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Technical Specifications (In-Cash Procurement)

Technical Specification for Design, Manufacturing and Qualification of the VVPSS VST Non Return Valves

This technical specification outlines the requirements for the design, fabrication, inspection, testing and qualification of a set of non-return valves (NRVs) for the Vacuum Vessel Pressure Suppression System (VVPSS). The scope covers all activities necessary to ensure the delivery of fully compliant and qualified VVPSS valves, meeting the project's structural, functional and regulatory requirements.

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1 PREAMBLE

This Technical Specification is to be read in combination with the General Management Specification for Service and Supply (GM3S) – [AD- 1] that constitutes a full part of the technical requirements.

In case of conflict, the content of the Technical Specification supersedes the content of [AD- 1].

2 PURPOSE

This specification defines the technical requirements for the design, manufacturing, testing, equipment qualification and delivery of a set of non-return valves for the Vacuum Vessel Pressure Suppression System (VVPSS) relief lines. The Contractor shall refer to this technical specification for the procurement of ***four*** (4) non-return valves.

The valves are classified as nuclear pressure accessories. The recommended standard for the VVPSS components is the American Society of Mechanical Engineers (ASME) and all equipment should be fabricated, inspected, qualified, examined and tested by this standard.

3 ACRONYMS

Acronyms	
ANB	Authorised Notified Body
ASME	American Society of Mechanical Engineers
ASN	Autorité de Sûreté Nucléaire (French Nuclear Safety Authority)
ASTM	American Society for Testing and Materials
DRR	Delivery Readiness Review
DTR	Drain Tank Room
DW	Dead Weight
ESP	Equipements Sous Pression (Pressure Equipment)
ESPN	Equipements Sous Pression Nucléaire (Nuclear Pressure Equipment)
ICE	Ingress of Coolant Event
INB	Installation nucléaire de base (Basic nuclear installation)
IO	ITER Organization
ISO	International Organization for Standardization
LOCA	Loss Of Cooling Accident
LOVA	Loss of Vacuum Accident
MIP	Manufacturing and Inspection Plan
MRR	Manufacturing Readiness Review
NRV	Non-Return Valve
PED	Pressure Equipment Directive (equiv. ESP)
PIA	Protection Important Activity
PIC	Protection Important Component
PQR	Welding Procedure Qualification Record
PS	Maximum Allowable Pressure
QA	Quality Assurance
QP	Quality Plan
RL	Relief Lines
SIC	Safety Importance Class
SLT	Small LOCA Tank
SRD	System Requirement Document

SSC	Structures, Systems and Components
SSPC	Steel Structures Painting Council
VST	Vapour Suppression Tank
VV	ITER Vacuum Vessel
VVPSS	Vacuum Vessel Pressure Suppression System
WPQ	Welder Performance Qualification

4 APPLICABLE DOCUMENTS, CODES AND STANDARDS

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

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

For the ITER Applicable and Reference Documents, the last approved version applies. A list of applicable versions will be provided after the contract is signed. During contract execution, IO will notify the Contractor if any of the documents listed in the table below are updated.

Ref	Title	IDM Doc ID
[AD- 1]	General Management Specification for Service and Supply (GM3S)	82MXQK
[AD- 2]	Deliverable 1 - IO/23/CT/4300002956 - VVPSS NRV Reverse Flow Analysis (CFD)	A8FVRT
[AD- 3]	Deliverable 1 IO/22/CT/4300002749	8F2LXV
[AD- 4]	MQP L1 ITER Quality Assurance Program (QAP)	22K4QX
[AD- 5]	Instruction for Seismic Analysis	VT29D6
[AD- 6]	List of ITER–INB Protection Important Activities	PSTTZL
[AD- 7]	Instructions for Structural Analyses	35BVV3
[AD- 8]	Radioprotection guide for ESPN application	2LTQ96
[AD- 9]	Overall supervision plan of the chain of suppliers for Safety Important Components, Structures and Systems and Safety Related Activities	4EUQFL
[AD- 10]	Software qualification policy	KTU8HH
[AD- 11]	ITER Numbering System for Components and Parts	28QDBS
[AD- 12]	Guide for writing Hazards and Risks Analysis of PE/NPE	WSJDGL
[AD- 13]	MQP L3 Working Instruction for Manufacturing Readiness Review	44SZYP
[AD- 14]	Allowable values and limits in service level C and D for ITER mechanical components	3G3SYJ
[AD- 15]	Template for Structural Analysis Reports	VQVTQW
[AD- 16]	Load Case Specification VVPSS – RL	UXX829
[AD- 17]	IO Template of Qualification Synthesis Report	X3AUHZ
[AD- 18]	ITER Qualification Guidelines	WGFF3G
[AD- 19]	MQP L3 Working Instruction for the Qualification of ITER safety codes	258LKL
[AD- 20]	Stress Test Detailed Methodology for Hard Core Components of ITER Plant	R5389R
[AD- 21]	MQP L3 Procedure for Qualification of Protection Important Components (PIC)	XB5ABP
[AD- 22]	Guidelines for the qualification of mechanical equipment	ADCXXD
[AD- 23]	Technical Specification for the Experimental Seismic Qualification of Active Electrical and Mechanical Components	AGL2QP
[AD- 24]	Guidelines for qualification by analysis	AKFUMQ

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[AD- 25]	Test method for ITER equipment for static magnetic fields	98JL4W
[AD- 26]	ASN Guide #8 Conformity Assessment of Nuclear Pressure Equipment - Version of 2012-09-04 - EN	DU9A7L
[AD- 27]	Specification for Labelling of Equipment on the ITER Project	TL25DK
[AD- 28]	Template for Qualification Strategy	AQKXEH
[AD- 29]	Template for Equipment Identification file	BK7Y2G
[AD- 30]	Template for Qualification Dossier	BXTPJP
[AD- 31]	Template for Qualification follow-up document	BXTNRJ
[AD- 32]	Template for Qualification Preservation Sheet	BXTLMX
[AD- 33]	Template for Qualification Plan	B9HR4D
[AD- 34]	Template for Qualification Synthesis Report	BXTDJE
[AD- 35]	Template for Qualification Test Specifications	BXD2SS
[AD- 36]	Template for Reference File	BXTMAL
[AD- 37]	Template for Qualification Test Report	BXSQE9
[AD- 38]	List of manufacturing documents to be prepared and stored for PE and NPE	WDBC7H
[AD- 39]	MQP L2 Procedure for Management of Nonconformities	22F53X
[AD- 40]	Quality Requirements for IO Performers	22MFG4
[AD- 41]	Working Instruction for the Delivery Readiness Review (DRR)	X3NEGB
[AD- 42]	ITER Numbering System for Components and Parts	28QDBS
[AD- 43]	Delivery Report Template	WZPYVZ
[AD- 44]	Package & Packing List Template	XBZLNG
[AD- 45]	Dynamic analyses of the sparger systems: SLT sparger versus ETT sparger	Annex of WKVBM5
[AD- 46]	Release Note Template	QVEKNQ
[AD- 47]	Procedure for the management of Deviation Request	2LZJHB
[AD- 48]	Provisions for Implementation of the Generic Safety Requirements by the External Actors/Interveners	SBSTBM
[AD- 49]	Requirements to check dimensions and DNRE	45NL4A
[AD- 50]	Template for compliance between ESR and code	45549J
[AD- 51]	Template for EPMN or PMA	XQEX3Y
[AD- 52]	Template for Hazards and Risks Analysis of PE/NPE	XKD845
[AD- 53]	Template of Instructions Manuals of PE/NPE	XYECVY
[AD- 54]	Template for PE/NPE Nameplate	Y3AZ83
[AD- 55]	Instructions for Computational Fluid Dynamics Analyses	VUEEDB
[AD- 56]	Guide for writing EPMN/PMA	WSJQDH

Ref	Doc. Reference	Title
[ACS- 1]	ASME B31.3:2024	Process piping
[ACS- 2]	ASME B16.34:2020	Valves – Flanged, threaded and welding end
[ACS- 3]	ASME B16.10:2022	Face-to-face and end-to-end dimensions for butt welding-end valves
[ACS- 4]	ASME B16.25:2022	Buttwelding ends
[ACS- 5]	ASME III:2023	Rules for construction of nuclear facility components set
[ACS- 6]	ASME NQA-1:2024	Quality Assurance Requirements for Nuclear Facility Applications

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[ACS- 7]	EN 10204:2004	Metallic products – Type of inspection documents
[ACS- 8]	ISO 17025:2023	General requirements for the competence of testing and calibration laboratories
[ACS- 9]	ISO 9712:2021	Non-destructive Testing - Qualification and Certification of NDT Personnel
[ACS- 10]	IEC/IEEE 60980-344:2021	Nuclear facilities – Equipment important to safety – Seismic qualification
[ACS- 11]	EN 12266:2012	Industrial Valves – Testing of metallic valves
[ACS- 12]	RCC-M:2022	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
[ACS- 13]	EN 17637:2016	Non-destructive testing of welds - Visual testing of fusion-welded joints
[ACS- 14]	EN 17636:2022	Non-destructive testing of welds - Radiographic testing - Part 1: X- and gamma-ray techniques with film
[ACS- 15]	ISO 10675-1:2022	Non-destructive testing of welds — Acceptance levels for radiographic testing — Part 1: Steel, nickel, titanium and their alloys
[ACS- 16]	EN 9606-1:2017	Qualification testing of welders – Fusion welding – Part 1: Steels

Ref	Regulatory Doc.	Title
[ARD- 1]	PED/ESP	European Pressure Equipment Directive 2014/68/EU of 15th of May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment
[ARD- 2]	ESPN Order	French ESPN Order of 30th December 2015 (modified in 2025)
[ARD- 3]	INB Order	Order dated 7 February 2012 relating to the general technical regulations applicable to INB

5 SCOPE OF WORK

The Contractor is responsible for all necessary design development, qualification and manufacturing activities to deliver the Vacuum Vessel Pressure Suppression System Non-Return Valves that meet all applicable requirements.

The activities are divided into the following tasks:

- **Task 1: Design & Structural Integrity Verification** – Develop a detailed design of the NRVs for manufacturing. Submit all geometry data, models and drawings required for the integration of the equipment into the VVPSS CAD model. Provide all mandatory qualification documentation needed for the Final Design Review.
- **Task 2: Manufacturing** – Manufacture the NRVs in line with the applicable requirements.
- **Task 3: Inspection, Examination and Factory Acceptance Tests** – Perform all necessary inspections, examinations and testing required by the design code and technical specification.
- **Task 4: Delivery to IO site** - Design, analyse and manufacture a suitable transport package for the NRVs. Clean and prepare the equipment for transport. Prepare and hand over all documentation required by this technical specification.

5.1 NRV TYPE

The Contractor can propose the most suitable Non-Return Valve design and type for this application, provided that the valve is installed in a vertical pipeline with the opening oriented downward, allowing for gas flow in the downward direction.

The NRV shall be configured as "normally open". The valve shall be normally open solely by internal mechanical design (disc weight + flow), without external actuation or external energy sources.

The overall weight of the valve is an important parameter to control, as defined in Section 5.5.5. The VVPSS team anticipates the use of a Dual Plate Check Valve or a Nozzle Check Valve.

5.2 BACKGROUND INFORMATION

The main functions of the Vacuum Vessel Pressure Suppression System (VVPSS) are to maintain the integrity of the primary confinement barrier in the event of ingress of coolant into the vacuum vessel and to maintain dynamic confinement of the vacuum vessel in the event of rupture of the primary confinement barrier. The VVPSS limits the vacuum vessel's internal pressure in case of various incidents or accident events (in-vessel leak of water or non-condensable gas), together with preventing the dispersion of radioactive materials in case of breach of the primary confinement barrier. The VVPSS mitigates the hazard associated with hydrogen that is contained or formed in the vacuum vessel during an incident or accident event.

Non-return valves will be on gas relief lines, in a vertical pipe segment – vertical down orientation, through which a mixture of steam and non-condensable gases, including tritium and radioactive dust, are discharged into Vapour Suppression Tanks (VSTs). When the VVPSS is not in operation mode, the NRV remains idle, submerged underwater. During a combined Loss of Vacuum Accidents (LOVA) and Loss of Coolant Accidents (LOCA), a significant amount of non-condensable gases, including hydrogen, is accumulated in the free volume of VSTs. According to the VVPSS procedure, controlled combustion of hydrogen is conducted at a low flammability level to mitigate the risk of a subsequent uncontrolled hydrogen explosion. This process is called hydrogen deflagration.

During deflagration, a pressure rise occurs in the free volume of the VSTs, causing water backflow into the relief lines. To prevent water from flowing back towards the Vacuum Vessel, non-return valves have been introduced in the relief lines above the spargers, which operate and close immediately. The formation of the water column inside the sparger and the sudden closing of NRVs will create a pressure rise in the relief lines, which is demonstrated to be lower than the assembly's Maximum Allowable Pressure.

The deflagration event described above is the controlled combustion of hydrogen in VSTs. In the worst case, a hydrogen explosion in VSTs can occur. During this event, called detonation, the water will be pushed back in relief lines with higher velocity and the hammer pressure waves will be of higher magnitude.

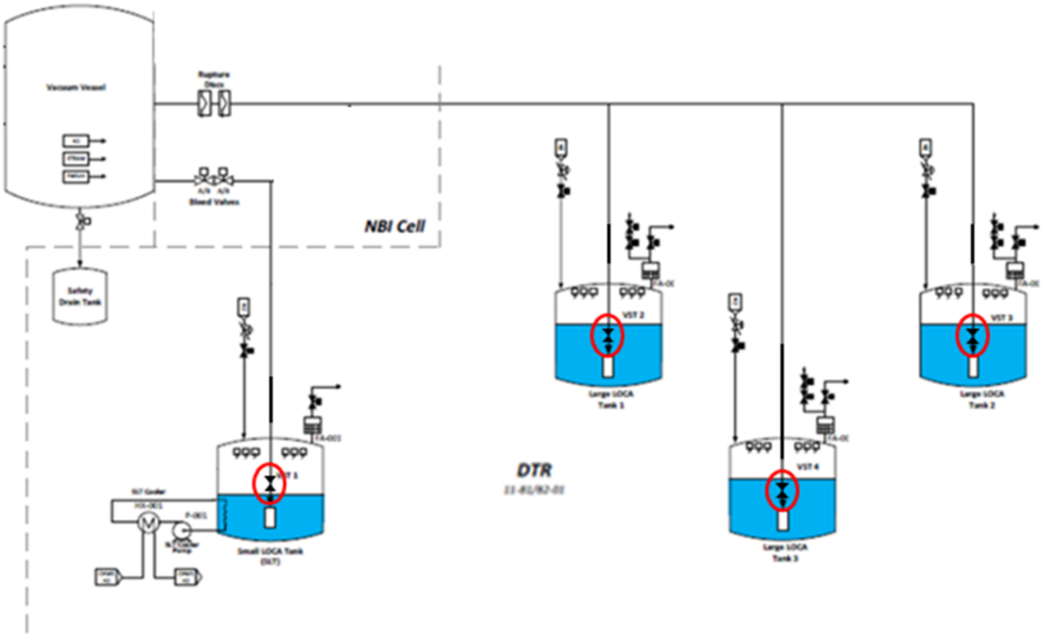


Figure 1, Extract of VVPSS PFD. NRVs have been highlighted

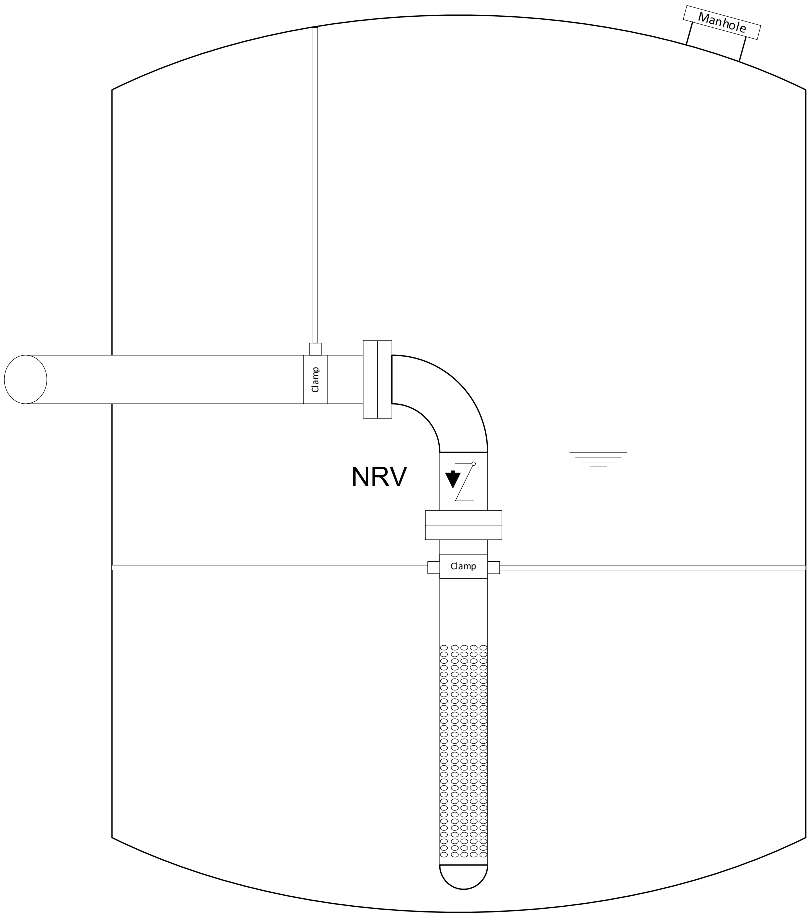


Figure 2, Schematic of the VST and the NRV/sparger assembly

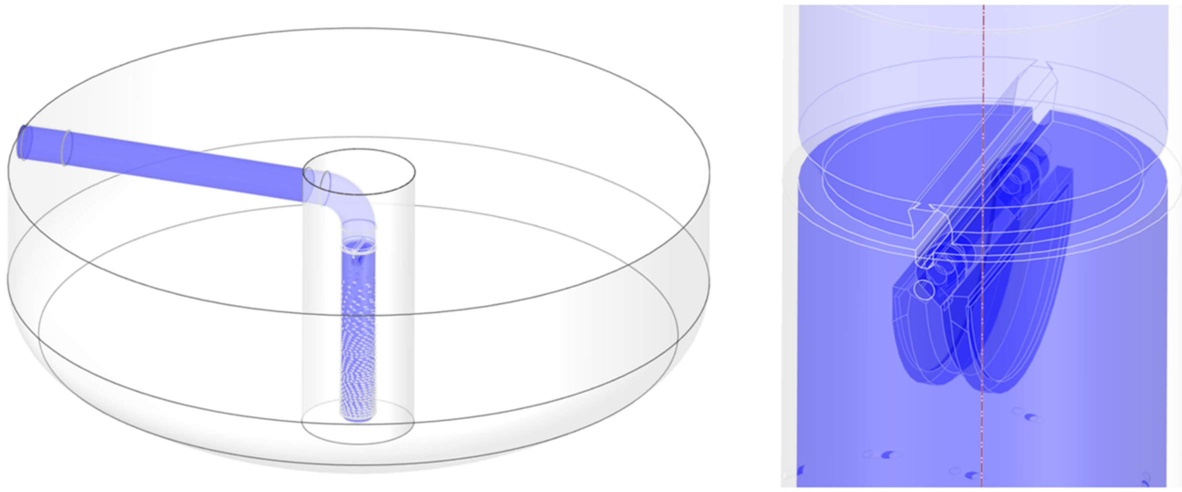


Figure 3, CAD representation of the open NRV inside the VST

5.3 CLASSIFICATION AND CONFORMITY DECLARATION

The VVPSS NRVs shall be considered a **Pressure Accessory of the ESPN Tank – Last ESPN Barriers** and shall be assessed for their conformity to PED/ESPN rules before being sent to IO.

Table 1, VST NRV classification

Safety class	Quality class	Seismic class	Vacuum class	Tritium class	RH class	PED Fluid type	PED	ESPN
PIC/SIC-1	QC-1	SC-1 (SF)	No-VQC	TC-2A	Non-RH	Gas - I[1]	III	N2

Declaration of conformity to PED – ESPN regulations

- According to the ESPN N2 classification, the Contractor shall appoint an Agreed Notified Body (ANB). A declaration of conformity shall be drawn up and signed certifying that the valves comply with the Essential Safety Requirements of the ESPN Order (dated 12/12/2005) [ARD- 1].
- The Contractor shall declare the module selected for the ESPN conformity assessment during the procurement phase.

The procedure governing the conformity assessment of nuclear pressure equipment is determined by the Contractor based on its level, risk category and nature. Even though it is the Contractor's responsibility to choose, IO recommends the selection of B+F or G modules for those Contractors with no experience in ESPN assessments and module H or H1 for those Contractors with proven experience in ESPN regulations and proven relevant certification.

As a general remark, the sizing of critical pressure parts shall consider the worst-case tolerance analysis for the ESPN conformity assessment. Designing to worst-case tolerance requirements guarantees that the parts will assemble and function properly, regardless of the actual component variation. Moreover, particular attention should be paid to the list of documents to be generated by the Contractor, in agreement with [ARD- 1] and [ARD- 2], to properly assess the additional work required for the ESPN conformity assessment.

[1] Fluid group Gas I comprises those fluids classified, according to the EC Directive, as hazardous substances. While the fluid is considered non-toxic, the hazard is given by the presence of activated dust and flammable hydrogen.

As a QC-1 component, the critical quality activities must be approved by IO before undertaking. Throughout the document, special processes are identified. These special processes require their procedures to be submitted to IO and accepted before their undertaking and reports are submitted in the manufacturing dossier.

5.3.1 Design Codes

- **Independently from the design code selected, the Contractor shall demonstrate the compatibility of the NRV assembly with the stainless-steel pipework, designed according to ASME B31.3** [ACS- 1]**.**

The final NRV should be designed and manufactured by ASME B16.34 [ACS- 2]. In addition to B16.34, the Contractor can use another design code, other than ASME, to meet the requirement. The choice of the code is at the discretion of the Contractor. The responsibility of the Contractor is the full respect of ESP/ESPN and the coverage of any gap between ESP/ESPN and the selected code. The alternative codes shall be accepted by IO.

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

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

5.4 ASSUMPTIONS AND LIMITATIONS

This technical specification is based on a defined set of assumptions regarding system behaviour, interfaces, environmental conditions and regulatory interpretation. These assumptions form the basis for the NRV design, qualification and conformity assessment. Any deviation from these assumptions shall be notified to IO and may require a revision of the design, analyses or qualification scope.

The VVPSS architecture (geometry, relief line layout and VST configuration) will remain consistent with the boundary conditions used in CFD analyses and load specifications.

The forward and reverse flow events, pressure profiles, temperature ranges, and mass flow rates provided in Sections 5.5.3 represent the most conservative credible scenarios supplied by IO at the time of contract award.

If IO updates CFD load profiles or detonation parameters, the Contractor shall re-evaluate NRV design and structural margins.

5.5 DESIGN REQUIREMENTS

5.5.1 Key Design Parameters

Size: DN300

Maximum Allowable Pressure (PS): 15 barg

Maximum External Pressure: 11 barg

Maximum Operating Temperature (TS_max): 250°C

Minimum Operating Temperature (TS_min): 6°C

Minimum Cv: 3800 in fully open position

Hydrostatic test pressure: 1.5*15 = 22.5 barg (§7, [ACS- 2])

External Pressure as per Table 5.

5.5.2 Fluid Composition

In VVPSS, NRVs are exposed to both gaseous streams, composed of steam and/or non-condensable gas, and liquid streams. Activated dust particles may be present in the gaseous stream.

Table 2, VVPSS relief lines fluid composition

	Component	Range
Gaseous stream (forward)	Steam H_2O (including tritiated forms)	0 – 100%
	Air, N_2, He	0 – 100%
	H_2 (including tritiated forms)	0 – 5%v/v

Solids (forward)	Dust of Stainless Steel and Tungsten	0 – 75 g/m³
	Dust Size	0 – 44 µm Av. 2 µm
Liquid stream (backward)	Demineralized Water	-
	Tritiated Water	< 0.015%

The NRV reverse flow analyses [AD- 2][AD- 3] conservatively assume 100% steam flow through the valve to cover the worst-case scenario. The presence of non-condensable gases reduces pressure surge due to their cushioning effect.

5.5.3 Operating Requirements

5.5.3.1 VVPSS Ready State – NRV Idle State

During normal ITER plasma operation, the VVPSS is isolated from the Vacuum Vessel and the NRVs are kept 0.8 m underwater, at a water temperature of 6°C. There is no gas flow through VVPSS and the valve shall maintain the open position.

Table 3, VVPSS VST NRV Ready State Parameters

Event	Mass flow rate [kg/s]	Flow velocity [m/s]	Idle External Pressure [kPa(a)]	Idle Internal Pressure [kPa(a)]	Temperature [°C]	Fluid composition
Ready State	0	0	20	20	6	Demin Water

5.5.3.2 Forward Events

In the event of a VV LOCA or LOVA, a flow of gas is discharged through the VVPSS Relief Pipes and NRVs. The flow could be initiated at an upstream pressure of either 50 kPa or 110 kPa and will vary due to the event conditions. Table 4 defines the key parameters in which the NRVs shall operate.

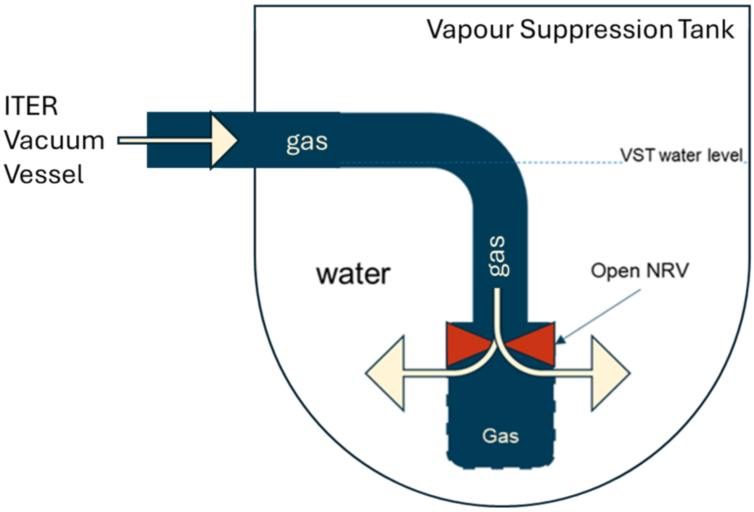


Figure 4, Schematic of the NRV forward events. The gas phase is discharged from the ITER VV into the VST

Table 4, VVPSS Normal Forward Operating parameters

Event	Service Level	Flow Rate [kg/s]	P at NRV location [kPa(a)]	ΔP from VV – VST [kPa]	Gas Temperature [°C]	Gas Composition
Min flow event	A	0.1	50	30	100 – 125	Air + Steam

Max flow event	A	5	150	90		

- The Contractor shall demonstrate that the valve can operate without any chattering in the interval of operation, as described in the table above.
- The valve shall be able to withstand 25 forward gas flow events in its lifetime, as defined in [AD-16].
- The VVPSS shall be able to vent gases from the VV for 72 hours.

5.5.3.3 Reverse Flow Events

Controlled burning of hydrogen in the headspaces of the Vapour Suppression Tanks (VST) may produce a reverse flow of liquid from the VST into the relief pipe. The pressure in the headspace can vary from 200 kPa(a) to as high as 1200 kPa(a), depending on the size of the combustion event.

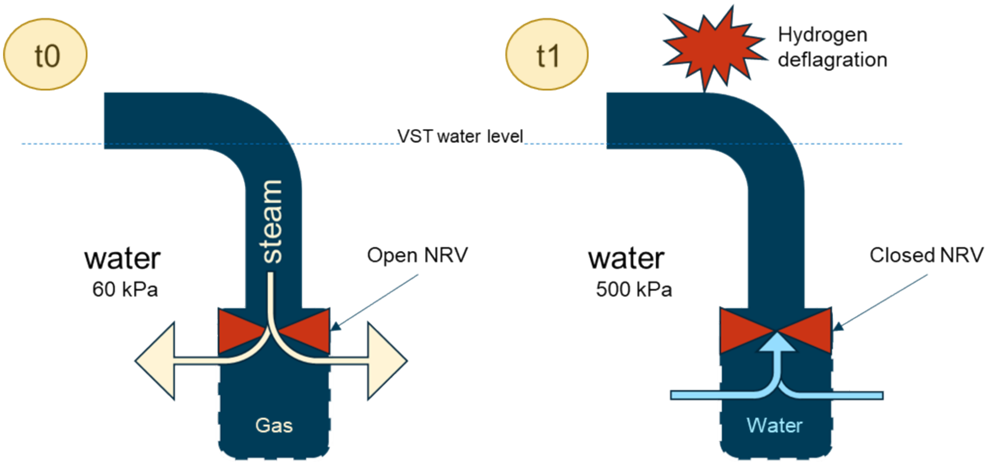


Figure 5, Schematic of a deflagration time sequence. At time 0, gas is discharged and condensed into the water tank, and at time 1, hydrogen deflagration occurs in the tank headspace, forcing the water to enter the sparger.

An extensive CFD analysis of the dynamic behaviour of the NRVs during reverse flow events is given in [AD- 2].

The high pressure in the tank headspace drives water back into the sparger. Without the presence of an NRV, the water would flow back into the relief line, causing a loss of the steam condensation function of the VST.

Table 5, H2 Deflagration/Detonation in VST – envelope cases, main parameters

Reverse flow event	NRV Service Level	ITER Cat.	VST Pressure [kPa(a)]	VV Pressure [kPa(a)]	VST Water T [°C][2]	Pressure at the valve's location [kPa]	Vertical Force on a closed valve [kN]	Time to reach the valve [s]
H_2 deflagration	A	II	500	100	64	600	38	0.1
H_2 detonation	D	IV	1200	100	64	1420	95	0.06

[2] [AD- 3] provides a study on the most conservative water/gas parameters.

The fast rise in pressure during hydrogen deflagration/detonation generates a pressure surge on a closed valve[3] positioned about 200 mm above the sparger. The CFD results demonstrated acceptable pressure surges and forces on a closed non-return valve.

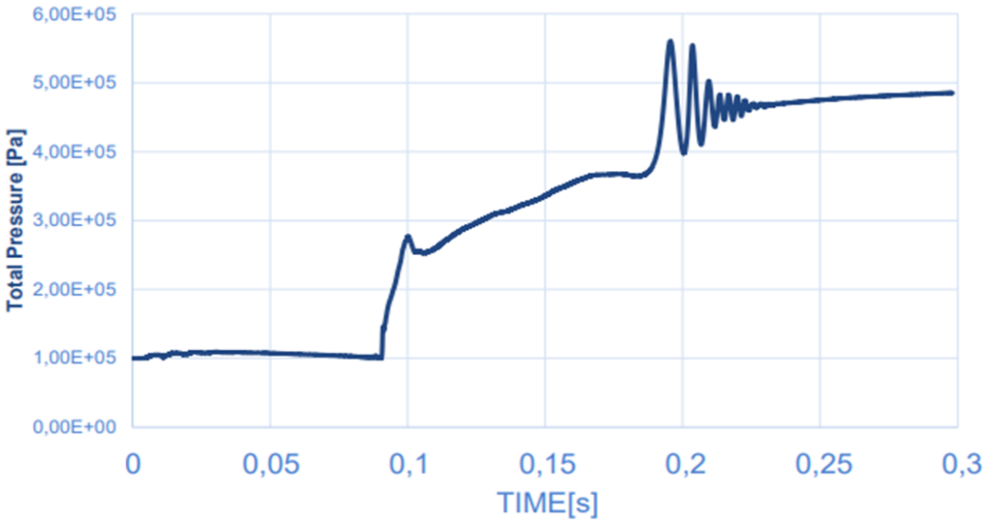


Figure 6, Total pressure acting on a closed valve in case of H_2 deflagration in the VST. See MOD9 [AD- 2]

The CFD demonstrated acceptable pressure surges and reduced forces on a closed non-return valve even in the event of hydrogen detonation.

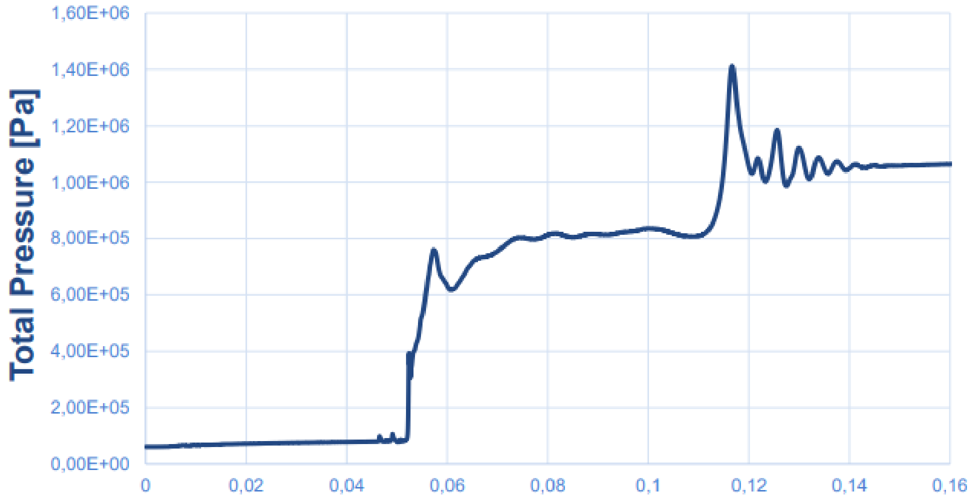


Figure 7, Total pressure acting on a closed valve in case of H2 detonation in the VST. See MOD10 [AD- 2]

- The valve shall be able to withstand at least 100 reverse flow events in its lifetime [AD- 16].
- The Contractor shall demonstrate structural integrity and full functionality of the NRVs by using structural analyses to verify that the components can withstand all identified loads. Full details of the different loading conditions are given in the CFD analysis report [AD- 2].
- The Contractor shall demonstrate that the pipe upstream of the NRV is not pressurised beyond 0.5 barg.

5.5.3.4 Valve Flow Coefficient – Cv

- The required minimum CV for the NRV is 3800, in the forward direction.

[3] The NRV assumed in the closed position generates the most conservative mechanical loads on the supporting structures.

- At the minimum forward flow conditions, the valve shall not be subjected to chattering, so that the valve stops and discs are not susceptible to damage in the open position. The fully open position of the valve shall be ensured by design.

The Contractor, based on its experience, shall specify the minimum disc travel and maximum oscillation frequency.

5.5.3.5 Summary of Operating Requirements

Function	Requirement	Governing Conditions	Verification
Idle state	Open under gravity, no drift	Submerged, zero flow	Inspection + Analysis
Forward flow	Fully open, Cv > 3800, no chatter	Min/Max forward flow envelope	Test + Analysis
Deflagration - Reverse flow	Rapid closure, no backflow	VST deflagration loads	CFD + Dedicated Qualification Test
Detonation – Reverse flow	Rapid closure, structural integrity, no loose parts	VST detonation loads	Analysis

5.5.4 Interface Requirements

The valve will be fully butt-welded in a vertical pipe section, providing a forward-downward (flow downward) direction for the relief gases and a backwards-upward direction for the water back-flow events.

- For end-to-end dimensions for butt welding-end valves, IO recommends using ASME B16.10 [ACS- 3]. Each valve shall be examined to ensure it meets the dimensional requirements of this section.

The final installation of the NRV within the VST is not included in this contract; however, the design of the valve shall consider the installation requirements to be defined by mutual agreement with IO.

5.5.4.1 Welded Joints or Permanent Joints

Welding activities are considered “Special Processes”.

NOTE, permanent joints, other than welds, shall follow the equivalent requirements described in this section.

NOTE, the scope of the work only covers the weld preparation at the VVPSS pipework interface. If any pressure-bearing joint is introduced, the Contractor shall comply with this section of the specification.

- The welding end preparation details for valves should follow ASME B16.25 [ACS- 4] with the tolerances for the inside and outside diameter conforming to ASME B16.34 para. 6.2.1 [ACS- 2]. Each welding procedure that is to be followed in fabrication shall be included or cross-referenced in the Manufacturing and Inspection Plan (MIP) and weld map. Additionally, the procedures shall be included in the Weld Data Package.
- The welded end must permit 100% volumetric NDT when it is classified as a pressure-bearing weld.
- All joints shall be butt-welded. No threaded joints or socket welds shall be used.
- To perform weld fabrication and heat treatment of welds (if needed), IO recommends the use of ASME B16.34 para. 2.1.6(b) [ACS- 2].
- 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.
- For any internal welds, the Contractor shall ensure a smooth welding pattern to prevent any penetration of the weld inside the pipe, causing internal reduction in diameter or exposed edges.
- All repairs, rework, or scrapping shall be documented and records shall be 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.
- The welding procedure qualification record and welder shall be approved by the Notified Body or RTPO when it is classified as a pressure-bearing weld.

5.5.4.2 Preparation for welding

- Preparation of piping welding should comply with ASME B31.3 Para. 328.4 [ACS- 1].
- This cleaning of internal and external surfaces should conform to ASME B31.3 para. 328.4.1, end preparation ASME B31.3 para. 328.4.2, and alignment ASME B31.3 para. 328.4.3. The surface within 50mm from the area of the weld shall be smooth, free from cracks, fins, tears and other discontinuities, which would affect the quality of the welding.

5.5.5 Mechanical Requirements

The NRV assembly will be integrated into a DN300, ASTM A312M, grade TP304L stainless steel pipework, designed according to ASME B31.3 standard.

The pipe schedule is 80s (12.7 mm thick).

- The mass of the selected NRV shall be less than 80 kg.
- The internals of the valve body shall be designed to limit the deposition of possible activated corrosion products and other erogenous materials inside the valve body. The internal geometry shall avoid dead volumes or pockets where dust or corrosion products may accumulate and be released during valve actuation.
- The NRV shall be designed such that no internal component (disc, hinge, spring, fastener) can become detached under any forward or reverse flow event, seismic event or detonation load.
- The valve shall be designed such that the closure of the valve is not adversely affected by oxidation at the level of the rotating parts. The increase of friction due to ageing (water exposure) over the entire lifetime, shall be demonstrated to not prevent the closure under the smallest backflow following controlled burning.
- The Contractor shall demonstrate that the selected material pairing for disc, hinge and supports eliminates galling risk under submerged conditions and after long idle periods.

5.5.5.1 Valve Seat

- It is the responsibility of the Contractor to select the most suitable option.
- The Contractor shall demonstrate that “Cold Welding” or Metal-to-Metal bonding between the seat and plates is ruled out based on the selection of a suitable valve seat.

5.5.5.2 Surface Preparation Requirements

- Selection, qualification, and application of coating materials shall follow applicable sections of the Steel Structures Painting Council (SSPC) specifications.
- Surface roughness is defined by ISO 4287. The maximum average internal surface shall be 6.3 μm.
- All coating systems must be applied following the Contractor’s recommendations.

5.5.5.3 Lifting/Hanging Lugs

- The NRV shall be designed for transporting and lifting in vertical and horizontal positions.
- The hanging and lifting lugs shall be attached before the final NDE and proof testing.
- Each hanging/lifting lug shall be designed to support 175% of the dry weight of the respective component. The strength of the lifting lugs should be checked considering all possible lifting conditions. The material requirements for the lifting lug shall be equivalent to those of the pressure boundary materials.

5.5.6 Materials Requirements

- The material selected for the VST Non-Return Valve is 300-Series Austenitic Stainless Steel. Any deviation from this material shall be agreed with IO and, in any case, compatible with the VVPSS piping assembly, which is ASTM A312M, grade TP304L.

Materials		
Cast items	ASTM A351 CF3	EN 10213 Grade GX2CrNi19-11 (1.4306)
Forged items	ASTM A182 F304L	EN 10222-5 Grade X2CrNi18-9 (1.4307)
Items fabricated from plate material	ASTM A240/A240M	EN 10088-2 Grade X2CrNi18-9 (1.4307)

- The body shall be constructed of materials as listed in the respective ASTM specifications referred to in ASME B16.34 Table 1 [ACS- 2].

- To ensure the VVPSS meets the radioprotection guidelines as stipulated in the Radioprotection Guide for ESPN Application [AD- 8], strict requirements are placed on the chemical composition of Cobalt, Niobium, and Tantalum in the materials for the valves.

As a general remark, it is important to highlight the fact that the requirements for the chemical composition of Cobalt, Niobium, and Tantalum apply to all components and not only to the "wet parts".

Table 6, Impurities maximum compositions

Composition, % (maximum, unless otherwise indicated)		
Co	Nb	Ta
< 0.2	< 0.1	< 0.1

NOTE, IO may consider deviation from this requirement where the Contractor can demonstrate the component to have a small mass (i.e. bolts, nuts, washers, etc.) and the cost of achieving the above low activation requirements would be excessive compared to the decrease in overall cobalt, niobium or tantalum. No deviation is allowed on large items.

- All material shall conform to the Essential Safety Requirements of the PED [ARD- 1] and ESPN [ARD- 2].

5.5.6.1 Prohibited Materials

- The Contractor shall be aware of the following requirements related to the prohibited materials:
  - Mercury shall not be used in any manner.
  - The use of lead or other low-melting-point metals in contact with the working fluid is prohibited.
  - The use of nitrided surfaces exposed to the working fluid is prohibited.
  - Care shall be taken to prevent contamination of materials by red lead-graphite-mineral oil, molybdenum disulphide lubricants, halides, sulphur, copper, zinc and phosphorus.
  - Teflon and similar elastomers may not be used.
  - The use of Halogen products is prohibited. This requirement applies to all components, including gaskets and other non-metallic materials. Any deviation from non-zero halogen content in any of the materials used shall be reported to IO and its use shall be subject to IO approval.
  - The use of materials containing asbestos shall be prohibited.
- The Contractor shall ensure that all stainless-steel material covered by this specification does not come into contact with any other metals (especially carbon steel), at any stage of the whole manufacturing process (in particular during raw material storage, manufacturing itself, final product storage) and shipping as well, by ensuring a proper segregation from non stainless-steel material. The purpose is to avoid cross-contamination of stainless steel with other metallic products. In case of proven contamination of stainless steel by carbon steel, the Contractor shall perform pickling and passivation of the contaminated material. Pickling and Passivation shall be considered as a "special process".

5.5.6.2 Testing Requirements

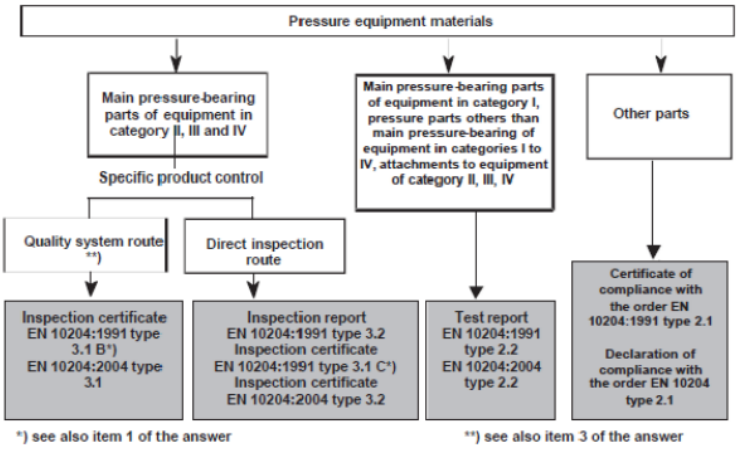
- As part of the conformity assessment, the Contractor shall provide a Nuclear Particular Material Appraisal. This document shall address those testing requirements defined by the PED [ARD- 2] and ESPN [ARD- 1] Essential Safety Requirements, as well as those defined by the design code selected.

Note, as per PED Essential Safety Requirements, the Offset Yield Point (Proof Stress) shall be evaluated at 0.2% and 1% plastic deformation.

- Certificates (test reports) showing that required tests have been carried out at the source should be submitted. Type 3.1 certificate of EN 10204 [ACS- 7] shall be provided for main pressure-retaining materials. The chemical Co, Nb and Ta concentration evaluation shall be included as a result in the Type 3.1 certificate. If the impurities' maximum concentration test is performed separately, the Agreed Notified Body shall be involved in this process to confirm the test results.
- **A second material testing certificate, submitted by an independent certified laboratory, shall be included in the list of documentation submitted to the Contractor after the placement of the supply order.**

- Inspection Certificate Type 3.2 must be provided by the Contractor when the material manufacturer does not have a Quality Assurance System in line with the requirements of PED Annex I 4.3 and ISO 9001. The certificate can be provided by the Contractor, provided there is justification from the competent bodies following material testing.
- Materials shall be clearly marked so that they are always readily identifiable with their test certificates and reports. 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. The method of marking and marking procedures are subject to IO acceptance.

Note, Considering the function of gaskets, inspection documents should be the type 2.2. As the gasket is not the main pressure-bearing part of the equipment, it is not necessary to have type 3.1 or 3.2 in terms of this regulatory framework.



5.5.6.3 Impact and Tensile Test

- Mechanical properties shall be obtained from test specimens that represent the final heat-treated condition of the material required by the material specification. The tensile test shall be carried out at all operating temperatures, up to the design temperature.
- The impact test shall be performed at a temperature not greater than 20°C but not higher than the minimum TS.

Table 7, Acceptance criteria for the Impact and Tensile Test [ARD- 2]

Type	Material structure	A @ RT	KV
Base metal	Ferritic	A ≥ 14%	KV ≥ 27J @0ºC
	Austenitic	A ≥ 25%	KV ≥ 60J @20ºC
		A ≥ 45%	No KV required
Deposited metal (weld)	Austenitic	A ≥ 25%	KV ≥ 50J @20ºC for test coupon
Bolting	Ferritic	A ≥ 12%	KV ≥ 40J @0ºC
		12%≤A ≤ 14%	KV ≥ 40J @0ºC & Reduction in area ≥ 0.45
	Austenitic	A ≥ 12%	KV ≥ 40J @0ºC or KV ≥ 50J @RT
		12%≤A ≤ 14%	KV ≥ 40J @0ºC or KV ≥ 50J @RT & Reduction in area ≥ 0.45

- All tests shall be carried out by an ISO 17025 [ACS- 8] accredited laboratory.

5.5.6.4 Sensitization

- The contractor must ensure that intergranular corrosion is completely avoided. The Contractor shall perform at least ASTM A262, Practice A, E and finally provide a detailed view of microstructures with SEM observations.

5.6 QUALIFICATION OF ITER PROTECTION IMPORTANT COMPONENTS

This contract includes the complete qualification of the equipment for both normal and accidental conditions. The Contractor shall perform Structural Integrity Analysis for pressure, temperature, interface and seismic loading conditions.

As stated in [AD- 21], the PIC qualification procedure applies to all active and passive Protection Important Components (PICs).

Equipment shall be qualified according to the following methods:

- Qualification by testing;
- Qualification by analysis (analogy/similarity, calculation, FEM);
- Qualification by the combination of both above methods.

Note, the Contractor is invited to provide information regarding its qualification experience and capabilities during the bidding process.

As a general rule, the qualification should be performed considering the last day of ITER operation life when the PIC equipment is aged. If the effects of ageing are demonstrated to be negligible, the ageing test could be avoided.

It is the responsibility of the IO to provide the Contractor with all the design input data.

Table 8 provides the qualification documents maturity at the end of the design phases.

Table 8, Qualification documents maturity

Output	Final Design Review	Manufacturing Readiness Review
List of equipment to be qualified	Complete	
Identification File	Preliminary	Complete
Qualification plan	Preliminary	Complete
Qualification Test Specifications		Complete
Qualification Test Report		Complete
Qualification Analysis Report		Complete
Qualification Synthesis Report		Complete
Qualification Preservation Sheet		Complete
Reference file		Complete

Once the design input data is submitted, the Contractor, as Equipment Qualification Performer, shall follow the steps provided in Figure 8.

5.6.1 Qualification of ITER Mechanical Components

Guidelines for the qualification of ITER mechanical components are available in [AD- 22].

Note, IO recommends the use of RCC-M [ACS- 12] *to complement what is indicated in* [AD- 22].

- The Contractor shall identify the equipment or assembly in the Identification File.

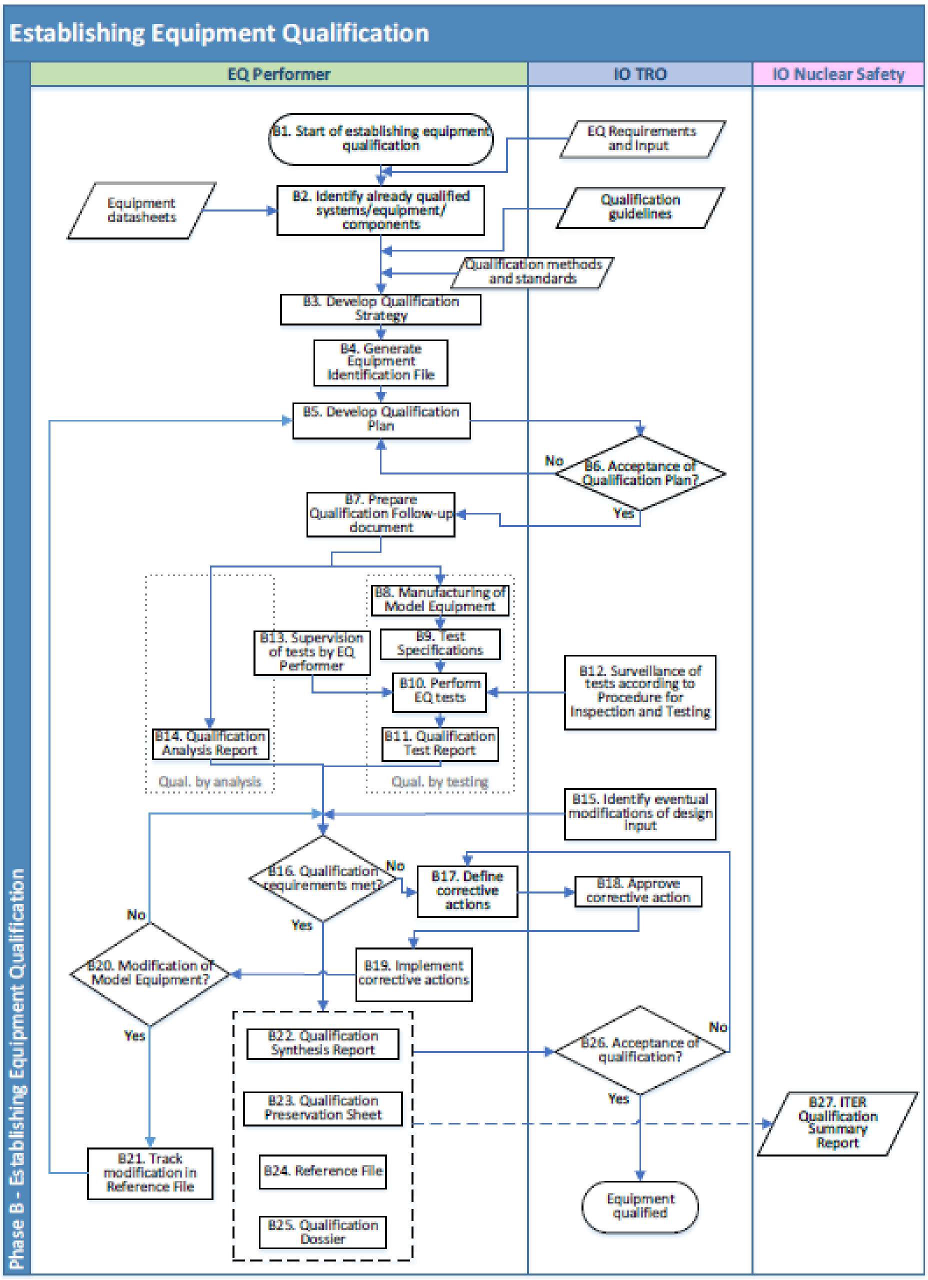


Figure 8, Equipment Qualification Roadmap

5.7 LIFETIME

The NRVs shall have a design life of 25 years.

From a qualification perspective, the lifetime starts at the end of manufacturing and so the duration spent in the warehouse and installation can be considered as follows:

- Storage at the ITER warehouse: up to 3 years - Storage Level C is considered.
- Installation: up to 2 years
- Operation: up to 20 years.

State	Storage - Level C	Installation	Operation
External Pressure	Atmospheric pressure		As per Section 0
Internal Pressure			
Temperature	-8°C to +40°C indoor, no temperature control		
Humidity	0 to 100% (not controlled)		

Electromagnetic field	N/A	
Seismic	As per Section 5.9.2	

5.7.1 Ageing

If the Contractor demonstrates that the effects of ageing are negligible, the ageing test could be avoided. The ageing of VVPSS NRVs is only partially addressed in this technical specification for the following reasons:

- They are submerged under demineralised water;
- The VVPSS system is not continuously operational within ITER; it is estimated that the NRVs will be operated less than 25 times in the gas-forward direction and 100 times in the water-reverse direction, over their lifetime.
- The NRVs are exposed to vibrations only during operation.
- While VVPSS items are exposed to irradiation during ITER plasma operation, irradiation qualification is only required for items that may degrade under fluxes (e.g. electronics, non-metallic items).

5.8 RELEVANT VVPSS LOAD SPECIFICATION

For components classified as Protection Important (PIC), qualification is carried out taking into account all accidental events.

Load Case	NRV Internal Pressure [bara]	NRV External Pressure [bara]	Temperature [°C]	Service Level	Functionality Targets
Hydrostatic test	See 5.5.1	1	30	A	-
Design conditions (PS, TS_Max, TS_Min)	See 5.5.1	See 5.5.1	See 5.5.1	A	NRV is fully operational. Flows normally. The valve disc is free to move.
VST Hydrostatic test	Downstream side 23.5, Upstream side 1	23.5	30	A	NRV is fully operational. After closure, the valve reopens and flows normally. The valve disc is free to move. Absence of local plastic deformations.
Forward Operation – Max and Min flow	See 5.5.3.2	See 5.5.3.2	See 5.5.3.2	A	NRV is fully operational. After closure, the valve reopens and flows normally. The valve disc is free to move. Absence of local plastic deformations.
Forward Operation + SL-3	See 5.9.3	1.5	See 5.5.1	A	NRV is fully operational. After closure, the valve reopens and flows normally. The valve disc is free to move. Absence of local plastic deformations.
Reverse Flow – VST deflagration	See 5.5.3.3	See 5.5.3.3	See 5.5.3.3	A	NRV is fully operational. After closure, the valve reopens and flows normally. The valve disc is free to move. Absence of local plastic deformations.
Reverse Flow – VST detonation	See 5.5.3.3	See 5.5.3.3	See 5.5.3.3	D	NRV is able to close during H2 detonation in the VST. No broken parts, minor local deformation is acceptable. No plastic collapse, no loose parts or debris. [AD- 14]

5.9 STRUCTURAL INTEGRITY ANALYSIS

Structural integrity analyses are considered “Special Processes”.

- Analysis reports shall be produced according to the template for the ITER Structural Analysis Report [AD- 15].

5.9.1 Stress Analysis

- The Contractor shall demonstrate the structural integrity of the pressure confinement boundaries by using the structural analysis to verify that the components can withstand all identified loads to the required service level. The structural analysis shall be undertaken in compliance with Instructions for Structural Analyses [AD- 7].
- The analysis shall include stress calculations, which can be performed analytically or via FEM, using ANSYS or ABACUS software and complying with the Software Qualification Policy [AD- 10]. All files in ANSYS or other software to make a calculation shall be submitted to IO.

5.9.2 Vibration Analysis

The most conservative vibration data are currently being post-processed and will be shared with the Contractors during the tendering phase.

The Contractor shall assess whether the vibrations specified in this specification would degrade the performance of the NRVs, in particular with respect to the risk of chattering.

As is recommended in [AD- 22], the Contractor should perform tests according to IEC 600068-2-6 (Test Fc).

5.9.3 Seismic Analysis

It is recommended that the Contractor provide, from the beginning, a detailed quotation and planning of the activities that consider the selected seismic qualification.

The NRVs shall be capable of withstanding the accelerations associated with the SL-3 seismic events without loss of functional performance or confinement. An envelope acceleration of 7.5 g in each direction (X-Y-Z) shall be taken into account[4].

The seismic classification of the VVPSS NRVs is SC-1 (SF) = Structural and functional performance both after and/or during the earthquake.

The methodology for seismic qualification of valves can be obtained from the guidelines for qualification by analysis [AD- 24] and the ITER Instruction for Seismic Analysis [AD- 5]. The methodology for performing seismic qualification by testing can be obtained from [AD- 23].

Qualification for seismic resistance can be performed by tests, analysis or mixed/combined methods.

During SL-3 seismic excitation, the disc shall remain open under forward-flow and shall not impact the seat. Demonstration may be performed by combined modal/transient analysis or shake-table testing.

Note, the qualification by analysis alone is recommended only for the analysis of the structural integrity of the equipment and its mounting; it is not recommended for analysing equipment functionality.

5.9.3.1 Seismic Qualification Test Sequence

The seismic qualification tests, applicable only to those extended structures for which the analytical qualification is deemed not sufficient, shall be performed according to the standard IEC/IEEE 60980-344 Nuclear facilities – Equipment important to safety – Seismic qualification [ACS- 10]. For seismic tests, it is recommended to use seismic spectra with 5% damping for all kinds of equipment.

5.9.3.2 Acceptance Criteria

Structural Integrity	Leak Tightness	Operability
No broken parts, no deformation.	No leaks out of the pressure boundary. Connections are maintained after the earthquake.	Gas flow normally NRVs work normally Ensure seismic accelerations do not cause premature closure

[4] The Drain Tank Room Floor Response Spectra shouldn’t be used for the internals of the Vapour Suppression Tank, as it would not describe the response of the internal piping arrangement. In the absence of a structure-to-structure amplification, a conservative envelope value is used.

5.9.4 Load and Environmental Qualification

Table 9: Environmental conditions applicable in the field (process area) in 11-B2-01 & 11-B1-01 Drain Tank Room (DTR)

	Normal condition	Accident condition
Ambient room temperature	18 ℃ – 35 ℃	5 ℃ - 130 ℃
Ambient room humidity	20% RH – 60% RH	0% RH – 100%
Ambient room pressure	86 – 106 kPa (a)	100 – 200 kPa (a)
Static magnetic field (modulus)	< 20 mT	
Transient magnetic field (modulus)	< 3.5 mT/s	
Total Ionising dose (TID, silicon-based)	< 2.3E03 Gy	
Dose rate (ionising radiation dose, silicon-based)	< 1.0 Gy/h	
Equivalent Neutron Fluence (ENF @ 1Mev, silicon based)	≤ 4.2E18 neutron.cm^{-2}	
Total Neutron Flux (TNF)	≤ 2.4E05 neutrons.cm^{-2}.s^{-1}	
Seismic	NO	YES, structural integrity during SL2

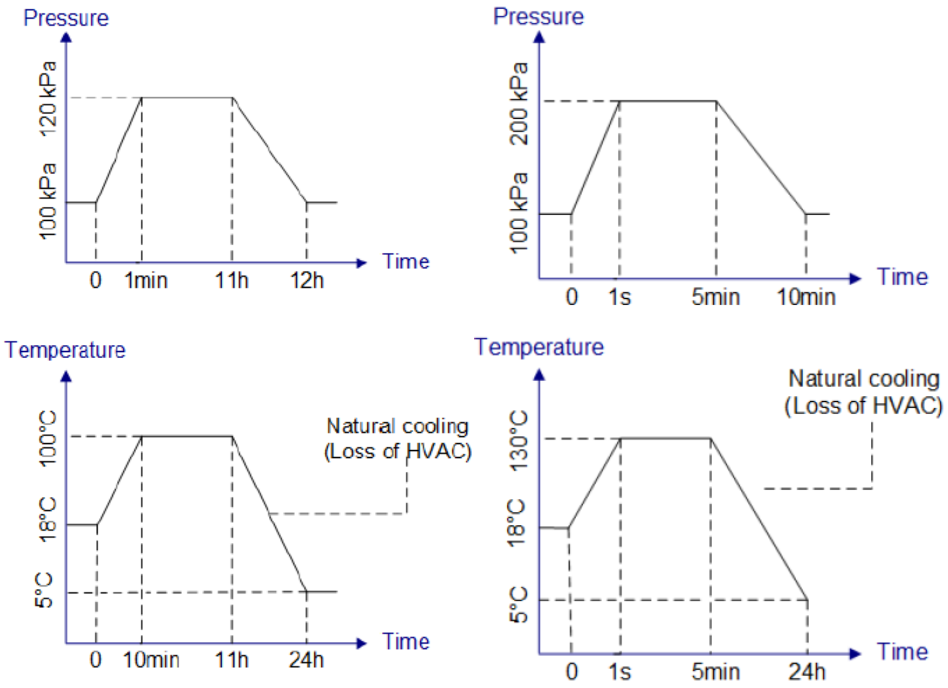


Figure 9, pressure and temperature profiles for a small/large LOCA in DTR[5]

5.9.4.1 Static Magnetic Field

The tests should be conducted according to the ITER test method [AD- 25].

[5]Given that the P/T profiles shown in Figure 9 may change, it is recommended to obtain IO validation of these profiles prior to initiating any qualification campaign.

Note, the static magnetic field can also have an impact on the valves if an additional load is generated when the mobile part comes into contact with the static part. The Contractor should assess the impact of the static magnetic field on the operability of the valve procured. As a general remark, IO recalls that the static magnetic field applied for the qualification test shall be between 1.4 and 2.0 times higher than the one experienced by the equipment during operation.

5.9.4.2 Irradiation

The valves are subjected to irradiation during ITER plasma operation.

- Neutron qualification is only required for items that may degrade under neutron fluxes, such as electronics, gaskets or diaphragms.

5.10 MANUFACTURING READINESS REVIEW

- Following the approval of the MIP, a Manufacturing Readiness Review (MRR) shall be conducted by IO, in line with [AD- 13], and closed before the start of manufacturing activities. This MRR shall be included on the MIP as a Hold Point.

The MRR is a meeting between ITER and the Contractor to approve the start of manufacturing. For the final approval, the following documentation shall be presented:

- Procedures for special processes;
- All manufacturing drawings;
- Material test certificates;
- Engineering analysis;
- Personnel qualification;
- Qualification plan;
- Qualification Synthesis Report;
- Qualification Preservation Sheet;
- Reference file.

5.11 MANUFACTURING INSPECTION AND TESTING PROCEDURES

- Inspection, examinations and tests shall be conducted to provide compliance with PED/ESPN Essential Safety Requirements.
- A Manufacturing and Inspection Plan (MIP) shall be prepared by the Contractor that meets the requirements of ITER MIP [AD- 40]. All testing shall be recorded as required by the referred standard for the relevant testing method. If testing is not recordable, the testing quality shall be ensured by quality control of the testing process.

Note, the MIP is a listing of the chronological sequence of manufacturing operations affecting quality, encompassing the whole scope of the subcontract and ranging from verification of materials, manufacture, inspection and test to delivery. For PIC elements, the MIP also clearly identifies the PIA. It will be used to monitor quality control and acceptance tests.

- Before Manufacturing operations, the MIP shall be generated by the procedure provided in Section 4 of ITER MIP [AD- 40].
- Non-destructive examinations shall be performed on the cast, forged, rolled, wrought or fabricated material after heat treatment required by the material specification.
- Examination personnel shall be qualified and certified by ISO 9712 [ACS- 9].
- NDE reports shall be catalogued according to the weld maps.

Note, the IO reserves the right to inspect all Non-Destructive Examination (NDE) reports for auditing purposes.

The Contractor is responsible for filling the gap between the design code selected and the PED/ESPN Essential Safety Requirements.

5.11.1 Visual Examination

Visual examination is considered a “Special Process”.

- All finished welds shall be subject to visual examination.
- Visual and dimensional control shall be conducted according to EN 17637 [ACS- 13] before the execution of non-destructive examination after possible heat treatment and before any machining or grinding operations of weld surfaces.

- During welding, each pass shall be visually examined, after the complete removal of the slag, if necessary.
- A complete visual inspection of the pressure boundary parts is required before final assembly and on accessible pressure boundary parts without disassembly after hydrostatic testing. The purpose of the visual inspection is to verify all surfaces are free of cracks, hot tears, arc strikes, prod marks and/or other detrimental discontinuities.

5.11.2 Volumetric Examination

- All pressure boundary welds shall be 100% volumetrically inspected. The Contractor may choose Radiography or Ultrasonic inspection as appropriate.

5.11.2.1 Radiography inspection

Radiography examination is considered a “Special Process”.

- IO recommends the use of EN 17636 [ACS- 14] and ISO 10675-1 [ACS- 15] for the radiographic procedures and acceptance criteria.

5.11.2.2 Ultrasonic inspection

Ultrasonic examination is considered a “Special Process”.

- IO recommends the use of ASME B16.34 para. 8.3.1.3 [ACS- 2] for the ultrasonic examination of casting products.
- IO recommends the use of ASME B16.34 para. 8.3.2.1 and Appendix IV [ACS- 2] for the ultrasonic examination of forgings, bars, plates, and tubular products. If during the examination, ultrasonic indications are not interpretable due to, for example, grain size, the material should be radiographed using the procedure requirements of para. 5.9.2.1.

The Contractor is responsible for filling the gap between the selected design code and the PED/ESPN Essential Safety Requirements.

5.11.3 Surface Examination

- All exterior and all accessible interior surfaces shall be given a surface examination. The Contractor will provide a detailed description of the surface examination method selected.

5.11.4 Wall Thickness Measurements

Dimensional inspection is considered a “Special Process”.

- Wall thicknesses of the pressure boundary shall be measured. The minimum thickness shall be the nominal allowable tolerance. The Contractor shall report the wall thickness examination.
- The Contractor shall take several measurements and record the location of the measurements on the drawings.

5.12 FACTORY ACCEPTANCE TESTING AND PROCEDURE

The Contractor shall perform tests of the NRV for the normal operating conditions of the VVPSS relief line, including, as a minimum, the functional test.

- The Contractor shall provide a report for each test and demonstrate compliance with the requirements specified in this technical specification. This program shall provide documented evidence that the equipment can fulfil its safety functions in all postulated normal and accidental conditions in which it is required and during the required operating period.

5.12.1 Functional Test

Functional testing is considered a “Special Process”.

- NRV normally-open:
  - **Valve Flow Coefficient –** C_v in fully open position
  - **Qualification of the closure under backflow load**
  - **Requalification pressure test demonstration**, as presented in Section 5.12.3.3.

Additionally, as part of the PED/ESPN conformity assessment, the following sequence of actions shall be performed and recorded:

- Document check;
- Visual examination before the pressure test;
- Hydrostatic Pressure test;
- Final visual examination after the pressure test.

5.12.2 Document Check

- As defined in Section 5.3, the Contractor shall be responsible for producing all relevant PED/ESPN documents, which will enable the conformity assessment procedure. The full list of documents to be produced during the different design, manufacturing and testing phases is provided in [AD- 26].

5.12.3 Pressure Tests

5.12.3.1 Post-Manufacturing Hydrostatic Pressure Test

The hydrostatic pressure testing is considered a “Special Process”.

- The parts of the valves operated under pressure shall be pressure tested in agreement with EN 12266 [ACS- 11] requirements. All process volumes shall be connected 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.
- For those valves performing the function of “isolation” or classified as “last pressure barrier”, the internals shall also be pressure tested.
- The minimum test pressure shall conform to the PED Annex I, 7.4 [ARD- 1].
- All joints, including welds, shall be left uninsulated and exposed for examination during the test.
- The hydrostatic test pressure shall be maintained for at least 30 minutes.

5.12.3.2 Post-Installation Pressure Test

Following the final installation of the valve in the Drain Tank Room, IO will conduct an external pressure test. The NRV must be engineered to permit cap installation on its downstream side and withstand an external pressure of 22.5 barg (ΔP of 21.5 bar).

The execution of the post-installation pressure test is the responsibility of IO.

- The Contractor is requested to demonstrate structural integrity under this external load scenario.
- The Contractor must temporarily isolate the valve's downstream section for hydrostatic testing to prevent leaks (i.e. using a cap or a blind flange).

5.12.3.3 In-Service Requalification Pressure Test

The NRV, as a boundary of an ESPN assembly and a compartment of an ESPN vessel, must undergo a requalification pressure test every 10 years at 18 barg (1.2*PS), with a maintained ΔP of 17 barg across the valve. To avoid accessing the harsh VST environment, the test will be performed remotely with the valve kept closed by sustaining the required ΔP.

The Contractor is responsible for determining the NRV leak rate under these static load conditions.

5.12.4 Visual Examination

- Visual examination shall be performed according to Section 5.11.1.
- The visual inspection must be conducted on every part of the equipment, both internally and externally, during manufacturing, only when it becomes impossible to examine during final inspection.

5.13 IN-SERVICE INSPECTION AND MAINTENANCE

Performing in-service inspection of the VST NRVs presents significant challenges due to their design and installation constraints. From a regulatory and reliability standpoint, the inability to perform in-service inspection on the lower components introduces risks unless mitigated by design.

While the top side of the valve can be accessed for visual checks or limited verification, the bottom side, where the lower components are located, remains inaccessible without complete disassembly. This limitation makes it impractical to confirm the integrity of critical internal parts during operation.

The valve must be qualified to demonstrate long-term integrity of all internal parts under the full range of environmental and operational conditions defined in the technical specification. This includes pressure transients, thermal cycles, seismic loads and radiological exposure as outlined in this specification.

Environmental qualification and structural integrity analysis must confirm that no degradation mechanisms, such as fatigue or corrosion, will compromise functionality over the 25-year design life.

The Hazard and Risk Analysis shall provide a robust justification for the absence of inspection on the lower part of the valve.

- The minimum periodicity for in-service inspection shall be 40 months.
- The Contractor shall provide specific dimensional requirements for the maintenance of the valves.

5.14 SPARE PARTS

- The Contractor shall recommend parts that should be stocked as spare parts for the operation of the valves. The recommendation for spare parts stock levels should take into consideration the lead time for delivery of replacement parts after order, the design life of the part, the wear-out rate of the part or similar pieces of equipment, and operating conditions to which the equipment will be subjected.
- Delivery of the spare parts selected by IO will be specified at the time of order. The Contractor shall identify all spare parts as such by securely attaching a tag showing the following information to each part:
  - IO Valve Item Number and Contractor's Part Number
  - Part Name and Part Description
  - Drawing Reference and Part Item Number

5.15 OBSOLESCENCE MANAGEMENT

- The Suppliers shall have in place a policy of technical continuity regarding product lifecycle management.
- The Suppliers shall indicate in their proposal:
  - o End date of the commercial availability of the product version,
  - o End date of the commercial availability of the spare parts,
  - o End date of the product support by the original equipment manufacturer.

5.16 CLEANLINESS AND PACKAGING

5.16.1 Cleanliness Requirements

- The interior surfaces of the valves shall meet the requirements for ASME NQA-1 [ACS- 6] Table 302.5 Class B cleanness.
- The exterior surfaces of the valves shall meet the requirements for ASME NQA-1 [ACS- 6] Table 302.5 Class C cleanness before packaging.
- During cleaning, particular attention shall be given to the removal of weld spatter, debris and other foreign matter, particularly from the coolant passages and sealing surfaces. Final cleaning shall ensure effective cleaning without damage to the surface finish, material properties or metallurgical structure of the materials. The Supplier shall submit to the IO the proposed cleaning procedure for approval/acceptance.
- Any expendable materials that come in contact with the valves shall minimise the impact on operating chemistry and shall not cause degradation (e.g., by cross-contamination with carbon steel). Use of expendable material shall be controlled by written procedure.
  - Before the start of fabrication, when such materials are used, a listing of proposed materials and products to be used on the valves for the expendable products covered by this specification, along with a Certified Product Report for each product, shall be submitted to the IO and ANB for approval. This list shall include grinding wheels, adhesives, dye penetrant materials, rust preventatives, tapes, temperature indicating sticks, paint sticks or inks, ultrasonic testing couplants, weld purge dams, welding/cutting compounds, wrapping materials including temporary insulating materials, desiccants, plugs, caps, layout dyes, machining coolants and lubricants, cleaning agents, and solvents.

5.16.2 Marking and Labelling

- The Contractor shall employ a material marking system that ensures the control of the material used in the manufacture of the valves.
- For stainless steel materials, electrochemical etching may be used. Etching must be performed according to a written procedure and the fluids used must be certified to contain less than 100 ppm of total halogens, lead and sulphur. The process must result in marking with demonstrated legibility and durability.
- All components and the main subcomponents shall be clearly marked permanently and in a visible place with the IO official numbering system according to the document "Specification for Labelling of Equipment on ITER Project" [AD- 27]
- Final nameplate information shall be approved by IO.
- The nameplate shall have suitable information as per the PED Essential Safety Requirement 3.3.

5.16.3 Packaging Requirements

- The Contractor shall provide a transport package, adequate to prevent damage during shipping lifting and handling operations.
- Before packaging, the Contractor shall prepare a manufacturing and qualification dossier as well as a Contractor Release Note (CRN) in accordance with [AD- 6] using template [AD- 46] and submit it to the IO for review and approval.
- 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.
- Shock-absorbing material shall be used.
- All the flanges shall be fitted with caps after final testing.
- The valves have to be wrapped in plastic covers to protect them during final storage and transportation. The use of adhesive tape for detection 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.

6 LOCATION FOR SCOPE OF WORK EXECUTION

The Contractor can perform the work at their location.

7 IO DOCUMENTS & IO FREE ISSUE ITEMS

The IO will make test results from the Full-Scale Steam Condensation Experiments available for the Contractor. The experimental facility is designed to conduct extensive research on the condensation of steam into water. This research will be carried out under the exact operating conditions expected for the VVPSS.

Data regarding pressures, temperatures and accelerations, along with video recordings from each experiment, will be provided as input for the design and qualification of the final components.

8 LIST OF DELIVERABLES

8.1 WELD DOCUMENTATION REQUIREMENTS

The following welding documentation shall be retained in the Contractor's shop and available for IO review.

- Administrative procedures for the control of the welding program, which includes qualification of Welding Procedure Specifications, qualification and assignment of welders, filler metal control, the performance of post-weld heat treatment (PWHT), control of welding work, specification of workmanship requirements, and other information related to the administrative control of welding.
- Records of Welder Performance Qualification and updates/renewal of qualification for the welders who will be assigned to the work, according to EN 9606 [ACS- 16].
- Drawing(s) depicting examination surface configuration and the surface finish for pressure retaining and integrally attached welds and adjacent base material subject to the volumetric examination shall be provided by the Contractor.

Welding and NDE documentation listed above shall comply with the requirements of Annex I – section 3.1.2 and 3.1.3 of the PED [ARD- 1].

8.2 MANUFACTURING DOSSIER

All the following documents shall be submitted to IO for acceptance.

Contract Documentation

- Final technical specification;
- Quality Plan;
- NDT procedures/Inspection personnel certifications, approved by RTPO;

- Full supplier list;
- List of Welders – Certificates;
- List of documents.

Design Documentation

- List of standards used and solutions adopted to meet the applicable requirements;
- Preliminary Qualification Dossier
    - Qualification Strategy, using template [AD- 28];
    - Equipment Identification Files, using template [AD- 29];
    - Qualification Plan, using template [AD- 33].
- Structural analysis report;
- Special process procedures;
- Verification and validation of software documents;
- Assembly, 3D models (.stp files) and detail drawings;
- Bill of Materials;
- Manufacturing Inspection Plan;
- Hazard and Risk Analysis;
- Essential safety requirements gap analysis.
- Technical Note on the process and sizing calculations.

Material Documentation

- Material test reports;
- Material supplier's quality system certificate;
- Consumable list;
- Destructive test report;
- Nuclear Particular Material Appraisal.

Fabrication Documentation

- Weld maps and weld repair procedures (if applicable);
- Heat treatment report, including temperature measurement data;
- NDT reports;
- Surface roughness measurement report;
- Inspection report with complete dimensional and tolerance evaluation – technical note justifying thickness in the case of a design by calculation;
- As-built drawings;
- Approval of welding documentation by RTPO or NB;
- Certificate of cleanliness;
- List of special tools, if any;
- Hanging/lifting lug load test report.

Qualification and Procedure Documentation

- Permanent marking and labelling procedures;
- Qualifications of the personnel for manufacturing special processes;
- Qualification dossier, using template [AD- 30]
    - Surveillance of tests;
    - Identification and definition of corrective actions;
    - Qualification Test Specifications, using template [AD- 35].
    - Qualification Follow-Up, using template [AD- 31];
    - Qualification test reports, using template [AD- 37];
    - Qualification analysis reports, using template [AD- 24];
    - Qualification synthesis reports, using template [AD- 34];
    - Qualification preservation sheets, using template [AD- 32];
    - Reference file, using template [AD- 36]
- ESPN dossier, see [AD- 38];
- Deviation requests and non-conformity requests;
- Installation, operation and maintenance manual – Instruction manual, bilingual English and French.

Delivery Documentation

- Cleaning and packing report;

- Final inspection report;
- Delivery report;
- Packing list;
- Preservation manual;
- Contractor Release Note;
- Photographs of packaged components;
- Any document/drawing/procedure that needs prior approval by the IO as mentioned elsewhere in this specification;
- Manufacturer Declaration of Conformity.
- Certificate of Conformity, issued by the Agreed Notified Body.

8.3 LIST OF DELIVERABLES

Table 10, list of deliverables

Deliverable	Description	Estimated due date	Contract Gate?	Percentage of Payment
D1.1	Kick-off meeting minutes	T0 + 1 week	No	-
D1.2	Approval of documents related to the "**Contract documentation**" section	T0 + 1 month	No	-
Hold Point (T1)	Approval of all the qualification documents needed for the Final Design Review and Preliminary Qualification Dossier	T0 + 2 months	Yes	10%
Completion of Task 1				
D2.1	Approval of documents related to the "**Design documentation**" section, excluding the Seismic analysis report	T1 + 2 months	No	-
D2.2	Approval of documents related to the "**Material documentation**" section	T1 + 2 months	No	-
Hold Point (T2)	Closure of the Manufacturing Readiness Review and approval of the Seismic analysis report. Approval of all the qualification documents needed for the MRR.	T1 + 4 months	Yes	20%
Completion of Task 2				
D3.1	Completion of the FAT	T2 + 6 months	No	-
D3.2	Approval of **Manufacturing Dossier**	T2 + 8 months	Yes	40%
Hold Point (T3)	Approval of the ESPN dossier, which enables the shipment of the equipment	T2 + 8 months	No	-
Completion of Task 3				
D4.1	IO acceptance of the delivered equipment	T3 + 1 months	Yes	30%
Completion of Task 4				

9 QUALITY ASSURANCE REQUIREMENTS

The Quality class under this contract is QC1, [AD- 1] GM3S section 8 applies in line with the defined Quality Class.

10 SAFETY REQUIREMENTS

The scope of this contract covers PIC, PIA and PE/NPE components, [AD- 1] GM3S section 5.3 applies.

List of VVPSS Defined Requirements: ITER_D_Q9DVN3.

11 DELIVERY

- The transport of the valves shall be the responsibility of the Contractor. The selection of the transport company shall be at the contractor's discretion and the Contractor shall be responsible for the transport to the delivery location.
- Before the shipment, a Release Note shall be prepared by the "Contractor Release Note" [AD-40] and approved by the IO. Additionally, a native file item-level packing list and a delivery report shall be provided to logistics.data@iter.org by the working instruction for the DRR [AD- 41], *at least 15 working days before the planned shipment date for each shipment.*
- Marking shall be transferred to all pieces when a part is cut to make more than one component. The method of marking and marking procedures shall comply with the document "ITER Numbering System for Components and Parts" [AD- 42]. IO will provide a detailed 'IO component identification standard' together with printed label (QR-code) templates.
- Shipment and Delivery will be undertaken using the International Commercial Terms (Incoterms) 2010. The Contractor shall deliver the Valves "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 [AD- 43] and Packing List [AD- 44] to the IO for review and approval. The Contractor shall sign the Declaration of Integrity and stamp it before submission to the IO. Declaration of Integrity is included in the Delivery Report.

12 SPECIAL MANAGEMENT REQUIREMENTS

The requirement for [AD- 1] GM3S section 6 applies in full.