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Technical Specification

Technical Specification for Neutral Beam Absolute Valve angular bellows (edge welded bellows)

The Pendulum shoulder block and feedthrough form part of the first confinement barrier and are required to be RCC-MR compliant. The feedthrough is a double walled angular edge welded bellows with pumped interspaced.The bellows end piece is bolted to the pivot block sealed with a double metallic seal configuration with interspace pumping.Edge welded bellows are not permitted / covered under RCC-MR. Common practice in ultra-high vacuum applications is to use edge welded bellows where space restriction are given and lateral and angular movement is needed.There is no viable option to verify the bellows by design according to the standard so a functional lifetime test on a prototype is proposed to validate the function of the double angular bellows.The full details of the testing programme to validate the bellows will be defined in this docuement

Neutral Beam Absolute Valve
Angular bellows qualification

Technical Specifications

china eu india japan korea russia usa

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ABBREVIATIONS, ACRONYMS & DEFINITIONS

BLC: Beam Line Component
BS: Beam Source
CP: Cryopump
DA: Domestic Agency
DCP: Dimensional Control Plan
EMR: End of Manufacturing Report
ES: Exit Scraper
FAT: Factory Acceptance Test
FDR: Final Design Review
FEC: Front End Components
FS: Fast Shutter
HNB: Heating Neutral Beam
HV: High Voltage
HVB: High Voltage Bushing
IO: ITER Organization
ICD: Interface Control Document
IS: Interface Sheet
ITER: International Thermonuclear Experimental Reactor
L1: Level 1 of the Tokamak Building
LDP: Liquid Dye Penetrant
PT: dye or liquid Penetrant Test
MIP: Manufacturing and Inspection Plan
NED: Neutralizer and Electron Dump
NDE: Non Destructive Examination
NB: Neutral Beam
PA: Procurement Arrangement
PMS: Passive Magnetic Shield
PQR: Procedure Qualification Report: a record of the parameters used during the WPQ defining the requirements of applicable codes and standards
RID: Residual Ion Dump
RT: Radiography Test
VH: Vacuum Handbook
VT: Visual Test
VV: Vacuum Vessel

1 Abstract

Each NB injector is connected to the Torus primary vacuum via the absolute valve that provides isolation between the ITER VV and the BLV. This component shall provide the primary vacuum containment for this section of the NB system and therefore provides a part of the first confinement barrier of the in-vessel radioactive inventory.

The valve is connected to the Fast Shutter and to the VVPSS box. Both these interfaces consist of similar flanges with a bore diameter of 1,600 mm to a standard design compatible with the NB cell RH equipment. The valve is also supported from beneath by means of a trolley which bears its weight, but with sufficient compliance to accommodate thermal expansion of the valve without transferring significant loads across the flange interfaces. The trolley provides no constraint in the axial or transverse directions.

The valve design is a pendulum type valve with a nominal bore dimension of 1600 mm and an axial length of 760 mm between the outer faces of the casing. The overall width of the valve is 3120 mm with edge of the rectangular pocket being 2140 mm from the axis of the valve bore. The overall height is around 3 m. The valve plate is suspended from the pendulum and carries a pair of all-metal seal rings.

This technical document outlines the scope of work for the qualification of the edge welded bellows used as primary confinement barrier and vacuum boundary on the Absolute Valve.

2 Background and Objectives

2.1 Background Overview of the NB system

The NB system for ITER consists of two heating and current drive (H&CD) NB injectors and a diagnostic neutral beam (DNB) injector. The layout allows a possible third HNB injector to be installed later. These NB injectors will be connected to equatorial ports #4 - #6 for the H&CD NBs. The DNB shares port #4 with the H&CD NB. The injectors will be located outside the cryostat inside a common enclosure, the NB cell, on north side of the Tokamak building in the L1 and the L2 levels. As they are directly coupled to the ITER vacuum vessel, the injectors are extensions of the primary confinement barrier of radioactive materials coming from the vacuum vessel. The NB cell will form the secondary confinement barrier.
The Figure 1 shows the NB-Cell including the 3 HNBs and the DNB.
The Figure 2 shows a view of the HNB components. The AV is highlighted.

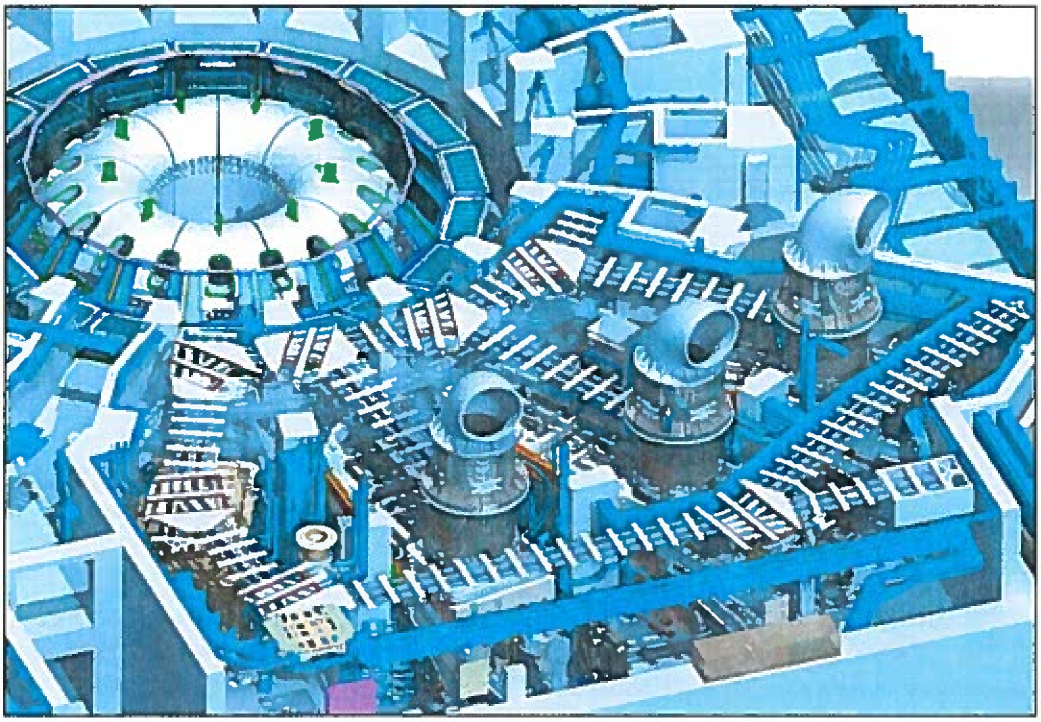

Figure 1: **Isometric view of the NB-Cell**

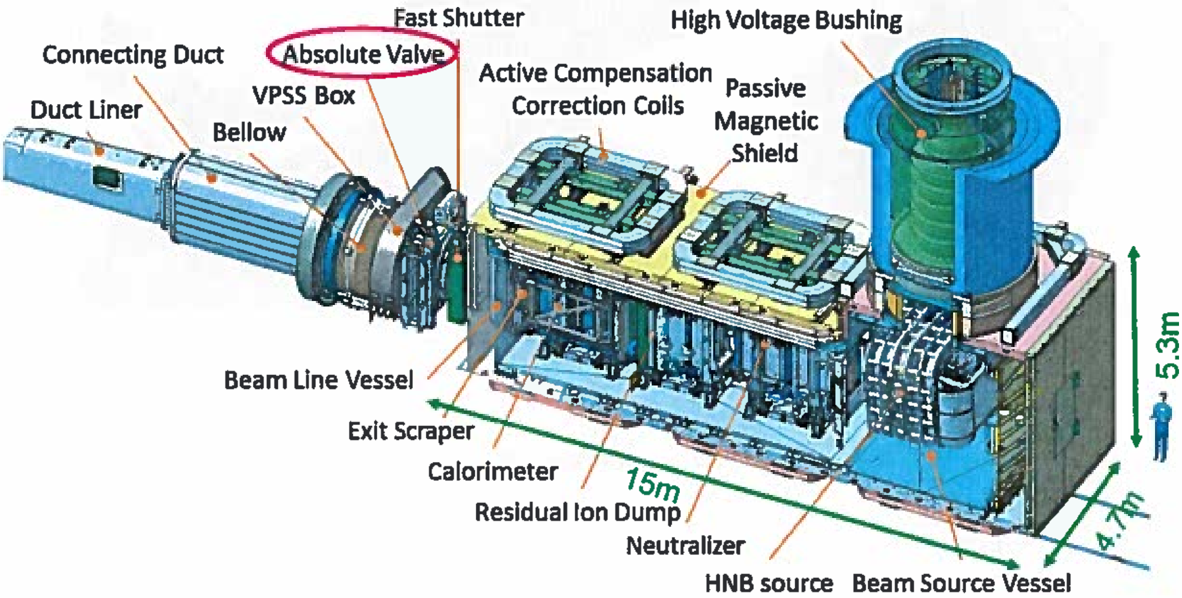

Figure 2: **Main HNB components**

2.2 Background

The AV has been split in 7 sub-systems defined as below:

- ✓ VATRING seal
- ✓ Seal Actuator
- ✓ Valve plate
- ✓ Casing
- ✓ Plate actuator
- ✓ Pendulum Shoulder block
- ✓ Seal Protection System

Those sub-systems shall comply with the classifications defined in the document

- ➢ ITER_D_RYH2UU - AV_subcomponents_classification

The valve casing including the pendulum shoulder block shall be in compliance with the "RCC-MR, Class 2 / Edition 2007" as they are identified as First Confinement Barrier
This document is focusing on the Pendulum shoulder block system:

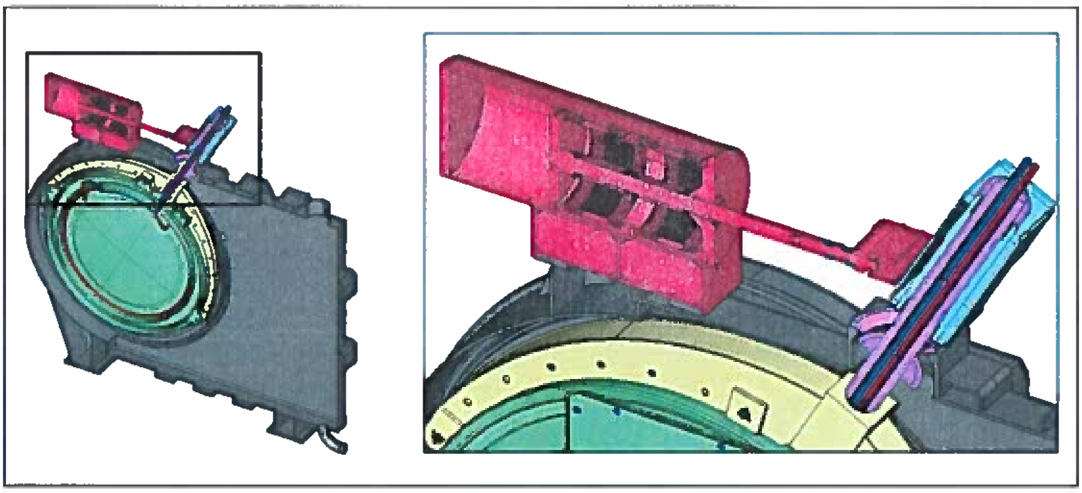

Figure 3: Pendulum Shoulder Block

First Confinement barrier	Vacuum Boundary	SIC Classification	Design code	Manufacturing code
Yes	Yes VQC1A	SIC-1	RCC-MR Class2	RCC-MR Class2

Table 1: Classification Pendulum Shoulder Block

Additional safety classification and requirements are:

- Quality: Class 1
- Tritium: TC1A
- Remote Handling: Class 3
- Seismic: SC1(S)

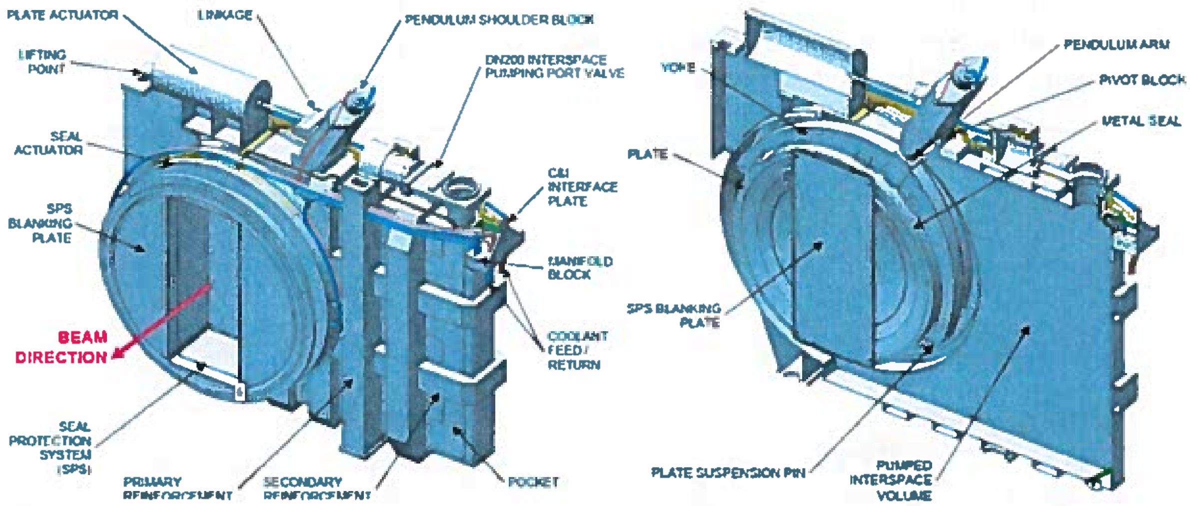

Figure 4: AV sub-systems

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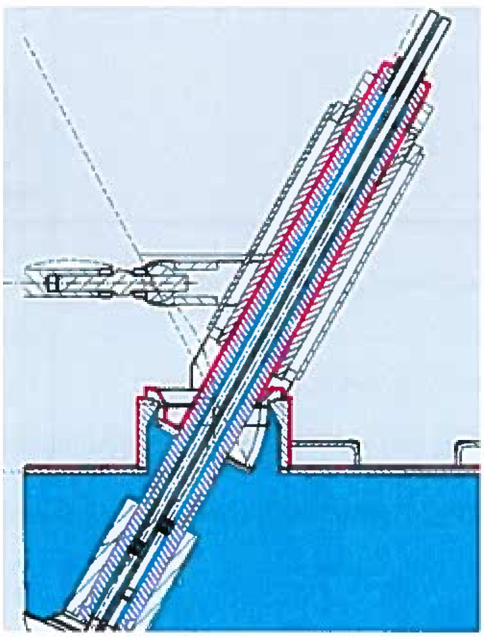


Figure 5: Pendulum Shoulder Block cross-section (Red= First Confinement Blue=Vacuum)

The plate actuator and pendulum mechanism is centrally mounted above the valve orifice ensuring that the whole valve is contained within the minimum axial dimension. The actuator drives the pendulum arm through an arc of just under 60° by means of a linkage and shoulder block. The shoulder block design ensures that all the pivot points requiring bearings are external to the valve casing and not, therefore, exposed to the primary vacuum. The shoulder block is attached to a pivot block which is welded to the top of the casing.
The pendulum arm is mounted in the shoulder block and passes through a double angular bellows in the pivot block and into the casing.

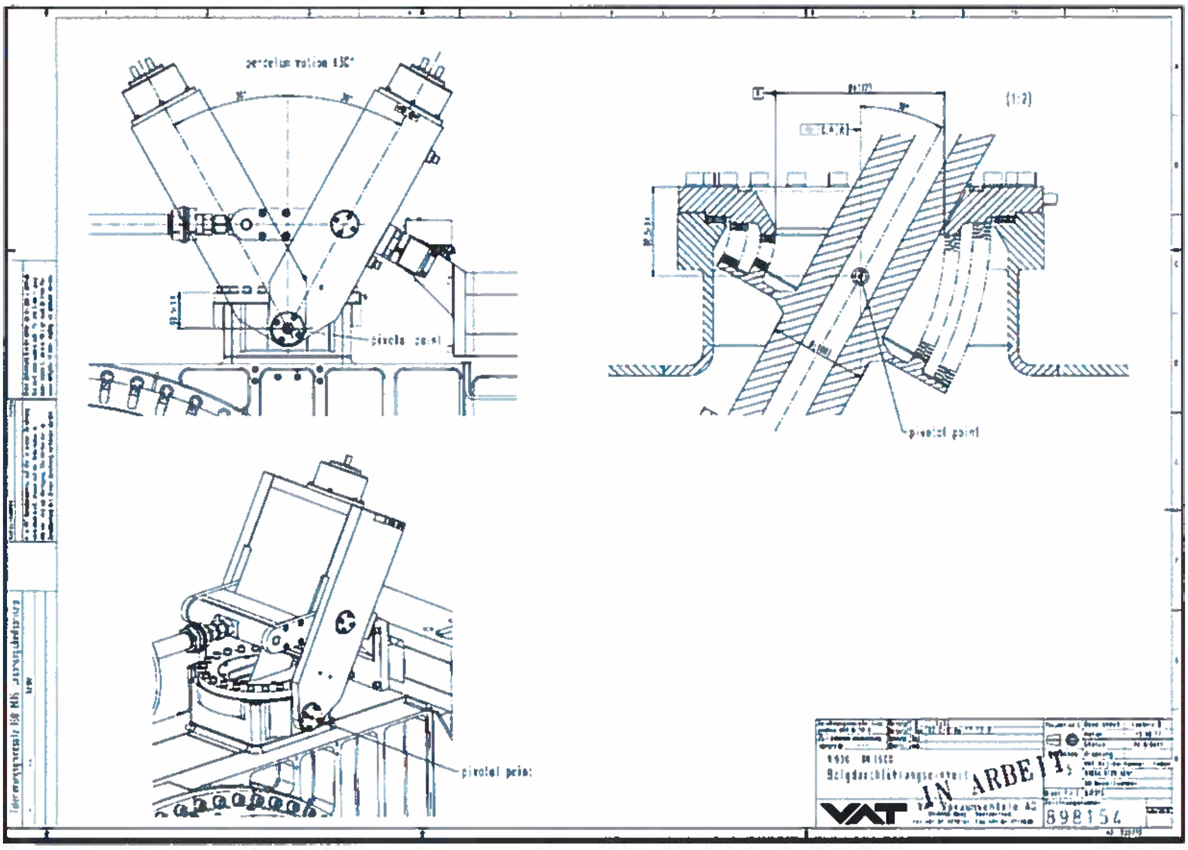


***Figure 6:** Sketch showing the actuator pivot point and angle of movement required for testing the bellows (*).*

(*): This detailed drawing will be given (Pdf format) to the contractor.

The diameter between the bellows end piece (where the pendulum rod is welded to the end piece) is 140.1 mm +/- 0.08
The PCD of the bolt pattern on the other bellows end piece is 340.0mm.

The Pendulum shoulder block and feedthrough form part of the first confinement barrier and are required to be RCC-MR compliant. The feedthrough is a double walled angular edge welded bellows with pumped interspace.
The bellows end piece is bolted to the pivot block sealed with a double metallic seal configuration with interspace pumping. The outer metallic seal is a Helicoflex and the inner is a VATSEAL*, which also acts as an alignment aid for the outer Helicoflex seal.

Edge welded bellows are not permitted / covered under RCC-MR. However it is a common practice in ultra-high vacuum applications to use edge welded bellows where space restriction are given and lateral and angular movement is needed. As well as a maximum He leak tightness is required.
The purpose of this qualification is not to qualify the edge welded bellows according the RCC-MR code. A concession to use edge welded bellows as primary confinement barrier non-compliant to RCC-MR has been approved on IO on the basis to demonstrate the reliability of the component and the compliance to ITER requirements.
Double containment edge welded bellows out of 316L with intermediate monitoring was chosen as this creates an interspace that can be pumped to secure first confinement functionality in the event of a leak in the bellows.

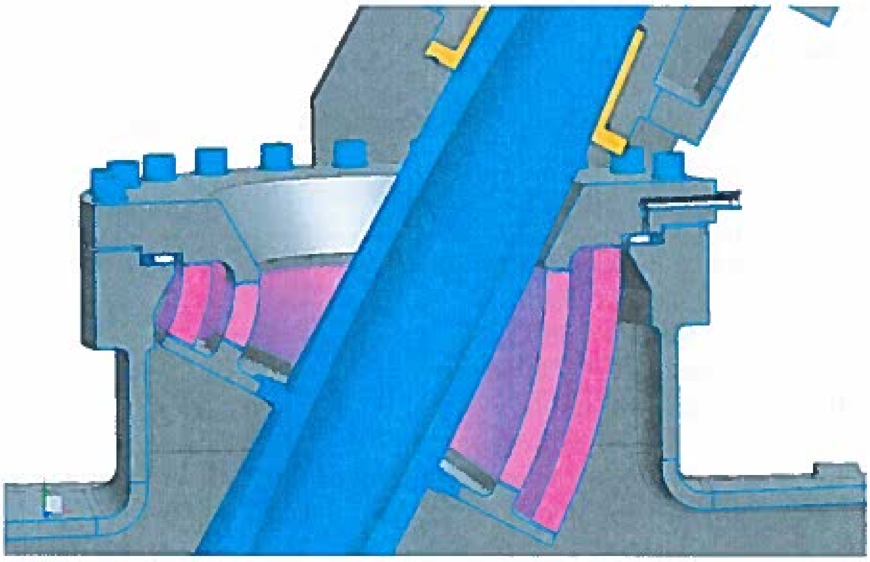


Figure 7: *Detail interspace pumping Helicoflex / VATSEAL*

There is no viable option to verify the bellows by design according to the standard so a functional lifetime test on a prototype is proposed to validate the function of the double angular bellows.
The full details of the testing programme to validate the bellows will be defined in the section below.

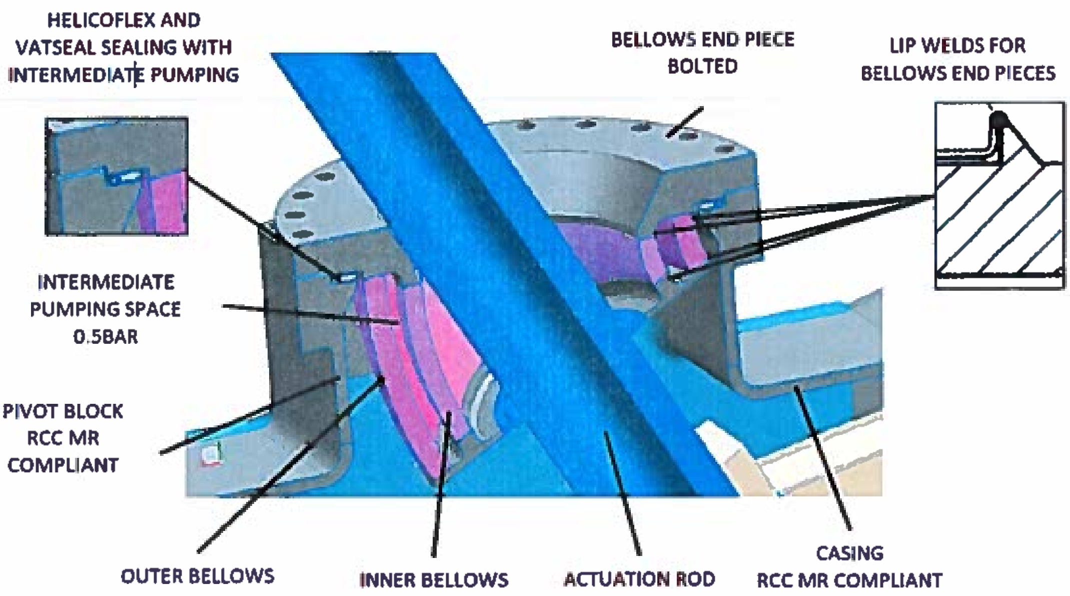


Figure 8: *Pendulum Feedthrough*

2.2 Objectives

A functional lifetime test on a prototype shall validate the function of the double angular bellows.
Testing shall demonstrate that with the bellows assemblies displaced axially and radially to the maximum design values, and subjected to a 0.2 MPa pressure differential applied internally or externally to the assembly, that the bellows can survive and remain unaltered when the bellows interspace is at the following pressures:

- < 10E-3 MPa (evacuated interspace)
- 0.05 MPa (interspace normal operation)
- 0.2 MPa (Interspace over pressure)

Definition and lay out of the proposed double angular bellows was made with the bellows manufacturer COMVAT in Switzerland. Dimensional drawing: C139700.

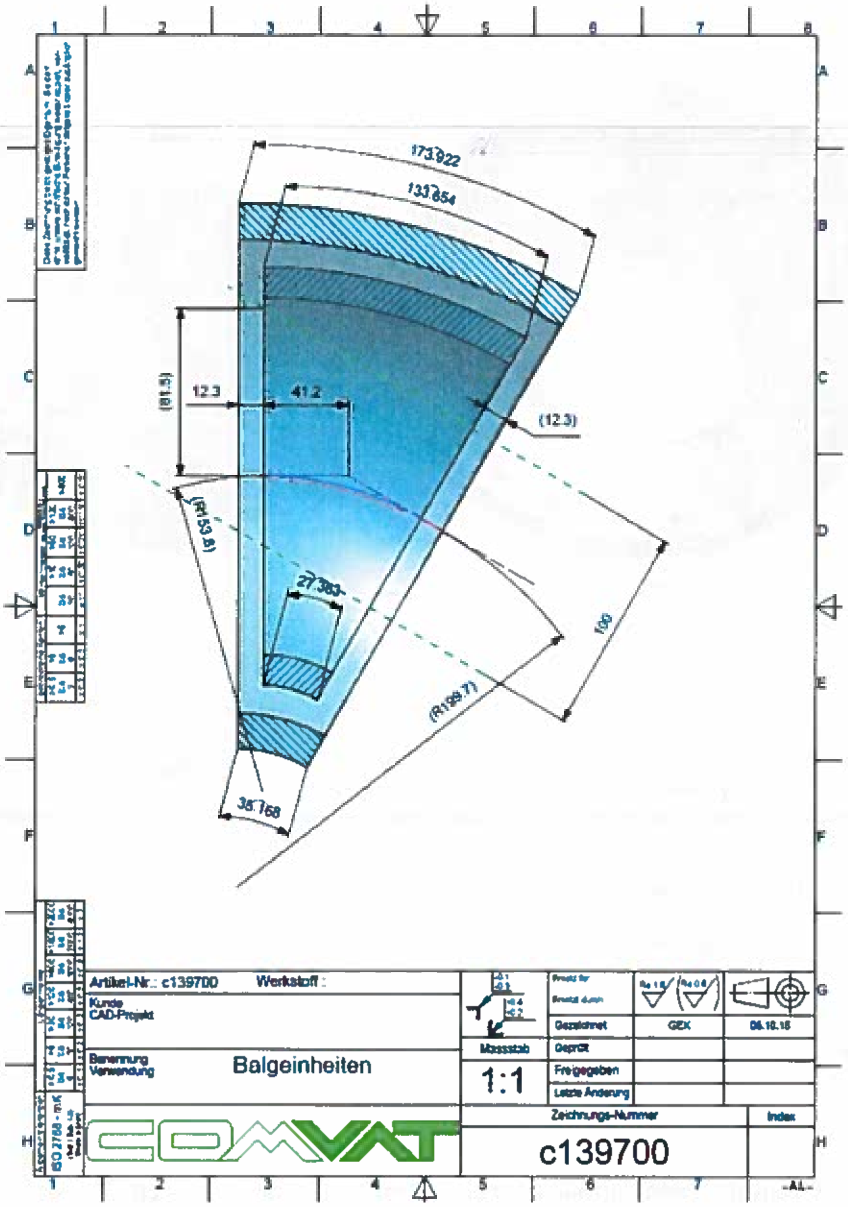


Figure 9: *2D drawing/ cross section of the edge welded bellows*

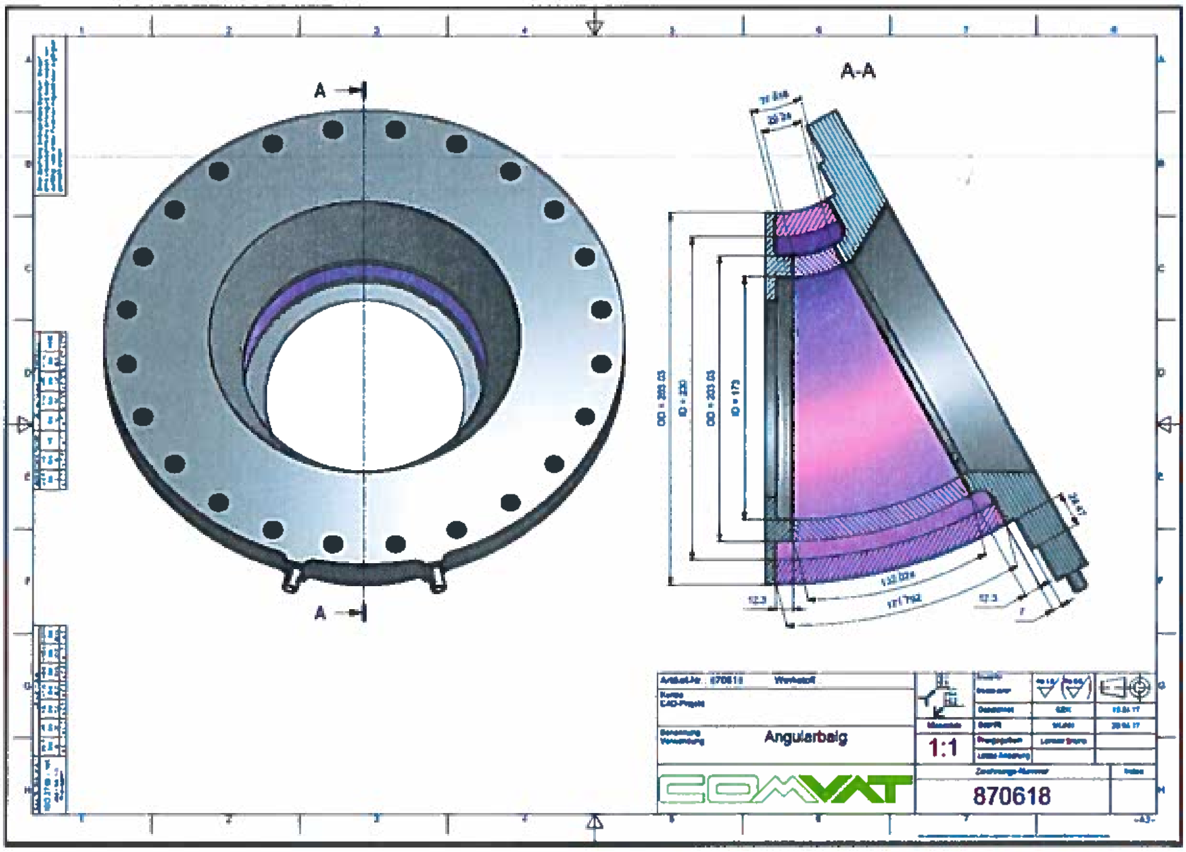


Figure 10: *Drawing* of the COMVAT edge welded bellows with its reference.*

(*): *This detailed drawing will be given (Pdf format) to the contractor.*

3 Scope of Work

A qualification procedure shall confirm that the equipment is capable of meeting, throughout its operation life, the requirements for performing safety functions and machine operations. The manufacturers and users of equipment for safety systems are required to provide evidence that such equipment will meet or exceed its performance requirements throughout its installed life.
These edged welded bellows shall be designed to ensure their function in all conditions and events for which their function is credited in the safety analysis. The confinement system shall be capable of withstanding all loads and conditions that result from accident sequences.

These angular bellows shall respect the requirements define for the AV [9] and the load cases defined in the document LS [7].

Three main methods of qualification are considered applicabquality inspectle for nuclear installations:

- Qualification by analysis

- Qualification by experience
- Qualification by tests

The scope of work of this contract is the qualifications by tests.
It refers to a series of tests subjecting equipment test's samples to limiting environmental and operational conditions, with appropriate margin, while required performance is verified.
It involves a planned test sequence subjecting equipment first to simulated normal service conditions, including ageing, and then to PIE (Postulated Initiating Event) service conditions.

The contractor shall submit for acceptance a Qualification Plan (as part of the quality plan) detailing the tests to be performed on bellows assemblies. After the completion of all manufacturing processes the bellows assemblies shall undergo the following qualification tests.

- Pressure test
- Fatigue life test
- Helium leak test

The prototype testing shall qualify and validate the preliminary design. Some of it comprising destructive tests is described hereafter.
Different prototype tests will be performed for the AV Angular bellows:

- Leak tests
- Pressure tests
- Fatigue life tests

The test shall be carried out on one set of bellows. This set of bellows shall be tested for fatigue to the rupture of the bellows. This set of bellows shall be purchased by the Contractor to COMVAT Company as defined in section above (see figure 8 and 9)

3.1 Qualification Plan

- A QP including detailed test parameters (with justifications) and measurements shall be provided for each test.
- The prototypes to be tested shall be chosen based on the design results of the bellows and agreed by IO-CT.
- This QP shall be provided and approved by the IO-CT before the prototype tests.
- The qualification tests shall be performed in accordance with the approved test plan.
- During performance of the prototype tests, a test report shall be compiled.
- Final test reports for the edge welded prototypes including all tests results shall be provided to IO-CT.
- The final test reports are the bases for IO-CT to judge whether the design as finally tested adequately meets all the design requirements.
- If a prototype is deemed to have failed to satisfy any design requirements, the contractor shall determine the cause of the failure and modify the design of the prototype to correct the failure.
- All tests are then repeated with the new design and an updated test report shall be compiled and submitted to IO-CT for judgement.

- This design adjustment process is repeated until the test report is approved by IO-CT and justification that the design meets all the requirements.
- The final design is undertaken when the design has been validated and qualified by prototype tests and is accepted by IO-CT.
- The final design incorporates any design adjustments found to be necessary during the prototype stage.
- The acceptance criterion for the design is the Final Test reports for the edge welded Bellows prototypes, including all tests results, which shall be provided to IO-CT.
- The final test reports are the bases for IO-CT to judge whether the design as finally tested adequately meets all the design requirements.

3.2 Qualification Plan load cases and acceptance criteria

The following data shall be used for the QP load cases and acceptance criteria.

Test type	Load case	Acceptance criteria
Helium Leak tests	As per Vacuum Handbook Appendix 9 paragraph 9.6.4 [4]	As per Vacuum Handbook Appendix 9 table 9-1 [4]
Pressure tests	See ANNEX 1 Test pressure = until bellows rupture	See ANNEX I
Fatigue Life test I	N = 600 cycles	Required number of cycle reached without crack / failure
Fatigue Life test II	Up to the rupture or a maximum of 6000 cycles max	NA

Table 2 – QP load cases and acceptance criteria

- ➢ If there are any failures, non-conformities shall be recorded with details explanations.
- ➢ The respective failure rate shall be reported in order to effectively use the outcome of the test result for the Reliability study to be presented at the FDR.

3.3 General Instructions

- The Contractor shall inspect the Edge welded bellows for full compliances with the technical specification and the approved drawings of the AV.

- The Contractor shall provide the details of all the inspection and testing facilities.. If deemed necessary IO will have the right to specify additional inspection / testing other than specified in this specification and cost of such test / inspection will be borne by IO. The records of all the tests and inspection shall be maintained by the Contractor and the same will be submitted to the IO.

- The inspection shall be in compliance with QP prepared by the Contractor and approved by IO. However depending on the manufacturing procedure, quality assurance system and manufacturing and inspection facilities available with the Contractor, some additional checks may also be necessary over and above approved MIP. Such checks shall be incorporated and implemented by the Contractor without any extra financial implications to IO.

- Records, certificates and performance curves (if any) shall be supplied for all tests carried out.

- Quality assurance program
  Quality assurance program of the Contractor shall be aimed to achieve quality through analysis of the tasks to be performed, identification of skills required, the selection and training of appropriate personnel, the use of appropriate equipment, the creation of appropriate environment in which activity can be performed and recognition of responsibility of the individual who is to perform the task. Briefly stated, the quality assurance program shall provide a disciplined approach to all activities affecting quality, including where appropriate, verification that each task has been satisfactorily performed and that necessary corrective actions have been implemented. It shall also provide for production of documentary evidence to demonstrate that the required quality has been achieved.

- Periodic Quality surveillance audit of the Contractor (as well as his sub-Contractors) shall be carried out at any stage of execution of contract. Quality surveillance as well as quality audit by the IO shall not relieve the Contractor from the responsibility of meeting the specification or the inspection duties.

- The Quality Assurance provisions, regulated by the Quality Plan are to be followed during execution of the contract.

- Each component, device, equipment shall be accompanied with all the necessary quality certificates, handbooks, drawings and text description.

- The Contractor shall also provide all the material certificates (as per EN10204 3.1) of the items procured for the Supply as per the relevant sections of this specification.

- In case of incompleteness of the certificates accompanying the purchased components or materials it is the Contractor's responsibility to execute all the necessary tests for product qualification.

- The Contractor shall also indicate the time required for the substitution of the components in case of faults.

- Calibration of Equipment

  Measures shall be established to ensure that tools, gauges, instruments and other inspection, measuring & testing equipment & devices used in determining conformance to acceptance criterion are of proper range, type, accuracy & precision. Testing & measuring devices used in activities affecting quality shall be controlled, calibrated and adjusted at specified intervals (as per DIN / EN / ISO) on or before use to maintain accuracy within limits.

- These activities shall be at expense of the Contractor in a calibration laboratory accredited to EN 45011 / A2LA / ISO 17025 which may be either his own or external. In case of accreditation by other international standards, acceptance of the same shall be subjected to the approval of IO.

- Test Procedure

  All tests shall be carried out in compliance with written procedures and approved by IO-CT.

  The tests as described in this specification are to be included in the QP.

  The Contractor shall provide all necessary equipment and the personnel details for carrying out the tests.

- Failure of compliance

  At the end of each test all the nonconformities and malfunctions shall be recorded and written in minutes and reports that shall be issued by the Contractor.

- Any component which fails to comply with the requirements of this specification in any respect whatsoever at any stage of manufacturing or testing, may be rejected by ITER.

  The Contractor shall propose and undertake all the necessary actions to resolve any possible problem in order to comply with all the requirements. After adjustment, modification or repair if so directed by purchase, the Contractor shall submit the item for further inspection and/or tests. Should the component fail under test to give the required performance, further tests which are considered necessary by IO shall be carried out by the Contractor and the whole cost of the complete test shall be borne by the Contractor.

- All surfaces to be examined shall be cleaned and free from all foreign matter, which may adversely affect evaluation of the test results. General guidelines to "Cleaning and Cleanliness for the IO Project" shall be referred from Appendix 13 of IO Vacuum Handbook (IVH)[6]. Cleaning procedures for vacuum bellows, section 13.21 of

Appendix 13 [6] of IVH shall be used for cleaning the bellows and bellows assemblies. A detailed Clean Work Plan shall be prepared by the Contractor and submitted to IO for prior acceptance before any cleaning operations are undertaken at the Contractor's site.

- For the welding of the Edge Welded Bellows the Contractor shall define the welding procedures and requirements. For all other welding operations, the Attachment 1 of the ITER Vacuum Handbook [4]: Inspection and Qualification of Welded Joints shall be followed.

- All proprietary "bought in" items shall be inspected to confirm dimensions and conformity to manufacturer's specifications, including material certification where appropriate.

- All manufactured components and sub-assemblies shall be inspected to confirm material specifications, dimensions and tolerances. Each item shall be checked, to ensure conformity with component drawing requirements

3.4 Pressure Test

3.4.1 Tests

Prior to leak testing it shall be demonstrated that with the bellows assemblies displaced axially and radially to the maximum design values, and subjected to a 0.2 MPa pressure differential applied internally or externally to the assembly, that the bellows can survive and remain unaltered when the bellows interspace is at the following pressures:

- $< 10^{-3}$ MPa (evacuated interspace)
- 0.05 MPa (interspace normal operation)
- 0.2 MPa (Interspace over pressure)

➢ The tests are clearly defined in the ANNEX 1.

3.4.2 Tests Procedure

The Contractor shall propose a procedure to be approved by IO.
Reference standard shall be in agreement between IO and Contractor.

3.4.1 Pressure Test media

Pressure test shall be with Nitrogen only.
Water is not allowed, in order not to endanger the effectiveness of subsequent He leak tests.
The Contractor is responsible for protection of personnel

3.4.2 Tests temperature

The test temperature shall be room temperature.

3.4.3 *Tests Gauge*

a) Location

Pressure gauge used in the tests shall be connected directly to the tested component. If the indicating gauge is not readily visible to the operator controlling the pressure being applied from a safe location, an additional indicating gauge shall be provided where it will be visible to the operator and inspector (IO) throughout the duration of the test. It is recommended that a recording gauge to be used in addition to the indicating gauge.

b) Range

The manometers used in the tests shall be graduated over a range of about two times the maximum intended test pressure, but in no case shall the range be less than 1.5 times nor more than four times the intended test pressure.
Digital reading pressure gauges having a wider range may be used provided the readings give the same or a greater degree of accuracy than obtained with manometers.

c) Calibration

All gauges shall be calibrated against a standard deadweight tester or a calibrated master gauge at least every 2 years or at any time there is a reason to believe that they are in error.

3.4.4 *Pressurization and Preliminary Check*

Pressure shall be gradually increased until a gage pressure which is the lesser of one half of the test pressure is attained, at which time a preliminary check shall be made to ensure integrity of installation, sealing and opening etc. After satisfactory check pressure shall be gradually increased in steps until the test pressure is reached &subsequently held for prescribed duration.

3.4.5 *Inspection and Testing*

Visual Examination shall be made for leakage and permanent deformation of all joints and connections (see ANNEX 1)
Any leakages that are present, except for that leakage that may occur at temporary test closures, shall be satisfactory repaired and retested.
IO shall reserve the right to reject the Pressure test program if there are any visible signs of permanent distortion and deformation.
Remote monitoring provision shall be arranged by the Contractor for the inspection.

3.4.6 *Pressure Test Record*

The Contractor shall record the following data of the pressure test report and submit to IO-CT for acceptance.

- Identification of Parts being tested.
- Calibration status of measuring instruments
- Test condition
- Test pressure

- Test duration
- Test Fluid and temperature
- Test Result
- Date of Pressure Test
- Detail of witnessing authority.
- Reference of the Procedure followed
- Point out any occurring elastic or plastic deformation of the test pieces during the test

3.4.7 Contractor's Responsibility

- The Contractor is responsible for confirming and controlling the tests job in order to ensure that the same is being carried out according to the prescribed procedure.
- The Contractor is responsible to communicate its readiness related to pressure testing and send out the invitation to witness the same.
- Documentation
  The Contractor shall submit a detailed pressure testing procedure (which fulfils the requirements of this specification) and applicable code requirements to IO for approval prior to pressure testing.
- The Contractor shall submit calibration certificate of Test gauge to IO prior to testing.
- The Contractor shall prepare Pressure test report after completion of testing.

3.4.8 Verification Prior to Pressure Testing

All Components upon completion of Fabrication and Assembly shall be checked and verified by the Contractor and IO to ensure the following:

- All Applicable Examinations, inspections and tests including NDT Tests and required heat treatments (If applicable) are satisfactorily completed and accepted
- All Inspection against Review, Witness and Hold point in Manufacturing Inspection Plan have been carried out and accepted.

3.4.9 Safety Precautions

The Contractor is responsible for protection of the personnel during the pressure tests.
It shall be carried out in an isolated place from work area / pit with appropriate safety precautions and equipment.
Before applying Test pressure, the test equipment shall be inspected to see that it is tight and that all low pressure filling lines and other appurtenances that should not be subjected to the test pressure have been disconnected or isolated by valves or other suitable means.
All the local safety norms shall be followed by Contractor and IO while performing / witnessing the pressure testing.

3.5 **Leak Test**

3.5.1 General Requirements

- Leak testing shall be performed after pressure testing
- Bellows and bellows assemblies subjected to leak testing shall be cleaned prior to Leak testing
- The Contractor shall perform leak testing of the bellows assemblies in accordance with the ITER Vacuum Handbook [3]. Guides to helium leak testing can be found in the ITER Vacuum Handbook Appendix 12[5].

- Bellows assemblies for use on VQC1 systems shall be baked and hot leak tested at the maximum operating temperature as follows:
  - Global test of bellows assembly
  - Leak test of water cooling circuits (if applicable)
- VQC 1A components which include joints of dissimilar materials shall be subjected to a minimum of three thermal cycles from ambient to the maximum possible operating temperature prior to leak testing.
- Normally, the time taken for any component to reach the specified bake temperature from ambient shall be less than 100 hours.
- Immediately after bake-out, the above tests shall be repeated at ambient temperature. In both cases, the acceptance leak rate shall be met with the background reading on the leak detector being at least one order of magnitude below the acceptance leak rate without electronic correction.
- In each case, the leak test procedure shall include three operating cycles of the bellows assembly at each test temperature before leak testing.

The angular edge welded bellows from the pendulum shoulder block is a VQC1A component
The Acceptance Leak Rate ($Pa.m^3.s^{-1}$ air equivalent) at maximum operating temperature is:

- Global leak rate is 1 X 10^{-10} $Pa.m^3.s^{-1}$
- Bellows interspace to atmosphere is 1 X 10^{-10} $Pa.m^3.s^{-1}$
- Bellows interspace to vacuum is 1X 10^{-10} $Pa.m^3.s^{-1}$

- All of these controls and tests shall be carried out in line with the procedures and guidelines approved by the Contractor Quality Control Department which certifies such tests. These tests can be carried out, monitored and/or certified by independent companies or classification societies

- The leak tests shall respect the requirements from the chapter 25 of (ITER Vacuum Handbook [4]).
- Before leak testing, components shall be cleaned, dried or baked in accordance with the ITER Vacuum Handbook [4].
- They shall be conducted according to methods described in Appendix 12 of (24).
- This test aims at validating the leak tightness of all the vacuum boundaries.
- The requirement to leak test proprietary components delivered to the ITER site with a Contractor's Certificate of Compliance may be waived by IO at the discretion of the ITER Vacuum RO.

- The ITER Vacuum Responsible Officer (RO) will nominate a Vacuum Specialist to witness the acceptance leak tests and any other leak test deemed necessary as part of a manufacturing process.

3.5.2 *Applicable Specifications*

- ITER Vacuum Handbook [ITER Vacuum Handbook with Attachment 1 and Appendicies 3 and 12 (ITER_D_AKEFTF v1.0)]
- ITER Vacuum Handbook Appendix 12 [ITER_D_2EYZ5F - Appendix 12 Leak Testing]

Guide to Leak Testing of Vacuum Components for the ITER Project

- ITER Vacuum Handbook Appendix 13 [ITER_D_2ELUQH - Appendix 13 Cleaning and Cleanliness]

Guide to Cleaning and Cleanliness for the ITER Project

3.5.3 *Procedure for Leak Tightness and Testing*

There shall be a leak test of the inner, outer bellows and interspace including welded connections which form the vacuum boundary but not the interspace.

The Contractor shall prepare the Leak testing procedure as specified in *appendix 12 of ITER Vacuum Handbook [5]* which shall satisfy following conditions:

- A test plan showing the configuration arrangement and the type of equipment as well as the test procedures.
- Chart recording of mass spectrometer signal to be made through test amplifier range identified. Standard Leak Signal, He introduction and termination shall be identified on the recording.
- The recording shall cover the full duration of each test.
- For each test, a document shall be prepared showing the mechanical set-up, the number of the assembly, base pressure, calibration & measured leak-rate.
- If the specification is not met, the leaks shall be localized and marked. The event shall be reported to IO.
- The test subject shall be re-tested after repair and the repairs shall be documented.
- The procedure shall be submitted to IO for review and approval.

3.5.4 *Clean Conditions*

At the beginning of the test, the component shall be temporarily extracted from the protection set up after cleaning. The test shall anyway be carried out in clean conditions. At the end of the test, the component shall be protected again unless the subsequent test is performed right after.

3.5.5 *Certification of Personnel*

The Examination shall be performed by suitable trained and experienced personnel.

3.5.6 *Choice of Units*

The measured leak shall be reported in SI units. i.e. Pascal cubic meter per second ($Pa.m^3/s$).

3.5.7 *Test Set-up*

- A separate calibrated leak shall be connected into the system at the test piece furthest point if possible; if this is not possible (test piece inside oven) then connect to suitable connection port above the inlet of the leak detector, this is to be used to confirm the detector/system calibration.
- Suitable test recording equipment connected to an output of the leak-detector shall be available; all data pertaining to the test shall be recorded on a test report and or chart recording.

3.5.8 *Test Procedure and Results*

Neither calibration errors nor any other errors shall be shown by the leak detector to ready for component testing.

3.5.8.1 *External Leak Test to Confirm Calibration*

a) To confirm the leak-detectors system calibration, open the external calibrated leak. The leak detector reading shall correlate with the calibrated test leak, within a reasonable margin of error ± 30% taking into account the temperature correction factor for the calibrated leak.

b) The sensitivity of the overall leak testing setup shall be smaller than $2.69 \cdot 10^{-10}$ $Pa \cdot m^3/s$ what is the Helium equivalent leak rate of a $1 \cdot 10^{-10}$ $Pa \cdot m^3/s$ air leak.

c) Sensitivity shall be determined by the calibration leak measurement:

$$\text{Sensitivity} = \text{VCCL} \cdot \frac{\text{SRS}}{(\text{MCL} - \text{BG}) \cdot \text{cHe}}$$

VCCL: Reference leak value corrected (Calibration leak value) [$Pa \cdot m^3/s$]
SRS: Smallest Readable Signal
MCL: Reference leak signal obtained (Measured Calibration Leak)
BG: Background noise/signal
c_{He}: Helium concentration, without Katharometer = 0.1

d) With a stable pressure and Helium background open the external test leak; wait for stable He leak signal; note reading for several minutes recording all data.

e) Close the external test leak.

f) When the background reading is stable and is at a level consistent with the leak specification of the item under test, which will be for most purposes at least an order of magnitude lower than the specified maximum leak rate of the component under test and without electronic correction, the global leak check may be started.

3.5.9 Cold Helium Leak Test of Component

A global cold leak test may be carried out according to the procedure defined in the ITER Vacuum Handbook Appendix 12 [5]

3.5.10 Hot Helium Leak Test of Component

3.5.10.1 Test Conditions

The baking requirements for the Absolute Valve are defined below:
The AV is baked at a temperature greater than 180°C with a pressure of 0.01MPa (vacuum). Baking may be performed up to 500 times in the life of ITER.

The internal pressure of the component is under vacuum pressure and the external pressure is at 1 Atmosphere.

All other surfaces exposed to the primary vacuum shall be baked at a temperature greater than 180°C, including the NB port (up to the torus isolation valve) and the VVPSS piping (up to the rupture disk). Exceptions for lower-temperature baking of components which are at or beyond the vessel ports boundary shall be treated on a case-by-case basis. [PR427-R] [10]

The VV and in-vessel components shall be capable of being raised from room temperature or operating temperature to the baking temperature within 2 days. [PR430-R] [10]

Following baking, the VV and in-vessel components shall be capable of being returned to their pre-pulse operating temperature within 24 hours. [PR431-R] [10]

All systems shall be designed to accommodate 500 baking cycles from the commissioning phase to the end of life. During D-T pulse operation, the estimated baking cycles are 40. [PR434-R] [10]

As part of the first confinement, the angular bellows is considered as a feedthrough that shall be baked at minimum 180°C.

1. Before commencing any part of this leak test procedure, the item under test must have completed one or more temperature cycles and is at that point on the cycle where it is specified that the hot leak test shall take place.
2. The leak detector shall be set up using the procedures of Sections 12.4.3.3 and 12.4.4 of [5]. If the response time of the system has already been determined, or is not required, it need not be re-measured.

3. If the background is elevated when the item under test is at temperature (as may often be found), then the conditions stipulated in 12.4.5.1 of [5] Point 3 may not be met. However with judicious choice of scale it may be possible to do a perfectly valid leak check at a raised background level. It may also be necessary to selectively pump hydrogenic species from the leak detector input gas stream (*As the volume is quite small this will not be required*). This can be done by the correct choice of getter installed in series with the leak detector inlet. The applicable conditions for this test must be agreed with the IO Vacuum Responsible Officer.

4. The helium enclosure used for these tests must be capable of tolerating temperatures above ambient since the increased thermal conductivity of helium will raise the temperature of this item above the level it would reach with only atmospheric air in the enclosure.

   Information on the maximum temperature attained by the bellows assemblies shall be provided by IO to the Contractor. However, it is foreseen that the maximum temperature of the bellows assemblies shall be between 60°C and 200°C (See ANNEX 1). Final figure will be confirmed by IO after detailed assessment.

3.5.10.2 Hot Leak Test

- The Hot Leak Test shall be in accordance of the requirements defined in [5].
- The temperature at which the hot leak test is performed shall be recorded and shall be within the limits as specified in the leak testing procedure.
- If, with the component at the specified hot temperature, no leak rate of size greater than that specified for the component has been observed, then provided that the conditions of section 12.4.6.1 [5] have been met, the component will be deemed to have satisfied the hot leak test requirement.

3.5.11 Final Cold Acceptance Check

This test shall be carried out following a satisfactory global hot leak test procedure when the item under test has cooled down to a temperature less than 60°C, since experience has shown that small leaks can be blocked by water vapour below this temperature.
It shall follow the procedures of Section 12.4.6.4 of [5]

3.5.12 Acceptance Criteria

If all the stages above have been successfully completed then the item under test maybe accepted by IO as having met the relevant specification provided that the following conditions have been met.

- The leak detector has been correctly calibrated and its calibration value is within ±30% of the standard leak rate value as corrected for the ambient temperature and the age of that item and that standard leak rate value is commensurate with the value of the maximum leak rate specified for the item under test.
- The test shall be carried out as per procedure approved by IO, performed by qualified personnel as stated in *Section 12.4.6.5 of [5]* and witnessed by IO.

- The leak rate value as measured by the leak detector has not increased in value above the measured background to a value greater than the specified leak rate during the entire duration of the global leak test (except for Hot Leak Test).
- The location and magnitude of all identified leaks shall be recorded. All practicable efforts shall be made, after agreement with IO to reduce any leak quantified during the manufacturing phase to a level lower than the limit of detection of the leak detection methods used.
- The helium concentration around the test piece shall be at a minimum of 50% for the duration of the test. The helium concentration shall be measured and recorded. The helium shall be maintained for a period calculated to be sufficient to identify leaks at the acceptance level.

➢ Leak rate shall not exceed 1×10^{-10}Pa m^3/s.

3.5.13 Test Report

Full records of the tests carried out on any component shall be completed in order to maintain traceability of the leak test history of a particular item. The records shall consist of the following as minimum.

- Identification of the Manufacturer, the purchase order and equipment
- Identification of the part ,weld or the area subjected to examination
- Reference approved procedures
- Surface condition and cleanliness
- Examination condition and in particular ,calibration conditions
- Data records of the output of the leak detector for all the global tests specified including the standard leak calibration and response time determination. These data records shall include the date and time of all tests as well as anything else of relevance, such as the start and finish time of helium gas application to the item under test.
- A record of the helium concentration during the leak test where that is required. In the case of a simple cold leak test this will be on request of IO, but in the case of a full cycle of leak testing involving temperature variation it will be required.
- A record of the system total pressure (pressure in the interspace) throughout a temperature cycle since it may pinpoint the time when a leak opened up and be instrumental in the subsequent diagnosis of the leak.
- The make, model and date of manufacturer of the helium mass spectrometer leak detector used in the tests.
- The nominal value of all standard leaks used, their date of calibration, ageing and temperature characteristics, and the ambient temperature(s) experienced during the tests.

- The results of all tests showing whether it was a pass or fail, and, if a failure, the measured leak rate and the location of the leak, together with the steps taken for any repair or elimination.
- The magnitude and location (if applicable) of all leaks identified during testing shall be recorded. This includes leaks of magnitude lower than the acceptance criteria for which no remedial action may have been taken.
- Interpretation of the results
- Name, qualification and experience in leak testing of the inspector
- Identification of the subcontractor conducting the examination (if applicable)
- Date & time of examination and inspector's signature.

3.6 Cycling Test

3.6.1 Cycling test I

- At least 600 cycles shall be carried out and after each batch of tests identified in annex 1 both hot and cold helium leak test and a visual inspection on wear or other damage shall be performed (see ANNEX 1).
- For the cycling test, operational pressure case shall be applied to the bellows assemblies to re-present the situation during the operation of the Absolute Valve.
- If the cycling tests reveal a critical issue the design of the bellows assembly shall be improved in agreement with IO.
- The finally agreed design shall be compatible with the interfaces to the Absolute Valve.

Pressure conditions for the cycling tests:

- $P_{internal}$: Vacuum
- $P_{external}$: 1 atmosphere
- P interspace: 0.05 MPa

3.6.2 Cycling test II

In order to derive relevant failure rate from the tests, the bellows shall be tested up to the rupture or maximum 6 000 cycles (10X600).

4 Acceptance Criteria (as defined in [5] 12.4.5.3)

If all the stages above have been successfully completed then the item under test may be accepted by the ITER Vacuum Specialist as having met the relevant specification provided that the following conditions have been met.

1. The leak detector has been correctly calibrated and its calibration value is within ± 30% of the standard leak rate value as corrected for the ambient temperature and the age of

that item and that standard leak rate value is commensurate with the value of the maximum leak rate specified for the item under test.

2. The leak test has been performed by suitably qualified and experienced personnel to the accepted procedure, with no significant deviation from that procedure and has been witnessed by the ITER Vacuum Specialist.
3. The leak rate value as measured by the leak detector has not increased in value above the measured background to a value greater than the specified leak rate during the entire duration of the global leak test.

The location and magnitude of all identified leaks shall be recorded. Normally, all practicable efforts shall be made by means agreed with the ITER Vacuum Responsible Officer to reduce any leak discovered during the manufacturing phase to a level lower than the limit of detection of the leak detection method used for the tests.

5 Responsibilities

ITER Organization:

ITER Organization will provide the needed information and access to the adequate IO files for executing this work when needed following the implementation plan.

In particular ITER Organization will make available any technical information, for example layout of the NB plant, drawings, references needed for contractor to perform the work. The documents containing this information must be returned to ITER Organization on completion of the contract.

Contractor:

The Contractor appoints a responsible person, the Contractor's Responsible (C-R), who shall represent the Contractor for all matters related to the implementation of this Contract. The Contractor shall provide results according to the scope of the work outlined above and shall fulfil the implementation plan and conditions of the contract.
The Contractor is responsible for supplying all jigs, seals and equipment along with the vacuum component to allow the leak tightness to be proven across all vacuum boundaries.
The Contractor shall supply the tooling and methodologies for the subsequent removal of jigs, seals, and temporary closure plates etc. which have fitted to vacuum components to facilitate all tests described in this document.

6 Licensing requirements

The Protection Important Activities are identified by the nuclear operator. The list of the Protection Important Activities is based on the chapter 10 of the RPrS [12] and the application of the INB Order [13] which applies to all the lifecycle of a nuclear facility.

The PIAs for the NB Injector are defined in [14] the Surveillance plan for PBS 53 ITER_D_U65RWF. During design phases, the safety demonstration is considered as PIA; the qualification of the Edge Welded bellows which are first confinement barrier is a safety demonstration.

IO shall manage this activity as follow:

PIA	Defined requirement	External interveners	Nature of the surveillance	Frequency of the surveillance	Actor of the surveillance	Formalization of the surveillance	Records management	Record location
Safety Demonstration related to safety demonstration	Compliance with the defined requirements for each PIC [(LAMFG2) Application of the procedure (LAMFG2)	All	Review of the document	For each document	TRO	Review in IDM	Standard IO rule (22K5JQ)	IDM folder 2N78DT

The Contractor shall provide a Quality plan at the kick off meeting. This QP shall remind the safety function of the AV.
The AV is SIC1 and the safety function associated is the confinement. The Edge Welded Bellows to be qualified in this contract is SIC 1 as it is part of the first confinement barrier.

All the AV items classified SIC are also classified PIC. The development of the AV shall comply with the Order dated 7 February 2012 relating to the general technical regulations applicable to INB [13].

The Suppliers and Subcontractors must be informed that:

- *ITER is a nuclear facility identified in France by the number-INB-174;*
- *The Order 7th February 2012 title I and II replace Order 10th August 1984 since the 1st July 2013;*
- *The Order 7th February applies to all the components important for the protection (PIC) and the activities important for the protection (PIA).*
- *The compliance with the INB-order must be demonstrated in the chain of in the chain of contractors and subcontractors.*
- *In application of article II.2.5.4 of the Order 7th February 2012, contracted activities for supervision purposes are also subject to a supervision done by the Nuclear Operator (IO).*

A specific management system has to be implemented by any Supplier and Subcontractor working on protection important activities, on the basis of activities defined and executed by the Supplier and Subcontractor.

The Contractor shall refer to the document: ITER_D_SBSTBM [15] - Provisions for Implementation of the Generic Safety Requirements by the External Interveners which is a declination of the French order 2012.

7 List of deliverables and due dates

The Contractor shall provide a report with a detailed description of the test procedure, the design of the test rig and the used equipment for each test:

- Pressure Tests
- Leak Tests
- Cycling Tests

These reports shall include all required design changes, proposals for improvement and definition of all interfaces.

Deliverables	*Description*	*Due Date (months)*
Qualification Plan review	Detailed overall procedure of qualification with a schedule and milestone for the witness of different tests.	*T0*
Pressure& Leak tests Report – OP (see Annex 1)	detailed description of the test procedure, the design of the test rig, the used equipment and results	*To(*) + 3 months = T1*
Pressure& Leak tests *Report – Baking* (see Annex 1)	detailed description of the test procedure, the design of the test rig, the used equipment and results	*T1+ 1 months = T2*
Pressure& Leak tests *Report – ICE event* (see Annex 1)	detailed description of the test procedure, the design of the test rig, the used equipment and results	*T2+ 1 months = T3*
Pressure& Leak tests *Report – NB LOCA* (see Annex 1)	detailed description of the test procedure, the design of the test rig, the used equipment and results	*T3+ 1 months = T4*
Fatigue Life test Report	detailed description of the test procedure, the design of the test rig, the used equipment and results	*T4 + 1 months = T5*

(*) To is the date of the Kick off meeting.

Prior to manufacture the Contractor shall have an approved Qualification Plan detailing the timing and type of tests to be performed during manufacture. The plan shall include which tests are to be witnessed by IO.
A representative of IO shall inspect the Contractor's testing equipment and witness a proof of procedure prior to the acceptance tests.
Acceptance tests shall be witnessed or, where there are many tests agreed to form the acceptance leak testing, a representative sample of the test shall be witnessed.
Those tests to be witnessed by IO, including the acceptance tests, shall be defined in the Qualification Plan.
No repair or re-work of the components (with the exception of simple tightening of flange joints or replacement of gaskets) shall be undertaken without prior agreement. Any repair or rework will require the leak test procedure to be repeated and may include a repeat leak test at the operating temperature.

7.1 Milestones

Abbreviation:

DP: (Decision Point) - This is an hold point, a decision (or acceptance) has to be taken before going to the next phase or step

Task	Name	Description	Hold Point
	T/QP	Quality Plan of the Contract	**DP**
	T/K-o-M	Kick-off meeting	
	TH/QP	Qualification Plan review	**DP**
	Tests OP	**OP test Phase**	**DP**
		PT phase- 1st Progress Meeting	
		PT phase- 2nd Progress Meeting	**DP**
	Tests Baking	**Baking test Phase**	
		LT phase- 1st Progress Meeting	**DP**
		LT phase- 2nd Progress Meeting	
	Tests ICE Event	**ICE event Test Phase**	
		FT phase- 1st Progress Meeting	**DP**
		FT phase- 2nd Progress Meeting	
	Tests NB LOCA	**NB LOCA Test Phase**	
		FT phase- 1st Progress Meeting	**DP**
		FT phase- 2nd Progress Meeting	
	Tests Cycling	**Cycling Test Phase**	
		FT phase- 1st Progress Meeting	**DP**
		FT phase- 2nd Progress Meeting	
	Final report	**Final report with conclusion on the qualification of the component**	

IO shall accept or reject the deliverables and shall authorize or not authorize the execution of the next sub-project of the project.

The ITER Organization shall have 30 days from receipt of reports to accept them. The ITER Organization reserves the right to reject the report. The IO shall submit reasonable grounds for rejection. The Contractor shall have 30 days in which to submit additional information or a new report.

7.2 Schedules

The reports shall be prepared and submitted to the IO by the dates outlined in the tables below. It is understood that the report is expected to be prepared in Microsoft Word format, however; an alternative format may be used subject to the prior written approval of the IO.

List of Deliverables and Milestones				
Task	**Name**	**Description**	**Due date* (months)**	**Acceptance criteria****
TESTS		**Coordination of the Contract**		
	T/K-o-M	Kick-off meeting	T0	B
	TH/QP	**Qualification Plan review**	T0	A
	OP Test	**OP test Report**	T0 + 3	
		PT phase- 1st Progress Meeting	T0 + 1	B
		PT phase- 2nd Progress Meeting	T0 + 2	A
	Baking Test	**Baking test Report**	T1 + 1	
		LT phase- 1st Progress Meeting	T1	B
		LT phase- 2nd Progress Meeting	T1+ 1	A
	ICE event Tests	**ICE event Test Report**	T2+ 1	
		FT phase- 1st Progress Meeting	T2	B
		FT phase- 2nd Progress Meeting	T2 + 1	A
	NB LOCA Tests	**NB LOCA Test Report**	T3+ 1	
		FT phase- 1st Progress Meeting	T3	B
		FT phase- 2nd Progress Meeting	T3 + 1	A
	Fatigue Tests	**Cycling Test Report**	T4+ 1	
		FT phase- 1st Progress Meeting	T4	B
		FT phase- 2nd Progress Meeting	T4 + 1	A
	Final report	**Final report with conclusion on the Qualification of the component**	T0+ 8	A

** Duration after the signature of the Contract*
** *A: Plan accepted by IO*
B: Minutes accepted by IO

The acceptance of the deliverables is based on the following procedure:

- The IO TRO will download the deliverables on ITER IDM

- The documents will be reviewed by an IO panel board within 5 weeks. It is a technical review.
- As soon as the document is approved on IO IDM, the deliverable of the contract is considered as accepted.

8 Acceptance Criteria (including rules and criteria)

These criteria shall be the basis of acceptance by IO following the successful completion of the services. These will be in the form of monthly progress reports as indicated in section 7, table of deliverables and further detailed below:

Report and Document Review criteria
Reports as deliverables shall be stored in the ITER Organization's document management system, IDM by the Contractor for acceptance. A named ITER Organization's Contract Technical Responsible Officer is the Approver of the delivered documents.
The Approver can name one or more Reviewers(s) in the area of the report's expertise.
The Reviewer(s) can ask modifications to the report in which case the Contractor must submit a new version.
The acceptance of the document by the Approver is the acceptance criterion.

9 Work Monitoring / Meeting Schedule

Meetings or video-conferences for the purpose of reviewing the results before the delivery of each report are planned during the course of this contract. The details of the discussion, including date, premise and method shall be determined by mutual agreement between the IO and the Contractor at least one month prior to each planned meeting. The cost and expenses for the meetings, including travel expenses for the participant(s), shall be borne by each party.

The meetings will be held for this contract, according to the following tentative schedule:

Name	Description	Due date* (months)	Acceptance criteria**
T/K-o-M	**Kick-off meeting**	T0	TBD **
TH/QP	Qualification Plan review	T0	TBD **
OP Test	**OP test Report**	T0 + 3	TBD **
	PT phase- 1st Progress Meeting	T0 + 1	TBD **
	PT phase- 2nd Progress Meeting	T0 + 2	TBD **
Baking Test	**Baking test Report**	T1 + 1	TBD **
	LT phase- 1st Progress Meeting	T1	TBD **
	LT phase- 2nd Progress Meeting	T1+ 1	TBD **
ICE event Tests	**ICE event Test Report**	T2+ 1	TBD **
	FT phase- 1st Progress Meeting	T2	TBD **
	FT phase- 2nd Progress Meeting	T2 + 1	TBD **
NB LOCA Tests	**NB LOCA Test Report**	T3+ 1	TBD **
	FT phase- 1st Progress Meeting	T3	TBD **
	FT phase- 2nd Progress Meeting	T3 + 1	TBD **
Fatigue Tests	**Cycling Test Report**	T4+ 1	TBD **
	FT phase- 1st Progress Meeting	T4	TBD **
	FT phase- 2nd Progress Meeting	T4 + 1	TBD **
Final report	**Final report with conclusion on the Qualification of the component**	T0+ 8	TBD **

*** To Be Define during the Kick –off meeting T0*

10 Quality Assurance (QA) requirement

The organisation conducting these activities should have an ITER approved QA Program or an ISO 9001 accredited quality system.
The general requirements are detailed in ITER document ITER Procurement Quality Requirements (22MFG4)
Prior to commencement of the task, a Quality Plan Quality Plan (22MFMW) must be submitted for IO approval giving evidence of the above and describing the organisation for this task; the skill of workers involved in the study; any anticipated sub-contractors; and giving details of who will be the independent checker of the activities.
Prior to commencement of any manufacturing, a Manufacturing & Inspection Plan Manufacturing and Inspection Plan (22MDZD) must be approved by ITER who will mark up any planned interventions.

Deviations and Non-conformities will follow the procedure detailed in IO document MQP Deviations and Non Conformities (22F53X)
Prior to delivery of any manufactured items to the IO Site, a Release Note must be signed MQP Contractors Release Note (22F52F).
Documentation developed as the result of this task shall be retained by the performer of the task or the DA organization for a minimum of 5 years and then may be discarded at the direction of the IO. The use of computer software to perform a safety basis task activity such as analysis and/or modelling, etc shall be reviewed and approved by the IO prior to its use, it should fulfil IO document on Quality Assurance for ITER Safety Codes Quality Assurance for ITER Safety Codes (258LKL).

References:

[1] Quality Classification Determination: ITER_D_24VQES - Quality Classification Determination

[2] Safety Important Components - Abstract for Presentation of Methodology to the French regulator: ITER_D_282VAQ - Safety Important Components - Abstract for Presentation of Methodology to the French regulator

[3] ITER Vacuum Handbook: ITER_D_2EZ9UM - ITER Vacuum Handbook

[4] Vacuum Handbook Appendix 9 Bellows link ITER_D_2E5LJA

[5] Vacuum Handbook Appendix 12 Leak Testing link ITER_D_2EYZ5F

[6] Vacuum Handbook Appendix 13 Cleaning and Cleanliness link ITER_D_2ELUQH

[7] ITER_D_44ZMKX - HNB/DNB Absolute Valve Loads Specification

[8] ITER_D_25EW4K - Codes and Standards for ITER Mechanical Components

[9] DRD link ITER_D_6TNU54 - DRD Absolute Valve

[10]The applicable design review procedure is ITER_D_2832CF - Design Review Procedure (V3.1)

[11] RCC-MR- RCC-MR code, 2007 edition. Design and construction rules for mechanical components of nuclear installations ISBN 2-913638-22-8

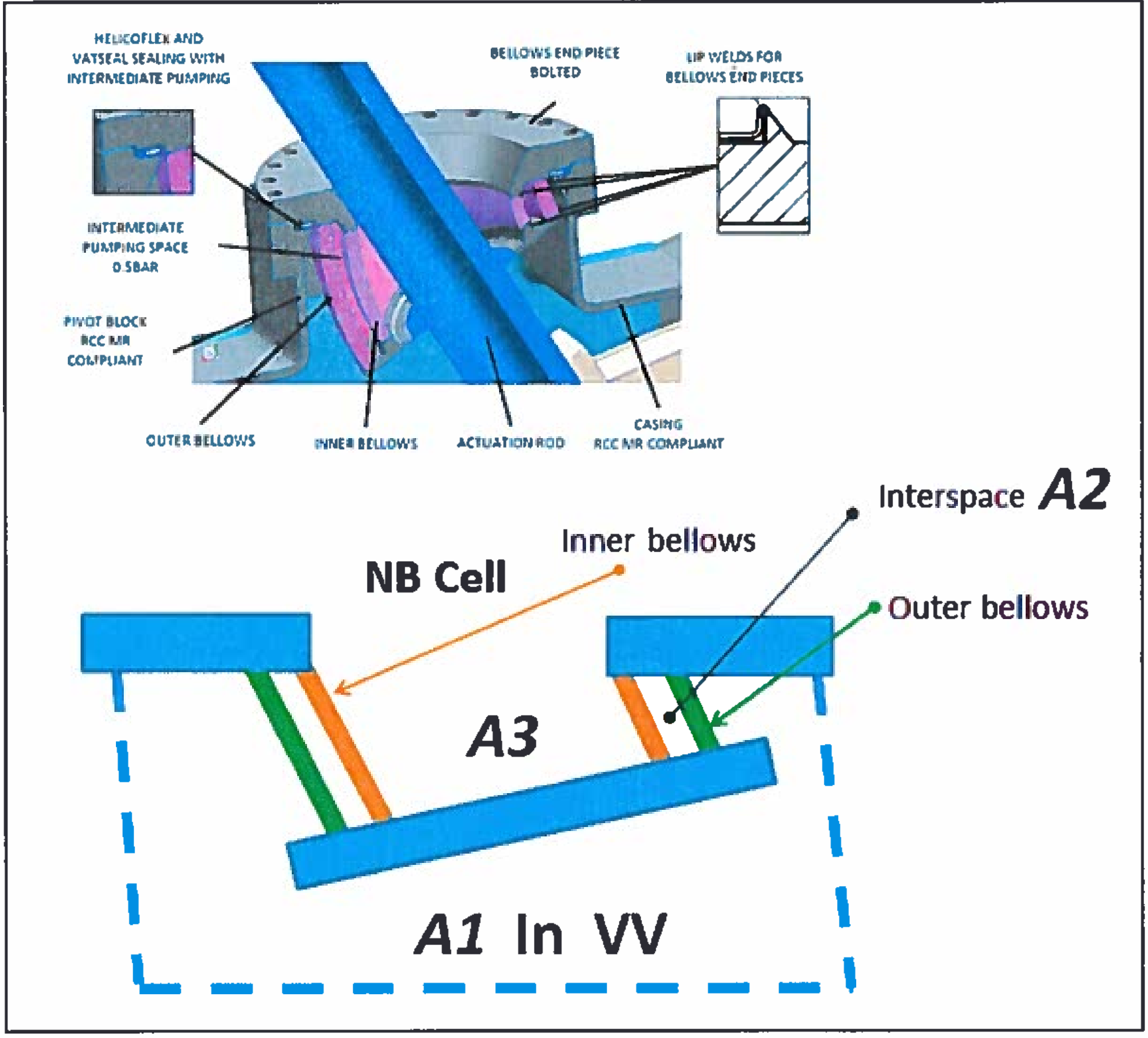
[12] *Preliminary Safety Report (RPrS).* ITER_D_3ZR2NC v3.0

[13] *Order dated 7 Feb 2012 relating to the general technical regulations applicable to INB.* ITER_D_7M2YKF v1.6

[14] Surveillance plan for PBS 53 ITER_D_U65RWF

[15] *ITER_D_SBSTBM - Provisions for Implementation of the Generic Safety Requirements by the External Interveners*

ANNEX 1
Summarisation of the TESTS



N ° Test	Area	Pressure (bar) defined in LS	Temperature (°C)	Duration	Cycles	Load case
During OP, the bellows assemblies shall displace axially and radially to the maximum design values subjected to						
1	A1	0 (vacuum)	60	*TBD by contractor*	600	OP / case interspace 1
	A2	0.5	*not relevant*			
	A3	1 (Atm)	18			
2	A1	0 (vacuum)	60	*TBD by contractor*	1	OP / case interspace 2
	A2	0 (vacuum)	*not relevant*			
	A3	1 (Atm)	18			
3	A1	0 (vacuum)	60	*TBD by contractor*	1	OP / case interspace 3
	A2	2	*not relevant*			
	A3	1(Atm)	18			
At the end of the 3 tests (1,2,3), He leak test to be done and visual inspection of the bellows. The leak test shall be done in the 2 maximal positions.						
During Baking, the bellows will not move.						
4	A1	0 (vacuum)	250	*time necessary to obtain a unifrom temperature (2)*	na	Baking / case interspace 1
	A2	0.5	*not boundary condition*			
	A3	1 (Atm)	18			
5	A1	0 (vacuum)	250	*time necessary to obtain a unifrom temperature (2)*	na	Baking / case interspace 2
	A2	0 (vacuum)	*not boundary condition*			
	A3	1 (Atm)	18			
6	A1	0 (vacuum)	250	*time necessary to obtain a unifrom temperature (2)*	na	Baking / case interspace 3
	A2	2	*not boundary condition*			
	A3	1 (Atm)	18			
7	A1	0 (vacuum)	250	*time necessary to obtain a unifrom temperature (2)*	na	Baking / case interspace 3
	A2	0.5	*not boundary condition*			
	A3	1 (Atm)	250			
8	A1	0 (vacuum)	250	*time necessary to obtain a unifrom temperature (2)*	na	Baking / case interspace 3
	A2	1	*not boundary condition*			
	A3	1 (Atm)	250			
At the end of the 5 tests (4,5,6,7,8), He leak test to be done and visual inspection of the bellows. The leak test shall be done in the 2 maximal positions.						
During ICE event, bellows will not move.						
9	A1	2 *(3)*	250 *(3)*	time necessary to obtain a unifrom temperature *(2)*	10 *(1)*	ICE / case interspace 1
	A2	0.05	*not boundary condition*			
	A3	1 (Atm)	18			
10	A1	2 *(3)*	250 *(3)*	time necessary to obtain a unifrom temperature *(2)*	10 *(1)*	ICE / case interspace 2
	A2	0 (vacuum)	*not boundary condition*			
	A3	1 (Atm)	18			
11	A1	2 *(3)*	250 *(3)*	time necessary to obtain a unifrom temperature *(2)*	10 *(1)*	ICE / case interspace 3
	A2	2	*not boundary condition*			
	A3	1(Atm)	18			
At the end of the 3 tests (9,10,11), He leak test to be done and visual inspection of the bellows. The leak test shall be done in the 2 maximal positions.						
During NB LOCA, bellows will not move.						
12	A1	0 (vacuum)	60	time necessary to obtain a unifrom temperature *(2)*	10 *(1)*	LOCA NB/ case interspace
	A2	0 (vacuum)	*not relevant*			
	A3	1.6 *(3)*	145 *(3)*			
13	A1	0 (vacuum)	60	time necessary to obtain a unifrom temperature *(2)*	10 *(1)*	LOCA NB/ case interspace
	A2	0.5	*not relevant*			
	A3	1.6 *(3)*	145 *(3)*			
14	A1	0 (vacuum)	60	time necessary to obtain a unifrom temperature *(2)*	10 *(1)*	LOCA NB/ case interspace
	A2	2	*not relevant*			
	A3	1.6 *(3)*	145 *(3)*			
At the end of the 3 tests (12,13,14), He leak test to be done and visual inspection of the bellows. The leak test shall be done in the 2 maximal positions.						
(1)	*IO would like to check the possibilty to close the AV that is why the edgae welded bellows shall be tested.*					
(2)	*T/C implemented on casing/ test rig* *Time heating sufficient to show that temperature will be uniform.*					
(3)	*reference ITER_D_KF63PB*					