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Technical Specifications: Supply of Elastomer sealed Ultra High Vacuum Valves for the ITER Project.

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1 Document Scope

The scope of this Technical Specification is to define the requirements for the supply of elastomer UHV valves for use on the ITER project, as part of the vacuum component standardisation process.

2 Terms and Acronyms

The following terms and acronyms listed have been used throughout this document.

Term/ Acronym	Contextual Meaning
Customer	ITER International Organisation, Domestic Agencies or sub-contractors working for either.
C of C	Certificate of Conformity – Certificate issued by the Supplier stating that the product concerned meets the requirements as specified in the Supplier's catalogue and/ or technical specification.
ISO-KF, K, F	Standard clamping and fixe flanges for nominal diameters of DN 10 to 630 mm
CF	Knife edge flange (conflat)
DA	Domestic Agency
IO	ITER International Organization
MQP	Management Quality Programme
NDA	Non-Disclosure Agreement
Proprietary item	Items which may be purchased using a Supplier's catalogue or other commercially available documentation.
UHV	Ultra High Vacuum

Table 1 Terms, acronyms and contextual meaning

3 Background

ITER will be the largest and most complex vacuum system yet to be built. Situated in Southern France, adjacent to the French CEA Cadarache site, the ITER International Organisation (IO) facility covers approximately 190 hectares and is designed to study the fusion reaction between the hydrogen isotopes of tritium and deuterium.

During machine operations, plasma of tritium and deuterium is held in place by a magnetic field and superheated to 200,000,000K. Under such conditions, the ionised atoms of tritium and deuterium may fuse to create helium and a neutron. The released energy, in the form of kinetic energy, is carried by the fast neutron and helium atom (known as helium ash). In a commercial reactor, the neutron is slowed and the energy collected as heat to produce steam to drive a turbine as in a conventional power plant, to create electricity. Due to the enormous amount of energy required to provide the required magnetic field, ITER will utilise a super conducting magnet system to confine the plasma and to further reduce the power required to sustain the fusion reaction. ITER will operate at conditions at which the energy of the produced helium "ash" is sufficient to self-heat the plasma.

The goal of ITER is to operate in conditions approaching steady state (i.e. continuous) with a Q=10 where Q is the ratio between the required power input to sustain the reaction and the fusion power output.

3.1 ITER Vacuum Systems

To reduce the impurities present in the plasma, the fusion reaction takes place in a high vacuum environment, the boundary of which, the primary vacuum boundary, also provides the first confinement barrier for radioactive material. The operating pressure within the primary vacuum boundary is in the range $10^{-4} – 10^{-6}$ Pa.

In order to minimise the conductive heat load to the super conducting magnet systems at 4.2K, the machine is housed in a cryostat pumped to 10^{-4} Pa.

The heating systems of ITER all operate under vacuum ranging from medium to high vacuum.

The ITER machine is supported by a Cryogenic Guard Vacuum System (CGVS) which provides insulation vacuums for components outside the cryostat which operate at cryogenic temperatures and a Service Vacuum System (SVS), designed to minimise the risk and mitigate the effect of leaks through components which have been deemed vulnerable and form the boundary of primary and cryostat vacuums.

The valves specified in these technical specifications are not intended to provide safety function, hence are not safety classified.

4 Strategic Agreement

The ITER International Organisation (IO) consists of 7 member states, Europe, China, America, India, Korea the Russian Federation and Japan. Each member state has a Domestic Agency (DA), responsible for the procurement of systems and components for the IO.

The aim of this call for tender is to establish a Strategic agreement to be utilised for the supply of high vacuum valves for the ITER project.

The DAs of each member state and Contractors working for the DAs will purchase components (valves) for delivery to their respective countries where the component may be integrated with a system and finally shipped to the IO in Saint Paul-Lez-Durance, France. In some cases components will be purchased by a DA and will need to be delivered directly to the IO. Other components may be procured directly by the IO or Contractors working for the IO.

Therefore the tenderer shall be able to supply components to all member states. The ultimate destination of all components is the ITER IO.

The purpose of setting up this Strategic agreement is to realise benefits from:

- Standardisation of valves validated for application on ITER vacuum systems
- cost savings from the potentially large quantity of total orders
- to allow effective procurement budget scheduling

It is envisaged that the Strategic Agreement shall have an initial duration of 5 years with two times of the optional extension for further 5 years per each extension.

5 Description of Equipment and Estimated Quantities

5.1 Valves types

The valves which are to be supplied under the scope of the contract have been classified by type. A description of the valve type to be supplied and an indicative number required under the scope of the Strategic Agreement is presented in Table 2. There shall be no obligation to place orders summing up to the indicative number of valve types as specified in Table 2. Numbers may vary as the project evolves. Especially for large sizes (> DN160), where no valve have been identified in the current model.

Valve Model	Description	Indicative total number / nominal size (DN)								
		16	25	40	63	100	160	200	250	320
1	Pneumatic UHV gate valves			15		50	15			
2	Pneumatic UHV right angle valve	60	140	210	80	30	100			
3	Manual UHV right angle valve			130		50				

Table 2: valve type and size

5.2 Commercialisation

All valves offered shall be of the Supplier's proprietary type (i.e. listed in the Supplier's catalogue)

6 Technical Requirements

Valve of all types must fully comply with the following technical requirements. Any changes to these requirements must be approved by the IO prior to any implementation.

6.1 Environmental conditions

6.1.1 Ambient conditions

The Valves shall be able to operate to specification under the following environmental room conditions (nominal):

Nominal room temperature	12°C < T < 35°C
Nominal room humidity	< 60% RH
Nominal room pressure	-100Pa below atm
Nominal operating valve temperature	Room Temperature
Nominal internal pressure	$1x10^{-6}$ Pa.....$1x10^{5}$ Pa

Valves shall maintain their mechanical integrity under the following environmental room conditions (accidental):

Accidental room temperature	-170°C < T < 300°C
Accidental room humidity	0 – 100% RH
Accidental room pressure (relative to atm)	-24kPa < P < +100kPa
Accidental internal pressure	$1x10^{-6}$ Pa – $1.5x10^{5}$ Pa

6.1.2 Radiation and Magnetic Environment

Valves and actuators shall withstand without loss of performance when measured against the requirements of this technical specification:

- A total integrated dose of at least 10^{6} Gy (gamma equivalent) with EPDM seat seal
- A magnetic field up to 150 mT

6.2 Valve flange

Valves shall be supplied with Customer specified flange options. KF, ISO K, ISO F and CF flange options shall be available. The Supplier is responsible for the manufacture and integration of specified flanges with the valves bodies of corresponding nominal diameter. Flange sizes shall be in accordance with ISO standards 2861:2013, ISO 1609:1986 (R09) and ISO 3669-2:2007.

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6.3 Valve Actuation

Gate valves shall be supplied fitted with a pneumatically operated double acting actuator.

Right angle valve shall be supplied fitted with a single acting with closing spring actuator (normally closed)

Valves will be operated from remote solenoid valves which are not part of the scope of supply

Actuator motion sealing shall utilise stainless steel (304 or 316) bellow.

6.3.1 Pneumatic Supply Pressure

Valves shall be fitted with actuators capable of valve operation utilising compressed air within a pressure range of 0.5 – 0.8MPa.

6.3.2 Connection to Pneumatic Supply

Valve actuators shall be supplied fitted with R1/8” / NPT 1/8” pneumatic connections to allow for connection to the pneumatic supply.

6.3.3 Loss of Pneumatic Supply

Valves shall remain in the closed and sealed position in the event of loss of actuator pneumatic supply pressure.

6.3.4 Position Indication

All valve actuators shall be supplied equipped with a visual position indicator (open and close).
All valve actuators shall be equipped with electric (micro-switch type) position indication switches
As an option, double position indication switch shall be available (two switches for each position, open and closed).
The position indicator contact rating shall be 50 V AC/DC, ≤1.2 A.

6.4 Maximum Differential Pressures

Valves shall be able to withstand 0.15 MPa maximum differential pressure across the closure plate in either direction

6.5 Materials

6.5.1 Valve Materials of Construction

Valve body, actuator motion feedthrough bellow, and flanges shall be stainless steel (304, or 316).

6.5.2 Sealing

6.5.2.1 Bonnet seal

Valve bonnet seal shall utilise a metallic seal arrangement.

6.5.2.2 Seat seal

Valves shall be supplied equipped with an EPDM seat seal.

6.5.2.3 Valve Seat Seal Side Indication

The valve seat seal side shall be indicated on the external of the valve body or flange.

6.6 Vacuum Performances

The valves shall be able to operate on a pressure range from 1×10^{5} Pa to 1×10^{-06} Pa.

For all valve types the maximum allowable helium leak rate across the air to vacuum boundary shall be 1×10^{-09} $Pa.m^{3}.sec^{-1}$ measured at ambient temperature.

For all valve types the maximum allowable helium leak rate across the valve seat shall be 1×10^{-09} $Pa.m^{3}.sec^{-1}$ measured at ambient temperature.

6.7 Inspection & Testing

Prior to delivery the Supplier shall test the valves to demonstrate that they both operate and meet the requirements of the Customer order.

The following tests shall be performed and documented by the Supplier. In each case the valve must pass the inspection or test.

6.7.1 Visual Internal & External Inspection

The Supplier shall visually inspect all internal and external visible surfaces of the valves to be supplied.

- The valves shall show no visible signs of damage either internally or externally.
- The valve shall show no signs of dirt or debris either internally or externally.

6.7.2 Valve Operation

For each valve ordered the Supplier shall perform valve operation tests including at least the following operations:

- Valve motion tests – required to ensure valve opens and closes as required to do so.
- Functional test of position indicators, visual and electronic – required ensuring functionality.

6.7.3 Helium Leak Testing

It shall be demonstrated that the valves meet the required leak tightness as specified in section 6.6 by helium leak testing.

6.8 Cleanliness

Valves shall be assembled in clean conditions conforming to at least ISO Class 8.

7 Reliability

Each valve covered by this technical specification shall be able to operate for 10000 cycles before first service. The Supplier shall provide available reliability data (MTBF) of the proposed valves.

The Supplier shall provide evidence of where and for what duration the proposed valves have been used in high energy physics accelerators or fusion machines.

8 Maintainability

The Supplier shall provide technical documentation and spare parts during at least 10 years.

9 Identification and valve ordering

Each valve shall be given a unique Supplier part number.

The Customer shall use the Supplier’s part numbers to place orders for valves under the scope of the Strategic Agreement.

The Supplier shall deliver with the valves a Certificate of Conformity stating that the valves supplied meet the requirements as specified in the Customer order

10 Design information

Valves will be rigidly connected to stainless steel pipe sections with no intrinsic static loads beside the valve mass. It may, however, be necessary to add an external framework to support the valves.

Supporting structures are outside of the scope of this Technical Specification and Strategic Agreement

To this end, the supplier shall provide a dimensional drawing, in electronic format, of each valve design. The supplier shall also detail any further information pertinent to validate mounting and orientation conditions

11 Documentation Required

11.1 Standard Documentation

11.1.1 Certificate of Conformity

Each valve shall be CE compliant and marked as such.

Each valve shall be supplied with documentation in support of performance. The documentation shall include as a minimum:

- Unique valve serial number – required to identify the individual valve.
- Equipment datasheet
- Results of tests performed
- Certificate of Conformity that the product meets its specifications (i.e. conformity to equipment specification and datasheet)

11.1.2 Manuals & Drawings

Each valve shall be supplied with operating manuals. The operating manuals shall include all the required information to allow correct operation by the Customer.

Each valve shall be supplied with a set of general layout drawings.

All documentation shall be provided in English, both paper and electronic format.

12 Quality Assurance

The Supplier shall have an IO approved QA Program or an ISO 9001 accredited quality system.

The general requirements are detailed in ITER IO document ITER Procurement Quality Requirements [1]. Deviations and Non-conformities shall follow the procedure detailed in IO document MQP Deviations and Non Conformities [2].

Changes by the Supplier and/or its subcontractors to processes utilised in the manufacture of the valves shall be considered a deviation and shall follow the procedure detailed in IO document MQP Deviations and Non Conformities [2].

Tenderers are required to provide the information required in the Invitation to Tender.

The IO shall be granted the right to visit the Supplier in order to audit the design, manufacturing, assembly, and test capabilities of the Supplier.

The IO shall be granted the right to visit the Supplier in order to audit the Supplier QA system.

13 Responsibilities

13.1 Supplier's Responsibilities

The Supplier is responsible for the supply of valves meeting all the requirements contained in these specifications to the Customer.

Supply shall include design, manufacture, inspection, testing, delivery and documentation of valves as specified in the Customer order.

The Supplier shall manage all aspects of the valve procurement which relate to the Suppliers scope of supply.

13.2 Customer's Responsibilities

The Customer is responsible for raising the order with the Supplier in compliance with the agreed procurement procedure indicated in the conditions of the Strategic Agreement.

The Customer is responsible for Supplier remuneration in respect of valve supply in compliance with the conditions of the Strategic Agreement

13.3 IO's Responsibilities

IO shall appoint a Responsible Officer who represents the IO for all technical matters relating to this work.

The supervision of the Strategic Agreement is under the scope of the IO. Any changes to the requirements and/or technical specifications of the Strategic Agreement requested by any Customer must be approved by the IO prior to any implementation. In all other cases, where the IO is not the Customer, the IO shall not participate in the procurement process of the standardised valves after the award of the Strategic Agreement.

14 References

[1]. ITER Procurement Quality Requirements (ITER_D_22MFG4).
[2]. MQP Deviations and Non Conformities (ITER_D_22F53X).
[3]. Procurement Requirements for Producing a Quality Plan (ITER_D_22MFMW).
[4]. ITER Requirements Regarding Contractors Release Notes (ITER_D_22F52F).
[5]. ITER Vacuum Handbook Appendix 7 (ITER D 2EPFG4)