection-important component so that it may perform the function, with the characteristics expected, provided for in the demonstration mentioned under the second paragraph of Article L. 593-7 of the Environmental Code, or assigned to a protection-important activity so that it may fulfil its objectives as regards this demonstration. The defined requirements associated with the EC system are given in [8].

Protection Important Components (PIC) shall be understood as a component that is present in the basic nuclear installation or that is under the responsibility of the operator and that implement a function required for the demonstration mentioned under the second paragraph of Article L. 593-1 of the French Environmental Code or that ensures that this function is implemented. The contractor shall be aware that the feedthroughs are protection important components (PICs). For those components, the compliance with the Order 7 February 2012 [9] shall be demonstrated. This order gives the general rules related to the design, construction, operation, final shutdown, dismantling, maintenance and surveillance of basic nuclear installations.

Protection Important Activities (PIAs) shall be understood in the scope of this work as an activity, failure of which can lead to a product which is not compliant with the technical and quality assurance requirements for the parts of the feedthroughs directly related to the nuclear safety of ITER. A PIA can itself include several sub-activities concerned by quality.

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

The contractor must be aware of [15] and must be also known, understood and applied by all staff of the contractor and cascaded down in the managerial lines of the contractor and all of their sub-contractors (when applicable).

13 Deviations and Non-Conformities

A deviation is defined in the Order [9] as a non-compliance with a defined requirement or noncompliance with a requirement set by the licensee's integrated management system that could affect the provisions of the Environment Code.

All deviations and non-conformities must strictly follow the procedure detailed in ITER Requirements Regarding Contractors Deviations and Non Conformities [16]. The principle is to ensure timely identification and review of deviations and non-conformances in order to determine the importance and to ensure that appropriate corrective actions are taken.

14 References

[1]. Study of the art for EC feedthroughs (ITER_D_VHKE22)
[2]. Mechanical design of EC feedthroughs (ITER_D_WEGJV6)
[3]. EC Electrical feedthrough Load Specification *(ITER_D_W35J59)*
[4]. Guideline for ITER System Load Specifications (ITER_D_33TTPJ)
[5]. ITER Guideline for structural analyses (ITER_D_35BVV3)
[6]. Guideline for Structural Integrity Report (ITER_D_35QTKD)
[7]. Decree No. 2012-1248 dated 9 November 2012 authorizing IO to create a basic nuclear facility called "ITER" (ITER_D_CZK7M5)
[8]. Defined Requirements for PBS52 (ITER_D_ TZWKK3 v1.0)
[9]. Order dated 7 February 2012 relating to the general technical regulations applicable to INB – EN (ITER_D_7M2YKF)
[10]. ITER Integrated Safety, Quality and Security Policy (ITER_D_43UJN7)
[11]. ITER Procurement Quality Requirements (ITER_D_22MFG4)
[12]. Procurement Requirements for Producing a Quality Plan (ITER_D_22MFMW)).
[13]. Quality Assurance for ITER Safety Codes (ITER_D_258LKL).
[14]. Provisions for Implementation of the Generic Safety Requirements by the External Interveners (SBSTBM)
[15]. ITER Policy on Safety, Security and Environment Protection Management (43UJN7)
[16]. MQP Deviations and Non Conformities (ITER_D_22F53X)

Other references to manuals or handbooks are given in the specification text.