

Call For Tender Documents

Technical Summary for the Design and Fabrication of Simplified Q2 Recycling System

The ITER Organisation (IO) intends to issue a call for tender for the final design and fabrication (D&F) of the Simplified Q2 Recycling System (SQRS). Q2 refers to mixtures of the six hydrogen isotopologues (H₂, D₂, HD, T₂, HT, DT).

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



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TECHNICAL SUMMARY

Call For Tender IO/23/10032488/JPK

Design and Fabrication of Simplified Q2 Recycling System

1 PURPOSE

The ITER Organisation (IO) intends to issue a call for tender for the final design and fabrication (D&F) of the Simplified Q₂ Recycling System (SQRS). Q₂ refers to mixtures of the six hydrogen isotopologues (H₂, D₂, HD, T₂, HT, DT).

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 heavy hydrogen isotopes which are rare and expensive. In addition, with tungsten first wall, a process of coating the wall with a fine layer of boron is required. This process uses diborane (B₂H₆) gas which is highly toxic and flammable and requires post treatment.

The role of the SQRS is to process Tokamak exhaust gas and recycle it during the first phase of operation of ITER. In addition, it will treat unused diborane during Glow Discharge Cleaning (GDC) Boronization in all phases of operation of ITER.

3 EQUIPMENT DESCRIPTION

3.1 Overview

SQRS is a gaseous effluent treatment system that treats gases from Tokamak exhaust in various scenarios.

SQRS comprises a number of process unit operations housed within an inerted (N₂) glovebox. The preliminary process flow diagram is shown in Figure 1. The throughput of gas is small, limited to 10 to 120 standard litres/min depending on the operating scenario,

There are two primary functions for SQRS:

Function 1: Recycle and discharge gases for torus fuelling during Start of Operations phase of ITER. This is for gas balancing, fuel removal and specific experiments using Helium-3.

This function includes the following sub-functions:

1. Receive tokamak exhaust gases from the vacuum pumping system
2. Measure the quantity of gases received
3. Measure the composition of gases received, including isotopic composition

4. Separate hydrogen gases from non-hydrogen gases
5. Measure the composition of the separated gases
6. Recycle gases to the Fuelling System
7. Discharge unrecycled gases to the Exhaust System

Function 2: Diborane removal. SQRS shall be used for the removal of diborane from GDC Boronization exhaust gases throughout the life of ITER.

This function includes the following sub-functions:

1. Receive GDC Boronization exhaust gases from the Vacuum Pumping System
2. Measure the diborane content of the gases received
3. Remove diborane from the gases received
4. Measure the diborane content of the processed gases
5. Recycle the processed gases to the Fuelling System as a carrier gas for boronization
6. Discharge the processed gases to the Exhaust Systems

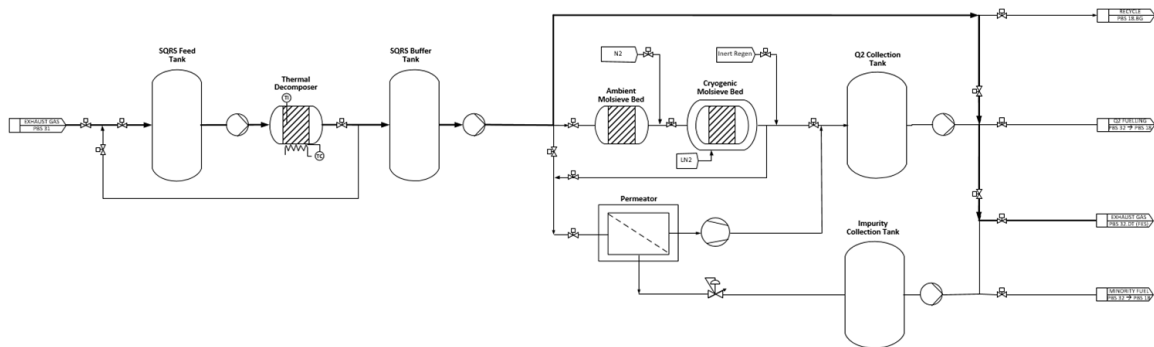


Figure 1: Process Flow Diagram for SQRS (preliminary)

3.2 Equipment location and layout

The Equipment shall be installed inside one room of the Tritium Plant Building (Building 14). This building has already been constructed and an access path remains open for installation. An illustration of the equipment is shown in Figure 2.

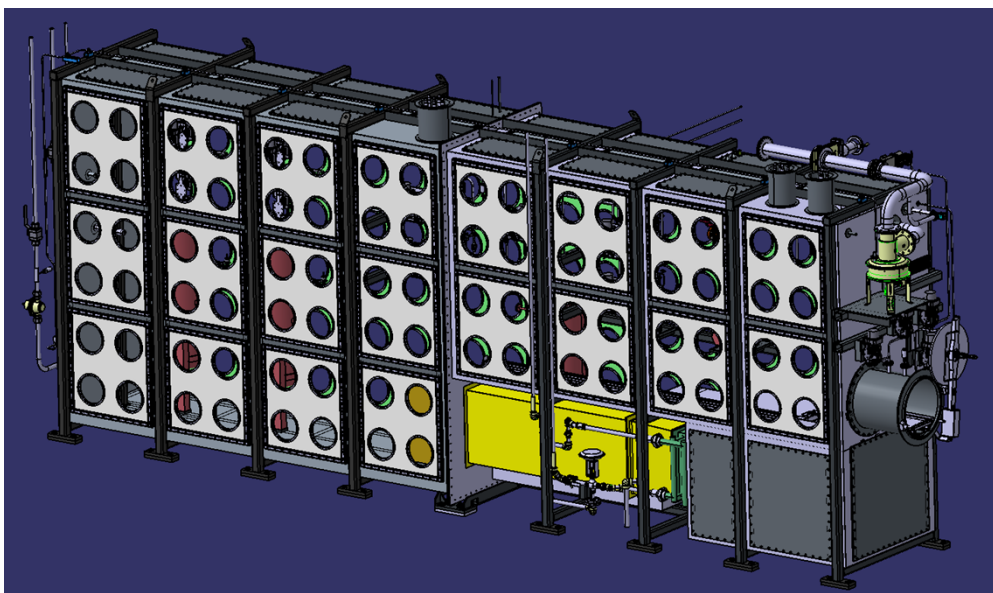


Figure 2: Illustration of the outline of the equipment (preliminary example)

3.3 Description of main process equipment items

The equipment consists of small-scale process gas unit operations located in a glovebox. The main equipment items that make up SQRS are listed in the following sections.

3.3.1 Process equipment (non PED/ESPN)

1. Room temperature gas storage vessels (~270 litre)
2. High temperature (~750°C) packed reactor (~100 litre) within a vacuum jacket
3. Process heat exchangers (Gas/Gas)
4. Hydrogen permeator (~1.3m² membrane area) operating at ~450°C within a vacuum jacket
5. Ambient molecular sieve bed (~0.5 litre)
6. Cryogenic molecular sieve bed (~2.5kg zeolite) operating at 77K with liquid N₂ coolant within a vacuum jacket
7. Glovebox atmosphere blower and cooler (N₂/Water)
8. Instruments (process and glovebox)
9. Analytical instruments for composition (some components provided by IO)
10. Valves and fittings
11. Process gas compressor and vacuum pump (IO scope)

The main material used for construction of the equipment, tubing and glovebox is stainless steel (304L or 316L). All process equipment will be located inside the glovebox.

3.3.2 Structural equipment

The scope of work includes piping/tubing supports, pipe racks and shelves used to support equipment and tubing.

3.4 Control & Instrumentation

The 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 monitor safe conditions within the equipment (most notably the glovebox atmosphere). The SCS shall be implemented with logic solvers to place the equipment in a safe isolated and de-energised state should off-normal conditions occur.

The PCS and SCS interface to operator terminal displays via the ITER central site control systems (CODAC) and ITER Central Safety System (CSS), respectively. A local HMI screen will be required for commissioning, maintenance and local monitoring inspections.

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 equipment (electrical power, cooling water, compressed air, nitrogen and liquid 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 room that houses the equipment.

3.7 Environmental conditions

The equipment 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 maintain its confinement function during and after seismic events and at elevated room temperatures.

4 TECHNICAL REQUIREMENTS

4.1 Classifications

4.1.1 Safety Classification

As the equipment will process radioactive material, there is a primary nuclear safety functions of gas confinement required in normal and in accident conditions. Components contributing to this function are 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

The 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

The primary process components shall be designed to maintain their gas confinement during a design basis seismic event without loss of gas containment. This qualification shall be demonstrated through testing or analysis. The supports, structure and hence the glovebox shall also be qualified to remain structurally sound and ensure no collapse or damage to the primary confinement barrier in seismic events.

4.2 Applicable codes and standards

The main applicable codes are listed in Table 1.

Table 1: Design codes / standards used

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

Gloveboxes	Eurocode (structure) ISO-10684-2 Class 1 (leak tight) AGS G001 & G006
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5 SCOPE OF WORK

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

- a) Process equipment, assembled as much as possible inside a custom designed glovebox to facilitate factory testing and installation on site
- b) Interconnecting tubing between the equipment items inside the glovebox and external tubing/piping for onward process gas connections, distributed utilities and glovebox ventilation
- c) Glovebox wall feed throughs (tubing, piping and cabling)
- d) Tubing supports, shelves and racks to support the equipment/tubing
- e) Instrumentation and control system and associated cabling, and control system programming
- f) Electrical supply equipment and associated cabling
- g) Typical glovebox equipment such as glovebox structure, walls, gloveports, glass, lighting, pass through box, depression control and detectors.

5.1 Performance responsibilities

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

- a) Selection, performance and supply of the gas compressors and vacuum pump
- b) Sizing and specification of the diborane destruction unit
- c) Selection, performance and supply of the isotopic measurement devices

The Contractor has responsibility to ensure that all other aspects of the Equipment 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, leak tightness of primary and secondary barriers).

5.2 Final 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 tubing has been performed. Based on this preliminary design, the Contractor shall complete the final engineering design, considering requirements for operability, maintainability and reliability, and integration with the building environment and interfaces. This shall include providing required documentation for IO to perform a Final Design Review and the subsequent completion of actions arising from the review.

5.3 Procurement and fabrication

Based on the final design, the Contractor shall perform all of the equipment procurement and fabrication. This will include manufacturing design that will be reviewed by IO at Manufacturing Readiness Reviews prior to the start of fabrication of custom components. 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 safety functions under all normal and, in some cases, accident environmental conditions. This is especially critical for components classified as Protection Important Components (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). The Equipment shall be delivered to the ITER site, Cadarache, France by **June 2029** at the latest.

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 May of 2026. The tentative timetable is as follows:

Call for Nomination Release	July 2025
Issuance of Pre-qualification Application	September 2025
Issuance of Call for Tender	January 2026
Tender evaluation	March 2026
Contract signature	May 2026

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 small to medium scale EPC type projects
- Detailed design and fabrication of equipment for highly pure gas treatment systems typically housed with glovebox including the equipment items listed in Section 3.3.
- Engineering design, analysis and preparation of technical documentation in the areas of process, mechanical, piping, structural, electrical and I&C engineering for process systems on a nuclear licensed facility
- Design of instrumentation and control for process systems and gloveboxes
- Quality assurance and quality control for design, procurement and fabrication of equipment and components for nuclear 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 would be advantageous as well as knowledge of hazard gas handling (e.g. semiconductor industry).

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 legal entities participating either individually or in a grouping/consortium. A legal entity is an individual, company, or organization that has legal rights and obligations and is established within an ITER Member State, being, the European Union (represented by EURATOM), Japan, the People's Republic of China, India, the Republic of Korea, the Russian Federation and the USA.

Legal entities cannot participate individually or as a consortium partner in more than one application or tender of the same contract. A consortium may be a permanent, legally established grouping, or a grouping which 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.

In order for a consortium to be acceptable, the individual legal entities included therein shall have nominated a consortium leader with authority to bind each member of the consortium, and this leader shall be authorised to incur liabilities and receive instructions for and on behalf of each member of the consortium.

It is expected that the designated consortium leader will explain the composition of the consortium members in its offer. Following this, the Candidate's composition must not be modified without notifying the ITER Organization of any change. Evidence of any such authorisation to represent and bind each consortium member shall be submitted to the IO in due course in the form of a power of attorney signed by legally authorised signatories of all the consortium members.

Any consortium member shall be registered in IPROC.

11 COST RANGE

This scope of work is identified at Cost Range D which is above 10 000 000 EUR.

12 SUB-CONTRACTING RULES

All sub-contractors who will be taken on by the Contractor shall be declared together with the tender submission. Each sub-contractor will be required to complete and sign forms including technical and administrative information which shall be submitted to the IO by the tenderer as part of its tender.

The IO reserves the right to approve any sub-contractor which was not notified in the tender and request a copy of the sub-contracting agreement between the tenderer and its sub-contractor(s).

Sub-contracting is allowed but it is limited to one level and its cumulated volume is limited to 40% of the total Contract value.