

**Technical Specifications (In-Cash Procurement)****Technical Specification strategic agreement of the supply  
of Spring Energised Metallic Seals for ITER vacuum  
systems**

This document is the Technical Specification for a strategic agreement of the supply of Spring Energised Metallic Seals used on the ITER Vacuum Systems with: ITER Style Flanges, Other equipment that uses the ITER Style flange as an interface, Circular Seals in sizes larger than the ITER Style flanges, Shaped Seals.

Seals that are qualified will become part of a strategic agreement for the supply of metallic vacuum flange seals in the project.

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## List of Abbreviations

For a complete list of ITER abbreviations see: ITER Abbreviations [\[1\]](#).

Acronym	Expansion
ASN	Autorité de Sûreté Nucléaire (French Nuclear Safety Authority)
C of C	Certificate of Conformity
CE	Conformité Européene
COTS	Catalogue off the Shelf Part
CTF	Critical to Function.
DA	Domestic Agency
DET	Data Export Task
DN	Nominal Diameter (Pipe)
EnS	Cadenas database system.
FAT	Factory Acceptance Test
HP	Hold Point
INB	Instillation Nucléaire de Base – Licensed Nuclear Installation
IO	The ITER Organization.
IVH	ITER Vacuum Handbook.
KoM	Kick off Meeting
MIP	Manufacturing and Inspection Plan
NCR	Non-Conformance Report
PIA	Protection Important Activity
PIC	Protection Important Component
PPS	Production Proof Sampling
QAP	Quality Assurance Programme
QP	Quality Plan
SIC	Safety Important Class
STEP	Standard for the Exchange of Product model data.
TRS	Thermal Radiation Shield
VCR	Swagelok Metal Gasket Face Seal Fitting
VQC	Vacuum Quality Class.

# 1 Purpose

The document is the Technical Specification for a strategic agreement of the supply of Spring Energised Metallic Vacuum Seals here after called “Seals” used on the ITER Vacuum Systems with

- ITER Style Flanges,
- Circular Seals in sizes other than the ITER Style flanges,
- Shaped Seals.

The ITER Organization (hereinafter called “IO”) requires the supply of seals to be used on Vacuum Systems on the ITER.

This Technical Specification shall define the technical requirements for the Supplier to manufacture, supply and deliver the required seals to the IO for that purpose. The seal qualification needs to be demonstrated by the supplier and the IO approval qualifies it as PIC COTS item.

The desired outcome of this tender is that a supplier will be selected as a seal supplier for use on the machine under a strategic agreement signed between the supplier and the ITER Organization.

The qualified seals shall be given a supplier part number and be available in their catalogue. The COTS seals may be procured against this part number by IO, DA or any of their suppliers.

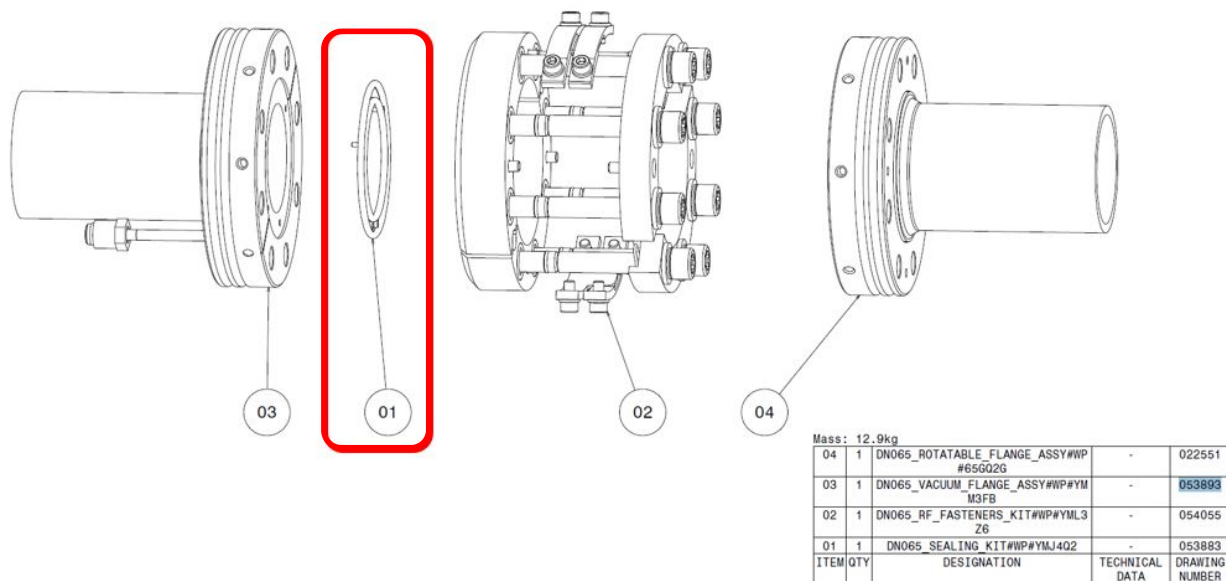


Figure 1 Metallic Sealing Kit shown in an typical flange assy (DN65)

## 2 Definitions

TERM	DEFINITION
Circular Seal	A seal that is of a generally constant radius.
Customer	ITER International Organisation; Domestic Agencies or Subcontractors working for either.
Certificate of Conformity	Certificate issued by the Supplier stating that the product concerned meets the requirements as specified in the Supplier's catalogue or this technical specification or both.
Deviations	A non-compliance with a defined requirement or non-compliance with a requirement set by the IO integrated management system that could affect the provisions of the Environment Code [2].
Domestic Agency	An organisation set up under the ITER Framework Agreements to provide goods or services to the ITER Organisation through Procurement Arrangements (PA) and Task Agreements (TA).
Double Seal	A seal that has two sealing boundaries with an interspace between these boundaries.
Interspace	The volume between two sealing toruses
Non-conformance	Any condition that does not comply with a specified IO requirement.
Nuclear Operator	ITER International Organisation
Protective Important Activity	An activity which can impact a Protection Important Component. The list of the main PIA is contained in Annex 2 of [3], [4].
Protective Important Component	A component important for protecting the interests of public security as defined in the INB Order [5] and the Environmental Code [2].
Proprietary Item	Items which may be purchased using a Supplier's catalogue or other commercial available documentation.
Qualification	The process used to ascertain that an item meets the requirements for use.
Safety Important Class	Classification corresponding to the graduated approach of a PIC as defined in [6]

TERM	DEFINITION
Seal Kit	The seal and any required fasteners required for its installation.
Shaped Seal	A seal that is non circular, these may be or Racetrack or Rectangular in form.
Special Process	Any process which is not used in the manufacturer of a Supplier's proprietary items which must be developed or qualified or both to meet the requirements of these technical specifications.
Spring Energised Seal	A seal with an internal spring device that provides a sealing force.
Subcontractor	Any entity that performs work for the Supplier.
Supplier	Any entity that provides goods or services to the ITER Organisation.

### 3 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, shall comply with the French Order of 7th February 2012 [5] establishing the general rules for licensed nuclear installations (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).

The Safety Function of the ITER Style Flange is to provide confinement as it forms part of the First Static Barrier in the First Confinement System and though the use of a double metallic seal the Second Static Barrier to the First Confinement System. Therefore the quality assurance requirements of Section 15 shall be applied as well as compliance with the INB Order of 7th of February 2012 [5].

This quality system shall be included in the Manufacturing and Inspection Plan or the Quality Plan. This management system shall include the list of PIA on the basis of reference [8] and the evaluation of Non Conformance Reports whether major or minor in accordance with ITER Requirements Regarding Contractors Deviations and Non Conformities [9], [10]

### 4 Previous Experience

The supplier shall have a background history in either Tokamak or other High Energy Physics vacuum sealing applications and include published case studies. These case studies shall be supplied as references in the tender.

### 5 System Classifications:

The following are the classification the seals shall be compliant with:

- Safety Classification (for confinement function) [6]: SIC-1,

- Vacuum Classification: [11] VQC 1A,
- Quality Classification: [12] QC-1,
- Seismic Classification: [13] SC-1 (SF).

Vacuum Quality Classes are defined [11] and this seal shall provide leak tightness to the VQC 1A criteria. A seal to VQC 1A may be used in any other vacuum quality class. The safety function of VQC1A is given in Table 1 below.

**Table 1 Seal Safety Function**

Vacuum Quality Class [11]	Safety Function of Seal	Notes
VQC 1A	To provide confinement as it forms part of the First Static Barrier (Inner Seal Boundary) in the First Confinement System and, though the use of a (Outer Seal Boundary) the Second Static Barrier to the First Confinement System.	Leak testing of the interspace between the two seal elements allows to verify the integrity of the static barriers.

## 6 Scope

### 6.1 Circular Seals

The supply of a number of circular vacuum seals to fit an existing flange design in a range of sizes. The seal shall provide sealing suitable for the environmental conditions mentioned in this technical specification and provide the safety functions given in Table 1 above.

ITER Flanges [14] are in the sizes, DN65, DN100, DN150, DN200, DN250, DN300 and DN500, used for vacuum flange applications of up to and including Vacuum Quality Class VQC 1A.

These seals shall be suitable for the Flanges Sizes given in Table 3.

In addition other seals are required for example Neutral Beam Duct, Cryopump and other applications. The supplier shall demonstrate the capacity to manufacture and qualify circular seals in the large sizes above DN500 up to DN2600 to meet this supply requirement, see Table 4.

### 6.2 Shaped Seals

In addition other seals are required in larger sizes for example Vacuum Vessel Port Plug and other applications. The supplier shall demonstrate the capacity to manufacture and qualify shaped seals in the large sizes. These sizes are up to 2550 x 2110 mm for the Vacuum Vessel Closures on Equatorial ports with the same VQC1A requirements, see Table 5.

### 6.3 Engineering Services

Services needed to cover future design changes, including the engineering of seals, seal surface repair methods, tooling and assembly aids shall be managed by this method below as part of the strategic agreement



### *6.3.1 Methodology to manage the Strategic Agreement in the case of a design change request by the ITER Organization.*

There is likely to be some future need for seal design over the life of the ITER project. These changes may range from small modifications based on seal use experience by ITER to the design of a new seal size.

The supplier shall in their offer supply the fixed hourly manpower rates of the engineering work rates used for these works. In the offer the supplier shall propose a price revision formula.

The updating of these rates will be agreed by negotiation before contract signature.

To manage such an additional service IO shall issue a Task Order for the service following this process.

1. The ITER Organization shall issue and send to the Supplier a Task Request for any additional engineering service it may require from the Supplier.
2. The Task Request shall include the following information.
  - Scope of work
  - Technical specification
  - Required completion date
  - Deliverables
  - Deadline date for the Task Offer submission
  - Any other information required.
3. By the deadline date described in the Task Request, the Supplier shall submit the financial and technical Task Offer to the ITER Organization.
4. The Task Offer shall include the following information:
  - Compliance with the Task Request
  - Required total manpower hours and its breakdown
  - Total costs in accordance with the hourly manpower rate in the Financial Annex (Appendix II of Exhibit A) of the Contract.
5. After the review of the Task Offer, the ITER Organization may issue and send to the Supplier a Task Order for the service it requires from the Supplier. The Task Orders shall be prepared and sent by two original copies.
6. The Task Order shall include the following information.
  - Scope of work
  - Quantity
  - Unit price in EURO
  - Total amount of order in EURO
  - Required delivery timing
  - Payment plan
  - Liquidated damages
  - Point of contact in each Party during the implementation of the Task

- Order
- Deliverables
- Any other conditions required

The supplier shall in their offer supply the fixed hourly manpower rates of the engineering work rates used for these works. Before any work commences on a new seal design outside the scope the supplier shall make an offer based on these rates for the approval of IO.

## 6.4 Exclusions

All other components shown on the reference drawings are excluded from this technical specification./

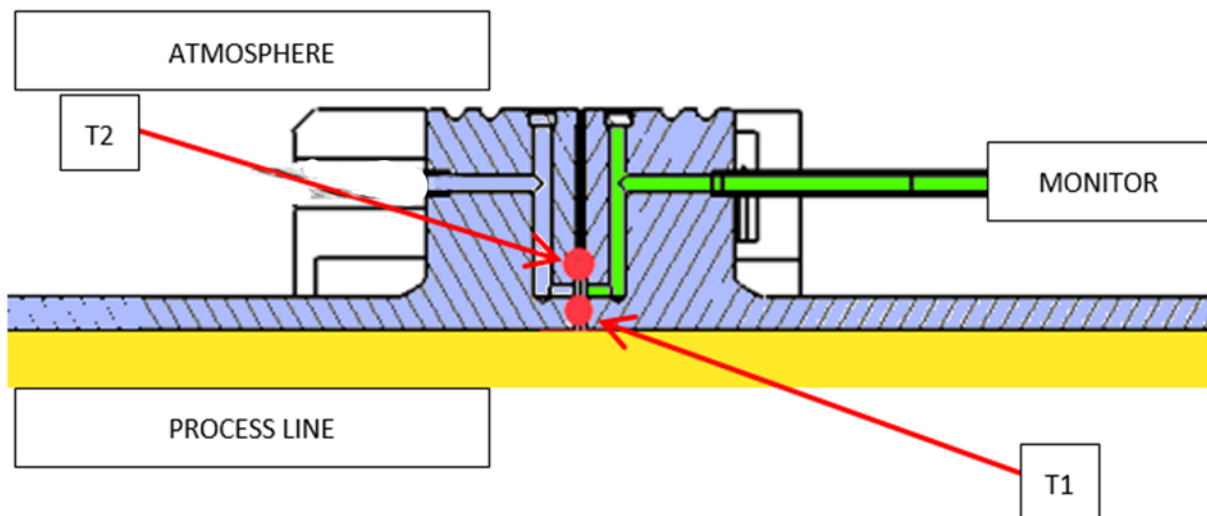
# 7 Technical Requirements

## 7.1 Safety Function of the Seal

The vacuum seal system has two sealing elements:

- Torus 1 – Provides the VQC 1A boundary and forms part of the First Static Barrier in the *First Confinement System*.
- Tours 2 – Provides the VQC 3A boundary and forms part of the Second Static Barrier to the *First Confinement System*.

The space between these two seals is provided with a port in the flange to allow testing of the condition of the First Confinement System, see Figure 2 below.



**Figure 2 VQC Boundaries**

This interspace shall be pumpable with free connectivity between any volumes so that there are no virtual leaks preventing the effective monitoring of the seal leak rates. The nominal pressure in the interspace is 50 kPa, but during any leak testing this pressure will be in the order of 10 Pa.

These sealing requirements and leak rates for each category are given in Table 6. The leak rate for Normal Operation shall be achieved within 1 hr of making the flange joint without baking of the assembly.

## 7.2 Seal Construction Materials

All materials used in construction of the system shall be fully traceable to their respective sources. Wherever possible all materials used in the seal shall be made from low activation materials. If a technical constraint forces the use of other materials then the expected composition and the technical requirement for this material shall be given.

IO requires that full disclosure of the materials and their compositions used in the construction is given and that all material test certification is provided in the QA documentation. An EN 10204 Type 3.1 Certificate [15] or IO approved equivalent is required. If an alternative to the Type 3.1 certificate is proposed then this shall be stated in the Supplier's offer for acceptance by IO.

Due to the possible irradiation levels that will be encountered during the end use special care must be taken to ensure no long lived residual activity is induced in the components. Specific limits of impurities and certain materials are restricted in their use. These are given in [16] and the values in Table 2 shall be applied for these seals.

In the case of an overriding technical constraint then the Supplier shall report the reason and actual values for the construction materials to allow IO to make an assessment via a Deviation Request [9] to this specification.

**Table 2 Radiological Element Limits**

Element Name – Symbol [17]	Maximum Weight %
Cobalt [Co]	< 0.2

## 7.3 Radiation

The supplier shall demonstrate that the proposed seal do not degrade and retain their sealing function in the radiation environment of the ITER machine.

## 7.4 Cleaning to Vacuum Standards

These seals are UHV components. The cleaning process shall comply with the requirements of IVH [11] Section 24 and IVH Appendix 13 [18]. The Supplier shall submit to the IO the proposed cleaning procedure for approval and acceptance as part of the offer.

During cleaning, particular attention shall be given to the removal of debris and other foreign matter. Final cleaning shall ensure effective cleaning without damage to the surface finish and material properties. Cleaned components shall be bagged to prevent contamination. The component part number shall be clearly marked on the bag and the outer packaging. This shall comply with 8.4 below.

If the supplier has a suitable alternative packaging method for UHV seals then this shall be described in their offer.

## 7.5 Resistance to corrosion

In the postulated event of a water leak into a vacuum systems the seal may be exposed to water for an extended period. Previous experience on the JET vacuum systems showed that Silver was a suitable material to interface to stainless steel. Therefore the outer seal surface shall be silver.

## 7.6 Baking

The seals shall be installed in systems that may be baked up to 240°C. The supplier shall demonstrate that the seal:

1. Does not suffer any degradation in performance when compared to the room temperature leak rate.
2. Does not give rise to any gasses or vapours that could cause a loss in performance of systems being connected by flanges sealed with the seal.

## 7.7 Drawings

### 7.7.1 ITER Style Flange Drawings

All drawings referenced and the CAD models of the flanges can be found in EnS Catalogue and are available on request from IO as a STEP files [19] via a DET request [20].

**Table 3 ITER Style Flange Drawing References**

Flange Size [DN]	Flange Assembly & Fixed Flange	Basic Flange	Rotatable Flange Assembly & Spool
DN65	008496	053893	022551
DN100	008475	053975	026127
DN150	008492	053800	022547
DN200	037374	053987	026130
DN250	037095	054018	026132
DN300	008500	054013	026134
DN500	050595	053885	In production *
* Seal interface is identical to 053885 Design finalisation expected End 2021			

### 7.7.2 Other Circular Seal Interface Drawings

Flanges interfaces for the other circular seals are detailed in the drawings referenced.

**Table 4 Other Circular Flanges**

Nominal Size [DN]	Item	Interface Drawing Folder <a href="https://user.iter.org/?uid=5JP3NV">https://user.iter.org/?uid=5JP3NV</a>
DN3000	Flange_HVB_BSV	
DN2600	Flange_FS_BLV	
DN1600	Cryostat Plug	
DN1000	HUMAN_FLANGE	

DN350	Cryopump Valve Stem	
DN100	Cryopump Valve Shaft	
DN65	TRS front supports	

### 7.7.3 Shaped Seal Interface Drawings

Non circular flanges for larger sizes for example Vacuum Vessel Port Plug and other applications are detailed in these drawings.

**Table 5 Non Circular Flanges**

Nominal Size [mm]	Item	Interface Drawing Folder <a href="https://user.iter.org/?uid=5JP3NV">https://user.iter.org/?uid=5JP3NV</a>
2169 x 1692	Equatorial Port Plug Flange	To be added
2209 x 1732	Equatorial Port Plug Flange (TBM Ports #16, and /#18) <sup>A</sup>	To be added
2607 x 2170	Equatorial Vacuum Vessel Flange	005457 SHEET 06
1126 x 1116	Upper Port Plug Flange	044950 SHEET 04
1464 x 1460	Upper Port Vacuum Vessel Flange	043254 SHEET 07
2365 x 1490	Lower Port Closure	041417 SHEET 05
1909 x 733	TBM Flange	044811 SHEET 07

### 7.7.4 Required Performance ITER Style Flange Seals

**Table 6 Leak Rates.**

Category		Max. Temperature [°C]	Max. Pressure Difference [kPa]	Max. Leak Rate [Pa.m <sup>3</sup> .s <sup>-1</sup> ] Air Equivalent Leak Rate i.e. 1E-9 Pa.m <sup>3</sup> .s <sup>-1</sup> Air Eq = 2.69E-9 Pa.m <sup>3</sup> .s <sup>-1</sup> He Leak Rate	
				VQC1	VQC3
CAT I	Normal Operation	60	100	1E-10	1E-09
CAT II		240	100		
CAT III	Upset		200	1E-10	1E-09
CAT IV	Accident	345	200	1E-5	

<sup>A</sup> TBM Ports are 40 mm larger than standard EPP Flange (PCR-705).

The seal should have a capacity to provide sealing when the piping system is subjected to various loads from both adjacent systems and from thermal loads. The ITER style flange is designed to remain face to face under loading. Maximum baking temperature in vacuum systems may be up to 240°C. The heat up rate for the flanges during baking is in the order of 5 to 10 °C per hour.

**Table 7 Temperature of the Flanges**

Category	Condition	Temperature [°C]	Duration	Expected Heat up rate [°C / hr]
CAT I	Ambient Temperature Range	0°C to 60°C	+20 years	-
CAT II	Operational Temperature Range	Ambient to 120°C	+20 years	-
CAT II	Baking	240°C	24 hrs	<10
CAT IV	Maximum Accidental Temperature	345°C [21]	2 hrs	-

The supplier shall demonstrate that the seal does not degrade significantly at 345°C for 2 hrs and shall evidence this in their tender return.

The supplier shall provide the ultimate failure pressure for each Category in Table 8 in their tender return.

### 7.7.5 Circular Seals

The leak rate requirements for these seals are given in Table 8.

**Table 8 Circular Seal Leak Rates.**

Category		Max. Temperature [°C]	Max. Pressure Difference [kPa]	Max. Leak Rate [Pa.m <sup>3</sup> .s <sup>-1</sup> ] Air Equivalent Leak Rate i.e. 1E-9 Pa.m <sup>3</sup> .s <sup>-1</sup> Air Eq = 2.69E-9 Pa.m <sup>3</sup> .s <sup>-1</sup> He Leak Rate	
				VQC1	VQC3
CAT I	Normal Operation	60	100	1E-10	1E-09
CAT II		240	100	1E-10	1E-09
CAT III	Upset		200	1E-10	1E-09
CAT IV	Accident	345	200	1E-5	

### 7.7.6 Shaped Seals

The leak rate requirements for shaped seals are given in Table 9.

The supplier shall provide the ultimate failure pressure for each Category in Table 9 in their tender return.

**Table 9 Shaped Seal Leak Rates.**

Category		Max. Temperature [°C]	Max. Pressure Difference [kPa]	Max. Leak Rate [Pa.m <sup>3</sup> .s <sup>-1</sup> ] Air Equivalent Leak Rate i.e. 1E-9 Pa.m <sup>3</sup> .s <sup>-1</sup> Air Eq = 2.69E-9 Pa.m <sup>3</sup> .s <sup>-1</sup> He Leak Rate	
				VQC1	VQC3
CAT I	Normal Operation	100	100	1E-10	1E-09
CAT II		240	100	1E-10	1E-09
CAT III	Upset		200	1E-10	1E-09
CAT IV	Accident	345	200	1E-2	

## 7.8 Flange Seal Requirement

### 7.8.1 ITER Style Flanges

#### 7.8.1.1 ITER Style Flanges Seal to Flange Fixation Method and Dimensions

For the DN500 flange size the seal fixation is by M5 x 10 long vented DIN 6912 low head height screws.

Seal Fixation to flange face for flanges in all sizes except DN500 uses three push fit low head height vented pins fitted to a Ø2.5H7 hole of overall depth 8 mm and the H7 tolerance depth 5 mm. The vented pin is internally threaded to enable extraction if needed. If required this method of fixation may be modified.

The seal fixation shall provide a robust mount of the seal to the flange to enable the flange to be assembled in any orientation. The supplier shall provide details of the seal fixation method and shall include the seal removal procedure in the case of seal replacement. The supplier shall detail what jigs, fixtures or tooling, if any, is needed to make the assembly and disassembly of the seal to the flange.

One scenario that shall be considered in the supplier's offer is the fixing of a seal to the upper flange in a vertical orientation with the mating flange approaching from underneath. In this case the seal shall not become detached when subjected to a 2 g vertical shock load in the downward sense.

The seal supplier shall demonstrate this vertical shock requirement of the seal attachment is met.

### 7.8.1.2 ITER Style Flanges Load on the seal and flange assembly

When subjected to operational loads the flange is expected to remain closed due to the bolt loads applied to the flange and the sealing leak rate maintained up to the max operational Bending Moment and Shear Loads in Table 10.

**Table 10 Expected Bending Moments on ITER Style Flanges**

	NO CAT I, II		ACC CAT III & IV	
Flange Size	Maximum Bending Moment [kN.m]	Maximum Shear Load <sup>B</sup> [kN]	Maximum Bending Moment [kN.m]	Maximum Shear Load [kN]
DN65	1	20	1	20
DN100	1.4	25	2.3	25
DN150	2.8	38	7.5	38
DN200	3.8	49	11	49
DN250	5.7	62	19	62
DN300	9.5	75	24	75
DN500	9.8	100	13.7	100

During operational conditions the flange faces are designed to be in contact. The seal design shall allow for this. Leak rates given in Table 6 shall be maintained.

During accidental loading cases (CAT IV) the flange faces may separate up to 0.15 mm. In this case the seal shall maintain the safety leak rate given in Table 6. The seal shall maintain this leak rate after a CAT IV event.

The supplier shall provide a Design Proposal for the seal and its attachment to the flange. This shall contain enough information to allow an assessment of the seal's design. Expected leak rate and reliability data shall be provided. This shall be based on the supplier previous experience with sealing to the leak rates given in Table 6. This previous experience shall be referenced.

### 7.8.1.3 ITER Style Flange Bolting

For each ITER Style flange size:

- The expected bolting loads required for sealing shall be provided.
- The bolting sequence recommended shall be provided.
- Any staged or progressive tightening steps and recommended torques shall be given.

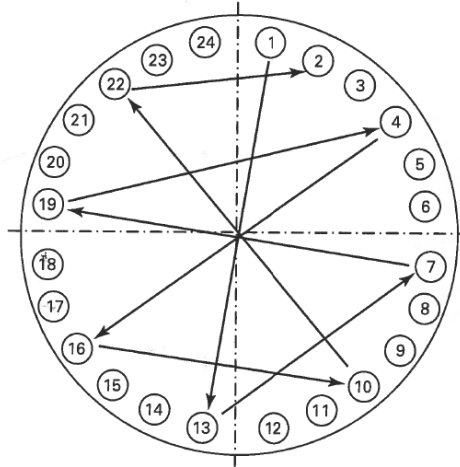
The order and tightening stages, if any, are to be presented clearly in a way such as ASME PCC-1-2013 [22] see Figure 3 or other recognised method.

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<sup>B</sup> Conservatively assumes friction coefficient  $\mu=0.2$



**Fig. F-1 Legacy Pattern Numbering System**



GENERAL NOTES:

- Pass 1 – 20% to 30% of Target Torque  
1,13,7,19 – 4,16,10,22 – 2,14,8,20 – 5,17,11,23 –  
3,15,9,21 – 6,18,12,24
- Pass 2 – 50% to 70% of Target Torque  
Same pattern as Pass 1.
- Pass 3 – 100% of Target Torque  
Same pattern as Pass 1.
- Pass 4 – 100% of Target Torque, in circular pattern, until nuts do not turn. 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19, 20,21,22,23,24 – 1,2,3,etc.
- Pass 5 (optional) – 100% of Target Torque (performed 4 h after Pass 4), in circular pattern, until nuts do not turn.

### Figure 3

**Figure 3 Example Presentation of Bolting Order taken from ref [22]**

Proposed Flange Main Bolting Materials are:

Grade	Standard
SA540 B21 Class 4	ASTM A540 / A540M - 06
SA540 B22 Class 4	ASTM A540 / A540M - 06
660 (Alloy A-286)	ASTM A453 / A453M -17
1.4980	EN10302
Alloy 718	ASTM B637-98
1.6580+QT	EN 10269
Stainless Steel A4-100	ISO 3506-1 ISO 898-1

The seal shall account for these available materials for the main flange bolting loads and be compatible for each.

#### 7.8.1.4 ITER Style Flange Seal Dimensions

The main dimensions for the seal interface are given in the reference drawings. Basic dimension of the proposed seal shall be given for the whole range of flanges sizes given in Table 2. It shall be clear from the tolerances included that the seal shall fit the flanges and allow face to face flange closure.

### **7.8.1.5 Design changes to the ITER Style Flange**

The ITER style flange design is fixed but if any minor design changes are required to the flange to accommodate the seal proposed by the supplier then these shall be detailed in the suppliers offer. Design changes shall be solely restricted to those needed to attach the seal to the flange.

### **7.8.2 Other Circular Seals**

#### **7.8.2.1 Fixation Method**

Details given in the reference drawing.

#### **7.8.2.2 Bolting**

Details given in the reference drawing.

#### **7.8.2.3 Seal Dimensions and Expected Tolerances**

Details given in the reference drawing.

### **7.8.3 Shaped Seals**

#### **7.8.3.1 Fixation Method**

Details given in the reference drawing.

#### **7.8.3.2 Bolting**

Details given in the reference drawing.

### **7.8.4 Seal Dimensions and Expected Tolerances**

Details given in the reference drawing.

## **8 Expected Quantities**

### **8.1 Circular Seals**

The estimated quantities needed for machine assembly and operation is given in Table 11 below for information. These estimates are the proposed number of seals needed over the life of the machine.

The supplier shall make an offer based on the machine assembly quantities in Table 11 for each seal size. This offer shall include any fastening required for seal assembly, i.e. the seal kit.

**Table 11 Estimated Seal Quantities – Circular Types**

Flange Size	Machine Assembly	Operation
ITER Style DN65	500	600
ITER Style DN100	500	600
ITER Style DN150	500	600
ITER Style DN200	50	60

Flange Size	Machine Assembly	Operation
ITER Style DN250	100	120
ITER Style DN300	100	120
ITER Style DN500	20	30
DN3000 Flange_HVB_BSV	To be defined	
DN2600 Flange_FS_BLV	To be defined	
DN1600 Cryostat Plug	To be defined	
DN1000 HUMAN_FLANGE	To be defined	
DN100 Cryopump Valve Shaft	To be defined	
DN65 TRS front supports	To be defined	

## 8.2 Shaped Seals

**Table 12 Estimated Seal Quantities – Shaped Types**

Flange Size	Machine Assembly	Operation
EQ Port	18 sets	36 sets
Upper Port	18 sets	20 sets
Lower Port	18 sets	36 sets
TBM	8	24
HNB_BSV	1	1

Where a Seal Set is mentioned this is a Seal for the Port Plug flange, a Seal for the Vacuum Vessel flange and all fastenings need to fix the seals to the respective flanges.

## 8.3 Batch size

For each seal based on the quantiles in Table 11 and Table 12 the supplier shall propose a manufacturing batch size in their response. In each batch of a size of seal the supplier shall provide an additional seal as a legacy or record seal to allow future investigation if needed. For each batch a leak test shall be performed on either an actual seal or in the case of large seals, either circular or shaped, a representative test shall be proposed. In the case of smaller or larger batch sizes the number of record seals shall be agreed in advance.

## **8.4 Handling, Storage, Packing & Shipping**

Handling storage packing and shipping shall conform fully to IVH Section 29 and [23]. All external packaging shall be marked or labelled in English and be of an agreed proper construction that is moisture proof to prevent damage or deterioration of the items being shipped or in controlled storage for up to five years. The package shall be marked with PNI described in section 8.6 below. The packaging shall allow the removal of the seal without hindrance or damage. Instructions for removal shall be printed on the outside of the package or attached to the package for ready reference.

## **8.5 Delivery Conditions to IO Site or DA or other entity.**

For delivery to IO site the delivery and reception process for PIC items shall apply. [23] in particular section 7.1.1.1 and Section 8.2.3. The supplier shall understand and agree to these specific conditions relating to the required delivery report, preservation requirements and packing list. The working instructions for the delivery readiness review shall be followed [24]. To allow proper control of these items the supplier shall be provided with an IDM account (s) on request to allow the uploading of the required documentation.

For delivery to another customer such as a DA or other entity the specific requirements for a PIC item for that entity shall be established at the time of order and shall be met.

## **8.6 Traceability – Item Numbering & Record Keeping**

The use of these seals is as a Protection Important Component in the ITER Machine. The seals and any manufacturing processes used are considered PIC and PIA respectively. Full traceability in terms of record keeping is essential. IO will require that all documentation related to the manufacture of a PIC is provided to the IO. The Supplier shall also retain their records for 5 years. If after that time the Supplier wishes to remove these data then IO should be informed in writing and IO reserves the right to extend the record keeping for a further period or take possession of the data.

ITER will advise the PNI for the seals and the manufacturer shall choose a serial number and apply a maker's mark.

Any marking on the component shall comply with requirement of IVH Section 28. Marking on the seal surface is prohibited. The use of marker pens is not permitted. The mark should be either stamped or legibly scribed in letters at least 3 mm high. The locations of this mark shall be noted on the supplier's drawing of the seal. If this is not possible due to the small size of the item or other overriding considerations then the article's packaging shall be clearly identified with any serial number to fully identify the component.

## **9 Supplier Qualification**

As part of the technical proposal the supplier shall provide evidence of a qualified Seal to this specification. The supplier shall provide an outline qualification plan [25] in their offer. The qualification type and evidence shall be provided in the form of a qualification matrix.

The supplier shall demonstrate either by testing, calculation or analysis, operating experience, ongoing qualification or a combination of methods the suitability of the seal and its compliance and qualification with this specification.

The IO Design Floor Response Spectra [26] shall be provided for the seismic testing for Building 11, L4 so that all anticipated vacuum flange connections are encompassed.

Post contract award the IO reserves the right to perform audit tests on any seal supplied and reject that batch of seals if found not to meet the requirements.

Any actual leak testing carried out on these seals the leak testing shall comply with the requirements of the ITER Vacuum Handbook Section 25 [11] and its Appendix 12 [27] unless otherwise agreed by the Vacuum RO.

## 10 Strategic Agreement Award

The definition of how ITER will award the strategic agreement to the supplier for the procurement of seals needed shall be given in the Invitation To Tender and will include but not be limited to:

1. Technical Criteria
2. Qualification
3. Pricing
4. Schedule
5. Quality Assurance

## 11 Pricing

In the tender return the supplier shall provide prices for the seal kits in this specification in the quantities given in Table 11 & Table 12.

As part of the offer the supplier shall:

1. Propose seal solution,
2. Propose attachment solution,
3. Provide sufficient information on the seal design for the interface to the flange to be checked and evaluated,
4. Provide Bolting Loads and tightening sequence,
5. Produce the qualification plan for the seal to demonstrate the seal is qualified to meet all technical requirements in the specification,
6. Demonstrate leak tightness following combined dynamic loading and bending moment,
7. Demonstrate Seal compliance with this specification through a compliance matrix<sup>C</sup>.

### 11.1 The Supplier's Responsibilities

1. The Supplier is responsible for the supply of seals meeting all the requirements contained in these specifications to the Customer. Supply shall include design, manufacture, inspection, testing, delivery and documentation of seal as specified in the Customer order.
2. The Supplier shall manage all aspects of the seal procurement which relate to the Suppliers scope of supply.

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<sup>C</sup> The compliance Matrix shall collate the requirements of this specifications and reference how these are met for each seal type.

3. The Supplier shall ensure that they satisfy the technical requirements in this Technical Specifications.
4. The Supplier shall appoint a Responsible Officer who represents the Supplier for all matters related to this work and who shall:
  - a. Coordinate the planning and performance of the work including any work assigned to subcontractors.
  - b. Maintain schedules and issue monthly progress reports.
  - c. Verify that the quality systems are consistently followed during the performance of the contract.
  - d. Assess and oversee quality in any subcontractors' premises
5. The Supplier shall ensure that all input information provided to perform the work remains the property of IO and shall not be used for any other activity than the one specified in this Technical Specification.
6. The Supplier shall ensure to maintain an organization and facilities suitable to perform the scope of the works as described in this Technical Specification.
7. The Supplier shall provide to the IO representative or the applicable ITER Domestic Agency or any applicable regulatory authorities' full access to its work premises, to permit the follow up of work progress, if requested by the IO.
8. The Supplier shall submit all documentation, information and deliverables in English.
9. All external packaging shall be marked or labelled in English.
10. All reporting and measurement shall use SI units as the primary units.

## **11.2 The IO's Responsibilities**

1. The IO RO (Responsible Officer) shall make available to the Supplier all technical data, specifications or information which the Supplier requires to carry out its obligations pursuant to this Technical Specification.
2. The IO RO shall assess the performance and quality of the work by the Supplier.

## **11.3 Customer's Responsibilities**

1. 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.

# **12 Quality Assurance (QA) requirements**

## **12.1 Quality Management**

The supplier shall have an IO approved QA Program or an ISO 9001 accredited quality system, or equivalent one. The Supplier's Quality Assurance Programme (QAP) is subject to approval by the IO in accordance with the ITER QA Programme and shall be applied to all work carried out as a result of any contract arising from this specification.

The ITER QA Programme is based on IAEA Safety Standard SGR-Part 2 [28] and on conventional QA principles and integrates the requirements of the French Order dated 7<sup>th</sup> February 2012 [2] 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 [29] and ITER Procurement Quality Requirements [30] whilst the specific requirements for the supervision of the supply chain for Protection Important Components, Structures, Systems and Activities is detailed in [3] [31].

## **12.2 Quality Plan**

Prior to commencement of the work, a Quality Plan [32] must be submitted for IO approval giving evidence of the above and describing the organisation for this task; the qualification and experience of the workers involved including named individual(s) who will act as Independent Reviewer(s) and Checkers(s) and any anticipated sub-contractors.

## **12.3 Manufacturing and Inspection**

Prior to the commencement of any manufacturing, a Manufacturing and Inspection Plan [32] must be approved by ITER who will mark up any planned interventions. Prior to the delivery of any manufactured items to the IO Site, a Release Note must be signed in accordance with [33].

## **12.4 Protection Important Components**

For the Protection Important Components, structures and systems, a specific management system must be implemented by the Supplier and any subcontractor working on protective important activities, on the basis of activities defined and executed by the Supplier and Subcontractor.

This system could be included in the Manufacturing and Inspection Plan or the Quality Plan. This management system will include the evaluation of Non Conformance Reports whether major or minor [10].

The use of computer software to perform a safety based task or activity such as analysis and/or modelling shall be reviewed and approved by the IO prior to its use, in accordance with [33].

## **12.5 Deviations and Non-Conformances**

A deviation is defined in the Order [5] as a non-compliance with a defined requirement or non-compliance 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 [9] and Non Conformities [10].

The overriding principle is to ensure timely identification and review of deviations and non-conformances in order to determine the importance and to ensure appropriate corrective action is taken. The management of deviations and non-conformances and the analysis of trends is also part of the overall IO Project continuous improvement process.

## **12.6 Additional Surveillance Requirements**

ITER Organisation is the Nuclear Operator and has the ultimate responsibility for the application of the INB Order [5] within the IO and in its chain of suppliers. IO must undertake additional surveillance for those components which are classified as Protection Important Components as described in Section 3.

The Supplier shall therefore grant access to the IO and ASN representatives to its facilities and records and those of its subcontractors for the purposes of surveillance of defined requirements during the design, construction, manufacturing, commissioning, assembly, maintenance and surveillance of a PIC. This surveillance shall also include the examination of all protective important activities and follow-up and verification of any corrective actions which are to be implemented.

### **12.7 Changes in the supply Chain affecting qualification of the seal.**

The supplier's supply chain forms an intimate part of the qualification validity. Any changes in this supply chain to a qualified seal shall be notified in advance to both the IO RO and QARO. The propagation of the French Order of 7th February 2012 [5] requirements shall be made to all those in the supply chain. IO reserves the right to audit subcontractors for PIC components.

### **12.8 Documentation**

All documentation related to the design, construction, manufacturing, commissioning, assembly, maintenance and surveillance of a PIC must be provided to the IO.

## **13 References**

- [1] ITER Abbreviations (ITER\_D\_2MU6W5).
- [2] Environmental Code. Ordinance 2000/914 dated 18 September 2000. As amended. Available: <http://www.legifrance.gouv.fr>.
- [3] Surveillance Plan for PBS 31 - Vacuum Systems (ITER\_D\_QEL38Hv1.2).
- [4] Surveillance Plan PBS 31 : Annex 2 (ITER\_D\_T3FCQRv1.5).
- [5] Order dated 7 February 2012 relating to the general technical regulations applicable to INB (ITER\_D\_7M2YKFv1.7).
- [6] Safety Important Functions and Components Classification Criteria and Methodology (ITER\_D\_347SF3v1.8).
- [7] Decree No.2012-1248 dated 9 November 2012 authorising IO to create a licensed nuclear facility called "ITER" (ITER\_D\_CZK7M5v.1).
- [8] List of ITER-INB Protections Important Activities (ITER\_D\_PSTTZL v2.2).
- [9] Procedure for the management of Deviation Request (ITER\_D\_2LZJHB v5.5).
- [10] Procedure for management of Nonconformities (ITER\_D\_22F53X v8.2).
- [11] ITER Vacuum Handbook (ITER\_D\_2EZ9UM v2.5).
- [12] Quality Classification Determination (ITER\_D\_24VQES v5.2).
- [13] ITER Seismic Nuclear Safety Approach (ITER\_D\_2DRVPE).



- [14] ITER Vacuum Handbook Appendix 8 Flanges (2DJYQA v2.5).
- [15] EN 10204:2005 Metallic products - Types of inspection documents.
- [16] Chemical composition and impurity requirements for Materials (ITER\_D\_REYV5Vv2.3).
- [17] International Union of Pure and Applied Chemistry (IUPAC).
- [18] IVH Appendix 13 Cleaning and Cleanliness, (ITER\_D\_2ELUQH).
- [19] ISO 10303 Standards for the Exchange of Product Model Data.
- [20] How to launch a CAD data exchange - How to fill a DET request (25MAL5 v2.2).
- [21] Nuclear Safety Roombook, (ITER\_D\_KF63PB v2.11).
- [22] Guidelines for Pressure Boundary Bolted Flange Joint Assembly (ASME PCC-1-2013).
- [23] Procedure for Transportation of Components to ITER Site (RY5C6Q v1.7).
- [24] Working Instruction for the Delivery Readiness Review (ITER\_D\_X3NEGB).
- [25] Qualification guidelines (ITER\_D\_WGFF3G).
- [26] Design Seismic Floor Response Spectra in the Tokamak Complex ( ITER\_D\_SVBRJZ v1.1).
- [27] Appendix 12 Leak Testing (ITER\_D\_2EYZ5F v1.4).
- [28] IAEA, Safety Standard SGR Part 2 Leadership and Management for Safety.
- [29] ITER Integrated Safety, Quality and Security Policy (ITER\_D\_43UJN7 v2.0).
- [30] ITER Procurement Quality Requirements (ITER\_D\_22MFG4 v5.1).
- [31] ITER Overall Supervision Plan of External Interveners Chain for Protection Important Components, Structures and Systems and Protection Important Activities (ITER\_D\_4EUQFL v6.1).
- [32] Requirements for Producing a Quality Plan (ITER\_D\_22MFMW v4.0).
- [33] Quality Assurance for ITER Safety Codes (ITER\_D\_258LKL v3.1).