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TECHNICAL SUMMARY

Call For Tender IO/22/10023123/JPK

Design and Fabrication of Tokamak Complex Detritiation System Central Processing Plant

1 PURPOSE

The ITER Organisation (IO) intends to issue a call for tender for the detailed design and fabrication (D&F) of the Tokamak Complex Detritiation System (TC-DS) central processing plant.

This document provides a summary of the work scope, the technical requirements and the required Contractor experience and competencies.

2 BACKGROUND

ITER is a joint international research and development project that aims to demonstrate the scientific and technical feasibility of fusion power. The fusion reactor will operate with tritium, which is a radioactive gas.

ITER is a nuclear licenced site, and TC-DS must therefore meet the requirements of French nuclear legislation and regulations.

The role of the Detritiation System is to remove tritium from (i.e. detritiate) effluent gases so that they can be safely released to the atmosphere. Detritiation is a specialised application, however the technologies used (blowers, filters, heat exchangers, catalytic reactors and scrubber columns) are standard HVAC and chemical engineering unit operations and as such, the Contractor does not require prior tritium experience.

3 TC-DS CENTRAL PROCESS PLANT DESCRIPTION

3.1 Overview

The TC-DS central processing plant is a gaseous effluent treatment system that removes tritium from gases from various clients before they are released to the atmosphere. The clients are connected to the central process plant through the TC-DS piping network, which is outside of the scope of this contract.

The TC-DS central process plant comprises eight separate modules, connected to common inlet and outlet piping manifolds and organised into two sub-systems, Normal-DS and Standby-DS as shown in Figure 1:

- Standby-DS (SB-DS)
    - Comprises six separate modules, each with 1400 Nm3/hr throughput, organised into two redundant trains A & B (three in each train).
    - Classified as PIC/SIC (credited for nuclear safety)
    - This system is normally not operating (in standby).
    - Required to start up within a defined duration in the event of certain accident conditions, and available to take over the client loads in the event that N-DS becomes unavailable

- Normal-DS (N-DS)
    - Comprises two separate modules, each with 1400 Nm3/hr throughput
    - Not classified PIC/SIC (Safety related)
    - This system is normally in operation

This arrangement is shown in Figure 1, with the scope boundary shown by the red box.

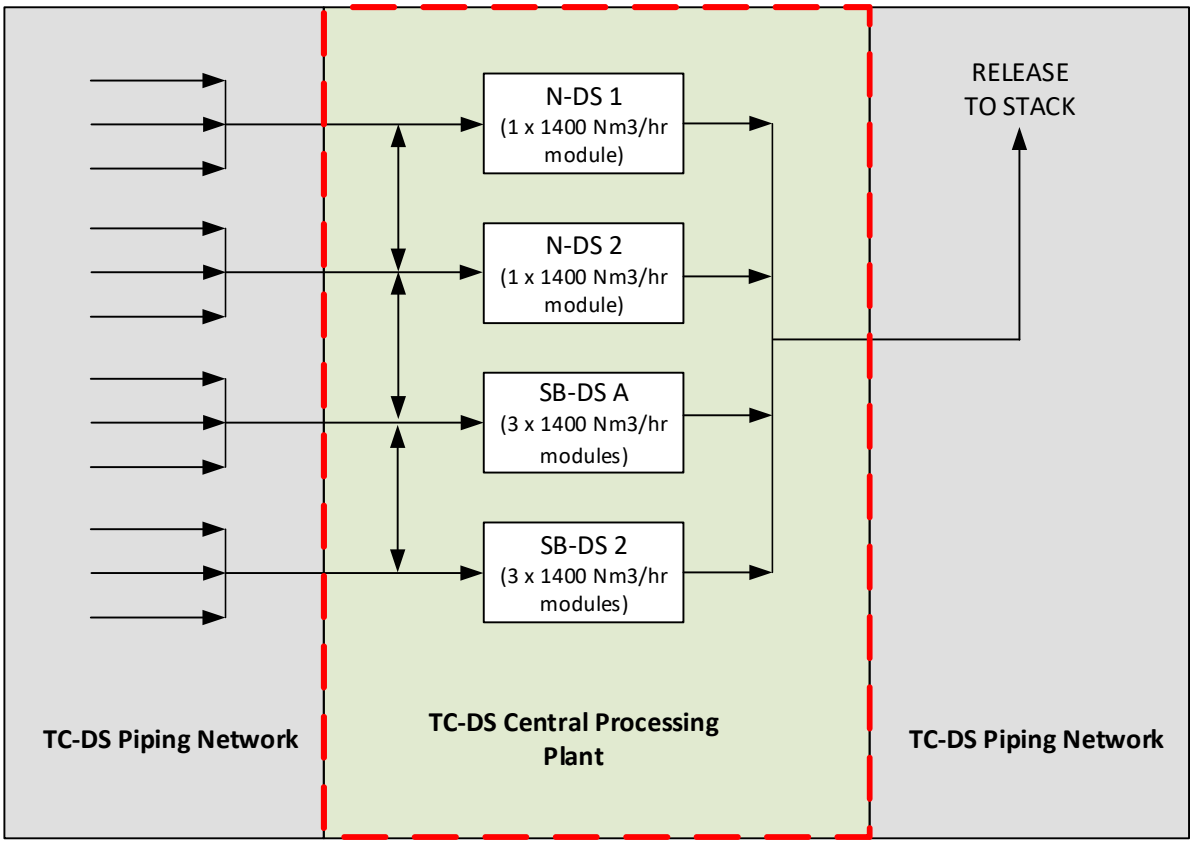

Figure 1: TC-DS Central process plant arrangement and scope boundaries within red box

3.2 Equipment location and layout

The TC-DS central process plant shall be installed inside the Tokamak Complex on levels 2 and 3 of the Tritium Plant Building (Building 14). This part of the building is currently under construction, and is scheduled for completion by 2024. A cut-section of the Tritium Building

with the location of the TC-DS central process plant is shown in Figure 2, with an illustration of the equipment in Figure 3.

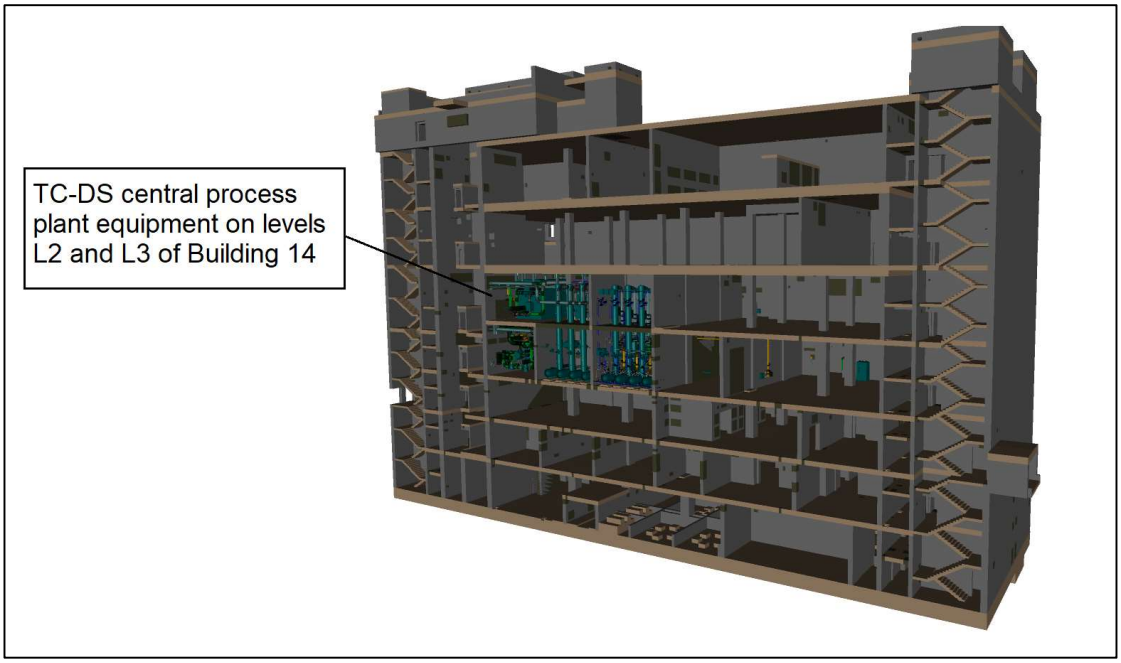

Figure 2: Cut section of B14 Tritium Building with TC-DS Central process plant on L2 and L3 shown

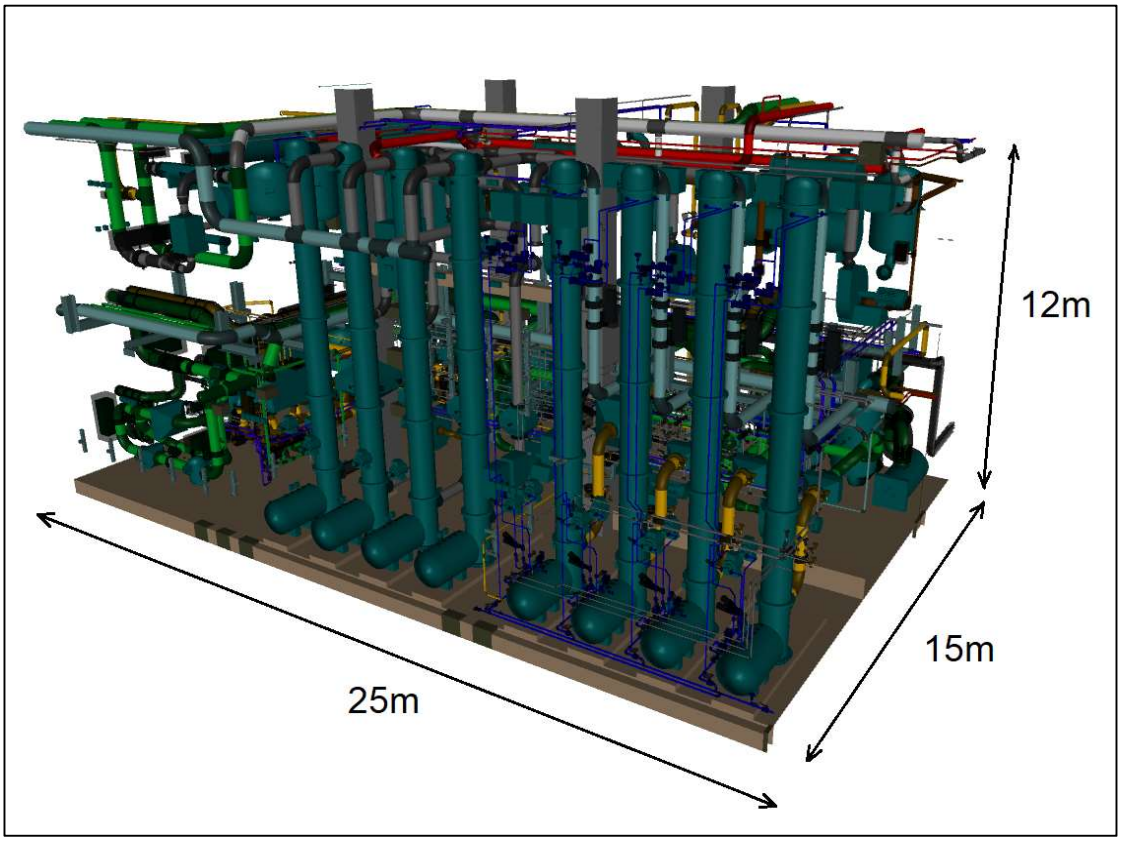

Figure 3: Illustration of TC-DS Central process plant equipment from 3D model

3.3 Description of main process equipment items

The main equipment items that make up the N-DS and SB-DS modules are listed in the following sections.

3.3.1 Process equipment

- HEPA filters
- Catalytic oxidation reactors
- Gas (Air) heaters
- Heat exchangers (Air/Air and Air/Cooling Water)
- Scrubber columns (liquid/gas contactors)
- Blowers
- Valves

The main material used for construction of the process equipment and piping is stainless steel.

3.3.2 Structural equipment

The scope of work includes piping supports, pipe racks and platforms used to support and access equipment.

3.4 Control & Instrumentation

The TC-DS control system comprises two parts: the Process Control System (PCS) and the Safety Control System (SCS).

The PCS is a non-PIC (non-safety) control system used to maintain operating parameters. The PCS shall be implemented by PLCs.

The SCS is a PIC (nuclear safety) control system used to start up SB-DS and take over control from the PCS in the event the system is not performing. The SCS shall be implemented with logic solvers.

The PCS and SCS interface to operator terminal displays via the ITER central site control systems (CODAC) and ITER Central Safety System (CSS), respectively.

3.5 Instrumentation

Industry standard instruments for measurement of process parameters such as pressure, temperature and flow shall be used. Instruments classified as PIC will need to be qualified according to the relevant nuclear standards and for the environmental condition where they are located.

3.6 Site utilities

All of the utilities required for operation of the plant (electrical power, cooling water, compressed air, nitrogen) are provided at the site, and are outside the scope of this contract. The contract scope includes the design and supply of the equipment up to the interface points with the site utilities. The interface points are located within the rooms that house the TC-DS central process plant.

3.7 Environmental conditions

The TC-DS central processing plant will be installed and will operate inside the Tritium Plant Building over typical ranges of conditions for such an environment. There will be no exceptional conditions of electromagnetic interference, ionizing radiation or magnetic fields. The equipment must continue to function during and after seismic events.

4 TECHNICAL REQUIREMENTS

4.1 Classifications

4.1.1 Safety Classification

TC-DS performs key nuclear safety functions in normal and in accident conditions. It is classified as a Protection Important Component (PIC), and consequently needs to comply with the French Order of 7th February 2012, which establishes the general rules for licenced nuclear installations in France.

4.1.2 Quality Class

TC-DS equipment and components that perform nuclear safety functions are assigned the highest quality class (Quality Class 1) under the ITER quality classification system. These components require strict quality controls to ensure and demonstrate that they are designed and manufactured in accordance with the technical requirements.

4.1.3 Seismic Class

TC-DS shall be designed to operate during a design basis seismic event without loss of processing function or gas containment. Components (including valves and electrical, instrumentation and control equipment) shall be qualified to demonstrate they are able to perform their function during and after a seismic event through testing or analysis.

4.2 Applicable codes and standards

The main applicable codes are listed in Table 1.

Table 1: Design codes used for TC-DS

Equipment type	Applicable design codes
Piping	ASME B31.3
Pressure vessels	ASME BPVC section VIII
Support structures and platforms	Eurocodes
Instrumentation & Control	IEC 61513 for PIC IEC 61508 for non-PIC

5 SCOPE OF WORK

The scope of the contract is to perform the detailed design, procurement, fabrication and delivery to site of the equipment for subsequent installation by others. The equipment to be designed and fabricated includes:

- Process equipment, assembled on pre-fabricated skids to facilitate testing and installation on site
- Interconnecting pipework between the equipment items
- Access platforms, pipe supports and pipe racks to support /gain access to the equipment/piping
- Instrumentation and control system and associated cabling, and control system programming
- Electrical supply equipment and associated cabling

5.1 Performance responsibilities

The IO, which has specialist tritium knowledge and expertise, is responsible for the design of the following:

- Sizing and selection of the catalyst used in the catalytic reactors to oxidise the tritium to tritiated water vapour
- Sizing and selection of the packing and water distributors in the scrubber columns used to collect tritiated water vapour as liquid water

The Contractor has responsibility to ensure that all other aspects of the plant meet performance specifications provided by the IO. For example, mechanical/electrical equipment needs to demonstrate appropriate performance (pressure drop, throughput, heating, cooling etc.) and the control system needs to demonstrate correct functionality in terms of alarms, trips, operating sequences, start-up, and shutdown. In addition, suitable demonstration of equipment qualification shall be provided by the Contractor (e.g. evidence of seismic qualification).

5.2 Detailed design

The IO has completed the preliminary design up to a level broadly equivalent to Front-End Engineering Design (FEED). The technologies and materials for the main equipment items have been selected, and preliminary sizing of the equipment items and piping has been performed. Based on this preliminary design, the Contractor shall complete the detailed engineering design, considering requirements for operability, maintainability and reliability, and integration with the building environment and interfaces.

5.3 Procurement and fabrication

Based on the detailed engineering design, the Contractor shall perform all of the equipment procurement and fabrication. This will culminate in factory acceptance testing at the Contractor (or subcontractor) premises.

5.4 Equipment qualification

Equipment and components will need to be qualified to demonstrate that they can perform their intended functions under all normal and, in some cases, accident environmental conditions. This is especially critical for components classified as PIC. The Contractor shall select suitable components, develop the qualification strategy for each component, perform the qualification

activities and prepare the qualification documentation. Qualification methods shall be based on RCCE (for electrical components) and RCCM (for mechanical components) standards. IO will include further guidance on acceptable qualification approaches within subsequent tender information.

5.5 Delivery

The Contractor shall deliver the equipment to the ITER site for installation (or storage if it cannot be installed immediately).

5.6 Installation

The installation of the equipment shall be performed outside of the scope of this contract; however, the Contractor will be involved in the installation phase to provide technical support. The Contractor shall be responsible for reviewing and accepting any changes during the installation, and shall endorse the installation after performing a final inspection. In addition, where the Contractor was working to performance requirements, the Contractor shall be responsible for performing an Operation Performance Test to demonstrate all performance requirements have been met prior to hand over of the plant to IO.

5.7 On Site Commissioning

The on-site commissioning of the system is outside of the scope of this contract; however, the Contractor shall provide commissioning plans, and shall be available to provide technical support during commissioning activities.

6 WORK REVIEW

IO will monitor work as it progresses through design and procurement/fabrication. During the design phase, for example, there will be hazard analysis/mitigation reviews; 3D model reviews; and operability, maintainability and constructability reviews. These will culminate in a final design review before moving to the procurement/fabrication phase.

7 CONTRACTING SCHEDULE

The Contract is scheduled to come into effect in April of 2023. The tentative timetable is as follows:

Call for Nomination Release	April 2022
Information Day	May-June 2022
Issuance of Pre-qualification Application	July 2022
Issuance of Call for Tender	October 2022
Tender evaluation	February 2023
Contract signature	April 2023

8 EXPERIENCE

The successful selected Contractor and its personnel shall possess technical and engineering expertise and experience in:

- The successful planning, execution and project management of medium scale EPC type projects
- Detailed design and fabrication of equipment for gas treatment systems, including the equipment items listed in Section 3.3.
- Engineering design, analysis and preparation of technical documentation in the areas of HVAC, process, mechanical, piping, structural, electrical and I&C engineering for systems performing nuclear safety functions.
- Design of instrumentation and control for systems performing nuclear safety functions
- Quality assurance and quality control for design, procurement and fabrication of equipment and components for nuclear safety applications
- Qualification of equipment and components for nuclear safety applications
- Ability to use the AVEVA E3D, Engineering and Diagrams software for process plant design

Prior experience in tritium applications is not required.

9 NUCLEAR AND QUALITY REQUIREMENTS

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

TC-DS performs nuclear safety functions. It is therefore classified under the French Order of 7th February 2012 (which establishes the general rules for licenced nuclear installations) as a system consisting of PIC components. Activities that have an impact on the ability of these components to perform their nuclear safety function are defined as Protection Important Activities (PIA) under this Order. The Contractor is informed that:

- The Order 7th February 2012 applies to all PIC components and PIA activities.
- Compliance with the INB-order must be demonstrated throughout the chain of sub-contractors.
- In application of article II.2.5.4 of the Order 7th February 2012, contracted activities are subject to supervision by the Nuclear Operator (i.e. the IO).

The Contractor shall implement a quality assurance programme and shall demonstrate that it is compliant with the IO quality management requirements, in particular for the application of the INB Order.

10 CANDIDATURE

Participation is open to all companies legally established in an ITER Member State either individually or as a consortium. A company cannot participate in more than one application or tender. A consortium may be a permanent, legally established grouping, or a grouping that has

been constituted informally for a specific tender procedure. All members of a consortium (i.e. the leader and all other members) are jointly and severally liable to the ITER Organization. The consortium cannot be modified later without the approval of the ITER Organization.