Title	Development and Supply of VVPSS Rupture disc Assembly
Sub Title	Part-A(II): Scope of Supply & Work, Technical and Management Specifications

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1. Purpose

Purpose of this document is to describe the technical requirements for the design, prototyping, equipment qualification, manufacturing and delivery of the Rupture Disc Assembly (RDA) for the Vacuum Vessel Pressure Suppression System (VVPSS).

2. Background

The ITER Vacuum Vessel (VV) is a 1300m³ ultra-vacuum chamber in which the ITER Facility's fusion plasma experiments will be undertaken. The VVPSS is a safety system that protects the VV from overpressure events and will limit the internal pressure to 0.15 MPa.

The VVPSS is formed of a steam condensation system (known as the Vapour Suppression Tanks), a non-condensable gas scrubbing system (the Hydrogen Mitigation System, HMS) and two relief pipes that convey hot gas from the VV to one of the above systems. The smaller DN300 relief line is activated by the opening of valves within a Bleed Valve Assembly (BVA) and the larger DN500 relief line is activated when a bursting disc opens within a Rupture Disc Assembly (RDA).

Figure 1 below indicates the major components of the VVPSS.

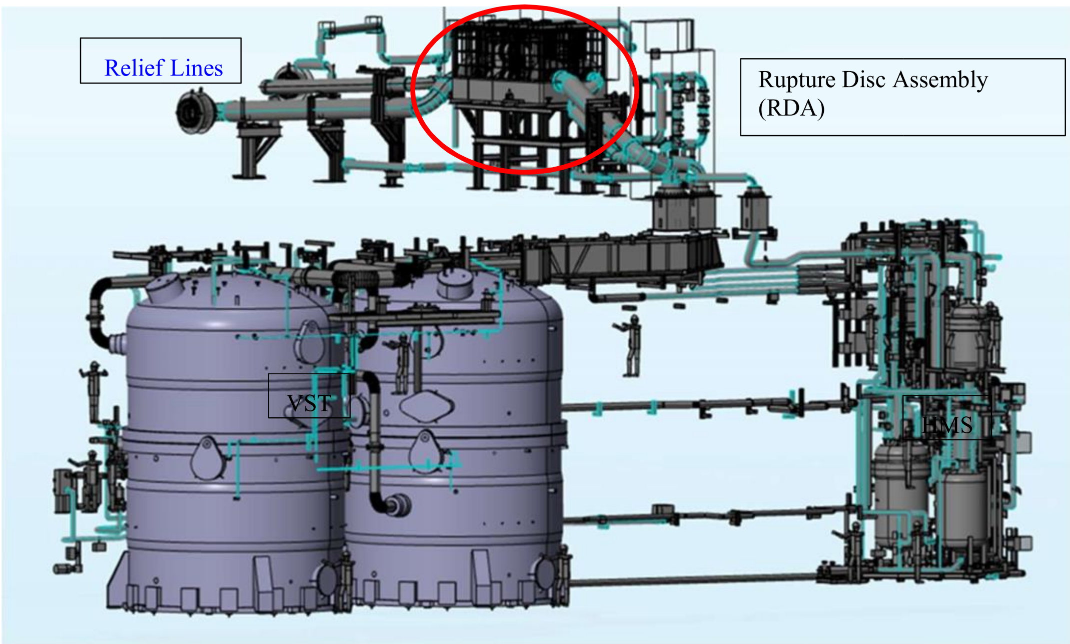


Figure 1: Major components of the VVPSS with the RDA highlighted

The RDA is a non-reclosing pressure relief device installed on one of the VVPSS relief lines that opens when the pressure within the VV reaches a threshold pressure, enabling the flow of gas from the VV into the VVPSS.

The RDA will be located within a high neutron and gamma radiation zone that necessitates full remote handling operations to perform maintenance activities. The RDA shall be designed to interface with the existing Remote Handling systems and facilitate remote installation and removal.

Whilst the subject of this specification is the Rupture Disc Assembly (RDA), the Bleed Valve Assembly on the small relief line shares a quantity of common equipment that this specification will also address.

The ITER Organization (IO) has developed a preliminary design of the RDA based on the functional requirements and physical constraints of the environment in which it will be installed. A general arrangement of the principal parts of the preliminary design is shown in Figure 2.

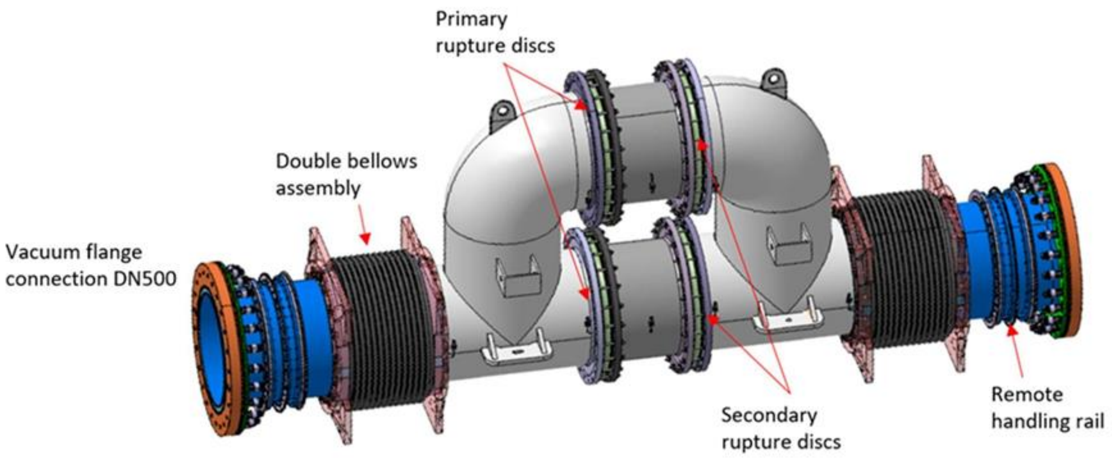


Figure 2: Preliminary VVPSS Rupture Disc Assembly (without housing or supports for clarity)

The VVPSS is a safety system and the RDA are designated a Safety Important Class (SIC) component that requires demonstration of successful functioning in both normal and accidental conditions. This demonstration, known formally as Equipment Qualification, shall be undertaken for the RDA and a Prototype will be manufactured for use in this Qualification.

3. Abbreviations & Acronyms

The following abbreviations shall be considered for the correct understanding of the specifications. For a complete list of ITER Abbreviations see [55].

Abbreviations	Definitions
ASME	American Society of Mechanical Engineers
ASN	French Nuclear Safety Authority (from French Autorité de Sûreté Nucléaire)
CAD	Computer Aided Design
CATIA	Computer-graphics Aided Three-dimensional Interactive Application
Contractor RO	Contractor Responsible Officer
DN	Nominal Diameter
DR	Deviation Request
EN	European Norm

ESPN	Équipement Sous Pression Nucléaire (Nuclear Pressure Equipment)
FEM	Finite Element Method
FRS	Floor Response Spectra
HCC	Hard Core Component
HP	Hold Point
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
ITER	International Thermonuclear Experimental Reactor
IO	ITER Organization
MIP	Manufacturing and Inspection Plan
MNFA	Minimum Net Flow Area
NB	Neutral Beam
NBC	Neutral Beam Cell
NCR	Non-Conformance Report
NDE	Non-Destruction Examination
NPP	Nuclear Power Plant
PED	Pressure Equipment Directive
PIA	Protection Important Activity
PIC	Protection Important Component
PIE	Postulated Initiating Event
PS	Maximum Allowable Pressure
QA	Quality Assurance
QC1	Quality Class 1
RCC-M	Regles de Conception et de Construction des Materiels Mecaniques des Ilots Nucleaires
RD	Rupture Disc
RH	Remote Handling
RDA	Rupture Disc Complete Assembly
SC1	Seismic Class 1
SIC-1	Safety Importance Class 1
SL-2	Seismic Level 2 – equivalent to Safe Shutdown Earthquake, corresponds to the seismic level required by French nuclear practice (RFS 2001/01).
SL-3	Seisme Noyau Dur, Extreme earthquake in Tokamak Building
SVS	Service Vacuum System
TRO	Technical Responsible Officer
VQC-1	Vacuum Quality Class 1

VV	Vacuum Vessel
VST	Vapour Suppression Tank
VVPSS	The ITER Vacuum Vessel Pressure Suppression System

4. Scope of Work

Above all other requirements of this technical specification, the Contractor shall be responsible for all necessary design development, qualification and manufacturing activities that ultimately enables the delivery of an RDA that has been demonstrated to fulfil all the applicable requirements.

Due to the preliminary nature of the design, the demanding functional requirements and the complex interfaces of the RDA, IO/ITER-India foresees a staged approach to execute this contract. IO/ITER-India believes an agile project approach is likely to be the most successful route to delivering the equipment, using both an iterative and incremental approach to deliver a fully qualified RDA.

The Contractor shall present at tender stage a proposal to meet the ultimate goal of this specification; the delivery of a qualified RDA. The following stages are foreseen:

1. A RDA sub-assembly prototyping phase
2. A 100% scale Prototype RDA detail design and manufacturing phase
3. A 100% scale Prototype testing & qualification phase
4. A final RDA design phase
5. A final RDA manufacturing, testing and delivery phase

The following sections provide further details of the scope of work and supply for each of the phases.

4.1. Phase 1 – Sub-assembly Prototyping

The goal of this phase of the project is to develop a series of prototype sub-assemblies that can ultimately be combined to form a complete RDA prototype.

The prototypes will demonstrate the critical performance requirements of the each of the RDA subassemblies.

The Contractor shall analyse the preliminary design of the RDA and determine the appropriate breakdown into sub-assemblies. It is anticipated that at the following sub-assemblies would be developed:

- Double Rupture Disc Sub-assembly
- Vacuum Flange & Double Bellows Sub-assembly

Each Sub-assembly shall be developed until all critical performance requirements can be demonstrated at 100% scale. It is anticipated that smaller scale prototypes could be developed prior to their production at full scale.

Due to the need for common sub-assemblies on the VVPSS Bleed Valve Assembly (BVA), the development of the Vacuum Flange and Double Bellows Sub-assembly shall be done at both DN300 and DN500 scale.

4.1.1. Double Rupture Disc Sub-Assembly

The RD sub-assembly consists of a pair of rupture discs in series (Figure 3). The rupture discs will be assembled into a piping spool that includes a space between the discs and extensions on both sides to enable connection to the rest of the assembly or the test stand.

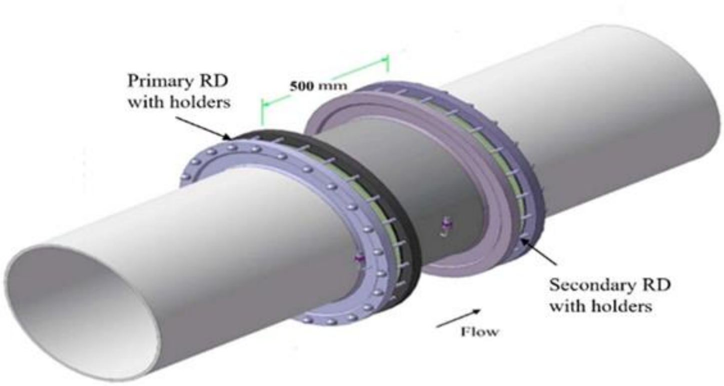


Figure 3: Rupture Disc Sub-Assembly

The specific scope of work for the double rupture disc sub-assembly shall include, but is not limited to the following tasks:

- Establishing a test facility to perform demonstrations of the bursting performance (pressure and fragmentation), leak tightness, and thermal cycling requirements.
- Identification and procurement of appropriate primary and secondary rupture discs;
- Identification and procurement of appropriate RD holders, it is anticipated that the RD will be welded into the holder to meet leak tightness requirements;
- Detailed design & manufacturing of the sub-assemblies;
- Performing at least 3 sets of tests to verify the reproducibility of the performances; - Production of records and reports of the testing activities.

4.1.2. Remote handled vacuum flange and double bellows sub-assembly

The vacuum flange and double bellows sub-assembly is the interface between the VVPSS Relief Pipes and the RDA. It consists of a DN500 flange that meets the leak tightness requirement, can be bolted, unbolted and retracted by remote handling tool and tolerates the piping displacements associated with all operating and accidental conditions.

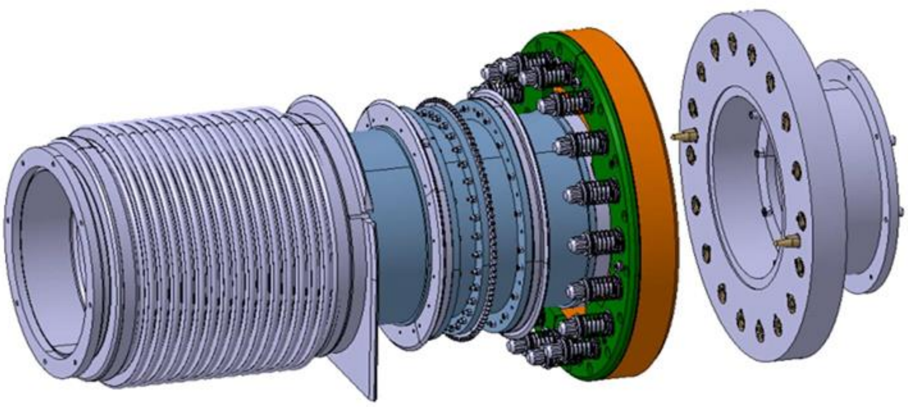


Figure 4: Remote handled vacuum flange and double bellows sub-assembly

Relative movement between the flanges and the RDA body is achieved by a process gas facing inner bellow and a secondary confinement outer bellow. The double bellows shall include a tool to compress the bellows sufficiently to enable remote installation and removal of the RDA. This tool is being developed by IO and will be made available to the selected Contractor, initially at DN300 and later at DN500. The Contractor is not required to develop or manufacture the bellows compression tool; however, confirmatory testing of the IO-supplied tool will be required.

The specific scope of work for the remote handled vacuum flange and double bellows sub-assembly shall include, but is not limited to the following tasks:

- Establishing a test facility to perform the necessary demonstrations of flange bolting, leak tightness, displacement tolerance, unbolting, and flange axial retraction (bellows compression using IO-supplied tool);
- Identification and procurement of appropriate bellows, flanges and other components;
- Detailed design & manufacturing of the sub-assemblies;
- Performing at least 3 sets of tests to verify the reproducibility of the performances; - Production of records and reports of the testing activities.

4.2. Phase 2 – 100% RDA Prototype Design & Manufacture

The goal of this phase is to produce a full-scale (DN500) prototype RDA by integrating the designs of the previously demonstrated sub-assemblies with the pipework, lifting features, supports and other ancillaries (Figure 5).

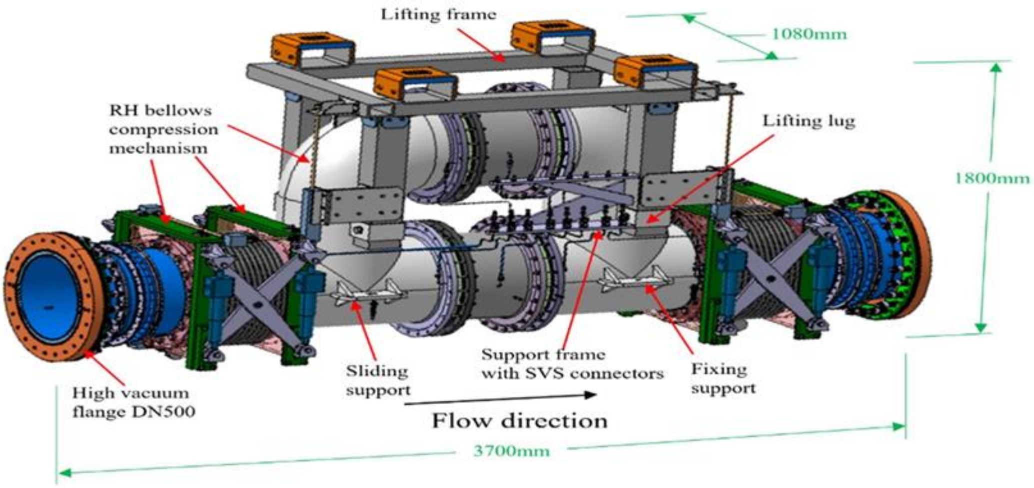


Figure 5: Rupture Disc Assembly with Lifting Frame

The main activities of the work are:

- Develop a 3D model of the full-scale RDA prototype
- Demonstrate by analysis the structural integrity of the RDA prototype when subject to the loads from operation and accidents
- Demonstrate the integration of the prototype RDA into the NBC environment
- Produce a manufacturing documentation package (drawings, BoM, component specs, etc.) sufficient to enable realization of the prototype RDA
- Manufacture of the full-scale RDA prototype

4.3. Contractor Success Criteria – Phases 1 & 2

The successful Contractor will have the experience and ability to rapidly iterate prototype mechanical components of comparable size and complexity.

The Contractor will have demonstrated experience in the development of manufacturing packages, drawings, specifications and other required manufacturing documentation.

The Contractor will manage uncertainty and change through the use of agile project management practices.

The successful Contractor will have in-house manufacturing capability or will have excellent links to precision manufacturing organizations.

4.4. Phase 3 – 100% Scale Prototype Qualification

The goal of this phase of the project is to qualify the 100% scale Prototype by performing equipment testing that verifies the functional performance and resistance to operational, thermal and seismic loads.

This phase of the project shall consist of the following main activities:

- Development of a qualification program that adequately demonstrates all functions
- Establishment of the necessary test facilities and supporting structures to perform the qualification activities
- Performance of the qualification activities as per the developed plan
- Production of a qualification documentation package

The RDA functional verification shall demonstrate all key requirements of the RDA, which shall include but is not limited to the following key characteristics:

- Leak tightness following installation
- Leak tightness following displacement of the connecting pipes
- Response to an overpressure scenario (bursting performance)
- Pressure loss through the RDA following bursting (by analysis)
- Vacuum flange remote bolting and unbolting
- Remote compression of the bellows
- Removal of the RDA from, and replacement of the RDA to the support frame

In addition to the functional verification, the prototype shall be qualified to resist the loads applied to it in normal and accidental operation. This qualification shall include the following demonstrations:

- Structural integrity and leak tightness of the RDA following seismic loading on a shaker table
- Structural integrity and leak tightness of the RDA following thermal cycling
- Structural integrity and leak tightness following pressure cycling
- RDA bursting performance following seismic shaking, thermal and pressure cycling

4.5. Contractor Success Criteria – Phase 3

The successful Contractor will have experience in the development of equipment test rigs, have access to existing testing facilities and have personnel experienced in establishing and executing test programs.

The successful Contractor will have demonstrated experience within the nuclear industry and a particular advantage will be gained by a Contractor with working knowledge of the requirements of the French Nuclear Regulator, ASN.

The ability to produce a Qualification Dossier to the required standards is a critical factor in identifying the successful contractor.

4.6. Phase 4 - Final RDA Design and Approval

The goal of this phase of the project is to produce a manufacturing documentation package for the RDA that has been qualified in phase 3 of the project. The design of the RDA prototype will be further developed to incorporate any updates necessary following the qualification phase and to ensure all applicable IO requirements are met.

Prior to commencement of the manufacturing of the final RDA, the completed design will be submitted to an IO Final Design Review where the full design details and justification will be reviewed with an aim for design approval. The Contractor will support IO in the preparation for the design review and will defend the design to the review panel.

4.7. Phase 5 – Final RDA Manufacture and Delivery

The goal of this phase of the project is to realize the design developed during the previous phases and supply a qualified Rupture Disc Assembly for installation on the ITER Site.

The main activities of the work are:

- Production of all manufacturing procedures, processes and inspection and test plans
- Successful completion of an Manufacturing Readiness Review
- Manufacturing of a Final RDA, spares and transport frames
- Successful performance of Factory Acceptance Testing
- Production of delivery documentation
- Packing and shipping the RDA to IO site

5. General Technical Requirements

5.1. Function

The critical performance requirements for the RDA are the following:

- Leak rate into the primary vacuum (volume upstream of the Primary rupture disc) less than 1x10-10 Pa.m³/s @ 1 bar DP, this necessitates the following:
    - Leak rate across Primary RD less than 1x10-10 Pa.m³/s @ 1 bar DP
    - Leak rate across a pair of mated vacuum flanges less than 1x10-10 Pa.m³/s @ 1 bar DP
- Successful opening (min. 80% open area) of the discs at 110kPa +/- 5%
    - No fragmentation of the RDs after bursting (or suitable fragment catcher where fragmentation cannot be avoided)
    - Maximum pressure loss through assembly with 15kg/s steam at 110kPa, 400K: 10kPa.
    - RDA tolerates the interfacing piping loads and displacements as defined in [52]
    - Remote handling installation and removal, i.e.:
    - Vacuum flange bolting/unbolting (i.e. integration with existing RH tools) o Axial retraction of each vacuum flange (i.e. compression of the bellows assembly) by 75mm (at DN300 and DN500, scaled from DN300 for smaller scale prototypes)
    - Confinement tool installation or Integration with remote handling lifting tools
    - Equipment containing the primary vacuum (all equipment upstream of and including the primary rupture disc) maintained at 100°C and periodically baked at 200°C.

5.2. Design Codes

The final RDA shall be designed and manufactured in accordance with ASME standards.

The rupture discs shall be in accordance with ASME B&PV Section VIII (Div. 1).

The interfacing relief pipes have been designed in accordance with and ASME B31.3 Process Piping [7]. Bellows and piping components of the RDA shall be in accordance with B31.3.

Qualification of mechanical equipment shall demonstrate the nuclear safety functions in compliance with RCC-M Section VI Chapter "Volume Q" Qualification of Mechanical Equipment [2].

The codes, standards, French regulations and relevant ITER documents applicable for this contract are listed in Section 27.

The design features not specifically addressed in this specification, and codes and standards specified herein shall be performed in accordance with good engineering practice.

The Contractor may propose alternative design codes where it believes adequate justification may be made. The alternative codes shall be accepted by IO.

5.3. Component Classification

The classification of VVPSS relief piping system is defined in Load Case Specification VVPSS-RL [20]. The RDA is a part of the VVPSS relief piping system. The classification of the RDA is given in Table 2:

Component	PIC/ Safety Class	Quality Class	PED Class	ESPN Class	Seismic Class	Vacuum Class	Tritium Class	RH Class
Upstream of Primary RD	PIC/ SIC-1	QC1	N/A	N/A	SC1	VQC-1A	TC 2A	Class 1
Downstream of Primary RD	PIC/ SIC-1	QC1	N/A	N/A	SC1	VQC-3A	TC 2A	Class 1

Table 1: Classification of the RD Assembly

Under operational conditions fluids containing radioactive materials will flow through the RDA from Vacuum Vessel plasma chamber. The fluids will contain tritium and activated dust (tungsten and beryllium).

Whilst the final RDA is a safety-related (SIC) component that shall have all necessary design and manufacturing quality control, the prototype sub-assemblies and the prototype RDA are not SIC components and the level of quality control shall be adapted accordingly.

5.4. Principal Design Parameters

- Process pipe size: DN500, reference thickness of the wall 12.7 mm (80S)
- Burst differential pressure of the primary RD: 110 kPa ±7kPa
- Burst differential pressure of the secondary RD[1] : 50 - 92 kPa ±7kPa
- Back-pressure minimum resistance of the RDs[2] : 100kPa
- Max. design temperature: 250°C
- Min. design temperature: 0°C
- Normal operating temperature: 100°C
- Baking operating temperature: 200°C

- Maximum design pressure (PS): 0.50 bar-g, (non-pressure equipment)
- Min. design pressure: full vacuum (~1x10-5 Pa)
- Normal operating pressure between the primary and secondary RD: 30-50 Pa
- Normal operating downstream pressure of the secondary RD: 6 - 10 kPa
- Abnormal operating downstream pressure of the Secondary RD: 100 kPa
- Process fluid: steam, air or an air-steam mixture with up to 5%v/v hydrogen and up to 100g/m³ fine beryllium or tungsten dust.

1 The Secondary RD shall have a forward direction burst pressure of as low as possible given the requirement for a 100kPa back-pressure resistance. A vacuum guard could enable this requirement to be met, but the use of a guard is permitted only with the demonstration that the overall flow requirement can be met.

2 The back-pressure resistance shall take into account the manufacturing tolerance of the RDs, a RD at the minimum value in the bursting range shall also resist the specified back-pressure.

5.4.1. Pressure Withstand Capability

Regardless of the above defined maximum design pressure, the Rupture Disc assembly components shall have the following pressure withstands:

- Internal bellows (process pressure boundary of the double bellows assemblies): 5 bar-g
- External bellows: 1.50 bar-g
- Pipe sections including the RD holders and the vacuum flanges DN500:15 bar-g
- The RDA shall be designed to exclude deformation and collapse due to full vacuum conditions inside the RDA (0 Pa) and an external pressure of 200 kPa-a outside the RDA.

5.5. Equipment Integration

The Final RDA will be installed into the Neutral Beam Cell (NBC) on Level 1 of the Tokamak Building. The NBC is a highly congested area with large quantities of equipment. The hostile radiological conditions require maintenance by Remote Handling (RH) equipment and systems.

The RDA shall be designed so that it is well integrated into the NBC without impacting the surrounding equipment and enabling all remote operations.

The following figures give dimensions of the envelope into which the RDA will be installed.

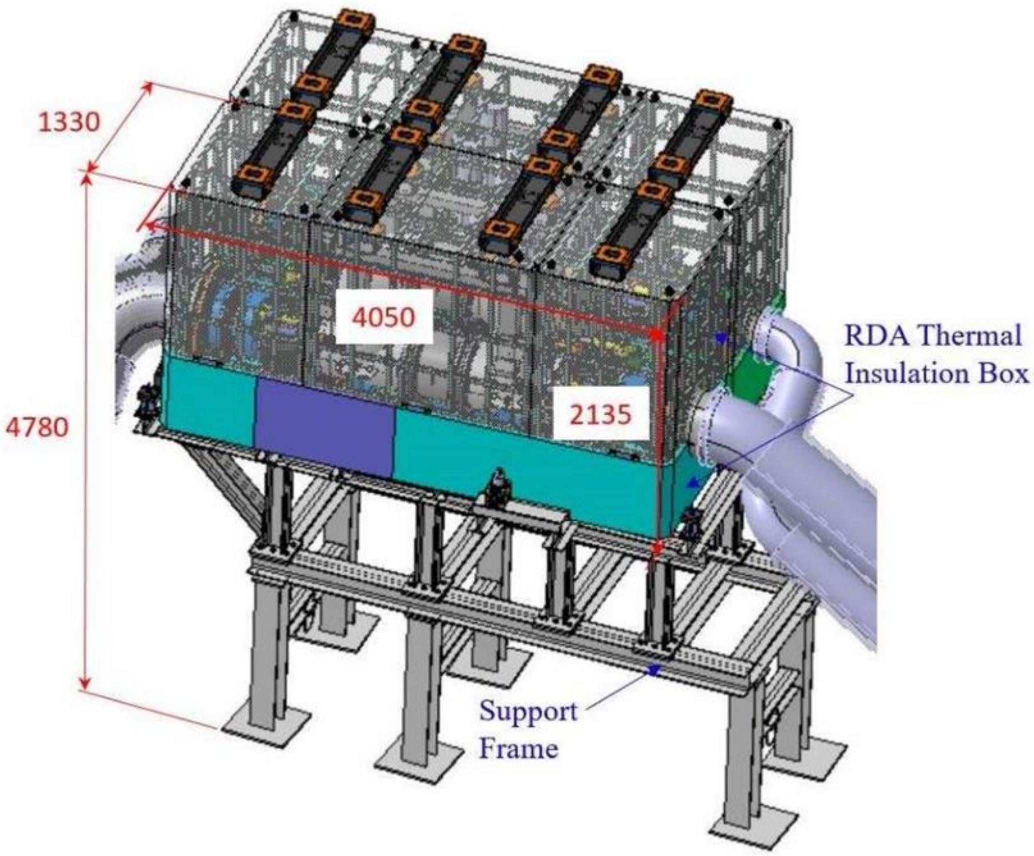


Figure 6:RDA and Support Frame Dimensions

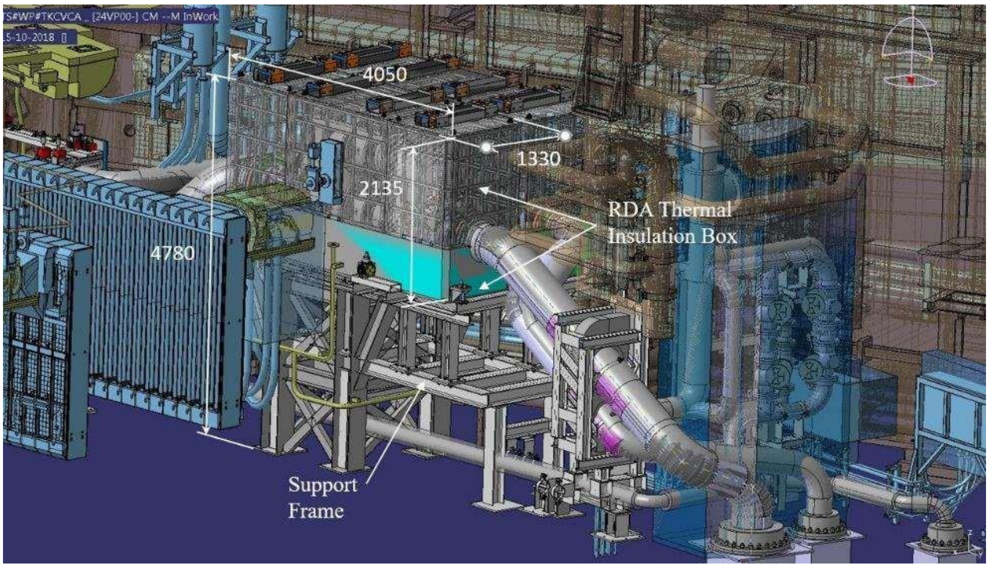


Figure 7 RDA and wider NBC Environment

In order to ensure integration with the RH system and the constraints of the NBC area, the maximum Vertical height of the RDA and Thermal enclosure is 1800mm, as seen in the figure below.

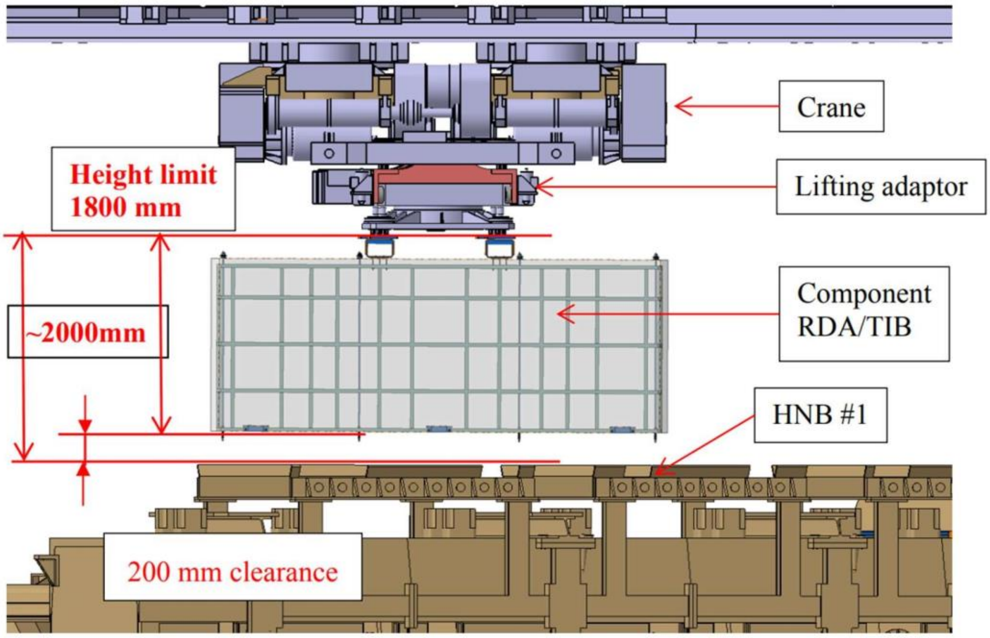


Figure 8: RH Lifting Arrangement & Constraints

5.6. Design Life

The Final RDA shall have a design life of not less than 25 years.

The Final RDA shall be operable (in-service) without need of predictive maintenance for a period of at least 5 years in service.

The above in-service period could therefore be subject to a maximum of 100 baking and pressure cycles.

6. Rupture Disc Assembly Description and Specific Requirements

The RDA includes two parallel sets of rupture discs, each set formed of an upstream primary vacuum facing disc and a secondary disc in series. The secondary disc provides a stable and controlled downstream pressure for the primary disc to ensure predictable bursting performance.

Each RD is held in the assembly by a RD holder. The RD holders support the disc, provide a leak tight seat between the assembly and the disc and shall enable the replacement of the disc following bursting.

To compensate for the interfacing piping displacements created by thermal expansion, seismic and other loads to the system, the RDA is equipped with a double bellows sub-assembly located on the upstream side of the primary RD and downstream side of the secondary RD. Bellows are identified as vulnerable components and as such shall be provided with double containment, hence the need for an inner (process facing) bellow and an outer (secondary confinement) bellow.

The interface between the RDA and the connecting DN500 pipework is a set of high vacuum flanges with double metal seal that enable the remote bolting and unbolting. One side of the flange includes two guide rails and a circular rack gear to enable installation and operation of the remote handling flange bolting tools.

The bellows sub-assemblies are equipped with a bellows compression mechanism that enables the vacuum flanges to be axially retracted to provide sufficient gap between the flange faces to enable the insertion of remote handling closure plates and facilitate removal of the RDA by remote operated overhead crane.

The RDA has a number of pumped interspaces to provide monitoring of the leak tightness of the RDA. These interspaces are connected to the ITER Service Vacuum System (SVS). All SVS monitoring capillaries are collected on the SVS connectors support frame attached to the RDA body. The connections to the SVS can be remotely connected and disconnected to enable remote removal of the RDA.

The RDA shall be equipped with a RH compatible lifting frame for lifting and transportation.

The RDA is covered by a RH compatible thermal insulation enclosure, which ensures a stable operating temperature and protects the component from fire.

The reference dimensions of the RDA are presented in Figure 5.

3D models and other design information developed for and by IO will be provided to the Contractor following contract award.

6.1. Vacuum Requirements

As a component that interfaces with the primary vacuum of the ITER tokamak, the RDA shall comply with the ITER Vacuum Handbook [18] and annexes.

VQC-1A components that are considered to be vulnerable shall be doubly vacuum contained with a monitored interspace connected to the Service Vacuum System (SVS). The welded seals of the RDs and the bellows are vulnerable components. The Contractor shall develop the double contained design for the welded seals of the RDs and provide connections that enable extraction to the SVS.

6.2. Rupture Disc, Holders and Sub-Assembly Requirements

The spool length between the RDs is 500 mm (see Figure 3). The petal of the primary RD1 shall not touch the secondary RD2 after the bursting.

Each RD shall open to not less than 80% of the full pipe cross-sectional area following bursting. The rupture discs shall not fragment, or a “fragment catcher” shall be included in the assembly. It is anticipated that the RD holders may need a hinge with teeth to fix the petals after bursting to optimize performance [56].

Provisions shall be made in order to design the RD holders in such a way that it must be impossible to install the discs and holders in the wrong position.

Each RD holder shall be designed for multiple replacements of the RDs. The holder's design shall provide at least three times an assembling/disassembling of the RD holder, including any welding or cutting of the RD seal.

The design shall make possible replacement of the RDA in the relief line using remote handling tools. No in-situ disassembly of the RDA is foreseen. Information concerning remote handling maintenance and tools to apply will be provided by the IO at the contract's Kick-off meeting.

The Contractor shall design the RDA for transporting and lifting in both vertical and horizontal positions. The supports and lugs shall be designed and stress calculated in line with the requirements specified in the Load Case Specification VVPSS-RL [20].

6.3. Remote Handled Vacuum Flanges

The Contractor shall design the vacuum flanges based on the technical requirements and the design of the ITER style flanges [47], [50]. ITER style flanges have been qualified with specific double seal gasket: metallic (silver) jacketed HELICOFLEX. The vacuum flange connection shall contain the fixed and rotated flanges, and metallic (silver) jacketed HELICOFLEX. The conceptual design of the vacuum flange connection is presented in Figure 6.

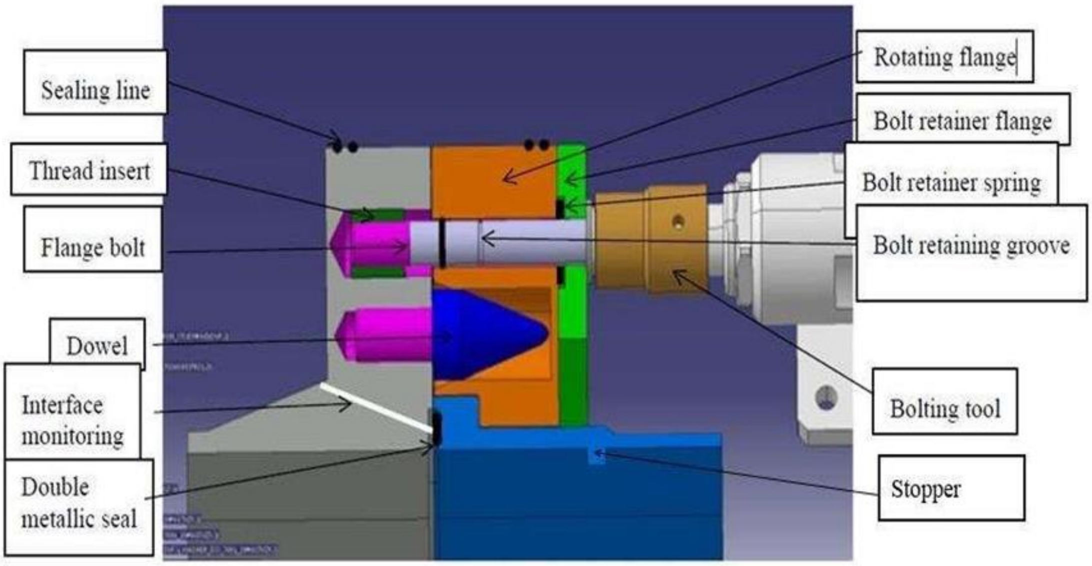


Figure 6: Conceptual design of the RH compatible flange connection.

The design of the vacuum flange connection shall be confirmed by FEM stress calculations.

The circular metallic seal flanges of the RDA shall have the standard interfaces for the RH maintenance as defined in [51]. The required bolt running torque of the metallic seal flange bolts shall be within the torque capacity of the flange bolt runner tools.

When installing the RDA, the RDA flange and that of the fixed relief line can have angular misalignment. In case of misalignment, the guide dowel rotates the rotating flange to align the flange bolts to the threads in the fixed flange (see Figure 6). The rotating flange design makes the alignment easier and requires less demanding manufacturing and assembly tolerances.

On top of the rotating flange, there is a bolt retainer flange fixing the bolt retainer spring inside. When the bolt is fully released from the thread, the bolting tool socket grips the bolt and drags it until the bolt retaining groove meets the bolt retaining spring. The spring keeps the bolt at the released position.

The double metallic seal is placed close to the internal surface of the relief line in order to exclude any possible dust trapping area.

The double metallic seal has interspace monitoring line between the metallic seal in the fixed flange so that the disconnection of the SVS line is not required.

There is a sealing line at the circumferential surface of each flange where the confinement tool will contact to keep confinement during the flange disconnection operation.

The metallic seal shall be fixed to the flanges of the RDA to be removed. The specific seal (Helicoflex type) shall be agreed with the seal manufacturer and approved by the IO. The composite section of the seal shall be fixed to the flange with small screws. The metallic seal is removed and installed together with the RDA to be maintained. No handling operation is foreseen only for the metallic seal.

Tolerances of the flanges (flatness and surface roughness) as well as quantity and sizes of the bolts shall be agreed with the seal manufacturer to provide the specified leak tightness.

The flange sub-assembly include the mounting guide rails and circular rack gear for installation of the flange bolting tool (see Figure 7). The free wheels on the flange bolting tool will be engaged to the guide rails and a pinion gear mating to the circular rack gear will drive the flange bolting tool to move around.

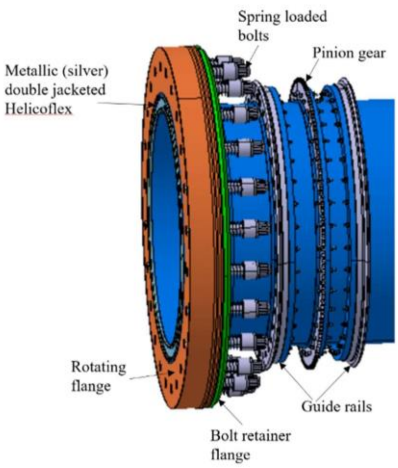


Figure 7: Mounting guide rails and circular rack gear

The bolts on the flange sub-assembly are of a RH compatible pop-up design. The bolts incorporate a number of relevant and unique features. The pop-up bolt design prevents the bolt from dropping down, whilst ensuring bolts cannot be dropped during operation, by using a spring held in place using captive collars on either side. A secondary thread in a retaining plate locks the total bolt travel.

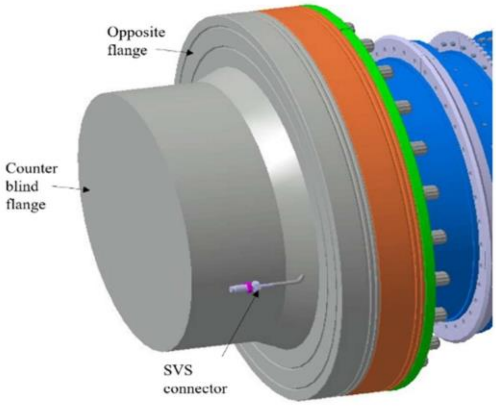


Figure 8: Flange sub-assembly with opposite flange

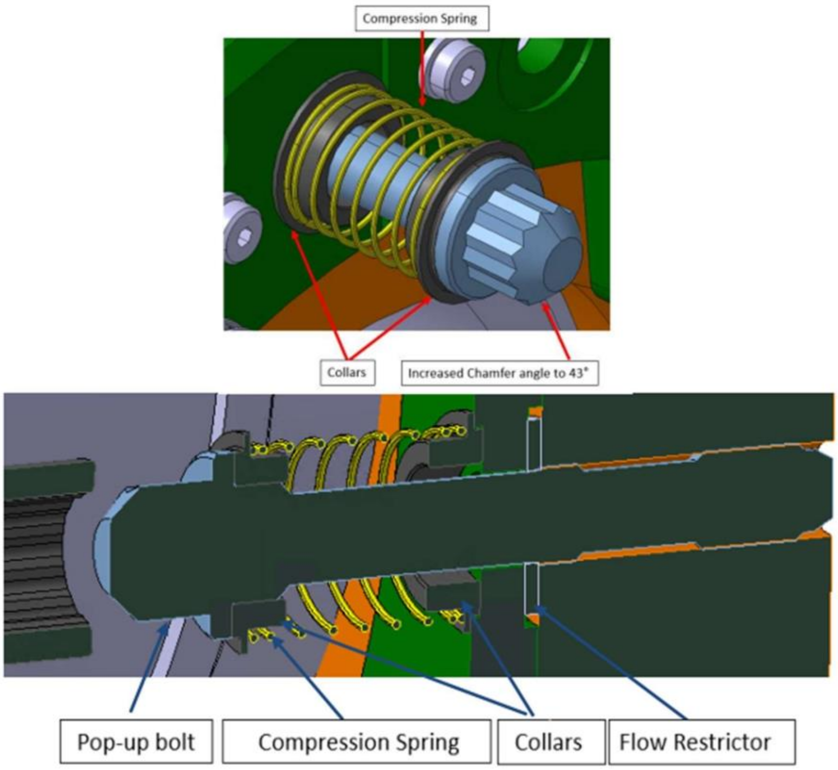


Figure 99: RH Flange Pop-up Bolts

The opposite flange of the flange sub-assembly shall have a pipe extension of at least 200 mm closed with the welded counter blind flange and be equipped with SVS connector (see Figure 8).

The Contractor shall experimentally verify the vacuum flange connection. The helium leak tightness of the vacuum flange connections with double metallic seal HELICOFLEX shall be:

- 1x10-9 Pa·m³/s from ambient to interspace between seals

- 1x10-10 Pa·m³/s from interspace between seals to process.

The vacuum flange design including the fasteners shall be in compliance with the following the ITER Remote Handling Code of Practice [51]. Bolting torque of the RH bolts shall be within the operating range of the RH bolting tools as defined in the ITER guideline, this value is 185 Nm for both DN300 and DN500 flanges [51]. The design of the vacuum flange connections shall be agreed with the IO and approved by the IO.

Following unbolting of the vacuum flange and compression of the bellows, the open flange ends will be closed by insertion of confinement plugs by a remotely handled confinement tool (not part of the scope of supply). The vacuum flanges shall include features to enable the location of the confinement plugs. Three stoppers shall be equally placed along circumference on the internal surface of the relief line (see Figure 6).

6.4. Bellows Sub-Assembly

The bellows design shall enable the displacements of the DN500 relief line due to thermal, pressure, seismic and other accidental conditions. The displacements of the relief line and bellows are determined and can be found in the Report on Stress Analysis of VVPSS Relief Lines [52].

Circular bellows shall be of double construction (or accepted multilayer design) with a continuously monitored interspace (see Figure 10).

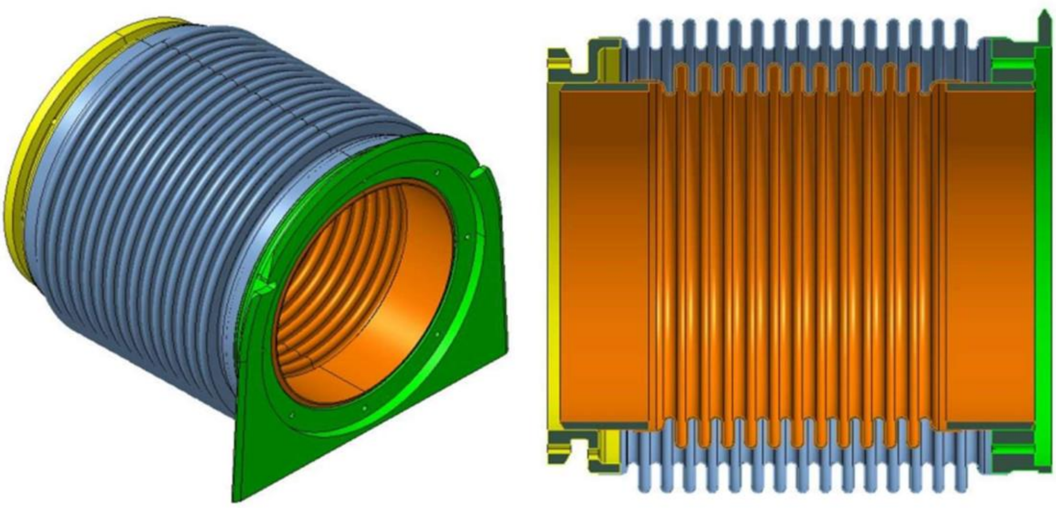


Figure 10: Double bellows sub-assembly and compression tool interface plates

The bellows located on each side of the RDA will be axially compressed by a minimum of 75 mm to provide adequate clearance during the RH maintenance at normal environmental conditions. IO has developed a bellows compression tool that will be provided to the contractor for ensuring a successful interface. The tool will be provided first at DN300 and later at DN500. The axial compression tool is expected to be able to apply a maximum force of 25kN to compress the bellows. Full details of the tool and its testing is available in [53] and [54].

For the stress analysis of the DN500 relief line, the following WITZENMANN bellows were used:

- Inner bellow ARN 06.0500.215.0
- Outer bellow ARN 02.0600.228.0

Design development of the Relief Piping is continuing and IO may update the bellows specification. The contractor may select other suitable bellows, but shall be agreed with IO and sufficiently similar to avoid any substantial impact onto the existing pipeline analysis.

The steam, flowing through the RDA from the VV, contains the activated materials. To exclude the contamination of the bellows by the activated dust, the Contractor shall design and manufacture the double bellows assembly with an internal sleeve.

As part of the bellows qualification the max internal pressure that the bellows can withstand while in the installed position without permanent damage shall be determined. The bellows shall also be tested at a pressure of up to 0.2 MPa (relative to the external environment) and the deformation/final conditions reported. The requirement is to maintain the confinement in these extreme conditions.

The bellows shall be designed and manufactured in accordance with ASME B31.3 process piping code /EJMA/ASME Sec VIII Div. 1 process piping code [7]. Detailed stress calculations to verify design shall be conducted by the Contractor for the combined loads specified in the Load Case Specification VVPSS-RL [20] and ITER Report on Stress Analysis of VVPSS Relief Lines [52]. The stress calculations of the bellows flanges shall be conducted taking into account the compression forces applied to the flanges during the bellows compression and the thermal displacements.

6.5. Heating System

The RDA shall have a system that maintains the equipment on the primary vacuum side of the RDA at 100°C and can be used to elevate the temperature to 200°C for baking.

It is anticipated that an external trace heating system will be applied to the metallic components to generate the necessary temperatures.

The heating system (in conjunction with the thermal enclosure) will be used to perform the thermal cycling testing of the RDA.

6.6. Remote Handling Bellows Compression Tool

Following operation (bursting) of the rupture discs, the RDA will be remotely disconnected from pipework and support frame and delivered to the Hot Cell facility for RD replacement and inspection. IO will provide a design of the RH tool for the bellows compression; the Contractor shall ensure the tool correctly interfaces with the RDA. The IO-supplied RH tool will contain the compressing jacks, support flanges, fasteners and transmission to drive the jacks. The Contractor shall provide the suitable interface for the tool in line with [51], [53] and [54].

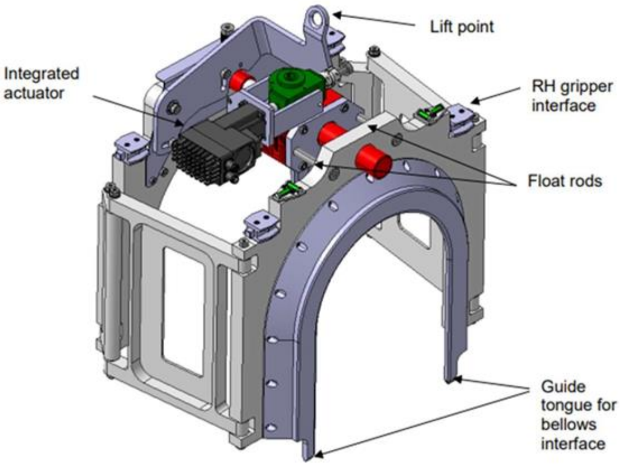


Figure 10: Bellows Compression Tool

6.7. Pumped Interspaces and SVS Monitoring System

All pumped interspaces of the RDA shall have SVS connections for the monitoring the interspace vacuum:

- Two interspaces between the primary and secondary RDs
- Four interspaces protecting the RD welded seals
- Two bellows interspaces
- Two interspaces of Helicoflex double seals

The SVS will create, maintain and monitor a pressure of 30-50 Pa in the interspaces.

For the SVS monitoring system the connectors SWAGELOK VCR 1/4" are applicable.

All RH interface connectors shall be collected and installed on the support frame welded to the body of the RDA. The distance between the RH interface connectors shall be applicable for the RH bolting tool application. The interface connectors shall be connected with the connectors located at the SVS monitoring points of the RDA using the capillaries of 6x1 mm. The capillaries shall be fixed to the

RDA body to be able to resist SL-3 event. The capillary fixations shall be designed taking account the thermal expansion of the capillaries during the baking.

The design of the VCR interface connector shall have an alignment pin to help engagement of the connectors by the Manipulator. The details of the RH compatible VCR connectors shall be developed by the Contractor.

To prevent the dust penetration the opened end of the connectors shall be closed during lifting, transportation and shipping to the IO site.

6.8. Remote Handling Lifting Frame

The Contractor shall design the RH lifting frame used for vertical lifting and horizontal transportation of the RDA in NB Cell. The lifting frame shall be capable of lifting the RDA weight. The load capacity margin of the lifting frame shall be at least 50% in reference with the total weight of the RDA including the weight of the lifting frame. The lifting frame shall be permanently bolted to the lifting lugs welded to the RDA body during the machine operation.

The lifting frame shall have four IO-style twist-lock interfaces for the Monorail Crane used in NB Cell for the equipment transportation.

6.9. Hanging, Lifting, RH lugs and Supports

The hanging, lifting and RH lugs as well as the supports shall be attached prior to final NDE and pressure testing. The RDA shall not be lifted utilizing a single hanging/lifting lug. The material requirements for the lugs and supports shall be equivalent to the requirements of the pressure boundary materials.

6.10. Fasteners

The RDA uses the fasteners for the following functions:

- RH vacuum flanges bolting
- RD holders bolting
- Bolting of the RH lifting frame to the lifting lugs
- Bolting the RDA to the supporting frame

The Contractor shall assess the sizes and number of the connecting bolts. The stress calculations of the bolting shall be conducted for the specified loads. The diameters and bolting torque of the RH fasteners shall be within the operating range of the RH bolting tools as defined in ITER Remote Handling Code of Practice [51] and the design code.

7. Test Requirements

The Contractor shall prepare a test or qualification program for the functional testing of the equipment. The test programme shall include all necessary aspects necessary to achieve successful equipment qualification. The test program parameters shall cover the full range of possible operating and accidental conditions including a margin for uncertainty.

The test program shall include a design of the experimental test-stands, apparatus and facilities including description of all instrumentation and recording devices necessary to perform all testing and demonstrations.

The test program shall be approved by ITER/ITER-India prior to starting the test activities.

7.1. Rupture Disc Sub-Assembly

The sub-assembly shall be installed into a suitable test facility that will enable the verification of leak rate and the bursting performance.

The test facility shall be equipped with adequate instrumentation for monitoring and controlling all relevant parameters (including pressure, temperature, acceleration, leak rate). High speed video recording shall be made of the bursting tests. All measurements shall be permanently recorded.

The functional tests of the RD sub-assembly shall be conducted at the following conditions as specified in Section 14:

- Normal environmental and operational conditions
- Normal environmental and baking conditions
- Following SL3 seismic shaking at normal environmental and operational conditions
- Following an appropriate number (preliminary 20) of thermal cycles from ambient temperature (below 40°C) to baking temp (200°C)
- Following an appropriate number (preliminary 20) of pressure cycles from vacuum (below 10 Pa) to atmospheric (100 kPa) pressure.

7.1.1. Helium Leak Testing

The sub-assembly shall be subjected to the specified conditions and then subsequently helium leak tested to verify the leak tightness into the primary vacuum.

The leak tests will be performed initially at ambient temperature, before increasing to operational temperature. Leak testing is not required at baking temperature, but shall be performed following thermal cycling to baking temperature.

The leak test shall be successful when a leak-rate of less than or equal to 1x10-10 Pa.m^3/s is demonstrated.

Leak testing shall be performed using vacuum methods. Testing is anticipated to be performed by the enveloping of the sub-assemblies and prototype with a suitable bag filled with helium and determining the leak rate into the pumped interspaces, and then by injecting helium into the interspaces and determining the leak rate into the process.

Thermal insulation may be used around the equipment to protect the enveloping bag from high temperatures.

7.1.2. Baking Testing

The ITER machine required to withstand 500 baking cycles from the commissioning phase to the end of life of ITER.

To exclude undue stress on the vacuum item being baked, the temperature shall be controlled such that it is uniform to within ±20°C at all points on the surface of the vacuum item, unless otherwise accepted by the IO. The rate of rise and fall of the temperature of the vacuum item shall be kept within specified limits and, unless otherwise accepted by the IO, shall be no greater than 10°C per hour [49].

The Contractor is invited to suggest accelerated heating cycles simulating the RDA baking. Number of baking cycles and the rate of temperature change shall be assessed and justified by the Contractor. Number of the baking cycles shall be correlated for the RD lifetime in service without replacement during the operating lifetime of the ITER machine.

7.1.3. Burst Testing

The RD sub-assembly shall be subjected to a series of burst tests.

At least 3 burst pressure tests shall be executed to verify the reproducibility of the burst pressure within the specified burst pressure tolerances as well as non-fragmentation of the RDs.

Burst testing shall be performed using air.

The length of the downstream pipe attached to the RD sub-assembly shall be assessed by the Contractor to mitigate an impact of the downstream volume on the dynamic of the secondary RD bursting and back wave. The test facility shall ensure similar conditions to those experienced in the real ITER plant are created (impact of upstream and downstream volumes and configuration).

The pressure of the primary vacuum side of the RD Sub assembly will be gradually increased until the rupture discs open.

Petal position, opening area and disc fragmentation of each RD after the bursting shall be inspected, measured and recorded.

Pressure, temperature and acceleration parameters shall be recorded throughout the burst test with instrumentation of sufficient sensitivity to record the high-speed phenomena.

7.1.4. Back-pressure Resistance Testing

The RD sub-assembly shall be subjected to a series of back-pressure resistance tests.

At least 3 tests each using different discs shall be executed to verify the reproducibility of the backpressure resistance of the RD sub-assembly. Both the secondary and primary discs shall be demonstrated to meet the back pressure requirements.

7.2. Vacuum Flange and Double Bellows Sub-Assembly

The double bellows sub-assembly shall be installed into a suitable test facility that will enable the verification of the following:

- Ability to accommodate the specified displacements and tolerate the interface loads
- Helium leak rates into the primary vacuum not above 1x10-10 Pa.m³/s
- Successful interface with the IO-supplied Bellows Compression Tool and ability to axially retract the vacuum flange by 75mm.

The test facility shall be equipped with adequate instrumentation for monitoring and controlling all relevant parameters (including pressure, temperature, acceleration, leak rate, displacement). Video recording shall be made of the displacement and flange retraction tests. All measurements shall be permanently recorded.

The functional tests of the sub-assembly shall be conducted at the following conditions as specified in Section 14:

- Normal environmental and operational conditions
- Normal environmental and baking conditions
- Following SL3 seismic shaking at normal environmental and operational conditions
- Following an appropriate number (preliminary 20) of thermal cycles from ambient temperature (below 40°C) to baking temp (200°C)
- Following an appropriate number (preliminary 20) of pressure cycles from vacuum (below 10 Pa) to atmospheric (100 kPa) pressure
- Following repeated displacement of the vacuum flange to the maximum displacements and loading to the maximum interface forces and moments.

7.3. Prototype Testing

The Contractor shall perform tests of the 100% scale prototype RDA to demonstrate all functional performance requirement in normal environmental and operational conditions of the VVPSS relief line including as a minimum:

- Verification of the functionality of the double bellows assembly to accommodate the specified axial and lateral displacements on each side of the RDA
- Vacuum control of the SVS monitoring interspaces
- Helium leak tests to verify the leak tightness
- Thermal cycling simulating the baking cycles (from ambient temperature to 200°C) with leak rate checking
- Pressure cycling from vacuum to atmospheric pressure with leak rate checking
- Number of thermal and pressure cycles and the rate of change variables shall be proposed and justified by the Contractor, and submitted to IO in the test program documentation for approval
- • At least one burst pressure test
- The discharge flow resistance of the RDA shall be determined by analysis following bursting and inspection of petal position / open area
- Conducting simulated RH maintenance (using suitable hands-on replacement of RH tools) to verify the vacuum flange bolting, unbolting and retraction followed by lifting from the support frame
- Pressure test of the assembly to the maximum withstand pressure

7.4. Factory Acceptance Testing of Final RDA

The Contractor shall perform the functional tests of the RDA for the normal operational conditions of the VVPSS relief line including as minimum:

- Pressure test
- Establishing operating and baking temperatures using installed heating system
- Helium leak testing to verify the leak tightness at operation conditions
- Vacuum control of the SVS monitoring interspaces.

7.4.1. Pressure Test

The parts of the RDA operated under pressure shall be pressure tested at a pressure of at least 1.43 times the maximum allowable pressure of the parts. Testing may be done in the component or assembled conditions. All process volumes shall be connected together to provide equal pressure in all process volumes. These tests shall be conducted after all machining and welding operations on the parts have been completed. The Contractor shall prepare and submit the pressure test procedures for the IO review and approval.

7.4.2. Helium Leak Test

Helium leak testing is to be performed prior to pressure test. Helium leak testing shall be performed in compliance with Section 25 of ITER Vacuum Handbook [18] and ITER Vacuum Handbook Appendix 12 Leak Testing [48]. Personnel shall have applicable qualification for conducting the helium leak testing.

Note that the sensitivity of the Helium mass spectrometer detector shall be better than 1x10-11 Pa·m³/s.

The extent of helium leak testing shall be performed in compliance with Table 2:

	Extent	Test Scope
Sub-assembly	100%	Global test of component
Complete Assembly or Prototype	100%	Global test of completed assembly

Table 2: Extent of Leak Testing for Equipment

Prior to each helium leak test, the RD assemblies and the components of the RDA shall be properly out-gassed at elevated temperature and dried in accordance with requirements of ITER Vacuum Handbook Section 5.4 [18].

The Contractor shall prepare and submit the helium leak test procedure for the IO review and approval.

7.4.3. Acceptance Criteria

A leak test shall be performed after sealing of the pipework to demonstrate that the pipework is sufficiently leak tight. For a given sealed section of piping and for the entire network, the leak rate shall not be greater than presented in Table 8:

Acceptance Criteria	VQC-1A Maximum Leak Rate (Pa·m³/s air equivalent)	VQC-3A Maximum Leak Rate (Pa·m³/s air equivalent)	TC2A
Prefabricated component (Global Test)	$1x10^{-10}$	$1x10_{-9}$	$1x10_{-9}$
Individual Weld	$1x10^{-10}$	$1x10_{-10}$	$1x10_{-10}$

Condition	Ambient temperature, ΔP=0.1 MPa (in either direction), Concentration He > 50% over area under test.

Table 8: Helium leak test acceptance criteria.

7.4.4. Lifting Test

The RDA and Prototype shall be subject to a load test of the hanging/lifting lugs.

Hanging and lifting lugs of the assemblies shall be load tested to 150% of the complete assembly weight without the lifting frame. The test load shall have a hold time of 20 minutes.

The lifting frame of the assembly shall be load tested to 150 % of the complete assembly weight including the weight of the lifting frame. The test load shall have a hold time of 20 minutes.

Acceptance criteria: no deformations of the lifting lugs as detectable by visual inspection.

8. Pressure Loss Assessment

The Contractor shall perform the pressure loss calculations of the RDA. The total pressure losses shall be assessed for the RDA. The loss coefficients shall be determined by analysis using Computational Fluid Dynamic (CFD) simulation.

Process design conditions are specified in Table 3 for use in all flow capacity determination and pressure loss analysis and testing. These process design conditions are the inlet conditions to the RDA. The flow resistances are different through each RD module; the design conditions are therefore different depending on which RD module has opened.

Fluid	Steam
Pressure (stagnation)	110 kPa
Temperature	125 °C
Density	0.565 kg/m³
Velocity	150 m/s
Mass flow	15 kg/s

Table 3: Process Design Operating Conditions at the RDA Inlet

9. Structural Integrity Analysis

9.1. Stress Analysis

The Contractor shall undertake structural analysis of the Prototype and Final RDA to verify that the components are able to withstand all identified loads to the required service level. The structural analysis shall be undertaken in compliance with Instructions for Structural Analyses [42]. Full details of all loading conditions and the required service levels are given in the Loads Case Specification for VVPSS-RL [20] and interface piping and support frame impacts in line with ITER Report on Stress Analysis of VVPSS Relief Lines [52] for the load combinations of dead weight, pressure, temperature, temperature gradients, seismic, fatigue, fire, pressure test, lifting, transportation and installation loads.

Interface piping loads and displacements have been developed by a stress assessment of the VVPSS relief line, the relevant interface loads for the DN500 relief line can be found in [52]. The layout of the RDA support nodes used in the stress analyse is showed in Figure 12:

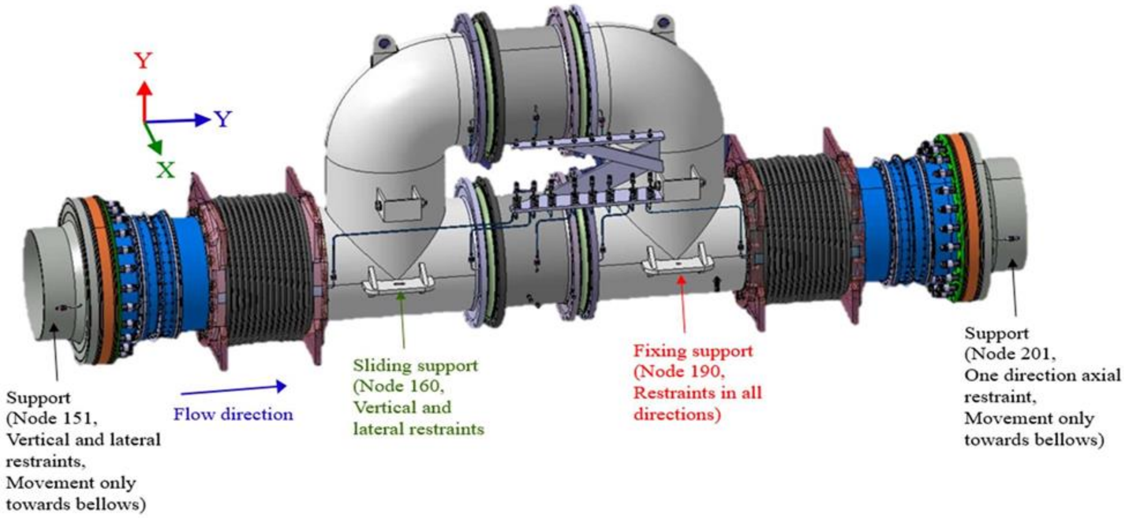


Figure12: Layout of the RDA support nodes

The analysis shall include FEM stress calculations based on ANSYS or ABACUS software. All files in ANSYS or other calculation software to make calculations (input files, scripts, meshes, external functions) shall be submitted to the IO. For each calculation, referenced in the reports, the Contractor shall provide a set of files, including results clearly identifying which calculation was done with each set of file.

The stress calculations of the lugs, supports and support bolts shall be conducted as well. The material properties using in the structural analysis are applicable in the reference [3] and [60].

Seismic analyses shall be conducted in accordance with Instructions for Seismic Analyses [43].

The Contractor shall undertake all necessary analysis and calculations required for the applicable design codes and conformity assessment.

9.2. Bursting Force Calculations

The Contractor shall calculate the bursting forces. The impact of the dynamic forces, applied to the RDA during the RD bursting, on the RDA supports including the support bolts shall be assessed.

9.3. Transportation Analysis

The Contractor shall design and analyze the transport packages used to deliver the Prototype and final RDA to the IO site.

The Contractor shall assume loads in all three axes of 3g for the analysis. No permanent deformation or stress ratio of greater than 80% shall be accepted.

A transportation analysis report shall be submitted to the IO for acceptance.

9.4. Analysis Documentation Requirements

Reports for all analysis performed for the Prototype shall be submitted to the IO for review and approval prior to the start of fabrication.

Analysis reports shall be produced in accordance with template for Structural Analysis Report [41] and shall contain the following information:

- Abbreviations and Acronyms
- Introduction
- Objective
- Scope
- Description of software and codes used in the analysis
- Validation and verification of software used in the structural analysis
- Material properties used in the analysis
- Description of FEM model: type (axisymmetric, thermal, static...), solve (linear, nonlinear…), materials, element types, element properties (real constants, sections), FE Mesh (orientation, duplication, density, shape…), units, rigid elements.
- FEA models:
  - i. FEA native files at start and end of tasks;
  - ii. Input files, scripts, meshes, external functions used for analysis;
- Assumptions, limits of applicability, calculation methods and acceptance criteria;
- Boundary conditions of FEM model: displacements constraints (fixed, imposed…),
- Contacts, gaps, symmetries;
- Detailed print outs of the meshed bodies / surfaces;
- Summary of maximum stresses;
- Output listing from FEA and Input echo. (Annexed, not part of main report body).
- Hand calculations (if any);
- Conclusions and Suggestions;
- References.

The FEA models as well the all calculations performed (including ASME code calculations) for the Prototype and final RDA (if any) shall be provided to IO.

10. Materials

10.1. Material Certification

All materials of the Final RDA shall be certified by the materials manufacturer as meeting the specific code requirements of the project.

The Contractor shall provide Inspection certificates Type 3.1 or Type 3.2, in accordance with EN 10204 [11]. The certificate shall include the information defined by EN 10168 [12].

Where chemical or mechanical properties additional to that required by EN 10168-2004 [12]is required for the relevant ASTM specifications, additional tests shall be performed on samples taken off the original materials to obtain the additional information and a new material certificate be created by the material manufacturer.

All tests shall be carried out by an ISO 17025 [15] accredited laboratory.

Inspection Certificate Type 3.2 must be provided by the Contractor that does not have a Quality Assurance System in line with requirements of ISO 9001 [13].

The Contractor shall ensure that each material is properly identified, each block of material being assigned a unique traceable number. Traceability of each material shall be maintained throughout all manufacturing processes. Traceability documentation which cross-references component parts to material certificates shall be included in the Final Report.

Each flange, elbow, piece of pipe and other component materials shall be clearly marked, so that they are readily identifiable with their test certificates and reports at all times. Marking shall be transferred to all pieces when a part is cut to make more than one component. Material without identification shall not be used in the manufacture of the RDA. The method of marking and marking procedures are subject to IO acceptance.

Hydrogenous materials (e.g. polymers, hydrocarbons) shall be excluded to the maximum extent possible for components in direct contact with the VVPSS system fluids containing radioactive materials including tritium due to hydrogen exchange leading to degradation of the components. Halogenated materials, sulphur and phosphorus, and processes involving the use of these materials, shall be excluded when possible for all components having a Tritium Classification.

Only materials listed in Appendix 3 [45] of the ITER Vacuum Handbook are approved for use. Materials not in the list can be added if demonstrated to meet ITER requirements and approved by the IO.

All materials shall be new.

10.2. Counterfeit Materials

The Contractor shall include a section in the Final RDA Quality Plan that defines the measures put in place to avoid the procurement of counterfeit materials. The full supply chain for all materials that become part of the RDA pressure boundary shall be provided in a document to be presented at the Manufacturing Readiness Review.

In addition to material testing required above, confirmatory material composition and tensile strength testing shall be undertaken on samples taken directly from each batch of pressure boundary raw materials following their delivery to the Contractor’s works.

10.3. Materials Requirements

The materials shall be austenitic stainless steel in accordance with code requirements of ASME B&PVC Section II Part D (Metric) [3] and for the piping components of the RDA in compliance of ASME B31.3 process piping code [7], Category M fluid Service.

The RD stainless steel material shall be suggested by the Contractor and submitted to IO for review and approval.

The base piping and fitting material shall be 304L stainless steel (seamless).

Stainless steel F304L forged material shall be used for the flanges and RD holders.

The flange fasteners shall be from the austenitic stainless steel Type B8 class 1 [60] and possible hardening may be required.

10.4. Low Activation Materials

Lower-activation materials for the RDA shall be selected, the following limits are applied to all materials forming the RDA:

Cobalt max. – 0.05% Niobium max. – 0.1% Tantalum max. – 0.01%

IO may consider deviation from this requirement where the Contractor can demonstrate the component to have a small mass and the cost of achieving the above low activation requirements would be excessive compared to the decrease in overall cobalt, niobium or tantalum.

The above requirement will be considered met when material testing certificates specifically identifying the above elements are approved by IO.

10.5. Carbon Steel Contamination

The Contractor shall properly segregate carbon and stainless-steel work areas to fully exclude carbon steel contamination. Protection provisions shall be taken in order to exclude any contamination from carbon steel dust during the manufacturing processes, cleaning, handling, marking, storage, transportation and other activities with the VVPSS pipes and piping fittings. The Contractor shall prepare a Clean Work Plan that details the measures taken to ensure the absence of contamination of stainless-steel components and submit to the IO for review and approval.

11. Manufacturing Requirements

Detailed Quality Plan [24], Manufacturing and Inspection Plan (MIP) [25], work plans and procedures shall be developed by the Contractor for the Final RDA. Work plans and procedures shall be developed by the Contractor for each step of manufacture. They shall be submitted to the IO for review and approval/acceptance. Manufacturing activities shall be carried out in accordance with Manufacturing and Inspection Plan.

Manufacturing of the final RDA shall take place in a dedicated stainless-steel manufacturing area, where contamination from non stainless-steel manufacturing is effectively eliminated.

11.1. Welding Requirements

The welding procedures and welders’ examinations for the RD, RD's holders and flanges shall be qualified in accordance with code requirements of the project.

The RD sealing welds shall be executed under the Contractor's responsibility and in line with his experience. The Contractor shall demonstrate the required quality of the RD sealing welds to be following the specified leak tightness.

Each welding procedure that is to be followed in fabrication shall be included or cross-referenced in the MIP and weld map. Additionally, the procedures shall be included in the Weld Data Package.

All weld metal mechanical testing and prior welding procedure tests shall be performed on the weld test coupons.

During the welding process for the stainless-steel piping, the inside of the root shall be protected by purging with a suitable inert gas to prevent oxidation. Oxygen concentration shall be monitored during welding.

During manufacturing, particular attention shall be given to cleanliness, especially the removal of weld spatter, debris and other foreign matter, particularly from the coolant passages. All surface treatment, cleaning, mounting, and vacuum acceptance testing of the RD assemblies shall be considered and accounted for in the design.

All burrs and rough edges shall be removed. For safe operation, the opened threaded holes shall be always closed by the removable plugs.

The hanging, lifting and RH lugs as well as the supports shall be attached prior to final NDE and pressure testing. The RDA shall not be lifted utilizing a single hanging/lifting lug. The material requirements for the lugs and supports shall be equivalent to the requirements of the pressure boundary materials.

All repairs, re-work, or scrapping shall be documented and records maintained for each specific item. The records shall relate repairs with the procedure used. A maximum of one weld repair cycle shall be permitted on austenitic stainless steel. The IO shall be notified in the event the weld repair is unsuccessful.

Grinding, surfacing equipment, tools and abrasives for use on corrosion resistant materials shall be new or not previously used on carbon steel or other metal(s)/alloy(s), such that contamination of the finished surfaces is completely excluded.

11.1.1. Welding Materials

The filler shall be qualified according to the approved weld procedure specification (WPS) and approved by IO Welding Quality Control engineer. Filler metals and auxiliary materials shall comply with Section 328.3 of ASME B31.3 [7] and approve with the IO/ITER-India.

The storage of the filler material shall be in controlled environment (ventilated and dry). It is prohibited to place different filler material touched together. Contractor shall prepare procedure or work instruction for filler material storage to be accepted by the IO/ITER-India.

Welding materials shall be identified and controlled so that they can be traced to each welding operation performed on the captive piping. The Contractor shall agree on a procedure for material traceability with the IO prior to commencement of the work.

11.1.2. Preparation for Welding

Preparation of piping welding shall comply with Section 328.4 of ASME B31.3 [7].

Parts to be joined by the fillet & groove welding shall be brought into as close contact with the base metal as is practical and aligned correctly in position with clamps, bolts or other suitable devices.

Arc ignition and arc quenching is prohibited beyond the welding area. Voltage, current level and shielding gas purging speed shall be recorded and meet the requirement of the approved WPS by the Contractor.

All welding process may be single pass or multiple pass according the welding size and length.

This entails cleaning of internal and external surfaces (Subsection 328.4.1), end preparation (Subsection 328.4.2), and alignment (Subsection 328.4.3). The surface within 50mm areas of the weld is to be deposited shall be smooth, free from crack, fins, tears and other discontinuities which will affect the quality of the welding.

11.1.3. Full Penetration Welds

The welding processes for use on vacuum sealing welds shall be compliant for VQC-1A with the ITER Vacuum Handbook [18]. For VQC-1A the boundary to air full penetration welds are required in accordance with Section 7 of ITER Vacuum Handbook [18].

11.1.4. Weld Identification

Each weld shall be identified with a unique weld identification number on the weld control record or equivalent. Weld numbers shall be specified on the Contractor's drawings. The location of all welds shall be shown on the Contractor's drawings. All the joints shall be fabricated in accordance with the issued drawing, including the exact position, weld effective size and length.

For pressure boundary parts, drawings that show fabrication by welding shall indicate the joints, together with the joint geometry and welding process and welding procedure(s).

11.1.5. WPS and WPQR

In order for a WPS to be qualified, conformance with all of the applicable requirements of the relevant part of ASME Section IX [7] is required for each type of joint, including the welding type, base metal type, filler material type, main WPS parameter, the fillet weld size and distance, etc. The WPS and WPQR shall be provided to IO engineer to review and approve by the IO one month before the welding erection.

11.1.6. Welding Repairs

Repairs shall be made using qualified personnel and qualified procedures prepared by the Contractor.

Welding repairs shall be in compliance with the following general requirements:

- All repaired welds shall be documented in compliance with the relevant code;
- NCRs shall be issued in case of welding repairs;
- Weld defects to be repaired shall be removed to sound metal;
- Preheating and heat treatments shall be as required for the original welding. Thermal processes dedicated to either the pipe or the weld shall not adversely affect each other.
- Repair welds shall be non-destructively tested to the same requirements as the original weld.

All repairs, rework, or scrapping shall be documented and records maintained of the repairs, rework, or scrapping performed on specific items. The location, depth and size of area of all base metal weld repairs, regardless of depth of repair, shall be documented and provided to the IO/ITER-India.

The records shall relate repairs with the procedure used. A maximum of one weld repair shall be permitted on austenitic stainless steel without prior approval of the IO/ITER-India. Repairs that are performed due to the conditions determined from informational or inadvertent NDE but prior to final NDE shall be included in the repair cycle limit.

The IO/ITER-India shall be immediately notified in the event the second weld repair is unsuccessful, or any repair results in greater than 25% of the welds being removed.

Non-conforming conditions shall be promptly reported to the IO/ITER-India, upon identification of the Nonconforming condition. No further work shall be performed until the IO/ITER-India have approved the proposed disposition of the non-conforming condition.

Weld control records for all welds shall be available for review by ANB and the IO/ITER-India.

11.2. Surface Finish

Preparation of surfaces is defined as a special process.

All wetted surfaces of the RDA (internal surfaces of the assembly) and sub-assembly shall be polished to a surface roughness (Ra) of less than 1.6µm.

The roughness of the metallic components for different VQC shall not exceed the maximum average surface roughness listed in Table 8-1, Section 8 of the ITER Vacuum Handbook [18].

All other external surfaces of the vessels including the external weld seams shall have a mill finish.

11.3. Tolerances

When dimensions, sizes, or other parameters are not specified with tolerances, the values of these parameters are considered nominal and allowable tolerances or local variances may be considered acceptable when based on engineering judgment and standard practices as determined by the designer. Resolution of design tolerances not specifically covered by this specification shall require review and approval by the IO/ITER-India.

12. Labelling and Tagging

To comply with the requirements of nuclear and other regulations and realize the full traceability and item control process throughout the project lifecycle the procedures for identification and item control shall be executed in line with [61].

All components and the main subcomponents shall be clearly marked in a permanent way and in a visible place with the IO official numbering system according to the document “Specification for Labelling of Equipment on ITER Project” [40].

12.1. Identification

The RDA shall be provided with a permanently attached nameplate made of the same material as the assembly, in a location where it is readable. The nameplate shall include at least the following information:

- Assembly name and number
- Safety class
- Quality Class
- Name and address of the manufacturer and, where appropriate, of the authorized representative established within the Community
- Year of manufacture
- Maximum allowable internal pressure (PS, bar-g)
- Minimum internal pressure (Pmin,int, bar-g)
- External working pressure (Pext, bar-g)
- Maximum external pressure (Pmax,ext, bar-g)
- Volume V of the pressure equipment in L
- Maximum allowable temperature associated with PS (TS Max in °C)
- Minimum allowable temperature (TS min in °C)
- Test pressure PT applied in bar-g and date
- Intended use • Tare mass in kg
- Fluid type and group.
- ANB number.

Final nameplate information shall be approved by the IO/ITER-India.

The nameplate and attachment shall be such that removal shall require willful destruction of the nameplate or its attachment system. The attachment weld to the pipe shall not adversely affect the integrity of the pipe. The nameplate area shall be identified as a low stress area. A qualified welding procedure shall be used to attach the nameplate to the pipe. The nameplate and its bracket shall be of the same material as the pipe.

Evidence shall be provided (i.e. pictures or inspection reports) to the IO that the markings and labelling requirements are fully respected prior to sending the goods. The pipes and piping fittings without identification shall not be supplied to the IO/ITER-India.

13. NDE Examination

The Contractor shall perform the examinations for the scope of work described in accordance with this Specification, the system specific NDE requirements and in compliance with ASME Section V Non-destructive Examination [4] and Section VI of ASME B31.3 process piping [7]. Liquid penetrant testing (LPT) and magnetic particle techniques are not applicable for the NDE examination of the RDA piping components.

For all VQC-1A vacuum boundary welds of the RDA which become inaccessible, 100% volumetric examination of production welds shall be performed. All welds shall permit the volumetric examinations to be performed in accordance with the applicable codes and standards.

All vacuum sealing welds in each VQC shall be subject to helium leak testing, in accordance with the Section 25 of the Vacuum Handbook [18]. Welds shall be made in such a way that they can be leak tested at the time of completion.

Welds that cannot be inspected are not permitted for use on VQC-1A.

Volumetric examination shall be performed using radiographic testing (RT). Ultrasonic testing may be used where RT is not possible and by specific IO/ITER-India approval of the procedures to be used.

In addition to the ASME B31.3 [7] requirements for Category M piping for NDE, the requirements for the piping components listed in Table 6 apply:

Component	Required NDE
Full penetration weld	Visual examination: 100% Volumetric examination: 100%

Table 1: NDE requirements for piping components

13.1. Examination Personnel

Examination personnel shall be qualified and certified in accordance with Section 342 of ASME B31.3 [7] and/or ISO 9712 - Non-destructive Testing - Qualification and Certification of NDT Personnel [14].

13.2. NDE Qualification and Responsibility

Any examination shall be performed in accordance with a written procedure that conforms to one of the methods specified in Section 343 and 344 of ASME B31.3 [7]. Welded joints shall comply with the requirements specified by the design and manufacturing codes.

13.3. Visual Examination

Internal visual examinations may be requested by the IO. Visual examination shall be in accordance with ASME B&VP Code Section V Article 9 [4].

13.4. Radiography Examination

Radiographic examination shall be in accordance with ASME BVP Code Section V Article 2 [4]. Radiography shall be performed after final post weld heat treatment.

13.5. In-Process Examination

In-process examination shall be as required by paragraph 344.7 of ASME B31.3 [7]. Dimensional and layout check is included as part of the in-process examination. The dimensional, geometry and layout check of all the manufactured/installed pre-assembly piping components run shall be carried out as per approved fabrication drawings.

13.6. Acceptance Criteria

The acceptance criteria shall meet the requirements stated in Table 341.3.2 of paragraph 341.3.2 of ASME B31.3 [7].

13.7. Progressive Sampling for Examination

An examined item with one or more defects shall be repaired or replaced; the repair shall be re-examined using the same methods, extent and acceptance criteria as the original work.

13.8. NDE Records

The IO reserves the right to inspect all NDE reports for auditing purposes. NDE reports shall be catalogued according to the weld maps.

14. Service Conditions

All service conditions are presented for the RDA.

14.1. Normal Environmental Conditions

Normal environmental conditions (external for the RDA) in NB Cell during normal operation of ITER machine:

- Temperature (maximum excursion range in the room): between 18°C and 35°C
- Humidity: up to 60%
- Pressure 99.86-101 kPa
- Magnetic field: up to 35 mT
- Total integrated dose at 1.5 m above the floor: 1.3E+4 Gy (gamma equivalent).

14.2. Normal Operational Conditions

Operational conditions (internal for the RDA) during normal operation of ITER machine are:

- Upstream side of the primary RD is in the range full vacuum (1x10-5 Pa), to the bursting pressure of the primary rupture disc (110 kPa)
- Interspace between the primary and secondary RDs: 30-50 Pa
- Downstream side of the secondary RD is 10 kPa
- Temperature: 100°C ±10°C or 200°C ±10°C during baking

14.3. Accidental Environmental Conditions

Accidental conditions (external to the RDA) in NB Cell are [19]:

- Accidental event LOCAIII NB Cell:

- Temperature (up to 145°C) - Pressure (peak, up 200 kPa) - Humidity (peak): 100%.

14.4. Seismic Events

The RDA is a Hard-Core Component and as such shall be capable of withstanding the accelerations associated with an SL3 seismic event without loss of functional performance.

The floor response spectra associated with SL3 events is provided in Appendix 1 - Seismic Event Floor Response Spectra.

15. Equipment Qualification Requirements

15.1. Qualification Process

The Contractor shall conduct the equipment qualification of the RDA in accordance with the equipment qualification requirements presented in RCC-M Volume "Q" [2] and ITER Equipment Qualification Program [27].

Qualification shall provide documented evidence that the equipment is able to fulfil its safety functions in all postulated normal and operating conditions in which it is required and during the required operating period.

The RDA is a passive mechanical equipment. The equipment for which a qualified life or condition has been established shall perform its safety functions without experiencing common-cause failures before, during, and after applicable events for qualification [27]. The equipment, with its interfaces, must meet or exceed the equipment specification requirements. This continued capability shall be ensured through a program that includes, but is not limited to, design control, procurement, qualification, quality control, delivery, installation, commissioning, operation maintenance, periodic testing/ in service inspection and surveillance.

The qualification process might consider the following methods of qualification applicable for nuclear installations:

- Qualification by analysis
- Qualification by experience
- Qualification by testing
- Ongoing qualification.

The methods above might be used in combination, as necessary.

The Contractor shall prepare and submit to the IO for review and approval the Qualification Program following RCC-M Volume "Q" [2] and ITER Equipment Qualification Program [27].

The Qualification Program defines the strategy and describes activities to be performed to qualify an equipment or an equipment family. It shall be established at the beginning of the qualification process.

The Contractor shall propose a Qualification Plan [27] covering the equipment qualification. The Qualification Plan shall address the strategy for qualification adopted, the targets of the qualification, the methods, the tools and the expected results. The Contractor shall demonstrate that the equipment can perform their intended functions, following the Qualification Plan. Equipment qualification of the RDA is protection important activity (PIA). The Qualification Plan shall be submitted to the IO for review and approval.

French and international standards provide reference methods for qualification of PIC equipment in NPPs. Such standards are applicable and adequate for ITER with the specific peculiarities of ITER in comparison with NPPs outlined in ITER Equipment Qualification Program [27]. The Contractor shall follow codes RCC-M Volume "Q" [2] and IEC 60068-3-3 [10] as reference codes using applicable documentation, methods, tests and procedures for the RDA qualification to meet with the qualification requirements in this Specification.

The Contractor shall suggest method to qualify the RDA for SL-3 event using as reference the seismic qualification test for SL-2 on the shaking table.

15.2. Qualification Testing

The qualification tests shall demonstrate ability of equipment to fulfil its functions under all operating (internal for the RDA) and ambient conditions in which is required and during the required operating period.

The qualification testing shall contain at least the following qualification tests of the Prototype as prototype equipment as defined in Section Q1200 of RCC-M Section VI Volume "Q" [2]:

The functional characteristics checked before, during or after each test shall be described in the specific qualification program for the qualified equipment. This information shall be noted before the tests are performed. The test results are deemed satisfactory if the noted functional characteristics correspond to the specified values.

The purpose of the thermal ageing qualification testing is to establish that there will be no unacceptable performance degradation during service life of the RDA without replacement. The Contractor shall suggest to the IO the thermal ageing methodology simulating the baking cycles. The thermal ageing tests shall be conducted with leak rate checking. Number of thermal cycles and the rate of temperature change shall be assessed and justified by the Contractor, and submitted to the IO for review and approval.

The purpose of the seismic testing is to establish that there will be:

- Structural integrity and pressure boundary integrity of the equipment
- Functional operability of the equipment after the seismic event.

The seismic qualification tests shall be performed to the standard IEC 60068-3-3 Environmental Testing Part 3: Guidance for seismic test methods for equipment [10].

The seismic tests shall be conducted by mounting the equipment on a shake table. The sizes and number of the bolts, fastening the RDA on the shake table, shall be in accordance with requirements specified in Section 6.12. During the test, the operational conditions of the equipment shall also be simulated adequately. The test shall conservatively simulate the seismic event at the equipment mounting location. At least two-directional nature of earthquake shall be simulated.

The RDA shall be seismic tested in the same orientation as the assembly in the NB Cell (see Figure 5).

The RDA is tested using defined seismic spectra for the equipment location in the NB Cell on L1 level of TOKAMAK building. The test spectra to be applied to the equipment are floor response spectra (FRS) is presented in Appendix 1 - Seismic Event Floor Response Spectra.

15.3. Acceptance Criteria

Functional characteristics that are verified during the qualification procedure shall be explained in the qualification program together with target values or limits that enable the declaration that qualification has been achieved.

15.4. Equipment Qualification Dossier

The Contractor shall prepare and submit to the IO the Qualification Dossier for the RDA. It includes the following detailed list of deliverables:

- Qualification Plan
- Test facilities and equipment descriptions;
- Documentation related to the test methods;
- Results, instrument data, photographs, videos, and other recordings captured during testing;
- Qualification Synthesis Reports (French "Note de Synthèse de Qualification") issued per family of equipment;
- Qualification Preservation Sheets
- Qualification File.

The Contractor shall produce equipment qualification documentation in format adopted by the IO and with quality sufficient for communication it to the ASN.

Some documentation shall be prepared in French as well as English to enable submission to ASN.

16. Spares

The Final RDA shall be delivered with a set of spares. The spares shall include:

- Two complete sets of rupture discs (two off primary and two off secondary discs)
- Three complete sets of Helicoflex metal seals for the vacuum flanges
- One complete set of fasteners used on the RDA
- Once complete set of any other component with a design life of less than 10 years
- Both vacuum flanges shall be delivered with the appropriate counter flange

All spares shall be at DN500 scale.

17. Documentation

The Prototype and RDA shall be supplied with a full set of manufacturing drawings.

The CAD data relevant for the design and the management of associated interfaces with the IO shall allow the proper integration with the IO CATIA version. CAD data associated only with production may be exchanged in other formats if compatible with the IO software and if agreed by the IO. 3D models of all RD assemblies shall be transferred to the IO.

All drawings shall be clean and legible white prints with uniform background density suitable for electronic scanning and subsequent reproduction. In addition, electronic formats of all documents shall be agreed and approved by the IO. Drawings and manuals shall be supplied in electronic and paper format.

The quality of reproductions shall be of such clarity as to produce a third generation copy which will meet the legibility requirements stated above.

The drawings shall contain at least component identification, materials, equipment design characteristics, fabrication inspection, finish treatment, dimensions with allowable tolerances and miscellaneous where appropriate.

Handwritten documents shall conform to the legibility requirements and quality requirements of this Section. Any pen and ink changes necessary after printing will be performed by drawing a single strike through line, preserving the original information, with neat ink text initialled and dated. Material certificates with white correction fluids on it will not be accepted.

Contractor shall submit documents/data through electronic transmission (e-mail or FTP site) as PDF files and native format. Hard copies may be submitted in addition to electronic transmission. Hard copies shall be submitted rolled, but shall not be folded.

Documents not meeting the quality requirements specified herein, will be returned to the Contractor without IO review for correction and resubmission. Rejected documents will not be a basis for approving schedule extensions or cost increases.

17.1. Operating Manual

The Contractor shall provide the RDA with instructions.

The instructions shall be provided in both English and French language.

These instructions shall detail the specific design characteristics which are crucial for the service life of the equipment. These characteristics shall include:

- For creep, the theoretical number of operating hours at determined temperatures
- For fatigue, the theoretical number of cycles at determined stress levels
- For corrosion phenomena, the allowance or characteristics of corrosion-resistance protection
- For thermal ageing, the theoretical number of operating hours at determined temperatures.

The instructions shall detail how in-service inspection and requalification activities are to be performed.

The instructions shall satisfy the requirements of the relevant design codes.

17.2. Manufacturing Dossier

The Contractor shall provide and organize a Manufacturing Documentation Dossier in the following manner:

- Section 1 – Table of Contents
- Section 2 – Contract Documentation
  - Final Technical Specification
  - Quality Plan
  - Manufacturer Declaration of Conformity
  - Certificates of Conformance
- Section 3 – Design Documentation
  - ASME Manufacturer's Design Report
  - Stress Analysis Design Report
  - As-Built Drawings
  - Bill of Material
  - Deviation Requests
  - Clarification Requests
  - Manufacturing Readiness Review Report
- Section 4 – Material Documentation
  - Material Test Reports / Type 3.1 or 3.2 Certificates
  - Material Supplier's Quality System Certificate
  - Full Supplier List
  - Consumables List
- Section 5 – Fabrication Documentation
  - Completed / Signed off Manufacturing and Inspection Plan
  - Clean Work Plan
  - Weld Maps
  - Heat Treatment Reports including Temperature Measurement Data
  - NDE Reports
  - Surface Roughness Measurement Report
  - Visual Inspection Report
  - Inspection Reports with complete dimensional and tolerance evaluation
  - Certificate of Cleanliness
  - Certified Non-destructive Electric Test Report
  - Contractor Deviation Request (CDRs) if any
  - Non-conformance Reports and Deviation Notices if any
  - Drawing Showing Identification Markings Locations and RT Station Marker Origins
  - Certified Pressure Test Report

- Remote Handling Test Report
- Hanging/lifting Lug Load Test Report

- Section 6 – Qualification and Procedure Documentation:
  - Manufacturing Procedures (Special Processes)
  - Permanent Marking and Labelling Procedures
  - Qualifications of the Personnel for Manufacturing Special Processes
  - NDE/Inspection Personnel Certifications
  - Calibration Certificates for Measurement and Test Equipment
  - Test Procedures (pressure, helium, lifting, remote handling)
- Section 7 – Delivery Documentation
  - Transportation Package Drawings
  - Transportation Package Calculations
  - Packing and Shipping Procedures
  - Photographs of Packaged components
  - Cleanliness Inspection Report
  - Contractors Release Note • Delivery Report.

18. Delivery

18.1. Cleaning and Passivation

The RDA and spares shall meet the cleanliness requirements of ASME NQA-1 (Subpart 2.1) Cleanness Class B for internal surfaces and Cleanness Class C for external surfaces [8].

The Prototype shall be cleaned before the delivery to the IO site

All piping components shall be thoroughly cleaned of mill scale, heat treating scale, heavy oxide, slag, flux, oil, grease, organic matter, dirt, oxide stains, or any other foreign materials.

The cleaning process shall not damage the surface finish, material properties, or the metallurgical structure. The cleaned parts shall be protected to prevent contamination until preservation or packaging is complete. Only clean stainless-steel brushes, chipping hammers, and grinding wheels, surfacing equipment, tools and abrasives for use on corrosion resistant materials shall be new or not previously used on carbon steel or other metal(s)/alloy(s), such that contamination of the finished surfaces is completely excluded.

All stainless-steel materials shall be passivated as the final stage in cleaning prior to shipment. The passivation shall be performed with a chemical treatment of the stainless steel with a mild oxidant, such as a nitric acid solution, to enhance the spontaneous formation of the protective passive film.

The pipes, piping fittings and flanges shall be pickled and passivated in accordance with ASTM A380/A380M [9].

Cleaning procedures, including pickling and passivation procedures, shall be submitted to the IO for review and acceptance prior to the start of production.

18.2. Packaging and Handling

The Contractor shall provide a transport package for the Prototype, RDA, and spares.

Prior to packaging, the Contractor shall prepare a manufacturing and qualification dossiers as well as a Contractor Release Note (CRN) in accordance with reference [29] using template [30] and submit to the IO for review and approval.

Packaging of the Prototype and RDA shall be provided to ensure adequate protection, during transport, shipping, lifting and handling operations and delivery, on-site storage prior to installation. The material certificates shall be submitted to the IO for acceptance.

The packaging shall meet the minimum requirements of Level D for overseas shipment in accordance with ASME NQA-1 [8]. The packaging design (drawings and specification) shall be accepted by IO prior to shipment.

The supplied components shall be properly packed in order to prevent any kind of damages that could lead to a loss of performance. The packing the RDA is PIA. The boxes shall be rigid enough to exclude deformation under the Prototype and RDA weights. The supports have to exclude extra loading on the Prototype and RDA due to sudden movements or accidental drop, in this respect a shock absorbing material shall be used.

All the flanges and SVS connectors shall be fitted with caps after final testing. The Prototype and RDA has to be wrapped in plastic covers to protect them during final storage and transportation. The use of adhesive tape for the protection and packaging shall be restricted to prevent the risk of contamination from the tape. In particular, tape used on austenitic stainless steel shall meet leachable chloride and fluoride limits of 15 ppm and 10 ppm, respectively. Where used, tape shall be fully removable leaving no residue, using isopropyl alcohol or acetone as the solvent to remove all traces of the adhesive.

For the plastic covers PVC shall be excluded. The fire protection ratings of the materials shall be agreed with the IO.

Internals of the RD complete assemblies shall be preserved by means of nitrogen gas (<100 ppm H2O) or dry air. All volumes shall be interconnected to provide equal pressure in each volume. Internal nitrogen or air dry preservation shall be maintained during transport and prior to on-site acceptance.

Accelerometers shall be fitted to the packaging and shall be capable of recording the acceleration along three perpendicular directions. Where appropriate, accelerometers or other sensors shall be fitted to ensure that limits have not been exceeded. When accelerometers are used, they shall be fixed onto each box and shall be capable of recording the acceleration along three perpendicular directions.

Placards shall be mounted on the exterior surface of the manways to identify items, such as temperature indicator, humidity indicator and desiccants.

The boxes shall be clearly marked in a permanent way and in visible places on the exterior surface of the boxes in line with the IO official numbering system, in accordance with the document "ITER Specification for Labelling of Equipment on ITER Project" [40].

Materials intended for use in preservation, packaging, and shipping such as tape, wood, plastic caps, sheet, vapour corrosion inhibitor (VCI) coverings or other covers which are applied directly to stainless steel and nickel-based alloys shall be compatible with the materials to which they are applied.

The interior of the RDA and Prototype shipping packages shall provide moisture control during shipping. The packaging method shall be approved by the IO. A humidity indicator(s) shall be arranged so that it can be viewed from outside the sealed shipping package. If desiccants are used, they shall be non-corrosive and shall not liquefy under saturated conditions.

The Contractor shall provide any special lifting equipment required for handling of the transport packages. All lifting equipment provided by the Contractor shall be proof tested to the applicable loads.

Delivery of the RDA as well as Prototype to their final destination is done under the Contractor's full responsibility and shall respect French law on exceptional transport. A representative of the IO shall be allowed to witness the packaging protocol if such a request is made.

18.3. Shipment and Transportation

The Contractor shall deliver the Prototype, Final RDA and associated spares to the IO Site.

Shipment and Delivery will be undertaken using the International Commercial Terms (Incoterms) 2010. The Contractor shall deliver the Prototype and RDA "Delivered At Place" (DAP) to the IO Site:

ITER Organization,
Route de Vinon-sur-Verdon
CS 90 046
13067 St Paul Lez Durance
Cedex
France

After packaging, the Contractor shall prepare and submit a Delivery Report [31] and Packing List [32] to the IO for review and approval. The Contractor shall sign Declaration of Integrity and stamp before submission to the IO. Declaration of Integrity is included in the Delivery Report. The following documents will be submitted to IO/ITER-India to logistics.data@iter.org / inda.logistics@iterindia.in; at least 15 working days prior to the planned shipment date for each shipment:

- Contractor Release Note [30];
- Delivery Report [31];
- Packing List [32].

IO shall prepare Equipment Storage & Preservation Requirements Form [38] and transfer to the Contractor a UID reference of this document that to complete the Packing List.

Notification of the shipping shall be also sent to: logistics-planning@iter.org/ inda.logistics@iterindia.in

Prior to transportation the IO/ITER-India shall conduct a Delivery Readiness Review (DRR) [62]. The purpose of the DRR is to validate that the IO/ITER-India has the CRN, Delivery Report, the native-file Packing List, the Storage & Preservation requirements, customs documents, and/or any other technical or logistical information that is needed so that the material can be adequately managed through transportation, reception, storage, and ultimately into ITER construction and assembly. The DRR is a Hold Point, and therefore it shall be fully completed by all of the concerned stakeholders before the transportation of components to the ITER Site begins.

Transportation of the components to the ITER site shall be executed in line with the requirements of Procedure for Transportation of Components to ITER Site [63].

Upon receipt of the package, the IO shall open the package and make a visual inspection of its content to check:

- The integrity of the package, including identifying visible damage;
- The number and type of components contained in the shipment;
- The enclosed documentation;
- The reading of the accelerometers or other sensors;
- The integrity of the components.

In the case of anomalies, the IO shall make any additional relevant remark on the inspection.

The IO will inspect the accelerometers or other sensors mounted on the boxes. If these accelerometers record shocks above 3g, a thorough inspection of the components shall be performed. A decision on acceptance of the delivery of the components will be made by the IO.

The original of the Delivery Report shall be kept by the IO and a copy of it shall be kept by the Contractor.

Declaration of conformity to be signed by the Contractor and enclosed with Packing List.

18.4. Final Acceptance

The components shall be handed over to the IO or its representative when they have satisfactorily passed all Factory Acceptance Tests, they have been delivered in accordance with this Technical Specification and all related documentation have been accepted by the IO and a Certificate of Final Acceptance has been issued (Final Acceptance).

The Certificate of Final Acceptance shall be signed by both the IO and the Contractor, after the definitive acceptance of each component and its related documentation.

Ownership of the components shall be transferred from the Contractor to the IO upon Final Acceptance at the delivery terminal once the components are loaded onto the transport vessel. Upon delivery, the RDA containers will be visually inspected.

The transfer of ownership to the IO shall not relieve the Contractor of its obligations under this

Contract in case of non-conformities of the components for the duration of the warranty period.

The Contractor shall provide a standard commercial warranty covering repair or replacement of the components up to 2 year after the Final Acceptance of the components.

19. Specific Requirements and Conditions

The official language of the ITER project is English. Therefore, all input and output documentation relevant for this work shall be in English. The Contractor shall ensure that all necessary members of staff involved in carrying out this work have a good standard of English both written and verbal in order to facilitate effective communication and to adequately draft all required technical documentation.

20. Intellectual Property

All intellectual property generated in the course of the contractor's work for this contract shall belong to IO. The Contractor shall submit a background intellectual property statement prior to launch of the contract to declare any pre-existing intellectual property being brought to the contract.

21. Responsibilities

The IO shall nominate a representative who shall be responsible for all matters relating to the execution of this Contract (IO-RO: ITER Organization Task Responsible Officer). ITER-India will also appoint a Task responsible officer as an official contact person for this task.

The Contractor shall nominate a representative who shall be responsible for all matters relating to the implementation of this Contract (C-RO: Contractor Task Responsible Officer).

22. List of Deliverables and Estimated Date for Deliverables

The estimated duration of this contract is 45 months from the Kick-off meeting.

<table>
<tr><th>Deliverable</th><th>Description</th><th>Due date</th></tr>
<tr><td>D1.1</td><td>Kick-off meeting minutes</td><td>T0+1 week</td></tr>
<tr><td>D1.2</td><td>Monthly progress report</td><td>Monthly from T01+1 month for all phases</td></tr>
<tr><td>D1.3</td><td>Establishment of the necessary sub-assembly test facilities</td><td rowspan="2">To be proposed by Contractor</td></tr>
<tr><td>D1.4</td><td>Successful demonstration of the DN300 Vacuum Flange and Bellows Sub-Assembly to meet all performance requirements</td></tr>
</table>

D1.5	Successful demonstration of the DN500 Vacuum Flange and Bellows Sub-Assembly to meet all performance requirements	
D1.6	Successful demonstration of the DN500 RD Subassembly to meet all performance requirements	
D1.7	Test reports of all sub-assemblies	T0+9 months
Hold Point 1	IO Approval for the Contractor to proceed to Phase 2 (T1)	
D2.1	Completion of the RDA Prototype design, approval of the design model and drawings	To be proposed by Contractor
D2.2	Completion of the manufacturing of the Prototype, approval of the Manufacturing Dossier	T1+9 months
Hold Point 2	IO Approval for the Contractor to proceed to Phase 3 (T2)	
D3.1	Equipment Qualification Program for the RDA, Approval of the Qualification Plan	To be proposed by Contractor
D3.2	Establishment of the necessary prototype test facilities	
D3.3	Successful demonstration of the 100% scale prototype to meet all performance requirements	
D3.4	Prototype Qualification Test reports	T2+9 months
Hold Point 3	IO Approval for the Contractor to proceed to Phase 4 (T3)	
D4.1	Completion of the Final RDA design, Approval of model and design drawings	T3+6 months
D4.2	Closure of RDA Final Design & Manufacturing Readiness Review	
Hold Point 4	IO Approval for the Contractor to proceed to Phase 5 (T4)	
D5.1	Approval of material test certificates	To be proposed by Contractor
D5.2	Completion of RDA manufacturing, Manufacturing Dossier and successful completion of FAT	
Deliverable	Description	Due date
D5.3	Completion of Qualification Process of the RDA, Qualification Dossier	
D5.4	RDA, prototype and spares delivery, Closure of the Receiving Inspection	T4+ 12 months

Table 4: Project Deliverables

T0 is the date of the Kick-off meeting to be held by both Parties within 2 weeks from the contract signature.

T1, T2, T3 & T4 are the dates that the relevant Hold Point released by IO RO/ITER-India RO.

23. Safety Requirements

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

The Final RDA under the scope of this Specification performs the safety function of confinement of radioactive material, and is therefore classified a Protection Important Component (PIC). Any activity related to the design, manufacture, testing, qualification, cleaning, packaging and delivery that can affect the pipework components is identified as a Protection Important Activity (PIA).

For Protection Important Components and in particular Safety Important Class components (SIC), the French Nuclear Regulation must be observed, in application of the Article 14 of the ITER Agreement.

Under the French Order of 7th February 2012 (the “INB Order”) [1] which establishes the general rules for licensed nuclear installations, Contractors and Sub-contractors must be informed that:

- The INB Order applies to all protection important components and the protection important activities.
- Compliance with the INB Order must be demonstrated in the chain of external Contractors.
- In application of article II.2.5.4 of the INB Order, the Nuclear Operator (IO) shall undertake supervision of activities undertaken by external interveners (The Contractor and subcontractors).

The above requirements shall be implemented via the Manufacturing and Inspection Plan (MIP).

For the purposes of performing surveillance, the Contractor shall grant representatives of the IO and the French Nuclear Regulator (ASN) access to its facilities, relevant records and to those of its subcontractors at all stages of the contract. Moreover, the IO reserves the right to take photographs of the test equipment and apparatus during the contract life. The surveillance shall include follow-up and verification of any corrective actions that are to be implemented in line with Provisions for Implementation of the Generic Safety Requirements by the External Interveners [35].

For the Protection Important Components, the Contractor shall ensure that a specific management system is implemented by any sub-contractor. This system will be included in the Manufacturing and Inspection Plan or the Quality Plan.

The MIP shall contain a dedicated column PIA to be identified by tag yes/no for each task.

This document shall be submitted for review and approval to the IO prior to the start of fabrication.

24. Quality Assurance (QA) Requirements

The Final RDA is PIC/SIC-1 system. The requirements of QC1 shall be applied to the Final RDA.

The Contractor shall have either an ISO 9001 [13] accredited quality system or an ITER approved QA Program.

Quality Requirements shall be in accordance with the “ITER Procurement Quality Requirements” [39]. The ITER Quality Assurance Program shall be applied to all the work under this Contract.

The Contractor shall establish and implement a dedicated quality assurance system equivalent to this ITER Quality Assurance Program, with basic elements defined by contract which may include the requirements for Quality Plan, Inspection Plan, Deviations & Non-Conformities and Release Note.

Subcontractors not performing critical quality activities may be exempted from the requirement to produce Quality Plans and MIPs at the discretion of the IO Quality Assurance Responsible Officer (QARO). This decision will be dependent on the level of detail about sub-contracted work in the Contractor's Quality Plan. In such cases, the work can be included in the Contractor’s MIP and managed in accordance with the Contractor’s management system. The list of critical quality activities will be provided by the Contractor for acceptance by IO prior to award of the contract.

Prior to commencement of work under this Specification, a “Quality Plan” must be submitted for the IO review and approval giving evidence of the above and describing the organization for this work; the skill of workers involved; any anticipated sub-contractors; and giving details of who will be the independent checker of the activities. This Quality Plan shall be produced in line with the requirements of [24].

Work shall not start until the Quality Plan is accepted by the IO. A revised Quality Plan shall be subject to the same acceptance procedure as the original Quality Plan. Work should continue in accordance with the current approved Quality Plan until the revised Quality Plan is accepted.

The Contractor shall include to the QP, as annexure, a skill matrix of the qualification level and validity of qualification of personnel performing the critical quality activities, special processes and non-destructive examinations.

Prior to commencement of any manufacturing, a “Manufacturing and Inspection Plan” (MIP) shall be produced by the Contractor and approved by the IO.

A Manufacturing and Inspection Plan shall be prepared by the Contractor in accordance with “Requirements for Producing and Inspection Plan” [25] that meets the requirements of “Inspection Plan (IP) Template” [37]. The MIP is a list of the sequence of manufacturing operations affecting quality prepared in accordance with "Work Instruction for Producing of the Manufacturing and Inspection Plan" [34]. For each particular operation, the Plan shall:

- Identify requirements and instructions applicable to those operations, identification of Project Important Activity;
- Allow for the identification of operations to be inspected or witnessed by the IO;
- Provide the verification and completion of these operations for recording;
- Have a level of detail that is sufficient to prevent the inadvertent by-passing of critical operations and to enable adequate planning, monitoring and verification of critical operations.

The IO will identify to the Contractor those activities that shall be subject to a Control Point as defined in Section 26.4 above.

Following the approval of the MIP, a Manufacturing Readiness Review (MRR) shall be conducted in line with [64] and closed (by the IO) prior to the start of manufacturing activities. This MRR shall be included on the MIP as a Hold Point.

The surveillance rights of the IO identified in Section 22 above shall apply in relation to any Subcontractor and in which case the IO will operate through the Contractor.

The overseeing of the quality control operation by the IO shall not release the Contractor from his responsibility in meeting any aspect of this Specification. The Contractor shall be fully responsible for quality with respect to all services, materials, manufacturing, qualification and testing, etc. They shall be responsible for imposing all technical and quality requirements as applicable to all the fabricator's sub-suppliers furnishing hardware or services in accordance with all applicable Specifications.

Documentation developed as the result of this Contract shall be retained by the Contractor for a minimum of 5 years and then may be discarded at the direction of the IO.

24.1. Non-Conformance and Deviation Requests

Non-conformities shall follow the procedure detailed in the IO document [26].

Non-conforming conditions shall be promptly reported to IO as per the requirements of [26], upon identification of the Non-conforming condition. No further work shall be performed until the IO provides approval of the proposed disposition of the non-conforming condition.

NCRs shall be done as per the IO NCR database. A dedicated platform will be created in the database. The internal process for management of NCR shall be done as per the Contractor's internal procedure.

Deviations shall follow the procedure detailed in the IO document [36].

The Contractor shall demonstrate that materials or subcomponents to be incorporated into the initial product are controlled and resources are checked to prevent the inclusion of Counterfeit, Suspect and Fraudulent items (CSFIs) in the manufacturing chain. The Contractor shall also demonstrate how requirements are transmitted to and controlled by sub-suppliers.

24.2. Traceability

The Contractor shall have traceability procedures in place that can guarantee traceability between materials delivered and the EN10204 [11] certificate. Procedures shall be submitted to and approved by the IO prior to that start of manufacturing operations.

Traceability can be maintained by procedural methods that cover receipt, identification, storage, transfer to production, temporary storage, and use in production. The correct inspection documents shall be made available at the final inspection.

The Contractor shall establish and maintain procedures for identifying the material by suitable means from receipt through production.

Where traceability is a requirement or necessary for the adequate control of the work, the plan should define its scope and extent, including:

- How affected items are identified;
- How contractual and regulatory traceability requirements are identified and incorporated into working documents;
- What records relating to such traceability are to be generated and how and by whom they are to be controlled.

24.3. Audits

The Contractor shall inform its Subcontractors that IO is a nuclear facility identified in France by the number-INB-174. Certain items that are subject to this Specification are classified as Protection Important Component (PIC) to which the French Order dated 7th February 2012 [1] applies and are subject to IO and regulatory body inspections. PIA shall be identified for PIC in order to comply with the requirements of the safety function [35].

The IO, ANB, and French regulator (for PIC) reserves the right to conduct announced or unannounced inspections and audits, at the Contractor's facilities to verify conformance of the work being performed to the requirements of the supply order and this Specification. The ANB shall have free access to perform any inspections there that it deems necessary to check compliance of the requirements stemming from the risk analysis or as applicable that the Contractor properly meets the obligations of the approved quality system.

Both Contractor and its Subcontractors are subject to such inspections and audits. No proprietary processes or information shall inhibit the IO, ANB, or other official party from performing its audit or inspection function. The IO, ANB, and French regulator exercise of, or failure to exercise this right to inspect or witness shall not relieve the Contractor of its obligation to comply with the terms and conditions of the supply order.

24.4. Quality Records

Records shall be maintained to show objective evidence of quality. No quality records shall be destroyed or otherwise disposed of prior to completion of the work, and the IO shall have an opportunity to acquire possession of such records prior to their disposal. Records shall be maintained for access and review by the IO at its discretion.

After completion and delivery of the Product to the IO, the Contractor shall maintain the records for a period of five years.

The IO shall have an opportunity to acquire possession of such records prior to disposal.

Documents shall be annotated with the IO supply order number or other numbering system traceable to it for identification.

25. Certificate of Conformity

A Certificate of Conformity shall be submitted along with the product delivery. The test reports shall show that the RDA satisfies the intent of this Specification and shall be submitted with a Certificate of Conformity. The Certificate of Conformity shall attest to completeness, accuracy and compliance with this Specification.

The Certificate of Conformity shall satisfy the following criteria:

1. Identify the Contract and/or supply order number and a description of the items as ordered, provided and certified in satisfaction of the Contract and/or supply order and all applicable agreed upon changes.
2. Identify the specific procurement requirements met by the purchased material such as codes, standards, and other specifications.
3. Identify any procurement requirements that have not been met.
4. A person cited in the Contractor’s quality assurance program as responsible for certification shall attest to the certificate by signature, title, and date of signing. The IO reserves the right to verify the validity of the Certificate of Conformity during the performance of audits of the Contractor or by independent inspection or test of the item(s).

26. Contract Management

The Contactor shall designate a Contractor Responsible Officer, within 10 working days after award of contract (AOC), who will be responsible for the overall design, manufacture, factory testing, performance testing, schedule, cost control and resolution of disputes and discrepancies. The Contractor shall also identify specific individuals responsible for each aspect of the Work. The Contractor's proposal shall provide an outline of the management structure and resumes of the team members for the project.

26.1. Contract Schedule

The Contractor's shall provide a preliminary schedule at tender stage and a detailed schedule, in Primavera P.6 format, within 10 working days of the Kick-off meeting. It shall identify the submittals to and approvals from IO of the Contractor's and Subcontractors' specifications, drawings, procedures, and other types of documents as appropriate.

As a minimum the schedule shall include task descriptions with start and finish dates for each task. Separate detailed task breakdowns shall be provided for design, procurement, fabrication, and factory testing phases and end with a Scheduled Delivery Date.

The schedule shall be made available in both hard copy and electronic form, in Primavera. The schedule shall include all work activities identified within the Specification. The schedule shall include milestones for design, fabrication, shop testing, and delivery of the VVPSS pipes and piping fittings to allow for the IO to monitor the progress of the Work and to schedule its interface activities with the Contractor. The schedule shall include all documents and deliverables listed in this Specification.

The project schedule must be provided to IO for approval prior to implementation of any Work.

26.2. Contract Kick-off Meeting

The Contractor shall participate in a Contract Kick-off Meeting. The Contract Kick-off Meeting shall be scheduled at a mutually agreeable time as soon as practical after AOC, but not before the Draft Schedule and Draft Quality Plan are submitted by the Contract Manager to the IO representative.

The Kick-off Meeting will include the Contractor Responsible Officer and other principal participants as requested by the IO. The primary purpose for the Contract Kick-off Meeting is to confirm that the meeting participants understand the terms and conditions of the contract, technical specification and drawings. The following topics will be discussed:

- Scope and content of the Quality Plan, Manufacturing and Inspection Plan.
- Expectations for satisfying quality standards, documentation requirements, delivery arrangements, acceptance criteria.

The Contractor shall prepare written draft Contract Kick-off Meeting Minutes that document the agreements and commitments resulting from the Contract Kick-off Meeting discussions. The Contractor is responsible for documenting meeting discussions and preparing written minutes for each of these meetings within three working days.

26.3. Monthly Progress Report

The Supplier shall submit monthly written and electronic progress reports, in Primavera, to the IO Representative that reflect the status of the engineering, fabrication and delivery phases of the Work. The reports shall be submitted both electronically and in hard copy. These reports shall discuss the following:

- Completion of all scheduled activities
- Actual and projected delays of all activities
- Inclusion of any additional schedule activities
- Proposed changes in project management or key project personnel
- Status of key existing engineering, procurement or manufacturing issues that may impact quality, performance, or delivery
- Anticipated or approved deviations from the Specification
- Other issues pertinent to project schedule or milestone completions
- Open items.

26.4. Control Points

The IO shall ensure a close oversight of the production of its main Contractors and Subcontractors in accordance with approved Manufacturing and Inspection Plans.

This monitoring shall include Control Points at critical steps in the Contractor's plans. The control points shall be integrated into the agreed schedule.

A Notification Point (NP) is a milestone where the Contractor is required to notify the IO that it has completed a specific task and is proceeding to the next task. A NP is meant to enable the IO personnel to follow the progress of the Contract and possibly to witness a critical manufacturing step at the

Contractor's premises. The Notification shall be sent by the Contractor to the IO at least 15 working days prior to the scheduled manufacturing step. The IO shall decide whether or not to attend. A NP shall not affect the production flow of the Contractor that shall continue the work even without a reply from the IO.

A Hold Point (HP) is a milestone where the Contractor is required to notify the IO that it has completed a specific task and must stop the associated processes until a HP Clearance is issued. The HP Clearance shall be issued on the basis of clearly identified Quality Control, data and/or Acceptance Test results provided to the IO at the time of the request. The IO shall have a maximum of 15 working days to review the Contractors data and to notify the Contractor of its decision. In case of clearance the Contractor shall resume its activity. In case of rejection, the Contractor shall develop a recovery plan that shall be submitted and reviewed by the IO within 15 working days of submission.

26.5. Review Duration

For other documents submitted by the Contractor to the IO:

- The IO will have 15 working days from the receipt of Contractor's Documents to review, comment on and/or, as the case may be, approve/accept them
- The Contractor shall have 15 working days from the receipt of commented documents to update and resubmit them to the IO via email
- The IO will have 15 working days from the receipt of the Contractor's e-mail to review and return the documents.

For documents submitted by the IO to the Contractor:

- The Contractor shall have 15 working days from the receipt of the IO documents to review, comment on and/or, as the case may be, approve/accept them.

Apart from the review cycle of the first submission, in each subsequent review cycle comments shall be limited to:

- Text related to previous comments (either modified or deleted).

26.6. Monitoring

In order for the Contractor to update the status of the works, the periodical video meetings shall also be held between both parties on biweekly basis or any other frequency agreed between the Parties. The Contractor shall use Video Conference System compatible with Skype for Business.

In addition, if necessary, the IO Technical Responsible Officer and/or the Contractor Responsible Officer may request additional meetings to be organized in order to resolve specific issues.

A minimum of 3 week notice shall be given prior to commencement of the tests. ITER reserves the right to attend the tests.

26.7. Access Rights

The Contractor shall ensure that access rights are granted to IO personnel and to representatives of the French Nuclear Regulator and give free access to all workshop and test facility engaged in performance of activities under the contract. Moreover, the IO reserves the right to take photographs of the test equipment and apparatus during the contract life.

27. References

27.1. Orders, Directives, Codes and Standards

The orders, directives, codes and standards that shall be used in this contract are listed in the Section below. The use of other standards may also be acceptable, subject to IO's approval. The Contractor shall demonstrate the conformity with the orders, directives, codes and standards in their last version.

For items not covered by the proposed codes and technical specifications, the Contractor shall justify the soundness of the design approach.

[1]. ITER_D_7M2YKF - Order dated 7 February 2012 relating to the general technical regulations applicable to INB - EN

[2]. RCC-M Section VI Design and Construction Rules for Mechanical Components of PWR Nuclear Islands, Volume "Q" Qualification of Active Mechanical Equipment (Pumps and Valves) Requirements Qualification to Accident Conditions in 2017 Edition

[3]. ASME B&PVC Section II, Materials, Part D (metric), 2019 Edition

[4]. ASME B&PVC Section V, Nondectructive Examination, 2019 Edition

[5]. ASME B&PVC Section III Rules for Constructions of Nuclear Facility Components

[6]. ASME B&PVC Section IX , Welding, Brazing, and Fusing Qualifications, 2019 Edition

[7]. ASME B31.3 Process Piping, 2018 Edition

[8]. ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Applications, 2019[38] Edition

[9]. ASTM A380/A380M-17 Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

[10]. IEC 60068-3-3 Environmental Testing Part 3-3: Supporting Documentation and Guidance - Seismic Test Methods For Equipment, 2019 Edition

[11]. EN 10204-2004 Metallic products - Types of inspection documents

[12]. EN 10168-2004 Steel Products – Inspection documents – List of information and description

[13]. ISO 9001 Quality management systems – Requirements, 2015 Edition

[14]. ISO 9712, Non-destructive Testing - Qualification and Certification of NDT Personnel, 2012 Edition

[15]. ISO 17025 General requirements for the competence of testing and calibration laboratories, 2017 Edition

27.2. ITER's Applicable Documents

The Contractor shall demonstrate the conformity with the referenced documents in their last version at the time of contract signature as referenced.

[16]. ITER_D_REYV5V v2.3 - Chemical composition and impurity requirements for materials

[17]. ITER_D_2LAJTW v1.4 - Tritium Handbook

[18]. ITER_D_2EZ9UM v2.5 - ITER Vacuum Handbook

[19]. ITER_D_KF63PB v2.11 - Safety requirement Roombook

[20]. ITER_D_UXX829 v2.5 - Loads Case Specification VVPSS -RL

[21]. ITER_D_3G3SYJ v3.1 - Allowable values and limits in service level C and D for ITER mechanical components

[22]. ITER_D_Q9DVN3 v2.1 - PBS 24 VVPSS for Defined Requirements

[23]. ITER_D_PSTTZL v2.2 - List of ITER-INB Protections Important Activities

[24]. ITER_D_22MFMW v4.0 - Requirements for Producing a Quality Plan

[25]. ITER_D_22MDZD v3.7 - Requirements for Producing an Inspection Plan

[26]. ITER_D_22F53X v8.2 - Procedure for management of Nonconformities

[27]. ITER_D_XB5ABP v1.2 - Equipment Qualification Program

[28]. ITER_D_VYJ7U2 v1.3- Procedure for Labelling on Physical Items

[29]. ITER_D_22F52F v5.0 - Requirements for Producing a Contractors Release Note

[30]. ITER_D_QVEKNQ v3.1 - Release Note Template

[31]. ITER_D_WZPYVZ v2.3- Delivery Report Template

[32]. ITER_D_XBZLNG v1.1- Package & Packing List Template

[33]. ITER_D_QV7GQF v1.3 - Inspection Plan (IP) Template

[34]. ITER_D_UKQG8M v1.5 - Work Instruction for Producing of the Manufacturing and Inspection Plan

[35]. ITER_D_SBSTBM v2.2 - Provisions for Implementation of the Generic Safety Requirements by the External Actors/Interveners

[36]. ITER_D_2LZJHB v8.1 - Procedure for the management of Deviation Request

[37]. ITER_D_QV7GQF v1.3 - Inspection Plan (IP) Template

[38]. ITER_D_WU9636 v4.3 - Template - Equipment Storage & Preservation Requirements Form

[39]. ITER_D_22MFG4 v5.1 - ITER Procurement Quality Requirements

[40]. ITER_D_TL25DK - Specification for Labelling of Equipment on ITER Project

[41]. ITER_D_VQVTQW v1.0 - Template for Structural Analysis Reports

[42]. ITER_D_35BVV3 v4.0 - Instructions for Structural Analyses

[43]. ITER_D_VT29D6 v2.0 - Instructions for Seismic Analyses

[44]. ITER_D_2FMM4B v1.2 - ITER Vacuum Handbook Attachment 1 - Welding

[45]. ITER_D_27Y4QC v1.20 – Vacuum Handbook Appendix 3 Materials

[46]. ITER_D_2ELN8N v1.14 - Vacuum Handbook Appendix 4 Accepted Fluids

[47]. ITER_D_2DJYQA v2.5 – Vacuum Handbook Appendix 8 Demountable Vacuum Flanges for use on the ITER Projects

[48]. ITER_D_2EYZ5F v1.4 – Vacuum Handbook Appendix 12 Leak Testing

[49]. ITER_D_2DU65F v1.3 – Vacuum Handbook Appendix 15 Vacuum Baking

[50]. ITER_D_PA3BXP v2.2 - ITER VACUUM FLANGE USE DESIGN GUIDANCE

[51]. ITER_D_2E7BC5 v1.2 - ITER Remote Handling Code of Practice

[52]. ITER_D_YWLH59 - Report on Stress Analysis of VVPSS Relief Lines

[53]. UKAEA TD-0014244 Bellows Compression Tool Mechanical Design Report

[54]. UKAEA TD-0013888 Mechanical final design report for Mock-Up Environment

27.3. ITER's documents for information

The documents shall be used for information in their last version at the time of contract signature:

[55]. ITER_D_2MU6W5 v1.17 - ITER Abbreviations

[56]. ITER_D_R5VNGW - VVPSS Rupture Disk Testing BS&B Phase 2

[57]. ITER_D_PQR228 v1.1 - ITER HARD CORE COMPONENTS - SUMMARY REPORT

[58]. ITER_D_TWYWUK v1.0 - Final Report of the Concept Design of the RH System for VVPSS Maintenance

[59]. ITER_D_2FMAJY v1.6 - ITER Remote Maintenance Management System (IRMMS)

[60]. ITER_D_RBFN56 v1.1 - VVPSS Materials Data Summary for Structural Analysis

[61]. ITER_D_R5389R - Stress Test Detailed Methodology for Hard Core Components of ITER

PlantITER_D_U344WG - Procedure for Identification and Controls of Items

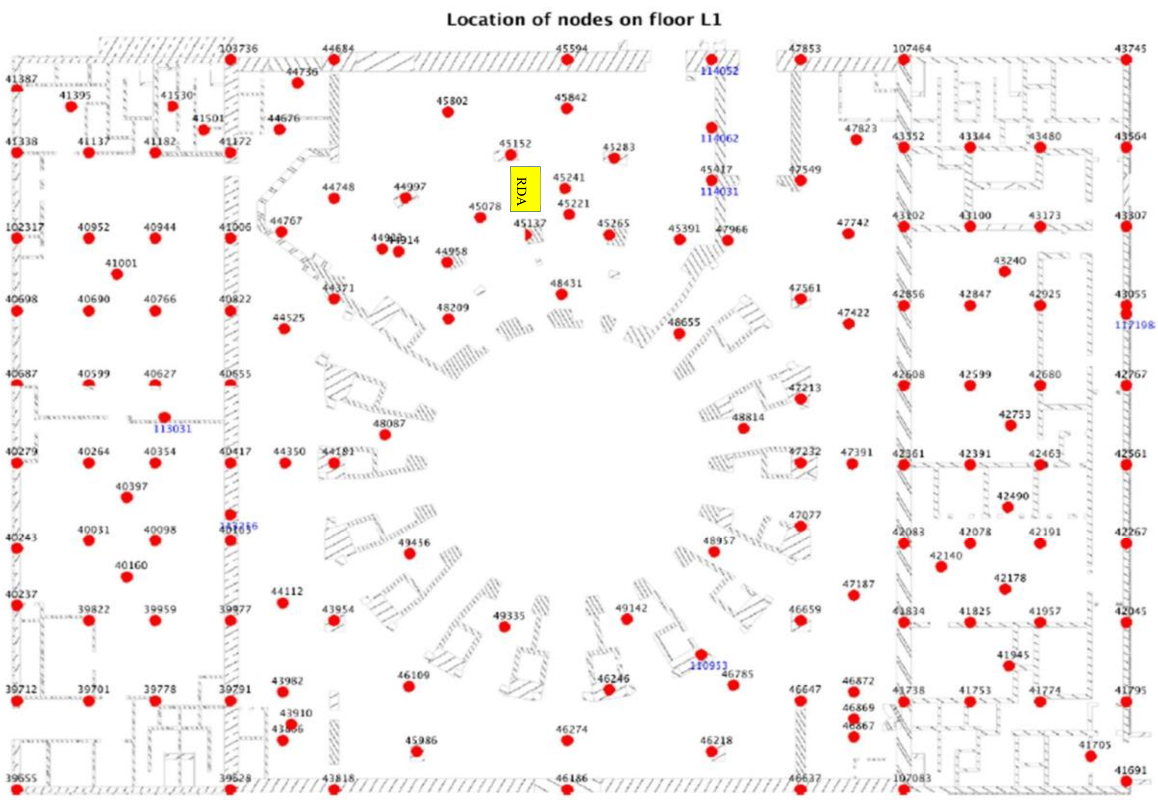
[62]. ITER_D_X3NEGB - Working Instruction for the Delivery Readiness Review (DRR)

[63]. ITER_D_RY5C6Q - Procedure for Transportation of Components to ITER Site

[64]. ITER_D_44SZYP - Working Instruction for Manufacturing Readiness Review

28. Appendix 1 - Seismic Event Floor Response Spectra

28.1. Response Spectra Nodes

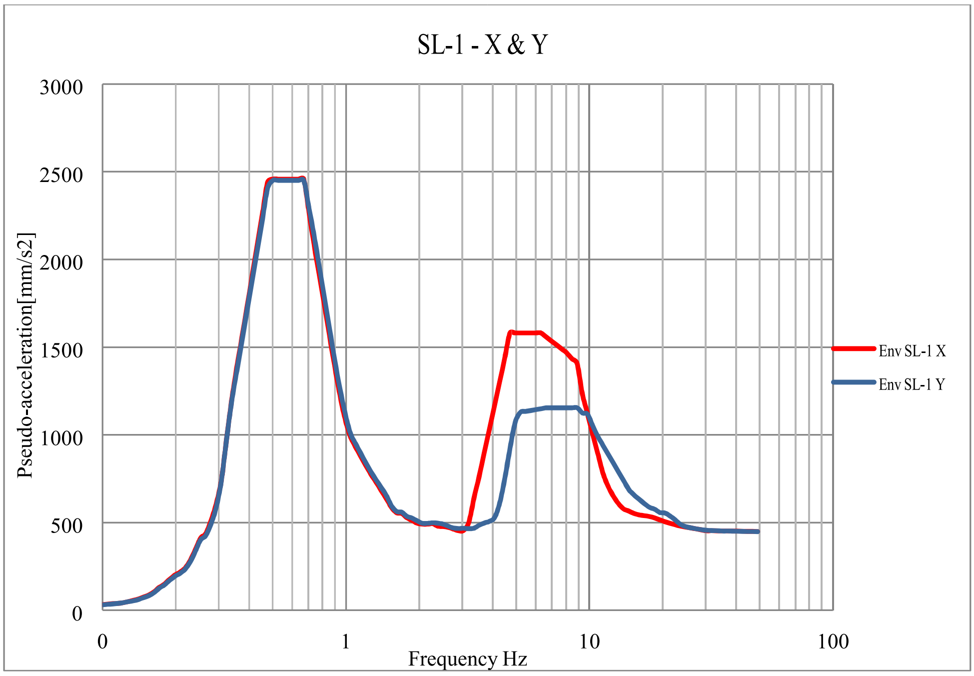


Nodes 45152, 45078, 45241 and 45137 shall be enveloped to determine the applicable FRS for the RDA.

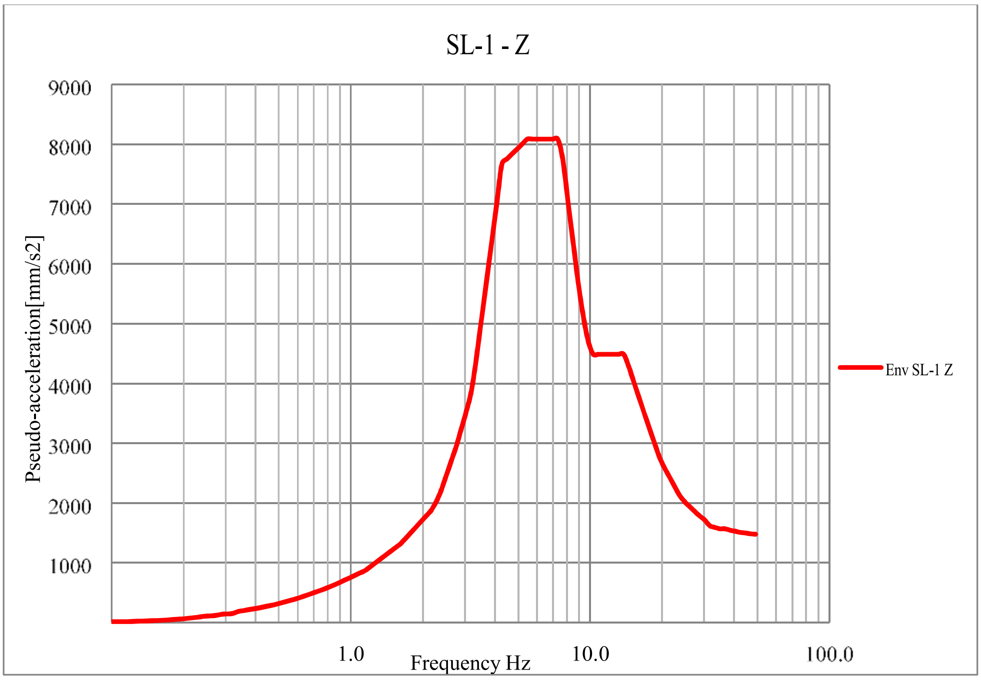
28.2. Damping Factors

The RDA is part of the VVPSS Relief Piping system and shall have the damping factors defined by [20]:

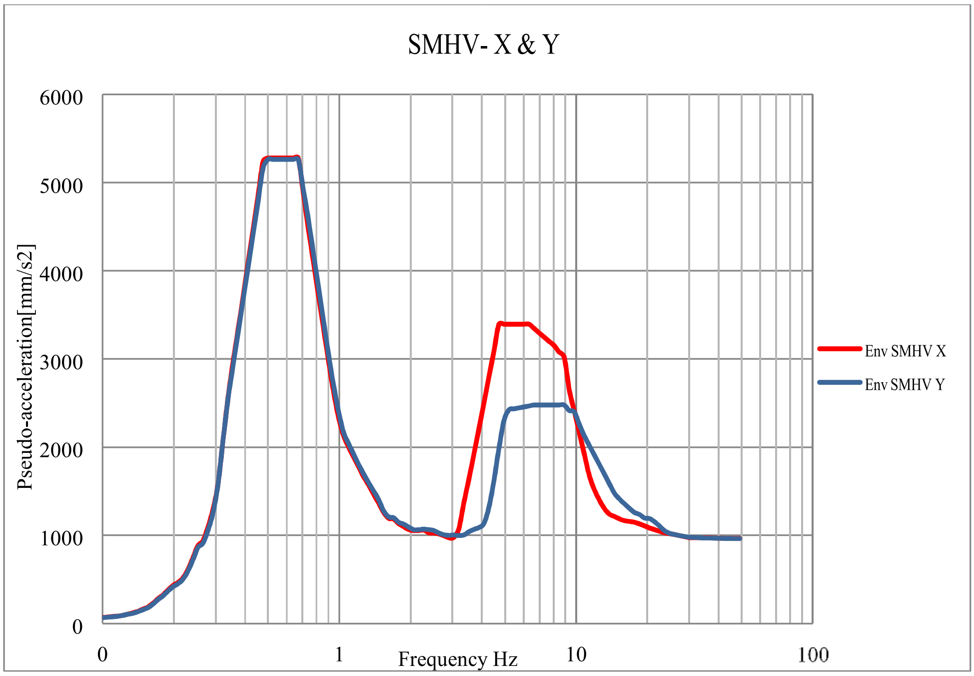
System	Description	SL-1	SMHV and SL-2	SL-3
Piping	Piping system	3%	4%	5%



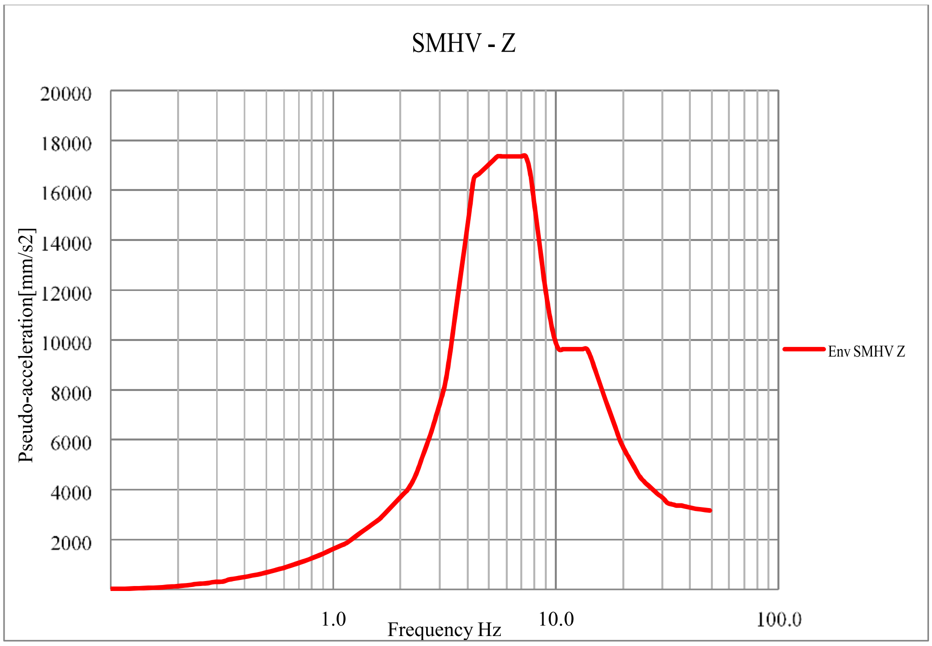
FRS RL- SL-1 - Horizontal (X&Y direction)



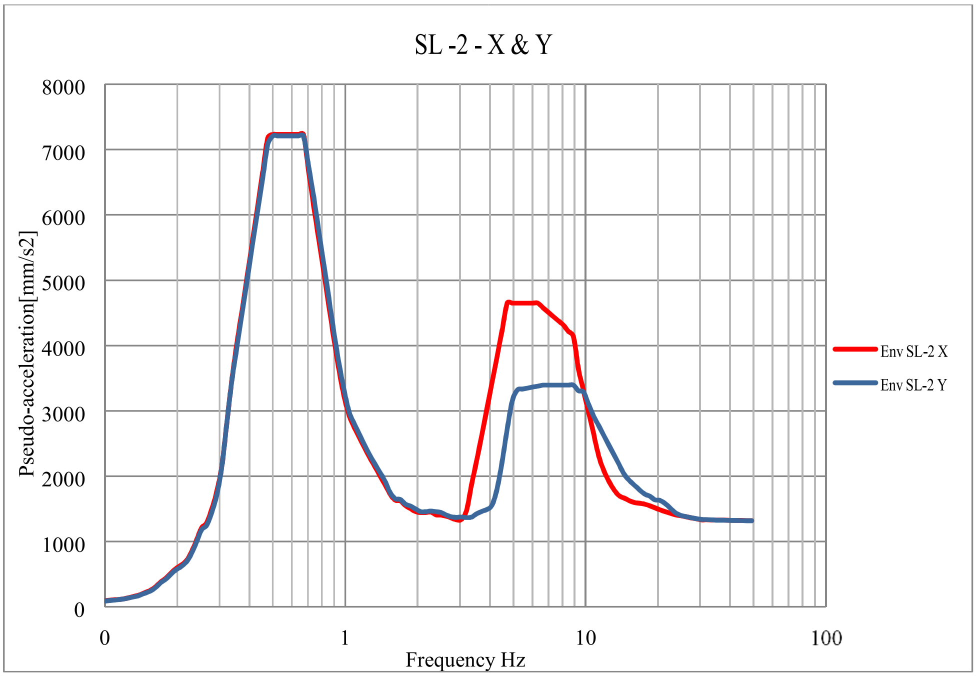
FRS RL- SL-1 - Vertical (Z direction)



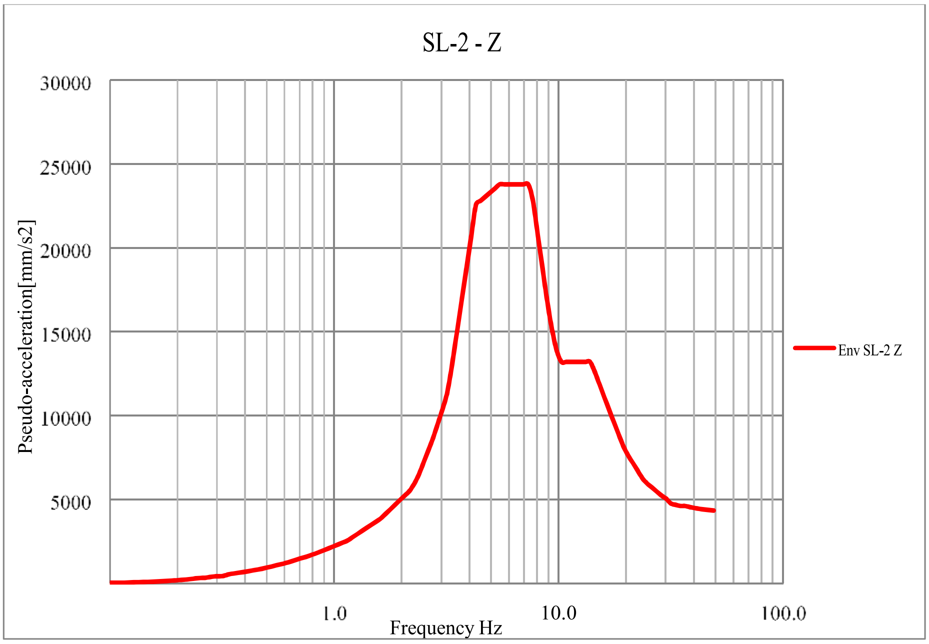
FRS RL- SMHV - Horizontal (X&Y direction)



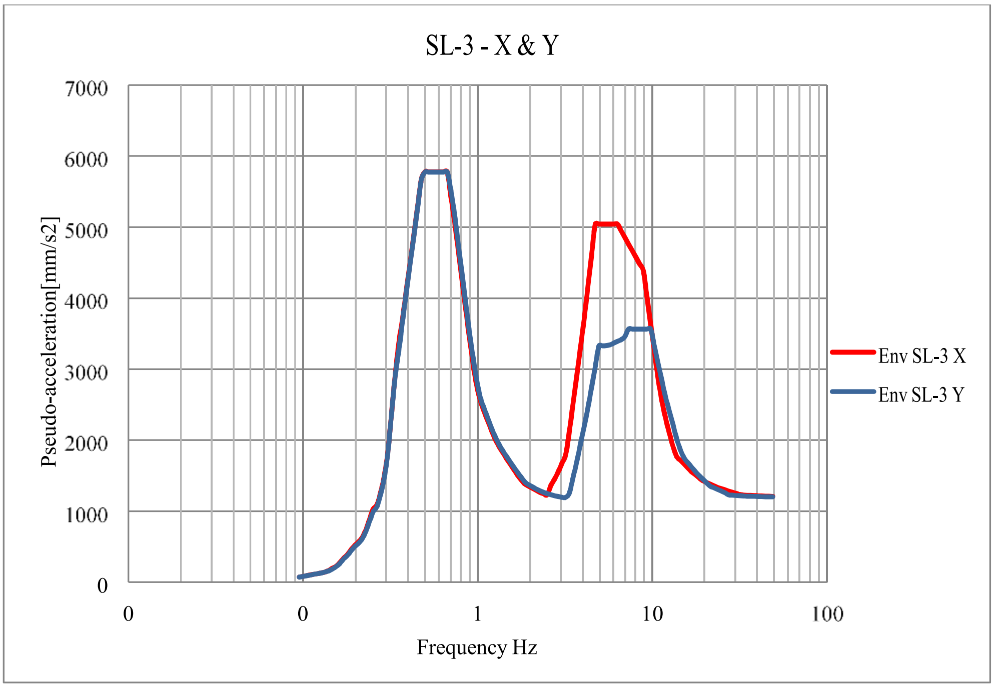
FRS RL– SMHV - Vertical (Z direction)



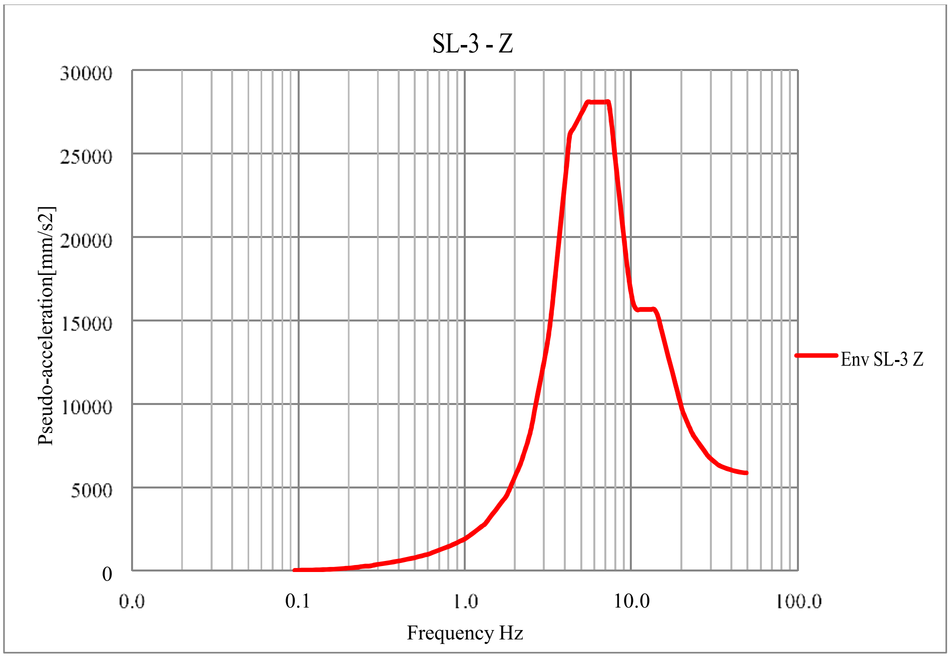
FRS RL- SL-2 - Horizontal (X&Y direction)



FRS RL- SL-2 - Vertical (Z direction)



FRS RL- SL-3 - Horizontal (X&Y direction)



FRS RL- SL-3 - Vertical (Z direction)

28.3. FRS of VVPSS RL – SL-1 and SMHV spectrum

Frequency	SL-1 Design FRS			Frequency	SMHV Design FRS		
Hz	X[mm/s2]	Y[mm/s2]	Z[mm/s2]	Hz	X[mm/s2]	Y[mm/s2]	Z[mm/s2]
0.10000	31.662	30.038	9.989	0.10000	67.979	64.492	21.447
0.10500	34.796	33.074	11.187	0.10500	74.709	71.012	24.020
0.11025	37.345	35.425	12.292	0.11025	80.181	76.059	26.392
0.11576	38.905	38.546	13.341	0.11576	83.531	82.761	28.643
0.12155	42.785	42.546	14.907	0.12155	91.863	91.349	32.006
0.12763	49.338	48.579	19.179	0.12763	105.932	104.301	41.179
0.13401	56.379	53.412	21.888	0.13401	121.049	114.680	46.996
0.14071	64.168	61.759	24.197	0.14071	137.772	132.601	51.952
0.14775	75.355	72.346	28.670	0.14775	161.791	155.331	61.556
0.15513	86.629	83.037	31.579	0.15513	185.999	178.286	67.803
0.16289	105.362	101.132	35.941	0.16289	226.219	217.137	77.167
0.17103	130.095	125.561	40.395	0.17103	279.322	269.587	86.731
0.17959	149.619	145.005	47.924	0.17959	321.240	311.335	102.896
0.18857	176.576	170.683	54.991	0.18857	379.118	366.466	118.069
0.19799	199.840	193.228	60.179	0.19799	429.067	414.871	129.208
0.20789	216.926	209.810	68.835	0.20789	465.752	450.475	147.793
0.21829	240.128	233.892	76.807	0.21829	515.568	502.179	164.910
0.22920	284.566	276.250	85.927	0.22920	610.980	593.124	184.491
0.24066	346.343	336.544	99.645	0.24066	743.619	722.580	213.943
0.25270	411.147	401.086	107.923	0.25270	882.757	861.155	231.718
0.26533	436.806	425.017	111.389	0.26533	937.848	912.536	239.159
0.27860	509.262	492.272	124.638	0.27860	1093.414	1056.938	267.605
0.29253	602.217	584.306	139.344	0.29253	1292.995	1254.540	299.179
0.30715	736.680	734.543	141.901	0.30715	1581.696	1577.107	304.671
0.32251	966.649	966.607	151.664	0.32251	2075.452	2075.362	325.631
0.33864	1192.487	1186.992	182.163	0.33864	2560.339	2548.542	391.116
0.35557	1382.334	1361.332	197.542	0.35557	2967.952	2922.860	424.134
0.37335	1552.285	1535.672	212.092	0.37335	3332.847	3297.178	455.373
0.39201	1727.401	1710.012	226.641	0.39201	3708.831	3671.496	486.612
0.41161	1905.705	1884.352	241.191	0.41161	4091.661	4045.814	517.851
0.43219	2084.010	2058.692	259.066	0.43219	4474.491	4420.132	556.231
0.45380	2262.314	2233.032	276.942	0.45380	4857.322	4794.450	594.611
0.47649	2440.619	2407.371	294.818	0.47649	5240.152	5168.768	632.991
0.50032	2458.293	2451.055	316.553	0.50032	5278.099	5262.559	679.659
0.52534	2458.293	2451.055	340.026	0.52534	5278.099	5262.559	730.057
0.55160	2458.293	2451.055	363.499	0.55160	5278.099	5262.559	780.455

0.57918	2458.293	2451.055	386.972	0.57918	5278.099	5262.559	830.853
0.60814	2458.293	2451.055	410.445	0.60814	5278.099	5262.559	881.250
0.63855	2458.293	2451.055	440.310	0.63855	5278.099	5262.559	945.371
0.67048	2458.293	2451.055	470.174	0.67048	5278.099	5262.559	1009.492
0.70400	2272.421	2293.637	500.039	0.70400	4879.021	4924.574	1073.613
0.73920	2086.548	2136.220	529.903	0.73920	4479.942	4586.589	1137.734
Frequency	SL-1 Design FRS			Frequency	SMHV Design FRS		
Hz	X[mm/s2]	Y[mm/s2]	Z[mm/s2]	Hz	X[mm/s2]	Y[mm/s2]	Z[mm/s2]
0.77616	1912.540	1958.575	560.488	0.77616	4106.337	4205.175	1203.401
0.81497	1738.532	1780.930	595.631	0.81497	3732.731	3823.761	1278.855
0.85572	1564.525	1603.285	630.774	0.85572	3359.126	3442.347	1354.309
0.89850	1390.517	1425.640	668.623	0.89850	2985.521	3060.933	1435.573
0.94343	1229.546	1263.861	708.119	0.94343	2639.908	2713.584	1520.372
0.99060	1093.084	1124.093	747.614	0.99060	2346.915	2413.494	1605.171
1.04013	994.213	1011.524	787.109	1.04013	2134.634	2171.802	1689.970
1.09213	933.451	951.263	826.605	1.09213	2004.175	2042.417	1774.769
1.14674	880.865	896.352	866.100	1.14674	1891.270	1924.522	1859.569
1.20408	828.279	841.442	930.323	1.20408	1778.365	1806.626	1997.459
1.26428	776.912	790.554	994.546	1.26428	1668.076	1697.365	2135.349
1.32749	731.767	744.288	1058.769	1.32749	1571.146	1598.030	2273.240
1.39387	683.855	700.473	1122.992	1.39387	1468.277	1503.956	2411.130
1.46356	636.837	654.686	1187.215	1.46356	1367.326	1405.650	2549.021
1.53674	587.183	595.405	1251.438	1.53674	1260.715	1278.369	2686.911
1.61358	555.665	562.882	1315.661	1.61358	1193.045	1208.541	2824.802
1.69426	551.833	558.720	1407.824	1.69426	1184.817	1199.604	3022.682
1.77897	527.026	534.538	1499.988	1.77897	1131.556	1147.684	3220.562
1.86792	511.835	525.009	1592.151	1.86792	1098.941	1127.224	3418.442
1.96131	496.092	509.270	1684.315	1.96131	1065.139	1093.432	3616.323
2.05938	490.588	495.439	1776.478	2.05938	1053.321	1063.737	3814.203
2.16235	490.588	495.439	1868.642	2.16235	1053.321	1063.737	4012.083
2.27047	493.561	498.442	2014.223	2.27047	1059.705	1070.184	4324.655
2.38399	479.192	495.792	2207.081	2.38399	1028.854	1064.494	4738.732
2.50319	477.249	491.014	2453.356	2.50319	1024.682	1054.235	5267.500
2.62835	472.557	478.389	2699.632	2.62835	1014.608	1027.128	5796.269
2.75977	463.076	468.834	2949.476	2.75977	994.252	1006.614	6332.699
2.89775	453.266	465.687	3244.567	2.89775	973.188	999.857	6966.276
3.04264	454.963	467.420	3539.658	3.04264	976.832	1003.578	7599.853
3.19477	450.986	464.584	3883.666	3.19477	968.293	997.489	8338.460

3.35451	462.222	467.269	4449.347	3.35451	992.419	1003.255	9553.010
3.52224	507.080	469.955	5093.731	3.52224	1088.731	1009.021	10936.540
3.69835	558.667	485.349	5738.115	3.69835	1199.491	1042.073	12320.071
3.88327	612.678	490.936	6382.499	3.88327	1315.455	1054.070	13703.601
4.07743	667.263	504.969	7026.883	4.07743	1432.653	1084.198	15087.131
4.28130	722.422	583.548	7671.267	4.28130	1551.084	1252.911	16470.661
4.49537	778.156	700.541	7753.842	4.49537	1670.748	1504.102	16647.954
4.72014	829.855	821.784	7836.416	4.72014	1781.747	1764.419	16825.246
4.95614	836.835	950.737	7918.991	4.95614	1796.734	2041.287	17002.539
5.20395	843.816	987.935	8001.565	5.20395	1811.722	2121.154	17179.831
5.46415	850.796	1007.487	8084.139	5.46415	1826.710	2163.134	17357.123
5.73736	860.541	1027.039	8084.139	5.73736	1847.632	2205.114	17357.123
6.02422	872.333	1046.592	8084.139	6.02422	1872.950	2247.094	17357.123
6.32544	884.125	1066.144	8084.139	6.32544	1898.268	2289.074	17357.123
Frequency	SL-1 Design FRS			Frequency	SMHV Design FRS		
Hz	X[mm/s2]	Y[mm/s2]	Z[mm/s2]	Hz	X[mm/s2]	Y[mm/s2]	Z[mm/s2]
6.64171	895.917	1085.696	8084.139	6.64171	1923.587	2331.054	17357.123
6.97379	895.917	1105.249	8084.139	6.97379	1923.587	2373.034	17357.123
7.32248	895.917	1117.649	8084.139	7.32248	1923.587	2399.658	17357.123
7.68861	895.917	1117.649	7740.842	7.68861	1923.587	2399.658	16620.043
8.07304	895.917	1117.649	7063.745	8.07304	1923.587	2399.658	15166.275
8.47669	895.917	1117.649	6386.647	8.47669	1923.587	2399.658	13712.507
8.90052	895.917	1117.649	5709.550	8.90052	1923.587	2399.658	12258.739
9.34555	842.319	1117.649	5142.188	9.34555	1808.509	2399.658	11040.580
9.81283	788.722	1117.649	4713.132	9.81283	1693.432	2399.658	10119.371
10.30350	735.124	1052.321	4485.660	10.30350	1578.355	2259.394	9630.976
10.81860	681.527	991.013	4485.660	10.81860	1463.278	2127.764	9630.976
11.35960	630.982	940.633	4485.660	11.35960	1354.755	2019.594	9630.976
11.92760	598.515	890.252	4485.660	11.92760	1285.046	1911.424	9630.976
12.52390	566.048	839.872	4485.660	12.52390	1215.337	1803.254	9630.976
13.15010	536.390	789.491	4485.660	13.15010	1151.662	1695.085	9630.976
13.80760	523.485	739.111	4485.660	13.80760	1123.953	1586.915	9630.976
14.49800	517.674	688.730	4282.448	14.49800	1111.477	1478.745	9194.667
15.22290	512.183	657.642	4026.930	15.22290	1099.687	1411.996	8646.055
15.98410	507.915	632.916	3771.412	15.98410	1090.523	1358.907	8097.444
16.78330	503.663	608.426	3515.895	16.78330	1081.394	1306.327	7548.833
17.62240	499.426	584.173	3267.754	17.62240	1072.298	1254.254	7016.060
18.50350	485.135	560.157	3023.002	18.50350	1041.614	1202.689	6490.564

19.42870	462.242	536.377	2778.251	19.42870	992.461	1151.633	5965.068
20.40020	453.211	512.833	2594.188	20.40020	973.072	1101.084	5569.875
21.42020	434.760	500.031	2439.246	21.42020	933.454	1073.597	5237.205
22.49120	426.539	497.124	2284.305	22.49120	915.803	1067.355	4904.536
23.61570	418.238	486.040	2129.363	23.61570	897.981	1043.556	4571.867
24.79650	414.298	476.629	2021.734	24.79650	889.522	1023.351	4340.783
26.03630	410.865	469.759	1940.986	26.03630	882.152	1008.600	4167.411
27.33820	407.455	464.431	1860.238	27.33820	874.829	997.160	3994.040
28.70510	404.174	459.503	1779.489	28.70510	867.786	986.579	3820.668
30.14030	401.740	455.325	1713.428	30.14030	862.559	977.609	3678.830
31.64730	401.740	454.362	1617.992	31.64730	862.559	975.543	3473.925
33.22970	400.913	452.992	1589.964	33.22970	860.785	972.601	3413.747
34.89120	400.573	451.435	1566.468	34.89120	860.053	969.257	3363.299
36.63580	400.421	451.435	1566.468	36.63580	859.728	969.257	3363.299
38.46750	400.096	450.567	1542.312	38.46750	859.029	967.394	3311.436
40.39090	399.911	449.973	1525.321	40.39090	858.633	966.120	3274.954
42.41050	399.752	449.295	1506.322	42.41050	858.291	964.662	3234.161
44.53100	399.584	448.936	1495.306	44.53100	857.931	963.891	3210.510
46.75750	399.505	448.421	1483.287	46.75750	857.761	962.785	3184.704
49.09540	399.396	448.118	1474.835	49.09540	857.526	962.136	3166.558

28.4. FRS of VVPSS RL – SL-2 and SL-3 spectrum

Frequency	SL-2 Design FRS			Frequency	SL-3 Design FRS		
Hz	X[mm/s2]	Y[mm/s2]	Z[mm/s2]	Hz	X[mm/s2]	Y[mm/s2]	Z[mm/s2]
0.10000	93.122	88.346	29.380	0.095238	74.457	72.228	24.702
0.10500	102.341	97.276	32.904	0.1	83.013	81.784	27.688
0.11025	109.837	104.190	36.153	0.105	92.569	92.019	31.132
0.11576	114.426	113.371	39.237	0.11025	103.008	102.423	34.867
0.12155	125.839	125.136	43.844	0.115763	112.997	112.370	38.577
0.12763	145.113	142.879	56.409	0.121551	122.085	121.388	43.474
0.13401	165.820	157.095	64.378	0.127628	132.240	131.097	50.509
0.14071	188.729	181.645	71.168	0.13401	145.766	143.414	57.804
0.14775	221.631	212.782	84.323	0.14071	167.861	160.934	63.751
0.15513	254.793	244.228	92.881	0.147746	197.079	188.982	71.635
0.16289	309.889	297.448	105.709	0.155133	226.953	219.914	80.724
0.17103	382.633	369.297	118.810	0.162889	278.569	267.187	91.417

0.17959	440.055	426.486	140.954	0.171034	340.918	328.724	103.382
0.18857	519.340	502.008	161.738	0.179586	389.918	377.105	122.267
0.19799	587.764	568.317	176.998	0.188565	456.941	441.183	139.656
0.20789	638.017	617.088	202.456	0.197993	519.546	501.681	151.170
0.21829	706.258	687.917	225.904	0.207893	566.541	547.284	172.777
0.22920	836.959	812.499	252.727	0.218287	627.881	610.852	191.450
0.24066	1018.656	989.836	293.073	0.229202	737.802	714.844	212.254
0.25270	1209.256	1179.665	317.422	0.240662	886.098	858.922	245.949
0.26533	1284.724	1250.049	327.615	0.252695	1030.837	994.055	270.482
0.27860	1497.828	1447.860	366.582	0.26533	1091.551	1066.347	277.371
0.29253	1771.226	1718.548	409.834	0.278596	1264.227	1243.636	311.556
0.30715	2166.707	2160.420	417.357	0.292526	1505.252	1478.700	362.076
0.32251	2843.085	2842.961	446.071	0.307152	1861.127	1847.374	392.607
0.33864	3507.314	3491.153	535.775	0.32251	2406.982	2402.063	423.138
0.35557	4065.688	4003.918	581.006	0.338635	2948.831	2928.358	455.131
0.37335	4565.544	4516.682	623.799	0.355567	3403.099	3296.710	491.798
0.39201	5080.590	5029.447	666.592	0.373346	3742.768	3711.683	528.465
0.41161	5605.015	5542.211	709.384	0.392013	4129.423	4103.346	565.132
0.43219	6129.440	6054.975	761.960	0.411614	4516.078	4495.009	601.798
0.45380	6653.866	6567.740	814.536	0.432194	4902.732	4886.672	645.844
0.47649	7178.291	7080.504	867.111	0.453804	5289.387	5278.335	689.890
0.50032	7230.273	7208.985	931.039	0.476494	5676.042	5669.998	733.935
0.52534	7230.273	7208.985	1000.078	0.500319	5780.228	5775.522	777.981
0.55160	7230.273	7208.985	1069.116	0.525335	5780.228	5775.522	831.945
0.57918	7230.273	7208.985	1138.154	0.551602	5780.228	5775.522	887.486
0.60814	7230.273	7208.985	1207.192	0.579182	5780.228	5775.522	943.027
0.63855	7230.273	7208.985	1295.029	0.608141	5780.228	5775.522	998.568
0.67048	7230.273	7208.985	1382.866	0.638548	5780.228	5775.522	1079.320
0.70400	6683.590	6745.992	1470.702	0.670475	5780.228	5775.522	1160.072
0.73920	6136.906	6282.999	1558.539	0.703999	5424.657	5513.137	1240.824

Frequency	SL-2 Design FRS			Frequency	SL-3 Design FRS		
Hz	X[mm/s2]	Y[mm/s2]	Z[mm/s2]	Hz	X[mm/s2]	Y[mm/s2]	Z[mm/s2]
0.77616	5625.119	5760.514	1648.494	0.739199	5069.086	5168.824	1321.575
0.81497	5113.331	5238.029	1751.856	0.776159	4662.460	4756.053	1402.327
0.85572	4601.543	4715.544	1855.217	0.814967	4255.833	4343.282	1483.079
0.89850	4089.755	4193.059	1966.539	0.855715	3849.207	3930.511	1581.288
0.94343	3616.313	3717.239	2082.702	0.898501	3442.580	3517.740	1679.498

0.99060	3214.952	3306.156	2198.865	0.943426	3073.251	3159.026	1777.707
1.04013	2924.157	2975.071	2315.028	0.990597	2756.217	2834.220	1875.916
1.09213	2745.445	2797.832	2431.191	1.040127	2550.611	2592.065	2011.866
1.14674	2590.781	2636.331	2547.354	1.092133	2397.335	2443.064	2171.736
1.20408	2436.116	2474.830	2736.245	1.14674	2265.500	2305.264	2331.606
1.26428	2285.035	2325.158	2925.136	1.204077	2133.665	2167.464	2491.477
1.32749	2152.255	2189.082	3114.027	1.264281	2010.033	2044.689	2651.347
1.39387	2011.338	2060.214	3302.918	1.327495	1914.801	1941.392	2811.217
1.46356	1873.049	1925.547	3491.809	1.39387	1827.773	1853.120	3087.959
1.53674	1727.007	1751.191	3680.700	1.463563	1742.072	1774.131	3364.702
1.61358	1634.308	1655.536	3869.591	1.536741	1664.186	1696.487	3641.444
1.69426	1623.037	1643.293	4140.660	1.613578	1586.300	1618.844	3918.187
1.77897	1550.077	1572.169	4411.729	1.694257	1508.948	1545.616	4194.929
1.86792	1505.398	1544.143	4682.798	1.77897	1442.414	1477.798	4471.672
1.96131	1459.095	1497.852	4953.867	1.867919	1382.484	1409.980	4924.116
2.05938	1442.906	1457.174	5224.936	1.961315	1353.309	1372.667	5410.856
2.16235	1442.906	1457.174	5496.004	2.05938	1324.134	1344.003	5897.596
2.27047	1451.650	1466.005	5924.185	2.162349	1294.958	1315.340	6384.336
2.38399	1409.389	1458.211	6491.414	2.270467	1267.486	1290.435	7024.859
2.50319	1403.674	1444.158	7215.754	2.38399	1248.026	1266.170	7685.036
2.62835	1389.874	1407.025	7940.094	2.50319	1230.268	1247.976	8463.792
2.75977	1361.989	1378.923	8674.930	2.628349	1258.745	1232.966	9555.562
2.89775	1333.135	1369.667	9542.844	2.759766	1317.860	1218.978	10654.435
3.04264	1338.127	1374.765	10410.758	2.897755	1381.271	1207.514	11753.308
3.19477	1326.429	1366.423	11422.549	3.042643	1444.682	1196.050	12852.180
3.35451	1359.477	1374.322	13086.315	3.194775	1508.092	1194.982	14122.784
3.52224	1491.412	1382.220	14981.562	3.354513	1571.503	1253.930	15810.017
3.69835	1643.138	1427.497	16876.809	3.522239	1692.171	1422.138	17866.605
3.88327	1801.993	1443.931	18772.057	3.698351	1841.460	1554.442	19923.193
4.07743	1962.538	1485.203	20667.303	3.883269	1990.750	1754.613	21979.781
4.28130	2124.772	1716.317	22562.550	4.077432	2140.039	1963.057	24036.369
4.49537	2288.696	2060.414	22805.417	4.281304	2289.328	2171.500	26092.957
4.72014	2440.749	2417.012	23048.282	4.495369	2438.617	2410.282	26489.742
4.95614	2461.280	2796.284	23291.149	4.720137	2587.906	2660.877	26886.527
5.20395	2481.811	2905.691	23534.015	4.956144	2669.823	2911.472	27283.312
5.46415	2502.342	2963.198	23776.881	5.203951	2686.297	2974.452	27680.097
5.73736	2531.003	3020.704	23776.881	5.464149	2702.771	3037.432	28076.882
6.02422	2565.685	3078.211	23776.881	5.737356	2719.245	3100.412	28076.882

6.32544	2600.368	3135.718	23776.881	6.024224	2748.541	3163.392	28076.882
Frequency	SL-2 Design FRS			Frequency	SL-3 Design FRS		
Hz	X[mm/s2]	Y[mm/s2]	Z[mm/s2]	Hz	X[mm/s2]	Y[mm/s2]	Z[mm/s2]
6.64171	2635.050	3193.224	23776.881	6.325435	2787.428	3243.484	28076.882
6.97379	2635.050	3250.731	23776.881	6.641707	2826.315	3350.574	28076.882
7.32248	2635.050	3287.203	23776.881	6.973792	2826.315	3457.665	28076.882
7.68861	2635.050	3287.203	22767.182	7.322482	2826.315	3564.756	28076.882
8.07304	2635.050	3287.203	20775.720	7.688606	2826.315	3564.756	26515.618
8.47669	2635.050	3287.203	18784.257	8.073037	2826.315	3564.756	24479.712
8.90052	2635.050	3287.203	16792.794	8.476688	2826.315	3564.756	22564.549
9.34555	2477.410	3287.203	15124.083	8.900523	2826.315	3564.756	20649.386
9.81283	2319.770	3287.203	13862.153	9.345549	2645.410	3564.756	18734.223
10.30350	2162.130	3095.061	13193.117	9.812826	2464.505	3564.756	17172.460
10.81860	2004.490	2914.745	13193.117	10.303468	2283.600	3323.910	16021.622
11.35960	1855.828	2766.567	13193.117	10.818641	2111.911	3083.064	15652.847
11.92760	1760.337	2618.389	13193.117	11.359573	2013.660	2842.218	15652.847
12.52390	1664.846	2470.212	13193.117	11.927552	1915.408	2609.412	15652.847
13.15010	1577.619	2322.034	13193.117	12.523929	1817.157	2414.585	15652.847
13.80760	1539.662	2173.856	13193.117	13.150126	1718.906	2219.758	15652.847
14.49800	1522.571	2025.678	12595.435	13.807632	1620.655	2024.931	15652.847
15.22290	1506.420	1934.240	11843.911	14.498014	1522.403	1866.762	15232.357
15.98410	1493.867	1861.517	11092.389	15.222914	1452.404	1750.777	14406.054
16.78330	1481.361	1789.489	10340.866	15.98406	1403.171	1671.449	13587.122
17.62240	1468.901	1718.156	9611.042	16.783263	1353.938	1592.121	12768.190
18.50350	1426.868	1647.520	8891.184	17.622426	1304.705	1517.853	11949.258
19.42870	1359.536	1577.579	8171.326	18.503548	1258.233	1457.105	11130.326
20.40020	1332.975	1508.334	7629.965	19.428725	1234.078	1410.506	10311.394
21.42020	1278.705	1470.680	7174.254	20.400161	1212.969	1363.907	9552.231
22.49120	1254.525	1462.130	6718.543	21.420169	1191.859	1327.701	9042.308
23.61570	1230.110	1429.529	6262.832	22.491178	1170.750	1293.969	8546.405
24.79650	1218.523	1401.850	5946.278	23.615737	1162.854	1260.236	8110.071
26.03630	1208.427	1381.644	5708.783	24.796523	1145.946	1247.287	7812.154
27.33820	1198.396	1365.972	5471.287	26.03635	1124.407	1237.540	7514.236
28.70510	1188.748	1351.478	5233.792	27.338167	1115.783	1230.872	7216.318
30.14030	1181.587	1339.191	5039.493	28.705075	1109.199	1225.826	6918.401
31.64730	1181.587	1336.360	4758.801	30.140329	1104.411	1221.864	6704.805
33.22970	1179.157	1332.331	4676.366	31.647346	1100.210	1218.688	6523.344
34.89120	1178.154	1327.749	4607.258	33.229713	1096.408	1215.552	6350.114

36.63580	1177.709	1327.749	4607.258	34.891199	1093.169	1211.442	6243.598
38.46750	1176.753	1325.197	4536.213	36.635758	1090.951	1210.215	6158.064
40.39090	1176.209	1323.451	4486.238	38.467546	1088.880	1209.465	6090.609
42.41050	1175.741	1321.455	4430.358	40.390924	1087.035	1207.543	6017.616
44.53100	1175.248	1320.399	4397.959	42.41047	1085.345	1206.033	5960.119
46.75750	1175.015	1318.884	4362.609	44.530993	1083.821	1204.794	5909.989
49.09540	1174.693	1317.994	4337.750	46.757543	1082.453	1203.679	5877.374
				49.09542	1081.229	1202.706	5861.536

29. Annexure: Clarifications