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Contract

Engineering services HCD-EC-UL

Specifications for the engineering services of the design and the related documentation for the EC Upper Launcher systems.

Approval Process			
	Name	*Action*	*Affiliation*
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1 Purpose

This document describes the engineering services needs and associated deliverables for the Heating and Current Drive systems (HCD). It includes the needs to finalise the design and the related documentation for the EC Upper Launcher systems.

2 Scope

The scope is to provide engineering service to bring the EC upper launcher system up to final design, with particular emphasis in the areas of design requirement, mechanical assessment, design documentation/interfaces and review of analyses.

3 Definition

Acronyms:

DA: Domestic Agencies
EC: Electron cyclotron
F4E: Fusion For Energy
IC: Ion Cyclotron
HCD: Heating and Current Drive
IDM : ITER Document Management
NB: Neutral Beam
TRO: Technical Responsible Officer
UL: Upper Launcher
VV: Vacuum Vessel

4 References

ITER Project requirement: https://user.iter.org/?uid=29DD9C
SRD PBS-52: https://user.iter.org/?uid=29D7J4
PBS 52 ICDs: https://user.iter.org/?uid=2EPPRS

5 Estimated Duration

The contract will have an initial firm period of 2 years. The deliverables for first year are listed in Table 1 whilst deliverables of year 2 will be detailed at T0+10 months and will form an amendment to the contract.

6 Work description

Auxiliary heating power of > 70 MW is envisaged at ITER in order to obtain the plasma temperatures and plasma profiles required to achieve Q > 10 for 400 s (inductive ELMy H-mode) and Q=5 for a pulse duration of 3600sec (non-inductive discharge). In addition to providing the desired heating, the systems are also expected to drive current, tailor the plasma profile and control the plasma instabilities.
As a result three systems are planned during the first operational phase of ITER, which include the neutral beam (NB), the electron cyclotron (EC) and the ion cyclotron (IC) systems. While the NB systems are expected to deliver 33 MW of heating power to the plasma and drive current through it by the use of two neutral beam injectors located at the equatorial ports of the

ITER machine, the IC and the EC systems shall deliver 20 MW each. EC heats the electrons providing local heating and current drive which can be steered across the plasma cross section.

- **Electron Cyclotron Resonance Heating**

The EC system is to inject up to 20MW of microwave power at 170GHz into the ITER machine for localized heating and current drive applications. The system consists of 12 high voltage power supply sets, 24 high power microwave sources (or gyrotrons), 24 transmission lines (TL) and 2 different types of launchers (1 Equatorial and 4 uppers).

The EC system is being designed and procured in collaboration between the ITER Organization (IO) and five Domestic Agencies (DAs): Europe, India, Japan, Russia and United States. In general, the EC section responsibility is to define the functional requirements, develop the conceptual design, oversee the development of the final designs, ensure the compliance with ITER required codes and standards, manage sub-systems integration and associated documentation.

The services aims at providing system engineering and design engineering for the 4 EC upper launcher systems development (see Figure 1), which includes the interface management, system integration, model management (knowledge beneficial using CATIA, ENOVIA), requirement propagation and compliance, diagram development/finalization, preparation of technical specifications and management of CAD Tasks.

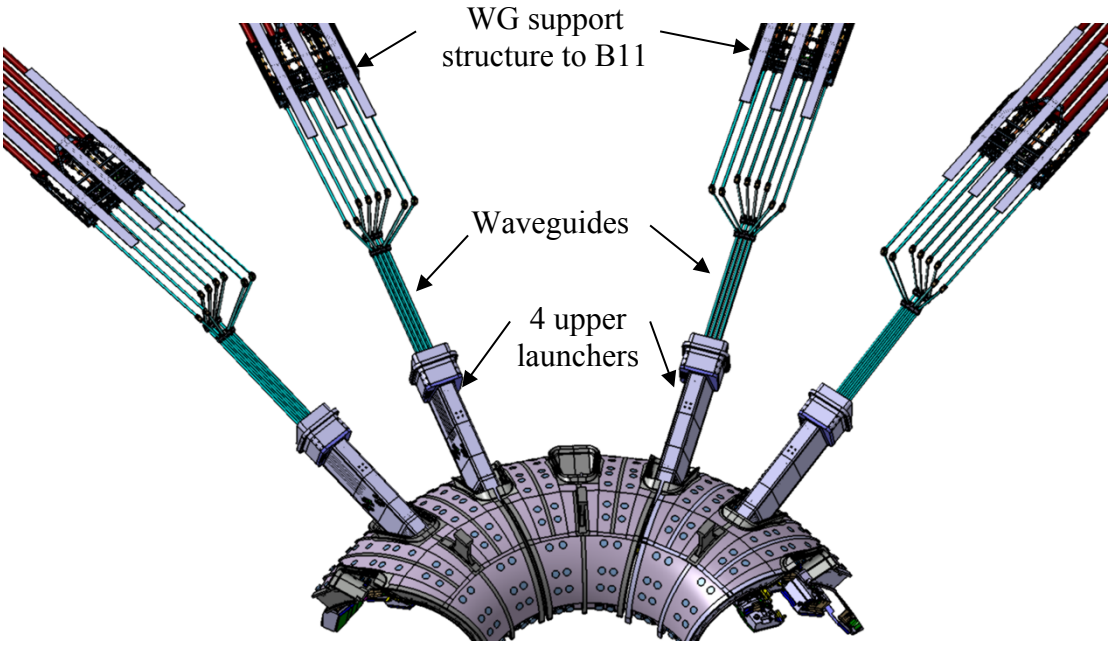

Figure 1: Four EC upper launchers connected to wave guides

These activities will span across the development of the EC upper launcher system from the transmission line up to the upper launchers. Experience in systems engineering, engineering standards (for example: SDC-IC, RCC-MR, EN, ASME, ASTM), experience in regulation

compliances (such as European Directives) and quality management (for example: ISO 9000s, 14000s, 17025, IAEA GS-R-3, ASME NQA-1) are highly beneficial. Experience in document management software (such as DOORS) and microwave transmission systems (in particular high power and long pulse) would be beneficial.

- **EC Upper Launcher:**

The four EC Upper launchers are made of several sub-components such as the main structure of the plug, internal shields, wave guides, various mirrors (M1, M2, M3), steering mechanism mirrors (M4), blanket shield modules, first wall panel, cooling pipes and a closure plate. The launchers are connected to the RF power supplies (located in B15) by the mean of wave guides (including, mitre bends, absolute valves and diamond windows) supported by a structure from the Tokamak building (B11) L2 ceiling and going out of the B11 through wall penetrations (See Figure 24) . The 4 upper launchers and the 32 associated waveguides up to the diamond windows are designed and procured by the European Domestic Agency (EU-DA).

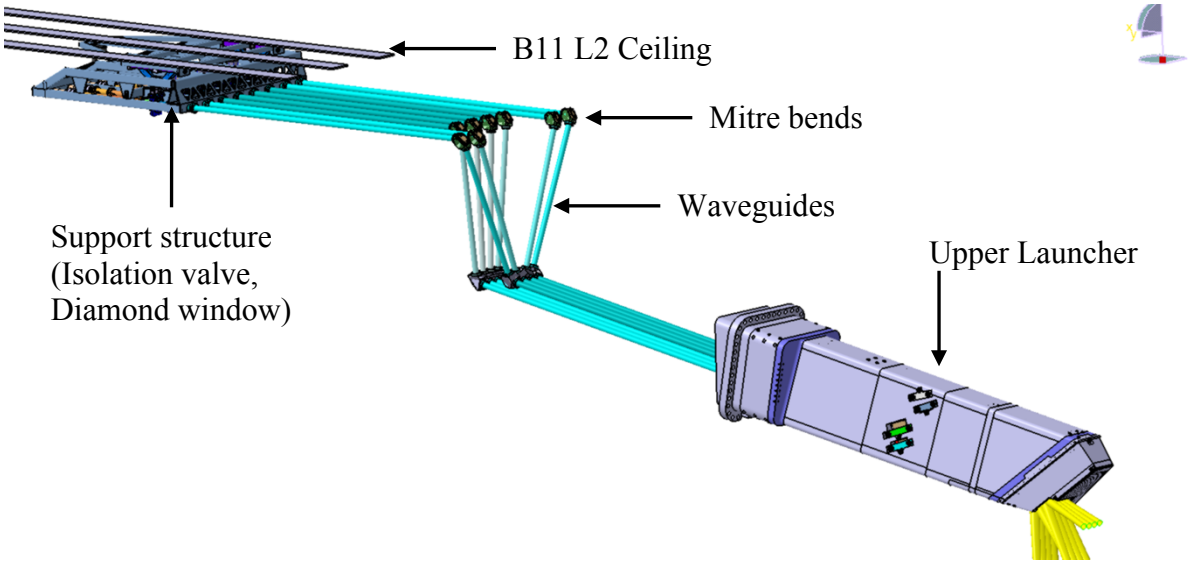

Figure 2: EC Upper Launcher assembly (first confinement and in-vessel components)

This contract is to provide Engineering services on the Heating & Current Drive Electron Cyclotron team on the Upper Launcher and its waveguides up to its diamond window (1st confinement barrier) to further develop the requirements, interfaces and the design to complete its final design.

- Part 1: First year of this contract is to provide Engineering services on the Heating & Current Drive Electron Cyclotron team on the Upper Launcher and its waveguides up to its diamond window (1st confinement barrier) to further develop the requirements, interfaces and the design to complete its final design.

The following tasks have to be performed:

- Following-up the design activities related to the EC Upper Launcher (UL) as well as the waveguide up to transmission line connection interface (EU procurement extent). In

collaboration with the F4E DA/consortium, bring the maturity of the design from preliminary to the final design.

- Writing of documentation relating to EC UL requirements, interfaces, design, technical specification, ESP justification dossier, etc… see exhaustive list in section 1.
- Communicating solutions and issues with IO RO, IO interface teams / F4E consortium.
- Ensuring correct integration of the EC UL components within the VV ports and B11 building.

The required lists of deliverables and due dates are reported in Table 1.

- Part 2 (second year): The work will be detailed at T0+10 months and will form an amendment to the contract.

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;
• 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.

7.1 IO's Responsibilities

• Nominate the Responsible Officer to manage the Contract;
• Organise a monthly meeting(s) on work performed;
• Provide offices, internet access, email and computer(s) at IO premises.

8 List of deliverables and due dates

- Part 1: First year deliverables:

D #	Description	Due Dates
D1	a) Finalization of ESP Exemption – EC UL&EL Document b) Revision of RH compliance documentation for the UL c) Generation of Maintenance task documentation requirements (draft version) d) Finalization of impact assessment for PCR-439 closure e) Revision of UL PBS and component classification documents based on revised design and PCR-635	T0 + 1 month

	f) Perform DET/DER of UL and UL/EL ex-VV waveguide assemblies and management of model approval.	
D2	a) Revision of UL Baseline documentation, includes revised CM from D1-d above. b) Management of IDM review for the UL isolation valve c) Generation of approximately 6 Design Requirement notes arising from the monthly technical progress meetings with UL design team and face-to-face technical meeting at either Karlsruhe or Lausanne d) Manage IDM review and subsequent revision of UL sub-system Load Specification (sLS) and Requirement Document (sSRD). e) Definition of EC UL ex-VV waveguide skeletons (RT and OT) f) Definition of EC Interface Skeletons with PHTS, CCWS-1, VV, gas, B11 Follow-up/assessment and liaise with F4E about on-going and upcoming PCRs associated to EC UL.	T0 + 3 months
D3	a) Participation in the F4E 6month Face-to-Face meeting, including preparation of IO summary report and presentation b) Participation in the KOM (in EU) for the EL port cell support structure design task. Revision of contractor work plan in line with F4E tasks, generation of 3 design requirements notes associated with task definition c) Generation of approximately 6 Design Requirement notes arising from the monthly technical progress meetings with UL design team and face-to-face technical meeting at either Karlsruhe or Lausanne d) Compliance Check of the UL design with the revised CM, and review assessment of EM, thermal-mechanical and MCNP analysis arising from the revised port plug design. e) Participation in ESP exemption meeting in Paris, includes subsequent revision of exemption and minutes of meetings f) Perform DET/DER of UL and UL/EL ex-VV waveguide assemblies and management of model approval.	T0 + 6 months

D4	a) Draft EC UL BSM Technical Specification b) Revision of EC IS with Upper Launcher c) Revision of internal IS between UL and other EC sub-systems d) Generation of approximately 6 Design Requirement notes arising from the monthly technical progress meetings with UL design team and face-to-face technical meeting at either Karlsruhe or Lausanne e) Upper Launcher Waveguide and mitre bend CFT, Control plan and MIP	T0 + 9 months
D5	a) Draft EC UL Structural Technical Specification b) Draft EC UL Waveguide Technical Specification c) Participation in the F4E 6month Face-to-Face meeting, including preparation of IO summary report and presentation d) Participation in the KOM (in EU) for the EL port cell support structure design task. Revision of contractor work plan in line with F4E tasks, generation of 3 design requirements notes associated with task definition e) Generation of approximately 6 Design Requirement notes arising from the monthly technical progress meetings with UL design team and face-to-face technical meeting at either Karlsruhe or Lausanne f) Review of Thermal Mechanical analysis of Port plug structure, BSM, internal components and mirrors; followed by compilation of comments arising from this review and comments from IDM review process. g) Review of MCNP analysis of Port plug structure, BSM, and internal shield components; followed by compilation of comments arising from this review and comments from IDM review process. h) Perform DET/DER of UL and UL/EL ex-VV waveguide assemblies and management of model approval.	T0+ 12 months

Table 1: List of deliverables and due dates (first year)

- Part 2 (second year): The deliverables will be detailed at T0+10 months and will form an amendment to the contract.

9 Acceptance criteria

The criteria shall be the basis of acceptance by IO following the successful completion of the Work. These will be in the form of deliverable documents to be uploaded on ITER IDM for review.

10 Specific requirements and conditions

The required resource is a mechanical engineer (master degree) at least 10 years of working experience in mechanical design.

The mechanical engineer shall have experience in the following activities:

- Experience in design of HCD component(s) in vacuum and nuclear environment
- Specification of nuclear components according to the French Regulations (ESP/ESPN/ Order dated 7 February 2012 relating to the general technical regulations applicable to Basic Nuclear Installations Knowledge in high heat flux performance systems
- Experience in ITER design activities follow up and project leadership
- Experience in fusion field is an advantage
- Knowledge of international and French industrial codes and standards (SDC-IC, RCC-MR, ASME VIII Div. 2, ASME III),
- Writing of technical specification and documentation and quality follow up
- Writing of interface documentation
- Catia V5 (mechanical design software used in ITER),
- Experience in Finite element analysis (e.g.: ANSYS WB v14 (thermo-mechanical analysis)
- Experience in manufacturing processes (deep drilling, forging, machining, EB-TIG welding, hipping, diffusion bonding, technique of inspections, leak detection, etc. …)
- English fluent (written and spoken).

The engineer will work under the direct responsibility of IO EC RO management.

The candidate should provisioned 8 missions per year to visit the collaborative associations or suppliers.

11 Work monitoring and meeting schedule

The work will be managed by means of progress meetings and/or formal exchange of documents transmitted by emails which provide detailed progress. Progress meetings will be called by the ITER Organization, to review the progress of the work, the technical problems, the interfaces and the planning.

A progress meeting is organized by H&CD sections every other week. The engineer will have to report the progress relating to its engineering services duties.

The main purpose of the progress meetings is to allow the ITER Organization/H&CD EC and the Contractor Technical Responsible Officers to:

a) Allow early detection and correction of issues that may cause delays;
b) Review the completed and planned activities and asses the progress made;
c) Permit fast and consensual resolution of unexpected problems;
d) Clarify doubts and prevent misinterpretations of the specifications.

In addition to the progress meetings, if necessary, the ITER Organization and/or the Contractor may request additional meetings to address specific issues to be resolved.

12 Quality Assurance (QA) requirement

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).

13 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.

14 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 [20].