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EXTERNAL REFERENCE / VERSION

Technical Specifications (In-Cash Procurement)

Technical Specification for Design, Manufacturing and Qualification of VVPSS Exhaust Filters

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

CONTENTS

1 PREAMBLE

This Technical Specification is to be read in combination with the General Management Specification for Service and Supply (GM3S) [AD- 19] – that constitutes a full part of the technical requirements.

In case of conflict, the content of the Technical Specification supersedes the content of [AD- 19].

2 PURPOSE

The purpose of this document is to describe the technical requirements for the design, manufacturing and delivery of the HMS Exhaust Filter for the Vacuum Vessel Pressure Suppression System.

3 ACRONYMS

For a complete list of the ITER abbreviations, see ITER_D_2MU6W5. The abbreviations listed below shall have the following meanings where used:

ANB	–	Agreed Notified Body
ASME	–	American Society of Mechanical Engineers
BIBO	-	Bag-in/Bag-out
CRO	–	Contract Responsible Officer
DA	–	Domestic Agency
DN	–	Nominal Diameter
EN	–	European Standard
EXF	-	HMS Exhaust Filter
HMS	-	Hydrogen Mitigation System
INB	–	Installation nucléaire de base (Basic nuclear installation)
IO	–	ITER Organization
ISO	–	International Organization for Standardization
MIP	–	Manufacturing and Inspection Plan
MRR	–	Manufacturing Readiness Review
MQP	–	Manufacturing Quality Plan
NDE	–	Non-destructive Examination
PBS	–	Plant Breakdown Structure
PED	–	Pressure Equipment Directive (equiv. ESP)
PIA	–	Protection Important Activity
PIC	–	Protection Important Component
PQR	–	Procedure Qualification Record
RH	-	Relative Humidity
QA	–	Quality Assurance
QAP	–	Quality Assurance Program
QC	–	Quality control
QP	–	Quality Plan
SIC	–	Safety Importance Class
SO	–	Supply Order
VVPSS	–	Vacuum Vessel Pressure Suppression System
WPQ	–	Welding Procedure Qualification
WPS	–	Welding Procedure Specification

4 APPLICABLE DOCUMENTS & CODES AND STANDARDS

The orders, directives, codes and standards used in this contract are listed here. 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 prod 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. IO will notify the Contractor if any of the documents listed in the table below will be updated.

Table 1, List of Applicable Codes and Standards

Codes and Standards		
[AD- 1]	EN 13445:2014	Unfired pressure vessel
[AD- 2]	EN 1092-1:2018	Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories PN designated – Part 1: Steel flanges.
[AD- 3]	EN 1515-4:2009	Flanges and their joints - Bolting - Part 4: Selection of bolting for equipment subject to the Pressure Equipment Directive 2014/68/EU
[AD- 4]	EN 1591:2013	Flanges and their joints - Design rules for gasketed circular flange connections - Part 1: Calculation
[AD- 5]	EN 3834-2:2021	Quality requirements for fusion welding of metallic materials - Part 2: Comprehensive quality requirements
[AD- 6]	EN 10204:2004	Metallic products – Type of inspection documents
[AD- 7]	EN 15614-1:2017	Specification and qualification of welding procedures for metallic materials – Welding procedure test – Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys
[AD- 8]	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
[AD- 9]	IEC/IEEE 60980-344	Nuclear facilities – Equipment important to safety – Seismic qualification
[AD- 10]	ISO 834	Fire Resistance Tests – General Reuquirements
[AD- 11]	EN 17637:2016	Non-destructive testing of welds - Visual testing of fusion-welded joints
[AD- 12]	EN 17636:2022	Non-destructive testing of welds - Radiographic testing - Part 1: X- and gamma-ray techniques with film
[AD- 13]	ISO 10675-1:2022	Non-destructive testing of welds — Acceptance levels for radiographic testing — Part 1: Steel, nickel, titanium and their alloys
[AD- 14]	EN 11666:2018	Non-destructive testing of welds - Ultrasonic testing - Acceptance levels
[AD- 15]	EN 17640:2018	Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment
[AD- 16]	ASME NQA-1 - 2019	Quality Assurance Requirements for Nuclear Facility Applications
[AD- 17]	EN 9606-1:2017	Qualification testing of welders – Fusion welding – Part 1: Steels

Table 2, List of ITER Applicable Documents

ITER Applicable Documents		
[AD- 18]	Radioprotection guide for ESPN application	2LTQ96
[AD- 19]	General Management Specification for Service and Supply (GM3S)	82MXQK
[AD- 20]	Qualification of Protection Important Components (PIC)	XB5ABP
[AD- 21]	Guidelines for the qualification of mechanical equipment	ADCXXD
[AD- 22]	Template for Structural Analysis Reports	VQVTQW
[AD- 23]	Instructions for Structural Analyses	35BVV3
[AD- 24]	Guidelines for qualification by analysis	AKFUMQ
[AD- 25]	Technical Specification for the Experimental Seismic Qualification of Active Electrical and Mechanical Components	AGL2QP
[AD- 26]	Instruction for Seismic Analysis	VT29D6

[AD- 27]	Working Instruction for Manufacturing Readiness Review	44SZYP
[AD- 28]	Quality Requirements for IO Performers	22MFG4
[AD- 29]	Software qualification policy	KTU8HH
[AD- 30]	Release Note Template	QVEKNQ
[AD- 31]	Template for Equipment Identification file	*BK7Y2G*
[AD- 32]	Template for Qualification Strategy	AQKXEH
[AD- 33]	Template for Qualification Dossier	BXTPJP
[AD- 34]	Template for Qualification follow-up document	BXTNRJ
[AD- 35]	Template for Qualification Preservation Sheet	BXTLMX
[AD- 36]	Template for Qualification Plan	B9HR4D
[AD- 37]	Template for Qualification Synthesis Report	BXTDJE
[AD- 38]	Template for Qualification Test Specifications	BXD2SS
[AD- 39]	Template for Reference File	BXTMAL
[AD- 40]	Template for Qualification Test Report	BXSQE9
[AD- 41]	Guidelines for qualification by analysis	AKFUMQ
[AD- 42]	Procedure for Analyses and Calculations	22MAL7

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 Exhaust Filter (EXF) that meets all applicable requirements.

The activities are divided into the following tasks:

- **Task 1: Design & Structural Integrity Verification:** Develop a detailed process and mechanical design of the EXF for manufacturing. Perform structural integrity verification of the designs using the loads specified in this technical specification. Submit all geometry data, models, and drawings required for the integration of the equipment into the VVPSS CAD model. Provide all mandatory qualification documentation and documentation needed for the Final Design Review.
- **Task 2: Manufacturing:** Manufacture the EXF 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 filter. Clean and prepare the equipment for transport. Prepare and hand over all documentation required by this technical specification.

Note, Task 2 can only begin after the approval of the internal ITER design gate. It is anticipated that the contract will be put on hold after the completion of Task 1, until the ITER Final Design Review, which is an internal ITER process, is completed. The target timeframe for the VVPSS Final Design Review is set from Q1 to Q3 of 2026.

5.1 CLASSIFICATION AND CONFORMITY DECLARATION

Table 3, EXF classification

	Safety class	Quality class	Seismic class	Vacuum class	Tritium class	RH class	PED	ESPN
EXF	PIC	QC-1	SC-1 (S) SL-2	No-VQC	TC-2A	Non-RH	Non-PED	Non-ESPN

5.2 DESIGN CODES

The selection of the design code is the responsibility of the Contractor. Independently from the design code selected, the Contractor shall demonstrate the compatibility of the filter assembly with the stainless-steel pipework, designed according to EN 13480 [AD- 1].

5.3 DESIGN REQUIREMENTS

5.3.1 Operating Conditions

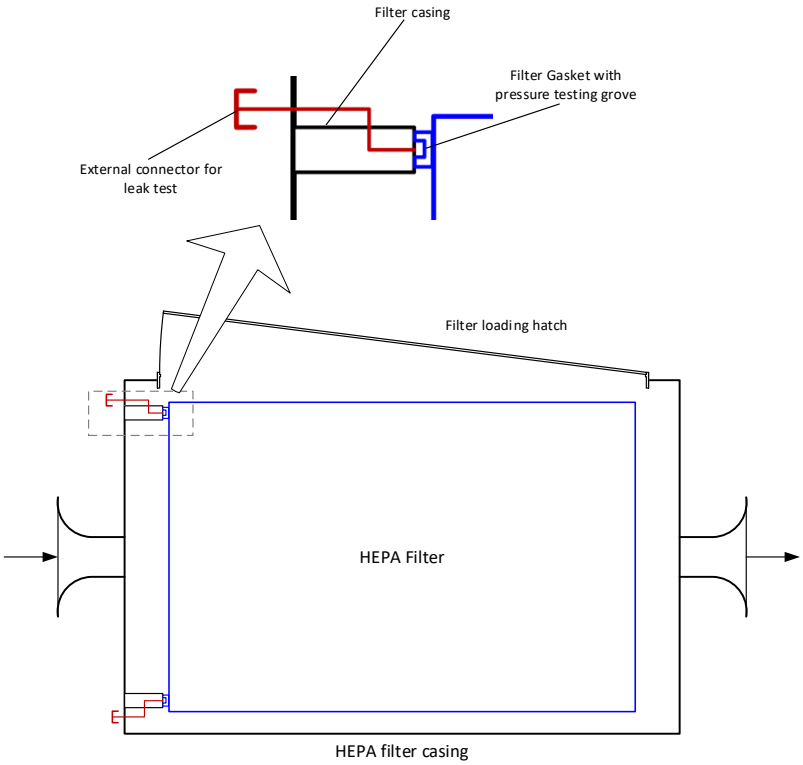
	Value	Unit
Fluid name	99% air (100% RH), 1% H_2	-
Type of Dust	Stainless Steel and Tungsten	
Maximum Mass of Dust per Event	50	g
Dust Size	0 – 44 Average 2	µm
Corrosive content	N/A	-
Filter Minimum Capacity	100	g
Maximum Flowrate	550	Nm^3/h
Minimum Flowrate	350	Nm^3/h
Operating Pressure	0.7 - 0.75	bar(a)
Maximum Allowable Pressure (PS)	1.5	bar(a)
Operating Temperature	7 - 13	°C
Maximum/Minimum Operating Temperature (TS_max/TS_min)	50/6	°C
Allowable Pressure Drop at Max Dust Load	1000	Pa
Efficiency Target (EN1822) @ 0.3 µm	H13, 99.95	%
Maximum Internal Bypass Leakage	0.01	%

5.3.2 Integrity Verification

- Each filter cartridge shall be factory-tested using aerosol challenge with PAO (Polyalphaolefin) or DEHS (Di-Ethyl-Hexyl-Sebacate), at maximum and minimum flowrate.
- Acceptance Criteria:
  - Overall penetration ≤ 0.05%
  - No local internal leak ≥ 0.01%
- After testing, the EXF shall be purged with dry air or N_2 until the downstream aerosol concentration ≤ 0.001 mg/m³ and no visible residue remains.
- All temporary items contacting the process volume must comply with the halogen-free requirement, as stated in Section 5.3.10.1.

5.3.3 Maintainability

- Dust may be activated. The Contractor shall provide bag-in/bag-out (BIBO) or an equivalent containment for cartridge change-out.
- The cartridge mass shall be limited to 15 kg per person.
- The filter shall ensure an ergonomic access envelope.
- A low-point valve is required for the drainage of condensed water.
- The cartridge cover shall be equipped with a leak test groove or a groove gasket that allows the possibility of performing a filter-leak test. A hardware test groove can be welded to the housing, so personnel can perform the leak test after each cartridge replacement.



5.3.4 Spares

- The Contractor shall supply one set of spare cartridges, gaskets/seals (if any) and BIBO sleeves.

5.3.5 Relevant VVPSS Load Specification

Qualification is carried out considering all accidental events for components classified as Protection Important (PIC).

Load Case	Internal Pressure [bara]	External Pressure [bara]	Temperature [°C]	Service Level
Design conditions (PS, T_d)	0.8	Ambient	50	A
External accident	1	1.2	130	A
Fire in 11-L3-02E	1	Ambient	ISO 834 (2h)	C
Normal Operation+SMHV	1	Ambient	Ambient	A
Normal Operation+SL-2	1	Ambient	Ambient	C

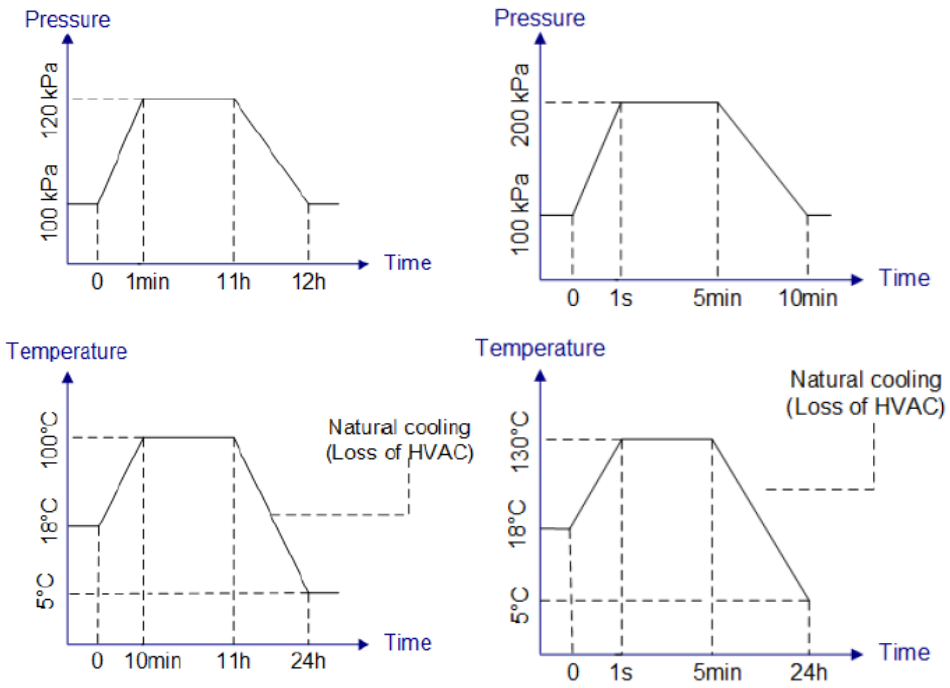


Figure 1, pressure and temperature profiles for a small/large LOCA in DTR[1]

5.3.6 Flanged Connections

Above all other requirements of this technical specification, the Contractor shall ensure that the flanged connections comply with the leak-tightness requirements.

- For the preparation of flanged ends with flange facing, nut-bearing surfaces, outside diameter, thickness, and drilling, IO recommends the use of EN 1092 [AD- 2].
- Flanges furnished with tapped holes shall provide full effective thread engagement, not including the chamfered thread, for a length at least equal to the nominal diameter of the bolt thread.
- The Contractor shall define the most appropriate type of flange and the final selection shall be approved by IO.
- Flanged ends shall be prepared with flange facing, nut-bearing surfaces, outside diameter, thickness, and drilling by EN 1092-1.
- Items supplied with flanged ends shall be provided with adequate bolts, nuts, washers, and gaskets as described below:
  - Bolts: Bolting for the flanged connections shall be supplied with each flange and should conform to EN 1515 [AD- 3]. The material selection shall be based on the assembly requirements to achieve leak-tightness. The Contractor shall calculate the bolt torques to provide proper assembly.
  - Nuts: Nuts for the flanged connections shall be supplied with each flange and should conform to EN 1515. The material selection shall be based on the assembly requirements to achieve leak-tightness.
  - Gaskets: Gaskets shall be supplied with each flange. The gaskets should conform to EN 1591 [AD- 4] to ensure compliance with leak-tightness requirements, as defined in section 5.9.1.
    - The Contractor shall be able to identify minimum gasket compression stress for assembly (Qa), testing (Qmin) and operation/accidents (Qsmin).

5.3.7 Welded Connections or Permanent Joints

Welding activities are considered “Special Processes”.

[1]Given that the P/T profiles shown in Figure 1 may change, it is recommended to obtain IO validation of these profiles prior to initiating any qualification campaign.

- 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.
- All repairs, rework or scrapping shall be documented and records shall be maintained for each specific item. The records shall relate repairs to the procedure used. The IO shall be notified in the event the weld repair is unsuccessful. The repairing procedure shall follow the prescriptions stated in section 10.3 of EN 13480-4 [AD- 1].
- Production welding operations may only be undertaken provided the following requirements are met:
  - Personnel satisfy the requirements of EN 13480-4 (Section 9.1) and EN 3834-2 [AD- 5];
  - The filler materials shall have an Inspection Certificate type 3.1 as per EN 10204 [AD- 6];
  - Welding procedures have been qualified in accordance with EN 15614-1 [AD- 7];
  - All the welds shall be identified with a unique number and shall be traceable back to the welder/operator and WPS used;
  - Any visible defect liable to affect the correct execution of the next pass shall be removed.
  - Cracks or cavities visible on the surface shall be removed by chipping, grinding, and/or milling.

5.3.8 Mechanical Requirements

The filter assembly will be integrated into a DN150 piping system, ASTM A312M grade TP304L stainless steel. The interfacing pipe schedule is 40s (7.1 mm thick).

Multiple cartridges may be arranged in a parallel configuration, which serves to minimise pressure drops and handle the specified flow rates.

Nozzles:

- Process Inlet: DN150
- Process Outlet: DN150
- Drain: TBD (Vendor to Advise)
- Access to filters: TBD (Vendor to Advise)

The filter shall be equipped with a qualified support frame.

5.3.8.1 Lifting/Hanging Lugs

- The filter assembly 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.

5.3.9 Insulation

- The EXF shall be thermally insulated on its external surfaces to limit heat gain from the environment to the vessels as well as act as a vapour barrier, protecting the vessels from external condensation.
- The insulation shall be a minimum of 25 mm thick and have a thermal conductivity less than or equal to 0.05 W/m.K at 25°C. The Contractor shall demonstrate that the thickness of the insulation is enough to ensure integrity under fire load, see Section -.
- The insulation material shall be free of halogenated material. Material is considered to be sufficiently free of halogens when the halogen content is lower than 0.025% by mass.
- The EXF shall be provided with supports upon which the insulation is fixed. Supports shall be capable of collectively supporting 125% of the insulation load. The insulation shall be reliably and safely fixed around the surface of each vessel and shall remain properly attached to the vessel following an SL2 seismic event.
- The insulation and cladding system shall be easily removable to enable inspection of the outer surface of the vessels.

5.3.10 Materials Requirements

- The material selected for the EXF 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.

- To ensure the VVPSS meets the radioprotection guidelines as stipulated in the Radioprotection Guide for ESPN Application [AD- 18], 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 4, Impurities maximum compositions

Composition, % (maximum, unless otherwise indicated)		
Co	Nb	Ta
< 0.2	< 0.1	< 0.01

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.

5.3.10.1 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".

5.3.10.2 Testing Requirements

- Certificates (test reports) showing that required tests have been carried out at the source should be submitted. Type 3.1 certificate of EN 10204 [AD- 6] 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.
- 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.

5.3.10.3 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.

5.3.10.4 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.

5.4 QUALIFICATION OF ITER PROTECTION IMPORTANT COMPONENTS

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

As stated in [AD- 20], 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.

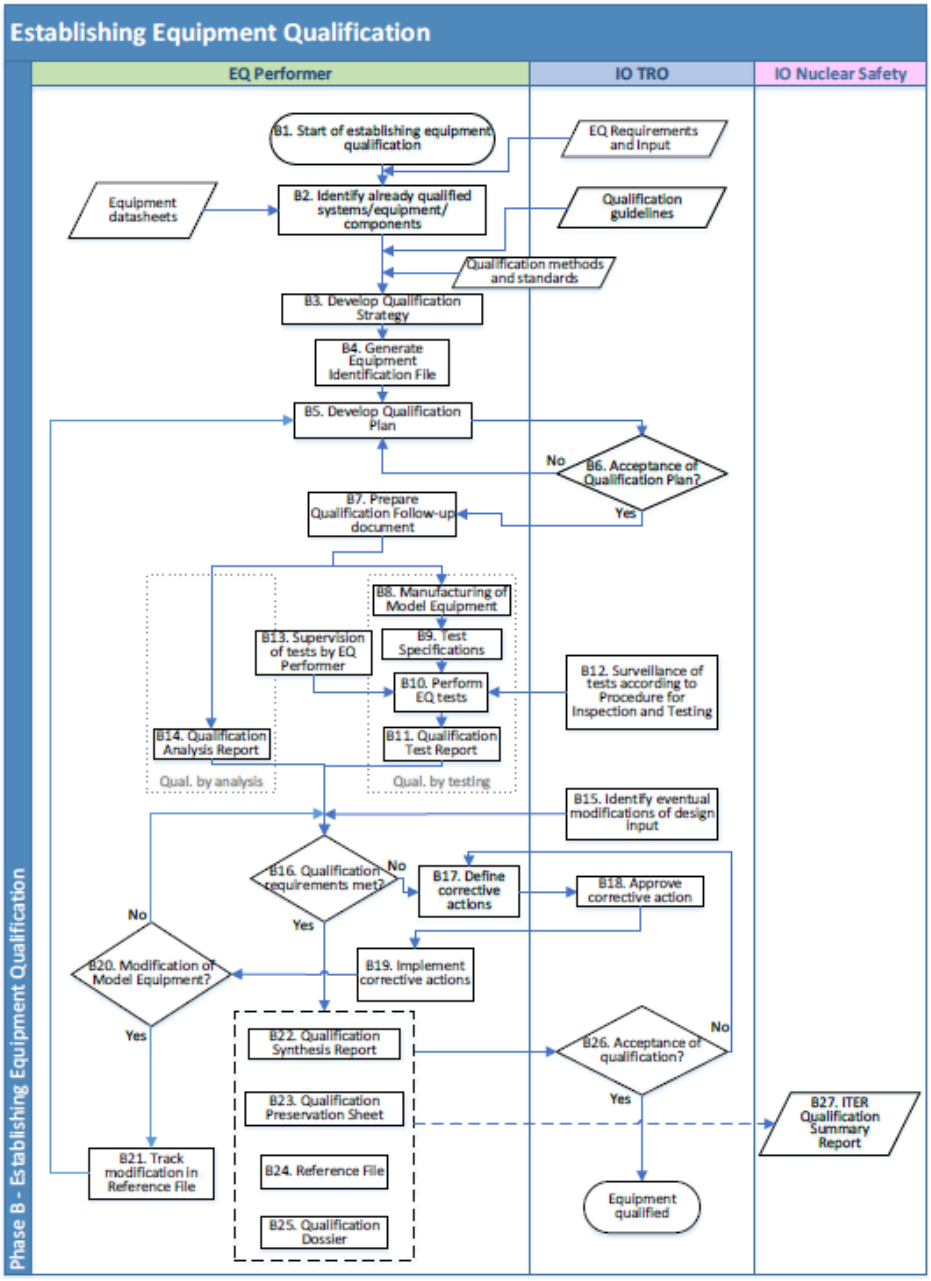
Table 5 provides the qualification documents maturity at the end of the design phases.

The Contractor is obligated to deliver successful results from the qualification process to IO. If testing fails or if the Contractor does not meet IO's requirements, resulting in the need to repeat tests, this shall not entitle the Contractor to make any financial claims.

Table 5, 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 following steps:



5.4.1 Qualification of ITER Mechanical Components

Guidelines for the qualification of ITER mechanical components are available in [AD- 21].

Note, IO recommends the use of RCC-M [AD- 8] *to complement what is indicated in* [AD- 21].

5.5 LIFETIME

The EXF 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 5.3.1
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 5.6.2	

5.5.1 Ageing

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

- It is located in the ITER B11 facility, which maintains a controlled temperature and humidity environment.
- The VVPSS system is not continuously operational within ITER; it is estimated that the EXF will be operated less than 100 times over its lifetime.
- The VVPSS system experiences only low levels of vibration, typical of a standard industrial environment.
- While VVPSS Filters are exposed to irradiation during ITER plasma operation, irradiation qualification is only required for items that may degrade under gamma radiation and neutron fluxes. Irradiation qualification is also necessary when electronic devices are included.

5.6 STRUCTURAL INTEGRITY ANALYSIS

Structural integrity analyses are considered “Special Processes”.

- The Contractor should use FEA or analytical calculations to address all those design provisions not fully validated by the design code selected.
- Analysis reports shall be produced by the template for Structural Analysis Report [AD- 22].

5.6.1 Stress analysis

- The Contractor shall demonstrate the structural integrity of the EXF 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 the Instructions for Structural Analyses [AD- 23] and the IO procedures for analysis and calculations [AD- 42].
- 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-29]. All files in ANSYS or other calculation software used to make a calculation, referenced in the reports, shall be submitted to IO.

5.6.2 Seismic qualification

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 EXF shall be capable of withstanding the accelerations associated with an SL2 seismic event without loss of functional performance or confinement.
- The Contractor shall demonstrate via analysis that the EXF can achieve the normal operation functionality following an SMHV (Maximum historical probable earthquakes) event and maintain structural integrity during SL2 seismic events.
- All pressure equipment shall maintain its pressure boundary integrity after a seismic event.

For SMHV, a factor of 0.8 will be applied to the SL-2 FRS.

The methodology for seismic qualification of the EXF can be obtained from the guidelines for qualification by analysis [AD- 24] and the ITER Instruction for Seismic Analysis [AD- 26]. The methodology for performing seismic qualification by testing can be obtained from [AD- 25].

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

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.

The Contractor shall refer to Appendix 1: Floor Response Spectra.

5.6.2.1 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 [AD- 9].

The seismic tests will have to be implemented after ageing preparation and tests.

5.6.2.2 Acceptance Criteria

Structural Integrity	Leak Tightness	Operability
No broken parts, no deformation.	No leaks out of the pressure boundary. Nozzle connection is maintained during and/or after the earthquake.	Gas flow normally.

- The Contractor shall ensure that the total leak rate does not exceed 10^{-5} Pa.m^3.s^{-1}.
- Filter cartridges shall pass factory scan testing and an in-situ aerosol integrity test after any seismic event.

5.6.3 Fire

ISO 834 [AD- 10] curve shall be used for determining the fire temperature during qualification.

- The contractor shall guarantee the structural integrity of PIC components during and after a fire accident for a minimum of 2 hours. Integrity is demonstrated with no external leaks after a fire event.
- After cool-down to ambient, the Contractor shall ensure that the total leak rate does not exceed 10^{-5} Pa.m^3.s^{-1}.

5.6.4 Irradiation

Filters are subjected to irradiation during ITER plasma operation.

A total dose of 2e+05 Gy and a neutron flux of 1e+05 n/cm^2.s shall be taken into account.

- Irradiation qualification is only required for items that may degrade.

5.7 MANUFACTURING READINESS REVIEW

- Following the approval of the MIP, a Manufacturing Readiness Review (MRR) shall be conducted by IO, in line with [AD- 27], and closed before the start of manufacturing activities. This MRR shall be included on the MIP as a Hold Point.

The MRR is a joint ITER-Contractor meeting to give approval for the Contractor to start manufacturing. For the final approval, the following documentation shall be presented:

- Procedures for special processes;
- All manufacturing drawings;
- Material test certificates;
- Engineering (Structural) analysis;
- Personnel qualification.

5.8 MANUFACTURING INSPECTION AND TESTING

- The Contractor shall prepare a Manufacturing and Inspection Plan that meets the requirements of ITER MIP [AD- 28]. All testing shall be recorded as required by the referenced 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.

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

5.8.1 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 [AD- 11] 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.

5.8.2 Volumetric examination

The rules of EN13445-5 [AD- 1] applies.

- The Contractor may choose Radiography or Ultrasonic inspection as appropriate.

5.8.2.1 Radiography inspection

Radiography examination is considered a “Special Process”.

- IO recommends the use of EN 17636 [AD- 12] and ISO 10675-1 [AD- 13] for the radiographic procedures and acceptance criteria.

5.8.2.2 Ultrasonic inspection

Ultrasonic examination is considered a “Special Process”.

- IO recommends the use of EN 11666 [AD- 14] and EN 17640 [AD- 15] for the ultrasonic examination of casting products.

5.8.3 Surface examination

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

5.9 FACTORY ACCEPTANCE TESTING

The Contractor shall perform the functional tests of the EXF for normal operating conditions, according to Section 5.3.1. FAT shall include as a minimum:

  - Aerosol integrity test, as described in Section 5.3.2;
  - Assembly leak test;
  - Removal and installation of the cartridges test;
  - Drainage test;
  - Lifting 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 is able to fulfil its safety functions in all postulated normal and accidental conditions in which it is required and during the required operating period.

5.9.1 Assembly leak test

Leak testing is considered a “Special Process”.

- The Contractor shall ensure that the total leak rate does not exceed 10^{-5} $Pa.m^3.s^{-1}$ at design conditions.
- A helium leak test shall be conducted. IO recommends following the requirements of EN standards referenced in [AD- 1]. Testing shall be performed prior to any painting or coating.

5.9.2 Removal and installation of the filter cartridges test

- The Contractor shall perform a removal and installation test of the filter cartridges. The procedures shall be described in the FAT report. All tools utilised during the test must be documented in the FAT report.

5.9.3 Drainage test

Drainage testing is considered a “Special Process”.

- The Contractor shall demonstrate that no pooled water remains after the full drainage of the Filter. IO recommends carrying out this test after the hydrostatic pressure test.

5.9.4 Lifting test

- The lifting test shall demonstrate that no deformation happens as the result of the hanging/lifting of the EXF. The Contractor shall lift 150% of the EXF dry weight for at least 20 mins. At the conclusion of the test, the Contractor shall examine all exterior surfaces around the lifting lugs with Dye Penetrant to exclude the presence of cracks or deformation.

5.10 PACKAGING AND HANDLING

- The Contractor shall provide a transport package for the EXF, 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 reference [AD- 28] using template [AD- 30] and submit it to the IO for review and approval.
- Packaging shall be provided to ensure adequate protection, during transport, shipping, lifting and handling operations and delivery, and on-site storage before installation. The material certificates shall be submitted to the IO for acceptance.
- The interior surfaces of the components shall meet the requirements for ASME NQA-1 [AD-16] Table 302.5 Class B cleanness.
- 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 EXF has to be wrapped in plastic covers to protect it 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.
- Internals of the EXF complete assemblies shall be preserved by means of nitrogen gas (<100 ppm H_2O) 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.
- The Contractor shall provide any special lifting equipment required for the handling of the transport packages. All lifting equipment provided by the Contractor shall be proof-tested to the applicable loads.

6 LOCATION FOR SCOPE OF WORK EXECUTION

The Contractor can perform the work at their own location.

7 LIST OF DELIVERABLES

7.1 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 [AD- 17]. Additional requirements of EN 13480-4 section 9 shall be applied as well.
- 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.

7.2 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;
- 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- 32];
  - Equipment Identification Files, using template [AD- 31];
  - Qualification Plan, using template [AD- 36].
- 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;
- Technical Note on the process and sizing calculations.

Material Documentation

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

Fabrication Documentation

- Weld maps and weld repair procedures (if applicable);
- Heat treatment report, including temperature measurement data;
- NDT reports;
- As-built drawings;
- Certificate of cleanliness;
- 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- 33]
  - Surveillance of tests;
  - Identification and definition of corrective actions;
  - Qualification Test Specifications, using template [AD- 38].
  - Qualification Follow-Up, using template [AD- 34];
  - Qualification test reports, using template [AD- 40];
  - Qualification analysis reports, using template [AD- 41];
  - Qualification synthesis reports, using template [AD- 37];
  - Qualification preservation sheets, using template [AD- 35];
  - Reference file, using template [AD- 39];
- 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;

7.3 LIST OF DELIVERABLES

Table 6, 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	TBD
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 + 3 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	TBD
Completion of Task 2				
D3.1	Completion of the FAT	T2 + 2 months	No	-
D3.2	Approval of **Manufacturing Dossier**	T2 + 2 months	Yes	TBD
Completion of Task 3				
D4.1	IO acceptance of the delivered equipment	T2 + 3 months	Yes	TBD
Completion of Task 4				

8 QUALITY ASSURANCE REQUIREMENTS

The Quality class under this contract is QC1.

[AD- 19] and [AD- 28] apply in line with the defined Quality Class.

9 SAFETY REQUIREMENTS

The scope under this contract covers PIC and PIA, [AD- 19] GM3S section 5.3 applies.

10 SPECIFIC GENERAL MANAGEMENT REQUIREMENTS

The requirement for [AD- 19] GM3S section 6 applies in full.

The Contractor and the IO shall meet to review the progress of the work and discuss technical issues.

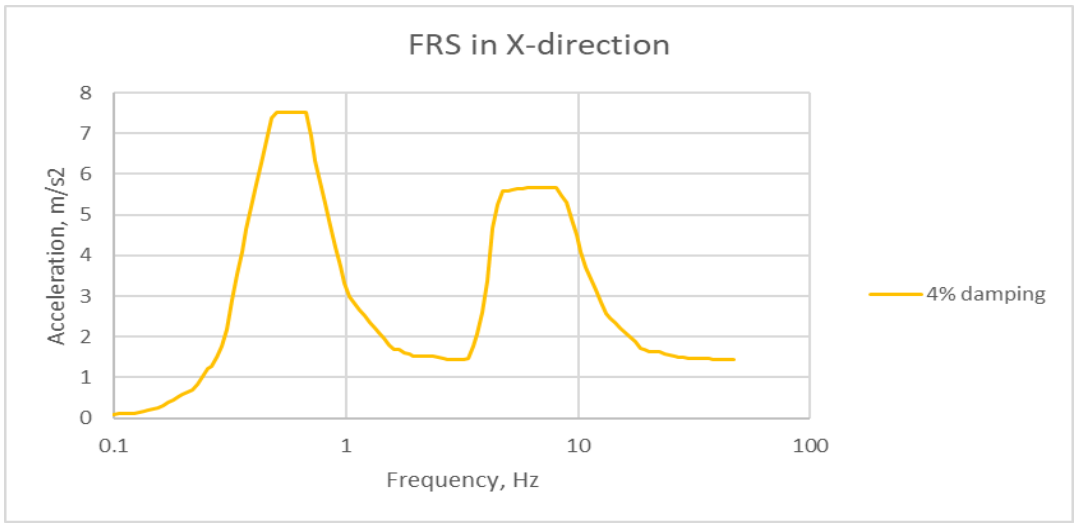
The Contractor or IO can request specific meetings or communications to resolve issues. All the meetings shall be held by video conference. The Contractor shall be responsible for producing minutes of each meeting, which shall be circulated for review and approval by all attendees before formal issue.

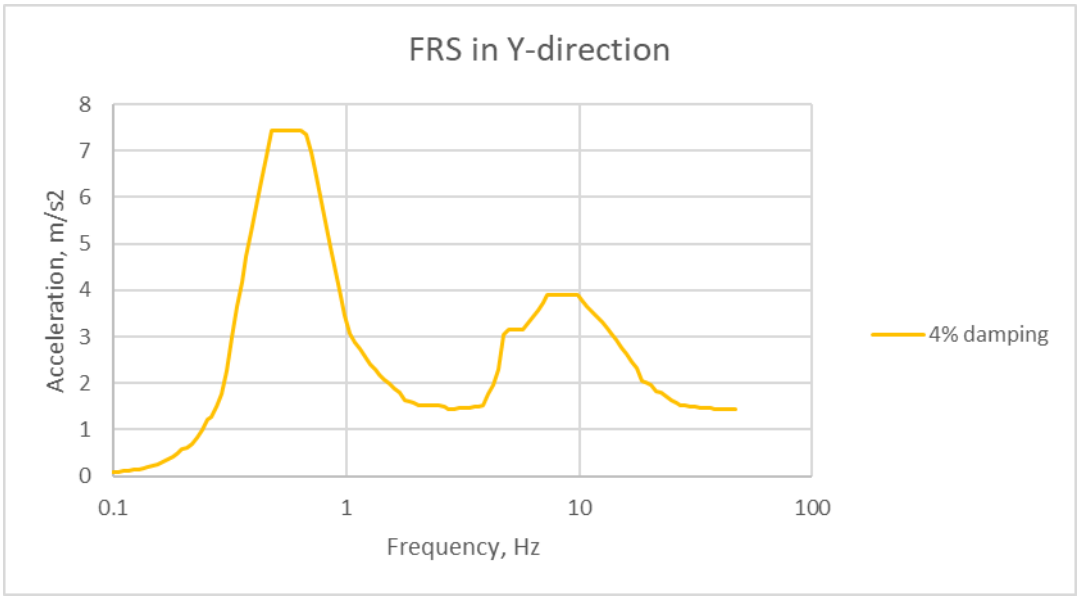
The Contractor shall provide the Deliverables corresponding to the Task assigned by IO in due time.

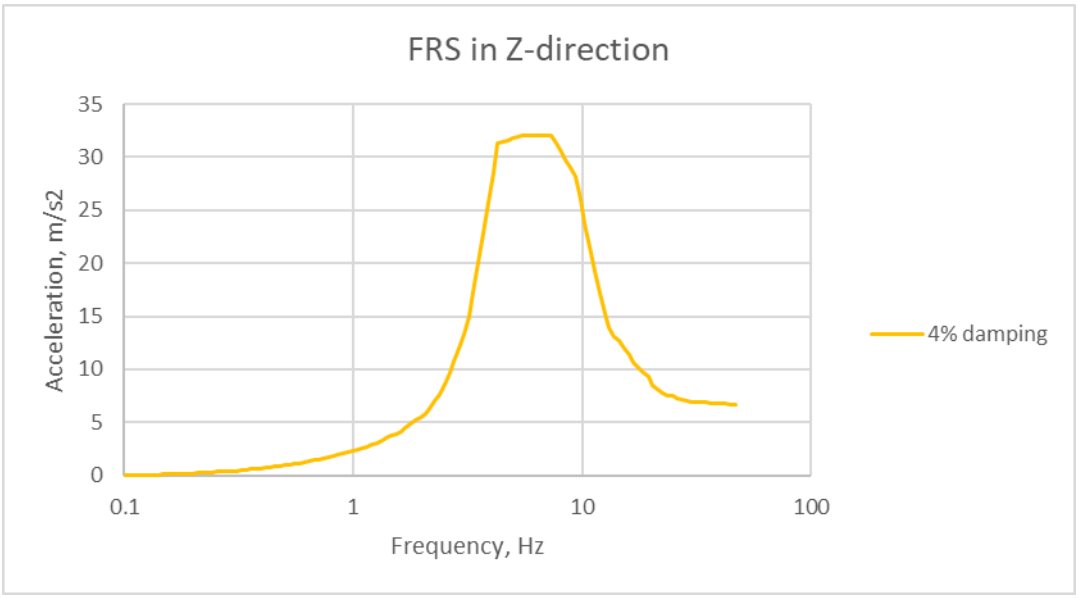
11 DELIVERY

APPENDIX 1: FLOOR RESPONSE SPECTRA

Seismic event SL-2






FRS in Z-direction
Acceleration, m/s2
35
30
25
20
15
10
5
0
0.1
1
10
100
Frequency, Hz
4% damping