

Technical Specifications (In-Cash Procurement)

VVPSS Primary Elements, Thermowells and Temperature Sensors - Technical Specification

This specification defines the technical requirements for the design, manufacturing, testing, equipment qualification and delivery of the full set of Primary Elements, Thermowells and Temperature Sensors for the Vacuum Vessel Pressure Suppression System (VVPSS). The Primary Elements' datasheet is provided in ITER_D_BGQXBT and the Thermowells and Temperature Sensors' datasheet is provided in ITER_D_BGR4R7.

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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

The Purpose of this document is to define the design, manufacture, testing and delivery requirements for the VVPSS instruments; Primary Elements, Thermowells and Temperature Sensors.

3 Introduction

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.

The VVPSS instruments monitor utility lines and the main process lines. The later see a wide range of process conditions as they always operate in dynamic conditions. IO has selected the desired sizing cases and pre-sized/pre-selected the instruments. Nonetheless, the Contractor shall advise the best suited technology according to their expertise, the guaranteed process conditions, the required performances, the environment conditions and above all to be compliant with this technical specification. The ultimate design will be decided in agreement and upon validation by IO.

4 Scope of the work

This specification defines the sizing, material grades, fabrication, inspection, examination, testing, QA, qualification and other requirements for the instruments, procured for the ITER VVPSS. Above all other requirements of this technical specification, the Contractor shall be responsible for all necessary design development, qualification and manufacturing activities that ultimately enable the delivery of the VVPSS instruments that have been demonstrated to fulfil all the applicable requirements.

The VVPSS instruments covered in this specification are divided into two (2) Procurement Lots: Lot 1 Primary Elements and Lot 2 Thermowells and Temperature Sensors. Depending on the bidder's capability they may submit a bid covering one or all procurement lots.

Due to the VVPSS planning, IO foresees a staged approach to execute this Contract. The Contractor shall present a proposal to meet the ultimate goal of this specification at the tender stage, which is the delivery to IO of qualified instruments. The following stages are foreseen:

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- Task 1: Design – The first task is dedicated to the design of the VVPSS instruments based on the requirements defined in this technical specification. The Contractor shall demonstrate compliance with all the requirements specified in this document.
- Task 2: Manufacturing Preparation – The Contractor shall complete all steps to achieve manufacturing readiness of the VVPSS instruments in line with the requirements defined in this specification.
- Task 3: Manufacturing and Testing – The Contractor shall manufacture the VVPSS instruments and perform all the necessary inspections, qualifications and testing required by the design codes and this technical specification. The Contractor shall complete the Manufacturing dossier.
- Task 4: Delivery to the IO site - The Contractor shall prepare and complete the delivery of the VVPSS instruments to the IO site and hand over all the documentation required by this technical specification and design codes to IO.

NOTES:

- Several exchanges are foreseen between the Contractor and the IO during Task 1 to settle the technical solution and to achieve maturity of the IO design impacting the VVPSS instruments (Line routing, Process Schematic, Qualification of Equipment)
- Task 3 can only start after the completion of the VVPSS Final Design Review, expected in March 2026.

5 Acronyms & Definitions

5.1 Acronyms

The following acronyms are the main one relevant to this document.

24VP00	Vacuum Vessel Pressure Suppression System
24VPHM	Hydrogen Mitigation System
24VPRP	Relief Pipe System
ACS	Applicable Code and Standards
AD	Applicable Document
ANB	Agreed Notified Body
AOC	Award Of Contract
ASME	American Society of Mechanical Engineers
ASN	Autorité de Sûreté Nucléaire (French Nuclear Safety Authority)
ASTM	American Society for Testing and Materials
CNB	Neutral Beam Cell
CRO	Contract Responsible Officer
DAP	Delivery At Place
DIM	ITER Functional Number for Diaphragm, Venturi, Orifice Plate, Nozzle (Flow Measurement Primary Element)
DRR	Delivery Readiness Review
DTR	Drain Tank Room
DW	Dead Weight
ENF	Equivalent Neutron Fluence
ESP	Equipements Sous Pression (Pressure Equipment)

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ESPN	Equipements Sous Pression Nucléaire (Nuclear Pressure Equipment)
ESR	Essential Safety Requirement
FAT	Factory Acceptance Test
GM3S	General Management Specification for Service and Supply
HRA	Hazard and Risk Analysis
ICE	Ingress of Coolant Event
IDM UID	IO Document Management system Unique Identifier – Unique reference number for IO documents
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
MFT	ITER Functional Number for Flow Transmitter
MIP	Manufacturing and Inspection Plan
MRR	Manufacturing Readiness Review
MTE	ITER Functional Number for Temperature Primary Element and Transducer
MTH	ITER Functional Number for Temperature Switch (High Value)
MTO	Material Take Off
MTW	ITER Functional Number for Temperature Thermowell
NCR	Non-Conformity Request
NDE	Non-Destructive Examination
NDT	Non-Destructive Test
NPMA	Nuclear Particular Material Appraisal
NQA	Nuclear Quality Assurance
NRV	Non-Return Valve
OD	Outside Diameter
PED	Pressure Equipment Directive (equiv. ESP)
PIA	Protection Important Activity
PIC	Protection Important Component
PQR	Welding Procedure Qualification Record
PRO	Procurement Responsible Officer
PS	Maximum Allowable Pressure
PTC	Performance Test Code
PWHT	Post-Weld Heat Treatment
QA	Quality Assurance
QC	Quality class
QP	Quality Plan
RL	Relief Lines
RTPO	Recognised Third Party Organisation
SC	Seismic Category
SIC	Safety Importance Class

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SLT	Small LOCA Tank
SRD	System Requirement Document
SSC	Structures, Systems and Components
SSPC	Steel Structures Painting Council
TCWS	Tokamak Cooling Water System
TID	Total Ionizing dose
TNF	Total Neutron Flux
VST	Vapour Suppression Tank
VV	ITER Vacuum Vessel
VVPSS	Vacuum Vessel Pressure Suppression System
WPQ	Welder Performance Qualification
WPQR	Welding Procedure Qualification Record
WPS	Welder Performance Specification

5.2 Definitions

Contractor: shall mean an economic operator who have signed the Contract in which this document is referenced.

6 List of applicable and reference documents

6.1 References internal to IO

The design conditions of the instruments are taken from several internal IO documents. The necessary sizing data for the Contractor have been extracted by IO from those documents and are highlighted in this technical specification. These documents are listed in this section to enable clarity and changes tracking for IO but will not and need not be shared with the Contractor.

- [IO-1] Static and transient magnetic field maps at level B1 tokamak complex – IDM UID QDFMW9
- [IO-2] Static and transient magnetic field maps at level B2 tokamak complex – IDM UID QE42YB
- [IO-3] Static and transient magnetic field maps at level L3 tokamak complex – IDM UID QQGFU6
- [IO-4] Radiation Maps During Plasma Operations (Mode-0), extracted data – IDM UID RJLLFY
- [IO-5] Safety requirement Room book – IDM UID KF63PB
- [IO-6] Static and transient magnetic field maps at level L1 tokamak complex – IDM UID QQEB3J
- [IO-7] ESTM-57 EFE Signal conditioners SMF test procedure – IDM UID BGKGDU
- [IO-8] Technical Specification: Framework Supply Contract for SCWS-TCWS I&C cubicles – IDM UID 3YV4V5
- [IO-9] VVPSS Non-safety IO list – IDM UID BK89B6
- [IO-10] VVPSS safety IO list – IDM UID BJZPVE
- [IO-11] Vapour Suppression Tanks P&IDs – IDM UID 4CSLSL
- [IO-12] VVPSS HMS P&IDs – IDM UID 5PVPZU
- [IO-13] VVPSS Relief Pipes P&IDs – IDM UID 5PVJYK

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- [IO-14] Loads Case Specification VVPSS -RL – IDM UID UXX829
- [IO-15] Design Seismic Floor Response Spectra in the Tokamak Complex + annex– IDM UID SVBRJZ
- [IO-16] SL-3 Floor Response Spectra for Tokamak Complex – IDM UID SFSN7Q
- [IO-17] Tokamak Complex - Floor Response Spectra 2016 -Esteyco – IDM UID TFN4DN
- [IO-18] Suitability of B11, B14 & B74, anticipated after the implementation of PCR-755 and its daughter PCRs – IDM UID UX5RXG
- [IO-19] Thermal analysis for passive fire protection of the VVPSS lines – IDM UID 4XYEJG
- [IO-20] B11 & B74 - Requirements for Fire sensitive system – IDM UID 3VSJHD
- [IO-21] Guide for writing EPMN/PMA – IDM UID WSJQDH

6.2 Applicable Documents & Codes and standards for the Contractor

6.2.1 Applicable Documents

This is the responsibility of the Contractor to identify and request for any documents that would not have been transmitted by IO, including the below list of reference documents.

This Technical Specification takes precedence over the referenced documents. In case of conflicting information, this is the responsibility of the Contractor to seek clarification from IO.

Upon notification of any revision of the applicable document transmitted officially to the Contractor, the Contractor shall advise within 4 weeks of any impact on the execution of the contract. Without any response after this period, no impact will be considered.

- [AD- 1] General Management Specification for Service and Supply (GM3S) – IDM UID 82MXQK
- [AD- 2] VVPSS Flow Measurement Datasheet - IDM UID BGQXBT
- [AD- 3] VVPSS Temperature Measurement Datasheet – IDM UID BGR4R7
- [AD- 4] **Quality Requirements for IO Performers – IDM UID 22MFG4**
- [AD- 5] Instruction for Seismic Analysis – IDM UID VT29D6
- [AD- 6] Radioprotection guide for ESPN application – IDM UID 2LTQ96
- [AD- 7] ITER Numbering System for Components and Parts – IDM UID 28QDBS
- [AD- 8] Working Instruction for the Delivery Readiness Review (DRR) – IDM UID X3NEGB
- [AD- 9] Working Instruction for Manufacturing Readiness Review – IDM UID 44SZYP
- [AD- 10] Allowable values and limits in service level C and D for ITER mechanical components – IDM UID 3G3SYJ
- [AD- 11] Software Qualification Policy – IDM UID KTU8HH
- [AD- 12] VVPSS piping specification - thermowells – IDM UID 7WKMK5
- [AD- 13] VVPSS piping specification - flow measurement instruments MFT – IDM UID 7WLBG2
- [AD- 14] Requirements for DA / Supplier / Subcontractors Deviations & Nonconformities – IDM UID 22F53X
- [AD- 15] Quality Assurance for ITER Safety Codes Procedure – IDM UID 258LKL
- [AD- 16] Overall supervision plan of the chain of suppliers for Safety Important Components, Structures and Systems and Safety Related Activities – IDM UID 4EUQFL

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- [AD- 17] List of ITER–INB Protection Important Activities – IDM UID PSTTZL
- [AD- 18] Propagation of the Defined Requirements for Protection Important Components Through the Chain of External Interveners – IDM UID BG2GYB
- [AD- 19] Specification for Labelling of Equipment on ITER Project – IDM UID TL25DK
- [AD- 20] Delivery Report Template – IDM UID WZPYVZ
- [AD- 21] Package & Packing List Template – IDM UID XBZLNG
- [AD- 22] Release Note Template – IDM UID QVEKNQ
- [AD- 23] IO cable catalogue – IDM UID 355QX2
- [AD- 24] Plant Control Design Handbook – IDM UID 27LH2V
- [AD- 25] Plant Control Design Handbook for Nuclear Control System – IDM UID 2YNEFU
- [AD- 26] Qualification Guidelines – IDM UID WGFF3G
- [AD- 27] System Requirement (SRD) Document SRD-24-VP (VVPSS) – IDM UID 28B2U6
- [AD- 28] PBS 24 VVPSS for Defined Requirements – IDM UID Q9DVN3
- [AD- 29] VVPSS Maintenance & In-Service Inspection Plan – IDM UID 5TK43V
- [AD- 30] ITER Policy on EEE in Tokamak Complex – IDM UID 6ZX6S3
- [AD- 31] Implementation plan for design & manufacture of PE/NPE – IDM UID VE2DSP
- [AD- 32] List of manufacturing documents to be prepared and stored for PE and NPE – IDM UID WDBC7H
- [AD- 33] Implementation Plan for PE/NPE cat 0 or I – IDM UID YWDJW2

6.2.2 *Applicable Codes and Standards*

This is the responsibility of the Contractor to procure the relevant Codes and Standards applicable to that scope of work. The codes and standards that shall be used in this contract are listed in the table below. The use of 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 proposed codes and technical specifications, the Contractor shall justify the soundness of the design approach.

- [ACS- 1] ASME NQA-1 - Quality Assurance Requirements for Nuclear Facility Applications
- [ACS- 2] EN 10204 - Metallic products – Type of inspection documents
- [ACS- 3] ISO 17025 - General requirements for the competence of testing and calibration laboratories
- [ACS- 4] ISO 9712 - Non-destructive Testing - Qualification and Certification of NDT Personnel
- [ACS- 5] IEC 60068-3-3 - Seismic test methods for equipment
- [ACS- 6] ASME PTC 19.3 Thermowells
- [ACS- 7] IEC 60751 Industrial platinum resistance thermometers and platinum temperature sensors
- [ACS- 8] EN 13480 Metallic industrial piping
- [ACS- 9] ASME PTC 19.5 Flow Measurement
- [ACS- 10] IEC 61513 Centrales nucléaires de puissance - Instrumentation et contrôle-commande importants pour la sûreté - Exigences générales pour les systèmes
- [ACS- 11] IEC 62671 Nuclear power plants - Instrumentation and control important to safety - Selection and use of industrial digital devices of limited functionality

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- [ACS- 12] ISO 9001 Quality management systems – Requirements
- [ACS- 13] EN 1092-1 Flanges and their joints – Circular flanges for pipes, valves, fittings and accessories PN designated – Part 1: Steel flanges.
- [ACS- 14] EN 1515-4 Flanges and their joints - Bolting - Part 4: Selection of bolting for equipment subject to the Pressure Equipment Directive 2014/68/EU
- [ACS- 15] ASME B18.21.1 Heavy Helical Spring Lock Washers
- [ACS- 16] EN 1591 Flanges and their joints - Design rules for gasketed circular flange connections
- [ACS- 17] ISO 724 ISO general-purpose metric screw threads – Basic dimensions
- [ACS- 18] EN 10269 Steels and nickel alloys for fasteners with specified elevated and/or low-temperature properties
- [ACS- 19] EN 3834 Quality requirements for fusion welding of metallic materials
- [ACS- 20] EN 15614 Specification and qualification of welding procedures for metallic materials – Welding procedure test
- [ACS- 21] ISO 9692 Welding and allied processes — Types of joint preparation
- [ACS- 22] EN 2516 Aerospace series - Passivation of corrosion-resisting steels and decontamination of nickel base alloys
- [ACS- 23] SSPC-1 Solvent Cleaning
- [ACS- 24] SSPC-2 Hand Tool Cleaning
- [ACS- 25] SSPC-5 White Metal Blast Cleaning
- [ACS- 26] SSPC-10 Near-White Metal Blast Cleaning
- [ACS- 27] EN 17637 Non-destructive testing of welds - Visual testing of fusion welded joints
- [ACS- 28] EN 17636 Non-destructive testing of welds - Radiographic testing - Part 1: X- and gamma-ray techniques with film
- [ACS- 29] ISO 10675-1 Non-destructive testing of welds — Acceptance levels for radiographic testing — Part 1: Steel, nickel, titanium and their alloys
- [ACS- 30] EN 11666 Non-destructive testing of welds - Ultrasonic testing - Acceptance levels
- [ACS- 31] EN 17640 Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment
- [ACS- 32] EN 9606-1 Qualification testing of welders – Fusion welding – Part 1: Steels
- [ACS- 33] ASTM A262-15 Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels
- [ACS- 34] IEC 60529 Degrees of protection provided by enclosures (IP Code)
- [ACS- 35] NF C32-070 Insulated cables and flexible cords for installations - Classification tests on cables and cords with respect to their behaviour to fire
- [ACS- 36] IEC 60332 Tests on electric and optical fibre cables under fire conditions
- [ACS- 37] IEC 61034 Measurement of smoke density of cables burning under defined conditions
- [ACS- 38] IEC 60754 Test on gases evolved during combustion of materials from cables
- [ACS- 39] IEC 60331 Tests for electric cables under fire conditions - Circuit integrity
- [ACS- 40] IEEE 383 Standard for Qualifying Electric Cables and Splices for Nuclear Facilities
- [ACS- 41] IEC 60544 Electrical insulating materials - Determination of the effects of ionizing radiation on insulating materials
- [ACS- 42] EN 13555 Flanges and their joints - Gasket parameters and test procedures relevant to the design rules for gasketed circular flange connections
- [ACS- 43] NF EN 1991-1-2 paragraph 3.2.1 “standard temperature-time curve”

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6.2.3 *Applicable Orders and Directives*

The orders and directives that shall be used in this contract are listed in the table below.

- [AOD- 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
- [AOD- 2] ESPN - Order dated 30th of December 2015 on nuclear pressure equipment. Consolidated version after the 1st of January 2019 shall be taken into account.
- [AOD- 3] INB Order - Order dated 7 February 2012 relating to the general technical regulations applicable to INB
- [AOD- 4] ASN Guide #8 - Conformity Assessment of Nuclear Pressure Equipment - Version of 2012-09-04 – EN – IDM UID DU9A7L
- [AOD- 5] Arrêté du 20 novembre 2017 relatif au suivi en service des équipements sous pression et des recipients a pression simple
- [AOD- 6] ASN Guide #19 - Nuclear Pressure Equipment - Application of order dated 12/12/2005 - Version of 21-02-2013 – FR – IDM UID FXQ9NZ

7 General requirements applicable to all procurement lots

The quality classification for each item in the scope of supply is defined in [AD- 2] and [AD- 3]. For QC-1 items, the critical quality activities must be approved by IO before being undertaken. Throughout the document, special processes are identified. These special processes will require their procedures to be submitted to IO and accepted prior to their undertaking and reports submitted in the manufacturing dossier.

The "Primary elements" are pressure accessories in terms of PED/ESPN order and the Contractor is the regulatory manufacturer. The "Thermowells" are components of piping to be welded in terms of PED/ESPN order and the IO is the manufacturer. If the piping to which it is welded is under the ITER module H, the Thermowell shall follow the ITER module H requirement [AD- 31].

7.1 Units of Measurement

The supplied equipment as well as corresponding documentation shall use SI units.

7.2 Declaration of conformity to PED – ESPN regulations

The PED and ESPN classifications for each item in the scope of supply are defined in [AD- 2] and [AD- 3].

For ESPN equipment, the Contractor shall appoint an Agreed Notified Body (ANB) to perform the conformity assessment according to the module selected. A declaration of conformity shall be drawn up and signed certifying that the Primary Elements and Thermowells comply with the Essential Safety Requirements of the ESPN Order [AOD- 2].

When a non-NPE equipment has a PED class higher than “I”, the Contractor shall appoint a Notified Body (NB) to perform the conformity assessment [AOD- 1] and obtain the CE mark.

The procedure governing the conformity assessment of nuclear pressure equipment is determined by the Contractor based on its ESPN level and PED category. Even though it is the Contractor’s responsibility to choose, IO recommends the selection of B+F or G modules for those

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Contractors with no experience in ESPN assessments and module H or H1 for those Contractors with proven experience in ESPN regulations.

Particular attention should be paid to the list of documents to be generated by the Contractor, in agreement to [AOD- 1] and [AOD- 2], to properly assess the additional work required for the ESPN conformity assessment.

7.3 Design codes

Independently from the design code selected, the Contractor shall demonstrate the compatibility of the Primary Elements and Thermowells with the stainless-steel pipework, designed according to EN 13480 [ACS- 8].

The expected applicable design codes are specified in the body of this specification. The Contractor may propose alternative design codes where he believes adequate justification may be made. The alternative codes shall be accepted by IO. The responsibility of the Contractor is the full respect of PED/ESPN and the coverage of any gap between the PED/ESPN and the selected code.

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

7.4 Operating conditions

Operating and design conditions to be satisfied are given in [AD- 2] for Primary Elements and in [AD- 3] for Temperature Sensors and Thermowells and in the body of this specification. The design of each item shall satisfy the requirements of these specifications as a minimum. The Contractor is expected to supplement these with the Contractor's design and quality requirements.

Each item shall be designed for safe, proper and continuous operation over the design life of twenty-five (25) years, at their design conditions as specified in [AD- 2] and [AD- 3]. They shall also be designed to minimize fatigue, thermal transient effects, corrosion, deterioration, vibration, and other operational problems. They shall be designed to permit satisfactory operation at the pressure conditions, accelerations, temperatures, flow rates, differential pressures, system fluid and imposed loads.

7.5 Design calculation

Each item shall be demonstrated to withstand all the loads applied in normal and accidental conditions (temperature, pressure, interface, seismic, fire, radiation, electromagnetic, etc.). Reports for all analyses performed for the selected instruments shall be submitted to the IO for review and approval before the start of manufacturing.

[AD- 2] & [AD- 3] provided for procurement may not exactly match the products available from the Contractor. Therefore, in all cases, the Contractor shall provide engineering analysis documenting how the supplied items meet or exceed the requirements detailed in the datasheets. Alternatively, the Contractor may provide engineering recommendations as to available alternatives, including engineering analysis justifying their use in the intended application. All the equations used for the sizing of the instruments shall be explicitly described in the calculation note by the Contractor.

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7.5.1 Wake frequency (for Thermowells)

The Thermowells in the scope of supply have been preliminary sized in [AD- 3]. It is the responsibility of the Contractor to ensure that the mechanical design of the supplied Thermowells complies with ASME PTC 19.3 [ACS- 6]. The Wake frequency calculation report shall be shared with IO.

7.5.2 Interface load

The Contractor shall demonstrate the structural integrity of the pressure confinement boundaries by calculation. The allowable loads for Primary Elements with flanged end-connection shall be calculated according to EN 1591-1 [ACS- 16]. IO will provide the piping interface loads during the contract execution. Iteration on flange thicknesses may be required during the design phase.

7.5.3 Seismic Qualification

All items shall be capable of withstanding the accelerations associated with the seismic events without loss of confinement.

In [AD- 2] & [AD- 3], each item is classified as follow:

- Safety class:
 - Safety classified (SIC), if they contribute to a safety function
 - Non-safety classified (Non-SIC), if they do not contribute to any safety function.
- Seismic class:
 - SC-1 (SF) = Structural and functional performance shall be ensured
 - SC-1 (S) = Structural performance shall be ensured

As per the system design requirements [AD- 27], the following apply:

	SL-1	SL-2	SL-3
SIC	SF	SF	S
Non-SIC	SF	S	N/A

The seismic loads to withstand for SL-1, SL-2 and SL-3 events are given in Table 1, Table 2, Table 3 and Table 4.

The seismic qualification for SC1 (SF) and SC1 (S) rated items shall be provided by the Contractor. Qualification by analytical calculation is acceptable for mechanical integrity verification but qualification by test is expected for operability verification. The methodology for seismic qualification of instruments can be obtained from the ITER Instruction for Seismic Analysis [AD- 5].

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 60068-3-3 [ACS- 5].

It is recommended for the Contractor to provide a detailed quotation and planning of the activities that consider the selected seismic qualification.

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7.5.4 Load and Environmental Qualification

Two different plant conditions are expressed:

- Normal conditions: This corresponds to the normal operation of the plant and for which all systems are requested to operate properly. These conditions are encountered during the whole life of the plant (14 years of nuclear operation and 10 years of commissioning operation),
- Accident conditions: This corresponds to a highly degraded operation of the plant due to unlikely failures or highly hypothetical failure. Safety classified VVPSS instruments are requested to operate properly during accident conditions (with accepted partial degradation of performance). The accident conditions are encountered only once during the whole life of the plant. The negative effect of ageing on component shall be taken into account; that means the safety classified equipment shall operate properly throughout the whole life of the plant.

	Normal condition	Accident condition
Ambient room temperature	18 °C – 35 °C	5 °C - 130 °C [IO-5]
Ambient room humidity	20% RH – 60% RH	0% RH – 100%
Ambient room pressure	86 – 106 kPa	100 – 200 kPa [IO-5]
Static magnetic field (modulus)	< 20 mT [IO-1][IO-2]	
Transient magnetic field (modulus)	< 3.5 mT/s [IO-1][IO-2]	
Total Ionizing dose (TID, silicon based)	< 2.3E3 Gy [IO-4]	
Dose rate (Ionizing radiation dose, silicon based)	< 1.0 Gy/h [IO-4]	
Equivalent Neutron Fluence (ENF @ 1Mev, silicon based)	$\leq 4.2E18$ neutron.cm-2 [IO-4]	
Total Neutron Flux (TNF)	$\leq 2.4E5$ neutrons.cm-2.s-1 [IO-4]	
Seismic [IO-14][IO-15][IO-16][IO-17]	NO	SL-3: X-Y: 5.5 g/Z: 3.5 g SL-2: X-Y : 4.5 g/Z : 2.5 g SL-1: X-Y :1.5 g/Z : 1.0 g
Flooding - submergence	NO	NO
Fire event maximum temperature	NO	< 7.1 m: 142 °C 7.1 to 9.6 m: 277 °C > 9.6 m: 905 °C [IO-20]

Table 1: 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 °C – 35 °C	5 °C - 130 °C [IO-5]
Ambient room humidity	20% RH – 60% RH	0% RH – 100%
Ambient room pressure	86 – 106 kPa	100 – 200 kPa [IO-5]
Static magnetic field (modulus)	< 7.5 mT [IO-2][IO-3]	
Transient magnetic field (modulus)	< 1 mT/s [IO-2][IO-3]	
Total Ionizing dose (TID, silicon based)	< 1.2 Gy [IO-4]	

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Dose rate (Ionizing radiation dose, silicon based)	< 2.1E-4 Gy/h [IO-4]	
Equivalent Neutron Fluence (ENF @ 1Mev, silicon based)	$\leq 2.6E13$ neutron.cm-2 [IO-4]	
Total Neutron Flux (TNF)	≤ 4.3 neutrons.cm-2.s-1 [IO-4]	
Seismic [IO-14][IO-15][IO-16][IO-17]	NO	SL-3: X-Y: 1.5 g/Z: 6.5 g SL-2: X-Y : 1.0 g/Z : 5.0 g SL-1: X-Y : 0.5 g/Z : 2.0 g
Flooding - submergence	NO	NO
Fire event maximum temperature	NO	SIC: ISO 834 [ACS-43][IO-20] / Non-SIC: N/A

Table 2: Environmental conditions applicable in the field (process area) in 11-L3-02E TCWS Area East

	Normal condition	Accident condition
Ambient room temperature	18 °C – 35 °C	5 °C - 345 °C [IO-5]
Ambient room humidity	20% RH – 60% RH	0% RH – 100%
Ambient room pressure	86 – 106 kPa	100 – 200 kPa [IO-5]
Static magnetic field (modulus)	< 75 mT [IO-6]	
Transient magnetic field (modulus)	< 15 mT/s [IO-6]	
Total Ionizing dose (TID, silicon based)	< 1.6E5 Gy [IO-4]	
Dose rate (Ionizing radiation dose, silicon based)	< 3.1E3 Gy/h [IO-4]	
Equivalent Neutron Fluence (ENF @ 1Mev, silicon based)	$\leq 7.6E21$ neutron.cm-2 [IO-4] (1)	
Total Neutron Flux (TNF)	$\leq 1.1E10$ neutrons.cm-2.s-1 [IO-4]	
Seismic [IO-14][IO-15][IO-16][IO-17]	NO	SL-3: X-Y: 1.5 g/Z: 4.0 g SL-2: X-Y : 1 g/Z : 3.0 g SL-1: X-Y : 0.5 g/Z : 1.0 g
Flooding - submergence	NO	NO
Fire event maximum temperature	NO	SIC: ISO 834 [ACS-43][IO-20] / Non-SIC: N/A

Table 3: Environmental conditions applicable in the field (process area) in 11-L1-CNB Neutral Beam Cell

	Normal condition	Accident condition
Cubicle temperature	10 °C – 15 °C [IO-8]	-15 °C - +60 °C [IO-5]
Ambient room humidity	20% RH – 60% RH	0% RH – 100%
Ambient room pressure	86 – 106 kPa	84 – 120 kPa [IO-5]
Static magnetic field (modulus)	< 20 mT [IO-7]	
Total Ionizing dose (TID, silicon based)	SIC: ≤ 1 Gy (2) [IO-18] Non-SIC: ≤ 10 Gy (3) [IO-18]	

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Equivalent Neutron Fluence (ENF @ 1Mev, silicon based)	SIC: $\leq 1E8$ neutron.cm-2 (2) [IO-18] Non-SIC: $\leq 1E10$ neutron.cm-2 (3) [IO-18]	
Total Neutron Flux (TNF)	SIC: ≤ 10 neutrons.cm-2.s-1 (2) [IO-18] Non-SIC: ≤ 100 neutrons.cm-2.s-1 (3) [IO-18]	
Seismic [IO-14][IO-15][IO-16][IO-17]	NO	SL-3: N/A SL-2: X-Y: 1.5 g/Z: 4.0 g SL-1: X-Y: 0.5 g/Z: 1.5 g
Flooding - submergence	NO	NO
Fire event maximum temperature	NO	N/A

Table 4: Environment conditions applicable in the shielded area (inside SIC and Non-SIC cubicles [IO-9][IO-10])

- (1) Based on 1% of total fluence during DT-1 operation.
- (2) ITER Maximum threshold for critical electronic functions
- (3) ITER Maximum threshold for non-critical electronic functions

In [AD- 2] & [AD- 3], the installation room is given for each item [IO-11][IO-12][IO-13]. The conditions in each room are defined below:

- In Table 1 for all items located in the 11-B2-01 & 11-B1-01 Drain Tank Room (DTR)
- In Table 2 for all items located in the 11-L3-02E TCWS Area East,
- In Table 3 for all items located in the 11-L1-CNB Neutral Beam Cell.

The electronic parts can be deported in cubicles with less stringent environment conditions, defined in Table 4.

7.5.4.1 Electromagnetic field

The general approach is to select passive sensors installed in field while electronic is deported to shielded area (cubicles).

Deviation from this approach could be granted by IO as long as the Contractor can demonstrate that sensors are suitable to operate under applicable environmental conditions as defined in Table 1, Table 2 and Table 3.

All component deported in the shielded area (cubicle) shall account for the electromagnetic load as specified in Table 4. This includes notably signal conditioners.

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. IO has an in-house static magnetic field-testing facility and can perform testing on behalf of the Contractor.

7.5.4.2 Irradiation and neutron flux

It should be noted that there is a very significant level of irradiation as a normal condition (and not only accidental condition) in ITER and it needs to be considered in the design of SIC as well as Non-SIC items (Table 1, Table 2 and Table 3). Very high neutron flux is present in ITER which is known as problematic for electronic devices due to Single Effect Event as encountered in aeronics and aero-spatial industry.

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7.5.4.3 Environment ambient conditions

Environmental qualification of the instruments shall be performed at the bounding environmental conditions defined in Table 1, Table 2, Table 3 or Table 4, depending on their location, to evaluate the function of the instrument components whose failure could prevent the instruments from performing the intended function. The qualification thresholds shall account for the values given in ITER Policy on EEE in Tokamak Complex [AD- 30].

For the adequate qualification of the instruments to operate in the accident conditions (defined in Table 1, Table 2, Table 3 or Table 4), the pressure and temperature profiles versus time used in the qualification test campaign shall be approved by IO.

The requirements for resistance to accident ambient conditions are as follow:

- SIC items: Structural integrity and functional performance shall be ensured,
- Non-SIC items: Structural integrity shall be ensured.

7.5.4.4 Fire

The contractor shall specify the maximal operating temperature without degradation of performance, as well as the maximal temperature to which the sensor and/or primary element can be subjected during fire accident.

The requirements for resistance to fire are listed in the table below (S: Structural integrity shall be ensured & SF: Structural integrity and functional performance shall be ensured & N/A: no requirement):

Scope	24VPRP	24VP00	24VPHM
SIC sensor	SF	SF	N/A
SIC Primary Element & Thermowell	SF	SF	S
Non-SIC Sensor, Primary Element & Thermowell	N/A	N/A	N/A

Integrity is demonstrated as no loss of confinement after two hours. Integrity and functional performance are defined as no loss of confinement and sensor functionality after two hours.

The maximum temperature achieved during a fire event is given in Table 1, Table 2 and Table 3. The elevation of components to assess the maximum temperature in the DTR (Table 1) are given in [AD- 2] and [AD- 3]. The Contractor shall note that IO will provide fire protection on piping system, hence Flow Primary Elements and Thermowells will be protected by insulation.

The Contractor shall either design the sensor and/or primary element for the maximum fire temperature achieved or specify the required thickness of the fire protection to be installed to protect the structural integrity and/or functionality of the sensor and/or primary element. If a specific fire protection equipment, such as an enclosure for the sensor, is deemed required and the Contractor has the capacity to include it in its scope of supply, it should be included in the quote as an option.

Any supplied equipment shall be specified to minimize the fire-load.

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7.5.4.5 Neutron irradiation

The instruments in the field and the components deposited in shielded area (cubicles) are submitted to irradiation during ITER plasma operation. The irradiation dose is provided in Table 1, Table 2, Table 3 or Table 4, depending on their location. The Contractor shall demonstrate that the supplied instrument and all related components are qualified against the given thresholds, particularly if equipped with electronic devices. The doses provided by IO shall be used as input for the development of the Maintenance Plan, as it is part of the input data needed from ESPN point of view.

7.5.4.6 Dust

For a number of Primary Elements as defined in [AD- 2], activated tungsten particles may be present in the gaseous stream. The dust is very fine with an average particle diameter of 2 μm and a maximum particle size of 44 μm .

7.6 Hazard and Risk Analysis

As the manufacturer of the Primary Flow Elements, the Contractor will produce their Hazard and risk analysis. As the manufacturer of the Thermowells, IO will produce their HRA.

7.7 Material requirements

The material selected for the VVPSS instruments is 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 EN 1.4307, grade 304L. The stainless-steel material shall be suggested by the Contractor and submitted to IO for review and approval. If available, and if cold working is anticipated during manufacturing, the preferred grade is 316L.

To ensure the VVPSS meets the radioprotection guidelines as stipulated in the Radioprotection Guide for ESPN Application [AD- 6], strict requirements are placed on the chemical composition of Cobalt, Niobium, and Tantalum in the materials for the instruments. 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 5 sets additional requirements for the impurities’ maximum concentration.

Location	Composition, % (Maximum, unless otherwise indicated)		
	Cobalt	Niobium	Tantalum
11-B1-01 11-B2-01	<0.2	<0.1	<0.1
11-L3-02E 11-L1-NBC	< 0.05	<0.1	<0.01

Table 5: Maximum Impurities Content for VVPSS instruments

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.

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

Fire resistance material with no or low flammability shall be selected to the extent practical.

7.7.1 *Prohibited materials*

The Contractor shall be aware of the following requirements, related to the prohibited materials:

- Mercury shall not be used in any manner, including the construction of the instruments, which can result in the exposure of instrument parts to the metal or its vapour.
- 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 instrument material 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 for the instrument shall be reported to IO and its use shall be subjected to IO approval.
- The use of materials containing asbestos shall be prohibited.

7.7.2 *Material testing requirements*

As the manufacturer of the Thermowells, IO will provide their Nuclear Particular Material Appraisal (NPMA). The Contractor needs to provide the inspection documents (type 3.1 or 3.2) for the thermowells, in final product condition.

The Contractor needs to establish the PMA/NPMA for the equipment (Primary Flow Elements) whose PED category is equal to or higher than I. The requirement for material testing shall be in line with the PMA/NPMA. [AOD- 1][AOD- 2]

Inspection document showing that required tests have been carried out at the source should be submitted. Type 3.1 certificate of EN 10204 [ACS- 2] 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 material Manufacturer is not able to issue the type 3.1, type 3.2 shall be provided. Type 2.2 needs to be provided for gasket and filler metal.

If there are missing test results in comparison with the NPMA, the NB/ANB needs to validate the dedicated test programs. The NB/ANB is then in charge of the conformity assessment.

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.

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 of the instruments. The method of marking and marking procedures are subject to IO acceptance.

Stainless steel sensitisation shall be tested according to ASTM A262-15 [ACS- 33] Practice A+E.

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7.7.3 Impact and Tensile test

Mechanical properties shall be obtained from test specimens representing the final heat-treated condition of the material required by the specification. As specified in [AD- 2] & [AD- 3], the tensile and impact tests do not need to be carried out at operating temperature. The impact test does not need to be performed if elongation at break (A5d) ≥ 45 % at room temperature. [IO-21]

As above-mentioned, as part of the conformity assessment, the Contractor shall demonstrate compliance with those testing requirements defined by the PED [AOD- 1] and ESPN [AOD- 2] Essential Safety Requirements as well as those defined by the design code selected.

All tests shall be carried out by an ISO 17025 [ACS- 3] accredited laboratory.

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

7.7.4 Traceability

The Contractor shall have traceability procedures in place that will guarantee traceability between materials delivered and from the beginning of manufacturing. These procedures shall be submitted to and approved by the IO prior to the start of any manufacturing. Traceability shall be maintained by procedural methods that cover receipt, identification, storage, and transfer to production, temporary storage and for use in production.

7.7.5 Counterfeit Materials

The Contractor shall include a section in the Quality Plan that defines the measures put in place to avoid the procurement of counterfeit materials.

The full supply chain for all materials that become part of the Flow Primary Elements and Thermowells (pressure boundary) shall be provided in a document to be presented at the Manufacturing Readiness Review.

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

7.7.6 Technical Qualifications

When a technical qualification is required, the Contractor must demonstrate that the manufacturing operations selected for the component subject to this technical qualification will ensure that the risks of heterogeneity among its mechanical and chemical characteristics are controlled.

7.8 Flanged connections

For preparing flanged ends with flange facing, nut-bearing surfaces, outside diameter, thickness, and drilling, IO recommends using EN 1092-1 [ACS- 13]. The Contractor is responsible for providing the pressure class of the selected flanges, based on the PS/TS.

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IO recommends the use of weld-neck type flanges, which provide a smooth transition between the Primary Element and the pipeline and minimize the pressure drop. 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 [ACS- 13].

Primary Elements that are listed as being supplied with flanged ends per [AD- 2] shall be provided with two counter-flanges, and adequate bolts, nuts, washers, and gaskets as described below:

- Counter-flanges: Counter-flanges shall be supplied with each flanged Primary Element. The counter flanges shall match the Primary Element's class and for their procurement/fabrication, IO recommends using EN 1092-1 [ACS- 13].
- Bolts: Bolting for the flanged connections shall be supplied with each flanged Primary Element and should conform to EN 1515 [ACS- 14]. 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 flanged Primary Element and should conform to EN 1515 [ACS- 14]. The material selection shall be based on the assembly requirements to achieve leak tightness.
- Washers: Washers (lock or Belleville) shall be supplied with each flanged Primary Element, as described in ASME B18.21.1 [ACS- 15].
- Gaskets: Gaskets shall be supplied with each flanged Primary Element. The gaskets should conform to EN 1591 [ACS- 16] to ensure compliance with leak tightness requirements.

The items provided shall be adequate for the Primary Element 's class with which they are supplied.

Threaded fasteners shall have M series threads conforming to ISO 724 [ACS- 17]. All threaded pressure-retaining fasteners shall be provided with corrosion-resistant locking devices.

All nuts and bolts shall have hexagonal heads unless otherwise specified.

The minimum strength of the material used for the nuts and bolts shall meet the requirements of EN 10269 [ACS- 18].

The Contractor is requested to verify that external leak rate complies with the leak rate of L0.001 according EN 1591 [ACS- 16] and EN 13555 [ACS- 42], taking into account the interface loads from the associated piping generated during all plant conditions.

7.9 Welded joints

Welding activities are considered "Special Processes".

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 joint welds shall be full penetration. No threaded joints or socket welds shall be used.

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

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All repairs, re-work, or scrapping shall be documented and records maintained for each specific item. The base metal repair welding shall be treated through IO NCR database. The location and size of the repairs shall be recorded in the as-built drawing. 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 repairing procedure shall follow prescriptions stated in EN 13480 [ACS- 8].

Production welding operations may only be undertaken provided the following requirements are met:

- Personnel satisfy the requirements of EN 13480 and EN 3834-2 [ACS- 19],
- The filler materials shall have Inspection Certificate type 2.2 as per EN 10204 [ACS- 2],
- Welding procedures have been qualified in accordance with EN 15614 [ACS- 20],
- The edges to be welded shall be prepared in accordance with EN 13480 [ACS- 8],
- 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 and by grinding and/or milling.

The Welding procedure qualification records and welder performance qualification shall be approved by a notified body or RTPO and shall be verified by IO and the NB/ANB as part of the conformity assessment.

7.9.1 Preparation for Welding

Preparation of welding should comply with EN 13480 [ACS- 8] and ISO 9692 [ACS- 21].

Weld over thicknesses shall not exceed the tolerances given in EN 13480 [ACS- 8]. If they exceed grinding or machining should be applied.

The edges to be welded shall be kept in the position, either by mechanical means temporary attachments, by tack welding or by a combination. Inspections before and after alignment shall be carried out.

The cleaning of internal and external surfaces should conform to EN 2516 [ACS- 22].

7.9.2 Surface Preparation Requirements

Selection, qualification, and application of coating materials should follow applicable sections of the Steel Structures Painting Council (SSPC) specifications. Surface preparation activities should be by the following standards or recommended practices as applicable: SSPC-SP-1 [ACS- 23], SSPC-SP-2 [ACS- 24], SSPC-SP-5 [ACS- 25], and SSPC-SP-10 [ACS- 26].

Surface roughness (Ra) shall not exceed 3.2 µm.

Weld joint preparation shall not be performed by thermal processes.

All coating systems must be applied following the Contractor's recommendations. The blast cleaned surfaces shall be coated with the base coat within 4 hours after blasting and before rusting occurs. All surface preparation and painting work shall be done after the visual examination, as part of the final assessment, and be subjected to the approval of IO. Colour selection shall be subject to IO's approval before the topcoat application.

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7.10 Manufacturing Readiness Review

Following the approval of the IO Final Design Review currently scheduled in March 2026, a Manufacturing Readiness Review (MRR) shall be conducted in line with [AD- 9] and closed (by the IO) enabling 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 (Inspection document),
- Engineering (Structural) analysis,
- Personnel qualification.

In addition, when relevant according to the PE/NPE classification defined in [AD- 2]&[AD- 3], the Contractor shall provide the documents listed in Appendix I of [AD- 32] that are available at the stage of the MRR, except those free-issued by IO as listed in Paragraph 14.1.

7.11 Manufacturing, Inspection and Testing

Before the Manufacturing operations, a Manufacturing and Inspection Plan shall be prepared by the Contractor as detailed in Section 11.3.2. Inspection, examinations and tests shall be conducted to provide compliance with PED/ESPN Essential Safety Requirements [AOD- 1][AOD- 2].

Non-destructive examinations (NDE) shall be performed on the cast, forged, rolled, wrought, or fabricated material after heat treatment required by the material specification. Surfaces shall be clean and free of surface conditions that may mask unacceptable indications.

Examination personnel must be approved by a Notified Body or a third-party recognized by a Member State. All NDE personnel qualifications shall conform to the following requirements:

- Personnel shall be qualified in accordance with ISO 9712 [ACS- 4].
- The third party or NB/ANB shall check that the qualifications of the personnel responsible for NDE are valid in terms of time and appropriateness for the work to be carried out.

The IO reserves the right to inspect all Non-Destructive Examination (NDE) reports for auditing purposes. NDE reports shall be catalogued according to the weld maps. Additional documents outside this specification's scope will provide detailed instructions for the commissioning of the components.

7.11.1 Visual Examination

Visual examination is considered a "Special Process".

Visual and dimensional control shall be conducted according to EN 17637 [ACS- 27] 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 on all Primary Elements is required. The purpose of the visual inspection is to verify all surfaces are free of cracks, hot tears, arc strikes, marks and/or other detrimental discontinuities. All finished welds shall be subject to

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visual examination. The Contractor is responsible for filling the gap between the design code selected and the PED/ESPN Essential Safety Requirements [AOD- 1][AOD- 2].

7.11.2 Volumetric Examination

For PED/ESPN components, all pressure boundary welds shall be 100% volumetrically inspected. The Contractor may choose Radiography or Ultrasonic inspection as appropriate.

Full volumetric inspection shall be performed also on end-connections. The Contractor shall ensure that the weld configuration allows the 100% volumetric inspection at the ITER site.

7.11.2.1 Radiography inspection

Radiography examination is considered a “Special Process”

IO recommends the use of EN 17636 [ACS- 28] and ISO 10675-1 [ACS- 29] for the radiographic procedures and acceptance criteria. The Contractor is responsible for filling the gap between the design code selected and the PED/ESPN Essential Safety Requirements [AOD- 1][AOD- 2].

7.11.2.2 Ultrasonic inspection

Ultrasonic examination is considered a “Special Process”.

IO recommends the use of EN 11666 [ACS- 30] and EN 17640 [ACS- 31] for the ultrasonic examination of casting products. The Contractor is responsible for filling the gap between the design code selected and the PED/ESPN Essential Safety Requirements [AOD- 1][AOD- 2].

7.11.3 Surface Examination

Surface examination is considered a “Special Process”.

When an item is classified non-ESPN and 100% volumetric inspection is not required, all exterior and all accessible interior surfaces shall be given a surface examination.

7.11.4 Wall thickness measurements

Dimensional inspection is considered a “Special Process”.

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

7.12 Factory Acceptance Testing

All components shall be tested to confirm their performances in line with the Manufacturing and inspection plan. This shall include as a minimum the following:

- Proof test
- Leak test
- Visual inspection
- Calibration test: The Contractor shall ensure the performance of sufficient calibration of the delivered equipment to ensure that the specified measurement uncertainties are met.

All documentation shall be provided to IO for approval prior to shipment.

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7.13 Final Assessment Procedure

As part of the PED/ESPN conformity assessment, the following sequence of tests shall be performed:

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

7.13.1 Document Check

As defined in Section 7.2, the Contractor shall be responsible for the PED/ESPN conformity assessment procedure. The full list of documents to be produced during the different design, manufacturing and testing phases is provided in [AOD- 4].

As-built drawing shall be prepared before final visual inspection.

7.13.2 Pressure Test

Pressure testing is considered a “Special Process”.

The Primary Elements / Thermowells shall be pressure tested in agreement with their specifications [AD- 2][AD- 3]. These tests shall be conducted after all **manufacturing** activities. The Contractor shall prepare and submit the pressure test procedures for the IO review and approval. The minimum test pressure shall conform to the PED [AOD- 1].

After this pressure test, if any operation might jeopardize the compliance of this equipment with ESR, new pressure test shall be performed again.

7.13.3 Visual Examination

Visual examination shall be performed according to Section 7.11.1.

Final visual inspection shall be done two times, before pressure test and after pressure test.

Final visual inspection before pressure test shall be done on all internal and external surfaces based on the as-built drawing. If some areas cannot be inspected during final visual inspection before pressure test (i.e., shell surface covered with support or pad), those area shall be identified at the design phase and final visual inspection during manufacturing at the last step shall be performed and recorded.

7.14 In-Service Inspection and Maintenance

The scope of this specification shall include technical field support and consultation services during the installation, initial operation of all equipment furnished, performance testing and training of IO operating and maintenance personnel.

Primary Elements shall be designed to permit inspection, satisfying the provisions given by Instruction manual which shall be prepared by Contractor, in ESPN [AOD- 2] and in [AOD- 5].

The minimum periodicity for preventative maintenance shall be 5 years. The minimum periodicity for in-service inspection shall be more than 18 months.

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For those surfaces classified as “non-visually inspectable areas”, the Contractor shall propose the IO equivalent areas to be inspected.

The Contractor shall include in the operation and maintenance manual instructions on how the internal and external inspections can be undertaken. Any tools required to perform the above inspections shall be included in the scope of supply of this contract (excluding cameras or endoscopes).

The parts requiring adjustment, inspection, or repair shall be accessible and capable of convenient removal, cleaning, replacement, and repair.

Equipment and subcomponents of the equipment that are not demonstrated to achieve a design life of 25 years without replacement shall be designed with a replacement interval of no less than 48 months.

A list of these spare parts and recommendation for their shelf life shall be well indicated in the Instruction Manual. The scheduling of the verification and replacement of these subcomponents shall also be included in the Instruction Manual.

The Contractor shall provide the requirements for periodic calibration and preventive maintenance.

7.15 Handling

Primary Elements above 20 kg shall be provided with a method of handling, such as lugs or eyebolts, to allow easy removal/maintenance and limit the exposure of workers to radioactive material. The Primary Elements shall be designed for transporting and lifting in both vertical and horizontal positions.

Each hanging/lifting lug shall be designed to support 175% of the dry weight of the respective component. Lifting and handling condition shall be considered for design. Any lug permanently attached to the shell shall be performed as per WPQR; approved by NB or RTPO, by qualified welder approved by NB or RTPO.

7.16 Cleanliness and Packaging

7.16.1 Cleanliness Requirements

The “wet” surfaces of the Primary Elements/Thermowells shall meet the requirements for ASME NQA1 [ACS- 1] Table 302.5 Class B cleanliness.

The other surfaces of the Primary Elements/Thermowells shall meet the requirements for ASME NQA-1 [ACS- 1] Table 302.5 Class C cleanliness 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 Contractor shall submit to the IO the proposed cleaning procedure for approval/acceptance.

Any expendable materials that come in contact with the Primary Elements/Thermowells shall minimize 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. 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,

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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 by other metallic products. The Contractor shall demonstrate how they achieve segregation of stainless steel and carbon steel materials in their tender offer. In case of proven contamination of stainless steel by carbon steel, contractor shall perform pickling and passivation of the contaminated material. Pickling and Passivation shall be considered as a “special process”.

Before the start of fabrication, when such materials are used, a listing of proposed materials and products to be used on the Primary Elements/Thermowells for the expendable products covered by this specification, along with a Certified Product Report for each product, shall be submitted to the IO for approval and NB/ANB if needed. 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.

All water used for cleaning and hydrotesting shall meet the requirements of ASME NQA-1, Part II, Subpart 2.1, Section 304.1, Water [ACS- 1] for hydrotesting and Grade A water quality according to RCC-M 2012, Annex F-III for cleaning.

7.16.2 Marking and Labelling

The Contractor shall employ a material marking system that ensures the control of the material used in the manufacture of the Primary Elements/Thermowells.

For stainless steel materials, electrochemical etching may be used. Etching must be performed to a written procedure and the fluids used must be certified to contain less than 100ppm 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- 19].

Final nameplate information shall be approved by IO. In case of PED/ESPN equipment, the nameplate shall be prepared as per PED ESR 3.3 [AOD- 1].

7.16.3 Packaging Requirements

All components requiring re-assembly at the ITER Site shall be clearly labelled and tagged.

All Primary Elements/Thermowells shall be prepared for shipment so that handling and unloading may be facilitated. At no time are Primary Elements/Thermowells, or accessories to be shipped in a disorderly arrangement or situation of disarray to promote damage or hamper inspection of the Primary Elements/Thermowells when received on the job site.

The Contractor shall design and supply appropriate packaging, adequate to prevent damage during shipping lifting and handling operations. 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.

Each shipment shall be accompanied by a Delivery Report shall be prepared by the Contractor, stating as a minimum:

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- The packing date,
- The full address of the place of delivery and the name of the person responsible for receiving the package, as well as the Contractor's name and full address,
- Bill of Materials,
- Security Measures,
- Release Note,
- Packing List,
- Material Safety Sheet,
- The declaration of integrity of the package,
- The declaration of integrity of the components,
- Any additional relevant information on the status of the components.

7.16.3.1 Primary Elements/Thermowells

The packaging for Primary Elements/Thermowells shall meet the minimum requirements of ASME NQA-1, Para. 302.3 Level B [ACS- 1], for overseas shipment, and the additional requirements stated herein.

Packaging of the Primary Elements/Thermowells shall be provided to ensure adequate protection, yet still allow adequate thermal breathing, during transport and delivery, on-site storage before installation, and during the idle period after the Primary Elements/Thermowells are installed and awaiting operations.

Packaging and shipping details, including drawings, shall be prepared by the Contractor and submitted for review and acceptance before shipment.

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

The interior of the Primary Elements/Thermowells shipping package shall provide moisture control during shipping. A maximum allowable relative humidity of 60% shall be required.

For Primary Elements/Thermowells, any open ends shall be properly cleaned and then securely fitted with plastic or wooden caps. The Primary Elements/Thermowells shall then be enclosed in clean, heavy-duty plastic and openings tightly sealed. Small openings shall be sealed by use of small light stainless-steel metal or plastic inserts pressed in and retained with a seal of waterproof tape.

7.16.3.2 Temperature Sensors

The packaging for the temperature sensors shall meet the minimum requirements of ASME NQA-1, Para 302.3 Level B [ACS- 1], for overseas shipment.

For temperature sensors, any open ends shall be properly cleaned and then securely fitted with plastic or wooden caps. A method of moisture control shall be provided for the packaging of the temperature sensors. The temperature sensor shall then be enclosed in clean, heavy-duty plastic and openings tightly sealed. Small openings shall be sealed by use of small light stainless-steel metal or plastic inserts pressed in and retained with a seal of waterproof tape

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8 Scope of Supply

This section defines the specific scope of work, in addition to the contract execution requirement as defined in [AD- 1].

8.1 Scope of Supply Overview

The Contractor shall submit a proposal to provide items requested in this specification meeting all applicable requirements. The supply of instrumentation is divided into procurement lots as indicated in Table 6 and Table 7.

Depending on the bidder's capability they may submit bid covering one or several procurement lots, but as minimum the bid shall cover all the equipment in one lot.

The scope of supply for each procurement lot is defined in Sections 8.2 and 8.3.

The preliminary number of sensors for the VVPSS covered in this specification is listed in Table 6 and the preliminary number of mechanical components associated with the sensors is listed in Table 7.

Measurement type	Code	Lot	Number of sensors	
			SIC	Non-SIC
Flow	MFT	1	0	0
Temperature – thermowell mounted	MTE	2	20	26
Temperature – thermowell mounted	MTH	2	20	0
Temperature – surface mounted	MTE	2	2	4

Table 6: overall scope of supply for sensors [IO-9][IO-10][IO-11][IO-12][IO-13]

Component type	Code	Lot	Amount
Flow Primary Element	DIM	1	10 gas + 10 liquid
Thermowell	MTW	2	20

Table 7: overall scope of supply for mechanical components [IO-11][IO-12][IO-13]

8.2 Procurement Lot #1 – Primary Elements

8.2.1 Scope

The Procurement Lot 1 covers flow measurements.

The Contractor shall supply as a minimum:

- Primary elements based on differential pressure measurement that fulfil all requirements imposed in this document and in the datasheet [AD- 2].
- Flow conditioners if necessary to achieve the performance given the available straight length [AD- 2]. The Contractor shall supply all items to integrate the Flow Conditioner in the Piping.

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- Comprehensive list of manufacturers recommended Spare Parts.

The flow measurement sensors (differential pressure sensors) are not in the scope of supply, neither the connection lines from the Primary Element to the Sensor.

8.2.2 Design requirements

Primary element types have been preselected and pre-sized for each item based on the process fluid, the expected Reynolds, the pipe size, the available straight length and the dust load [AD- 2]. The Contractor shall advise if another type is more suited for each application and preform the final sizing according to the maximum available pressure drop. The Primary Elements shall comply with ASME PTC 19.5 [ACS- 9]. One exception is 24VPHM-DI-1050: for this item, IO fully imposes the geometry of the primary element as per Figure 1. The Contractor shall define the position of the pressure tapings and calibrate the primary element as per the data in the flow measurement datasheet [AD- 2].

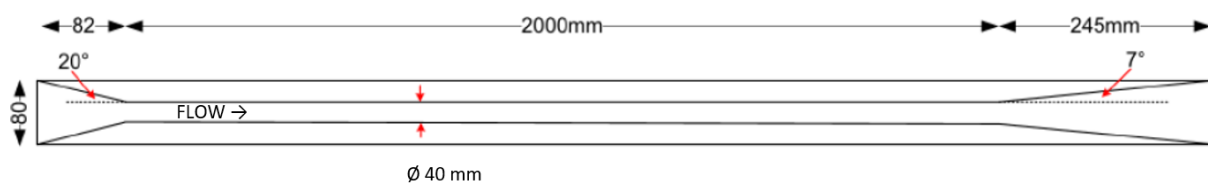


Figure 1: Primary element geometry for 24VPHM-DI-1050

An uncertainty of $\pm 1.5\%$ of the measurement range is requested for the Primary Element. This uncertainty is requested at the desired operated flow range provided in [AD- 2].

The taping for the impulse lines will be implemented on the Primary Elements or the Flanges depending on the technology. The taping points are in the scope of the Contractor. The number of taping points for the impulse lines and the type of connections are specified in [AD- 2]. Impulse line tubing specifications are OD 12.7 mm (1/2 inch) and thickness 1.245 mm (0.049 inch). The detailed piping connection and installation preliminary specification for the VVPSS flow measurement is available in [AD- 13]. It will be revised based on the detail engineering solution resulting from this procurement.

8.3 Procurement Lot #2 – Thermowells & temperature sensors

8.3.1 Scope

The Procurement Lot 2 covers temperature measurements and the associated thermowells. The scope is detailed in [AD- 3].

The Contractor shall supply as a minimum:

- Resistance Temperature Detectors (Pt100) matching the thermowell design when Thermowell-mounted or adapted to the process pipe when surface-mounted,
- Thermowells when included in the scope,
- Signal transmitters which will provide 4-20 mA signal output (for safety classified measurements),
- Comprehensive list of manufacturers recommended Spare Parts.

The Non-SIC resistance sensors will be connected directly to the RTD input card of the PLC and therefore no transmitter is required.

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Several Thermowells are already procured and installed and are therefore not in the scope of supply. The detailed scope is given in [AD- 3].

The insulation is not in the scope of supply.

Connector from the sensor to the cable and from the cable to the junction box shall be in the Contractor's scope of delivery.

The cable selection and design is in the scope of the Contractor and shall comply with IO requirements. It is appreciated that the cable reference is part of the IO Cable Catalogue [AD- 23]. The supply of the cables is IO's scope.

8.3.2 Design requirements

The detailed piping connection and installation specification for the VVPSS temperature measurement as well as the drawings of the Thermowells that are not in the scope of supply but for which the paired sensor is to be supplied by the Contractor are available in [AD- 12].

8.3.2.1 Thermowells

The mechanical design of the thermowells, in the scope of supply, shall comply with ASME PTC 19.3 TW [ACS- 6]. Given the large number of dynamic process conditions in the VVPSS system, all the thermowells in the scope of supply, have been pre-sized to avoid the risks inherent to the wake frequency in all operating conditions.

All the thermowells in the scope of supply will be directly welded into the pipe. They shall have tapered shank. The sizing is given in [AD- 3].

The sizing of thermowells on the Recombiner Heater (24VPHM-MTW-8061, 24VPHM-MTW-8062, 24VPHM-MTW-8161 and 24VPHM-MTW-8162) will be defined by IO during the design phase.

8.3.2.2 Temperature Sensors

Temperature measurements shall be based on RTD Pt100 sensor installed either in thermowell or on the pipe surface as per [AD- 3]. The sensor to thermowell connection is defined in [AD- 3].

For sensor uncertainty, at least Class A according to IEC 60751 [ACS- 7] is requested.

A time response ≤ 27 s is requested for the sensor (including the thermowell, if the RTD is mounted in a thermowell).

The sensors are generally not insulated except for SIC sensors (depending on the location of the sensor). The surface sensors are installed below the fire insulation of the piping.

No dedicated power supply shall be required for the sensors.

The field instruments shall be certified at least to the degree of protection IP68 and the components installed inside the signal conditioning cubicles shall be certified to the degree of protection IP20 or better according to IEC 60529 [ACS- 34].

8.3.2.3 Cables

All cables shall be NF C32-070 [ACS- 35] C1 or the equivalent IEC ones:

- Reduced flame propagation (IEC 60332 [ACS- 36]),
- Flame retardant (IEC 60332 [ACS- 36]),
- Low smoke (IEC 61034 [ACS- 37])

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- Halogen-free (IEC 60754 [ACS- 38])
- Nontoxicity (IEC 60754 [ACS- 38])

In addition, all SIC cables shall be fire resistant (IEC 60331 [ACS- 39] or NF C32-070 [ACS- 35] CR1).

All cables in High Radiation areas (more than 10 kGy) shall be qualified according with IEEE 383 [ACS- 40] or IEC 60544 [ACS- 41] for the dose values indicated in this document.

8.3.3 *Layout and installation*

Due to the service conditions in the process area, the cubicles assigned for the signal transmitter might be located several levels above/below the physical location of the sensor.

The current specification is to consider a maximal cable length of 300 m (distance from sensor to signal transmitter).

The cables are expected to be twisted pair shielded cables, and the use of the junction box between the sensor and the signal transmitter is forecast to limit the footprint. There is no imposition from ITER for the connection of the sensor to the electrical cable. Already qualified electrical connectors could be used but the Contractor is free to select the most suitable option as long as it allows to remove the sensor from the field to perform maintenance outside without cutting the cables. A total number of 50 occurrences is assumed for the whole lifetime of the plant.

The Contractor shall provide a specification for signal connection from the sensor to the transmitter, including definition of electrical connection type, definition of junction box type, etc. If the Contractor proposes to use junction boxes for signal connection, the cable length of 20 m between the sensor and the junction box shall be assumed.

Cable types shall be selected from the IO Cable Catalogue [AD- 23] unless a need for specific cable type is identified and justified by the Contractor.

Any components that will be foreseen for installation inside junction boxes or I&C cubicles shall be DIN-rail mountable.

8.3.4 *Signal conditioners*

SIC signal conditioner shall be DIN rail mounted inside the PLC cabinet.

For MTH sensor, signal conditioner with HIGH switch NC contact are required.

9 Documentation

All documentation shall conform to the following requirements:

9.1 General Requirements

All documents shall be submitted to the ITER Document Management System (IDM). A dedicated project area will be created for the purpose.

The documents produced by the Contractor may be bi-lingual. The primary language is English and the secondary language is that of the Contractor. The English text shall have the same technical meaning as the Contractor text. When bi-lingual text is used, it shall apply to all texts on the drawing.

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All documents shall be clean and legible white prints with uniform background density suitable for electronic scanning and subsequent reproduction from an electronic format. In addition, all documents shall be submitted in PDF files and native format, or another electronic format if mutually agreed upon. Hard copies may be submitted in addition to electronic transmission.

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

All documents shall utilize IO's Primary Elements/Thermowells/Temperature Sensors Item Number and Contractor's part number for those items and component identification.

All or part of the Contractor's documents, sketches, or instructions (or the Contractor's subcontractor's) may be copied or reproduced as necessary by IO for project use. This shall include documents that are labelled "Copyright".

The Contractor is responsible for the document requirements. This includes documents from subcontractors. This responsibility may not be delegated or passed on to any other subcontractor. Contractor's as-built record drawings shall be updated to reflect changes made during shop fabrication. All as-built drawings (both physical copies and in native format) shall be provided prior to shipment of the equipment.

The Contractor shall provide all the documentation required to clean, start up, test, operate, and maintain all Contractor-supplied valves and accessories.

Acceptance by IO of any of Contractor's documents neither certifies nor warrants Contractor's conformance to any of its obligations under the Purchase Order.

Shall the Contractor, upon receipt of documents as commented by the IO, for whatever reason, not incorporate every of IO's comments as so marked by IO on the Contractor's documents, the Contractor shall so advise the IO in writing the reason for not incorporating these comments.

Note: Release for material procurement and fabrication shall be in writing and not dependent on document status.

The Contractor shall review and approve under its QA program drawings and/or documents submitted by the Contractor's subcontractors before submitting these documents to the IO for review. Specific cases in which parallel review by the IO and Contractor would be advantageous to the project schedule will be considered on a case basis.

Before the Release for Manufacture, the documentation shall be submitted to the IO for review and acceptance. No material orders or fabrication shall begin until released by the IO.

9.2 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- 32]. Additional requirements of EN 13480 [ACS- 8] 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

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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 [AOD- 1].

10 Manufacturing Dossier

At the completion of the contract, all the following documents shall be submitted to IO for acceptance.

In addition, when relevant according to the PE/NPE classification defined in [AD- 2]&[AD- 3], the Contractor shall provide the additional documents listed in Appendix I of [AD- 32], except those free-issued by IO as listed in Paragraph 14.1.

10.1 Contract Documentation

- Final technical specification,
- Quality Plan,
- NDT/Inspection personnel certifications,
- Full supplier list,
- List of documents.

10.2 Design Documentation

- Design/sizing calculation note,
- Hydraulic characteristics,
- Verification and validation of software documents,
- Assembly, 3D models and detail drawings,
- Bill of Materials.

10.3 Manufacturing Readiness Documentation

- Special process procedures,
- Manufacturing Inspection Plan,
- Weld maps and weld repair procedures (if applicable),
- Material test reports (Inspection documents),
- Material supplier's quality system certificate,
- Consumable list.

10.4 Fabrication Documentation

- Heat treatment report, including temperature measurement data,
- NDT reports,
- Surface roughness measurement report,
- Inspection report with complete dimensional and tolerance evaluation,
- Certificate of cleanliness,
- List of special tools, if any,
- Hanging/lifting lug load test report.

10.5 Qualification and Procedure Documentation

- Permanent marking and labelling procedures,

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- Qualifications of the personnel for manufacturing special processes,
- Qualification dossier,
- ESPN dossier, bilingual English and French,
- Deviation requests and non-conformity requests,
- Installation, operation and maintenance manual – Instruction manual, bilingual English and French.

10.6 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, bilingual English and French.

11 Quality Assurance

GM3S Section 8 [AD- 1] applies in full. The following is a non-exhaustive reminder and an addition to the GM3S.

11.1 Classification

The detailed safety and quality classification of each component in the scope of supply is defined in [AD- 2] and [AD- 3].

11.2 General

Quality Requirements shall be by the “ITER Procurement Quality Requirements” [AD- 4].

The Contractor shall have an ISO 9001 [ACS- 12] accredited quality system or an IO approved QA Program.

11.3 Quality Plan and Inspection Plan

11.3.1 Quality Plan

Before the commencement of any work under this Contract, a “Quality Plan” (QP) [AD- 4]. shall be produced by the Contractor and Subcontractors and submitted to the IO for approval, describing how they will implement the ITER Procurement Quality Requirements.

The IO has the option to use a third party to evaluate the Contractor’s quality assurance program. In such a case, the third party shall be the technical organization that is responsible for the approval and monitoring of the Contractor’s quality assurance system and the direct inspection of the product. The Contractor shall provide access and information required by the third party to perform the necessary evaluations and tests to fulfil its responsibilities.

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11.3.2 Manufacturing and Inspection Plan

Before the commencement of any manufacturing, a “Manufacturing and Inspection Plan” (MIP), according to [AD- 1], shall be produced by the Contractor and Subcontractors and approved by the IO, who will mark up any intended intervention point.

MIPs are used to monitor Quality Control and acceptance tests during the execution of the Contract. 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, as further explained in Section 12. It is permissible for the Contractor to submit multiple MIPs that are more sufficient and manageable to the particular operation. The level of detail in a MIP shall be sufficient to prevent the inadvertent by-passing of critical operations and to enable adequate planning, monitoring and verification of critical operations.

It should be noted that interventions additional to those required in this Technical Specification may be included on the MIP by the IO. The right of the IO listed above shall apply in relation to any Subcontractor and in this case, the IO will operate through the Contractor. The overseeing of the quality control operation by the IO shall not release the Contractor from his responsibility to meet any aspect of this Technical Specification. Subcontractors not performing Critical Quality Activities (i.e. activities that if not performed correctly may affect safety, functionality or reliability) may be exempted from the requirement to supply Quality Plans and Manufacturing & Inspection Plans, subject to agreement by the IO.

11.3.3 SIC and PIC

In case of Contracts concerning SIC components and/or a Safety Related Activity, or PIC and/or Protection Related Activities, the Quality Assurance Programme of the Contractor shall comply with the requirements of the INB Order and the subsequent ASN decisions linked to this Order. For this purpose, the Contractor and Subcontractors carrying out contracts placed under the Contract shall comply with the QA requirements under the relevant QA classifications as defined in “Quality Classification Determination” and additional requirements of the INB Order and the subsequent ASN decisions linked to this Order.

In particular for SIC, the IO, as the Nuclear Operator, will supervise the whole production cycle of the Contractor and Subcontractors by the document “Overall supervision plan of the chain of Suppliers for Safety Important Components, Structures and Systems and Systems and Safety Related Activities” [AD- 16], which shall be identified in the MIP.

11.4 Quality Records

Records shall be maintained to show objective evidence of quality.

11.4.1 Document Retention Requirements

Documentation records shall be maintained in accordance with the Contractor’s QA program to show objective evidence of quality.

No quality records shall be destroyed or otherwise disposed of prior to completion of the work and the IO shall have an opportunity to acquire possession of such records prior to their disposal.

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

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

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

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11.4.2 Test Sample Retention Requirements

Any test coupons and specimens used for acceptance per lot shall be kept by the Contractor for a period of up to five (5) years.

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

11.4.3 Equipment Calibration

Measuring and Test Equipment shall be calibrated, and calibration records maintained according to a calibration program based on a recognized standard. The measuring and test equipment shall have a current Certificate of Calibration traceable to a national recognized testing laboratory.

Certificates of Calibration shall be submitted to the IO.

All heat treatment equipment shall be calibrated and all personnel performing heat treatment shall be qualified to do so.

11.5 Non-conformities and Deviation Requests

Non-conformities are the product or process which does not fulfil or fails in meeting IO specified requirements. Deviation requests are requests for deviation from a formal agreement between the Contractor and the IO. The Deviation requests shall be issued by the Contractor or by the IO. All requirements of this Technical Specification and subsequent changes proposed by the Contractor during the execution of this Contract are subject to the Deviation Request process described in “Contractors Deviations and Non-conformities Procedure” [AD- 14].

If the conformity assessment of the NPE/PE is not completed because of NCR from the Contractor and/or its subcontractor(s) and supplier(s), the Contractor shall have the related activities or parts redone at its own cost.

11.6 Software Qualification

The use of computer software to perform a safety-based task activity such as analysis and/or modelling, etc. shall be reviewed and approved by the IO before its use, by “Quality Assurance for ITER Safety Codes Procedure” [AD- 15].

Software based devices (Smart devices) shall be avoided as far as reasonable. If the software-based devices are proposed, the Contractor shall perform the Verification and Validation of all the software applications used within the framework of this contract according to the Software Qualification Policy [AD- 11] and for any SIC related software IEC 61513 [ACS- 10] and/or IEC 62671 [ACS- 11]. The Contractor shall prepare software qualification plans or technical procedures based upon the software requirements. The plans or procedures shall include test cases encompassing the range of intended use for the new or revised software. Qualification testing shall be taken into consideration to demonstrate that software meets its specifications and is ready for use in its target environment or integration with its containing system.

Where necessary to evaluate technical adequacy for verification, the plan shall indicate how the results are to be evaluated. For example, the results may be compared to results from alternative methods such as:

- Analysis without computer assistance
- Other qualified software
- Experiments and tests
- Standard problems with known solutions
- Confirmed publications or correlations

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12 Propagation of Safety Requirements

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

12.1 Classification

The nuclear safety class, the seismic class and the pressure class under this contract are defined per item in [AD- 2] & [AD- 3].

12.2 General

ITER is a nuclear facility (an “INB”, for Installation nucléaire de base, “Basic nuclear installation” in French regulation) identified in France by the number “INB no. 174” [AOD- 3]

Contractors and Sub-contractors must be informed that:

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

The IO shall inform the Contractor that the equipment being procured is considered protection important components (PIC). Under Order 7 February 2012 [AOD- 3], the PICs require control and guarantee of the quality of the PICs during the design, manufacturing and transportation phase to ensure its safety functions can be maintained in all postulated situations.

In the contracts passed down to the subcontractors, it is clearly stated that in addition to technical requirements, and defined requirements on PIC, IO shall ensure the surveillance of the Protection Important Activities (PIA). The contractor shall ensure technical control. The subcontractor must possess a quality system in agreement with the importance of the item being delivered and in particular for the follow-up of the PIA corresponding to the PIC to be provided under the contract. The contractor shall provide documented information on how to perform the technical control (each protection-important activity undergoes technical monitoring), to ensure that the activity is carried out in compliance with the requirements defined for the activity and, if necessary, for the protection-important components concerned and that the appropriate corrective and preventive actions have been defined and implemented. This system shall be included in the MIP or Quality Plan.

The list of PIA for ITER is described in the “List of ITER-INB Protections Important Activities” [AD- 17]. Additionally, the generic safety requirements to be implemented to satisfy the requirements of the INB Order are identified in “Provisions for implementation of the generic safety requirements by the external interveners” [AD- 18].

This applies to all levels of subcontractors. Additionally, the Contractor shall inform the IO of all subcontractors at all levels involved in the supply.

12.3 Role of NB/ANB

The Contractor and the NB/ANB contracted by the Contractor shall be allowed to perform inspections in the facilities of the fabricator. No proprietary processes or information shall inhibit

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the NB/ANB/Contractor from performing its functions. This applies to all levels of subcontractors.

12.4 Audits

Contractor shall inform its Subcontractors that IO is a nuclear facility identified in France by the number INB-174 [AOD- 3]. Certain items that are subject to this Specification are classified as PIC to which the French Order dated 7th February 2012 applies and are subject to IO and regulatory body inspections. PIA shall be identified for PIC to comply with the requirements of the safety function.

The IO, NB/ANB and French regulator (for PIC) reserve the right to conduct announced or unannounced inspections and audits, at the Contractor's facilities to verify conformance of the work being performed to the requirements of the supply order and this Specification. The NB/ANB shall have free access to perform any inspections there that it deems necessary to check compliance with the requirements stemming from the risk analysis or as applicable that the Contractor properly meets the obligations of the approved quality system. Both the Contractor and its Subcontractors are subject to such inspections and audits. No proprietary processes or information shall inhibit IO, NB/ANB, or other official parties from performing its audit or inspection function. The IO, NB/ANB, and French regulator exercise of, or failure to exercise, this right to inspect or witness shall not relieve the Contractor of its obligation to comply with the terms and conditions of the supply order.

IO reserves the right to verify the validity of the Certificate of Compliance during the performance of audits of the Contractor or by independent inspection or test of the item(s).

12.5 Access to Contractor's Premises

The Contractor shall grant access rights to the IO, NB/ANB and French regulator as well as to their selected representatives to its facilities, records, proprietary processes and/or information and those of its Subcontractors for surveillance of defined requirements during the construction/manufacturing of a PIC. This surveillance shall also include the examination of all protective-important actions and the follow-up and verification of all corrective actions which are to be implemented.

The IO and Host regulatory body representatives shall have the authority to refuse release for shipment if the requirements of this Specification have not been fulfilled. Copies of required inspections and certified test reports shall be available for review. Final acceptance of material or components shall be performed on the ITER site.

The Contractor shall inform the IO of all locations where fabrication will be done. Source surveillance activities may be conducted at the Contractor's facility or any sub-tier supplier facility that the IO determines necessary to ensure quality objectives are met.

Such surveillance may include auditing and monitoring of production processes, in-process inspection and controls, chemical or physical certifications, final inspection and tests, preparation for shipment, and review of certification data.

Surveillance visits can be announced on short notice.

Source surveillance by IO, NB/ANB and French regulator as well as their selected representatives shall not constitute product acceptance by the IO and shall in no way relieve the Contractor of the responsibility to furnish acceptable items.

To ensure the safety of the IO, NB/ANB and French regulator as well as their selected representatives who visit the Contractor's or their supplier's facilities, the Contractor shall provide relevant information about facility safety procedures including, for example, safety glasses, hearing and respiratory protection, emergency preparedness, rally point, and general

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safety rules; and shall review typical workplace hazards with the representative(s) upon their arrival.

The IO, NB/ANB and French regulator as well as their selected representatives who visit the Contractor's or their supplier's facilities shall be bound by appropriate confidentiality obligations to be agreed upon in advance.

13 Location for Scope of Work Execution

The Contractor will perform the work at their own location. No work is anticipated at the ITER site in the framework of this contract.

14 IO Documents & IO Free issue items

14.1 IO Documents:

Under this scope of work, IO will deliver the documents listed in Section 6.2.1.

IO will provide during the contract execution:

- the complete piping interface loads,
- the sizing data for the thermowells which have not yet been communicated in [AD- 3],
- the Hazards and Risk analysis for the Thermowells (i.e. the HRA of the piping to which they will be connected) when relevant according to the PE/NPE classification defined in [AD- 2]&[AD- 3],
- the PMA/NPMA for the Thermowells (i.e. the PMA/NPMA of the piping to which they will be connected) when relevant according to the PE/NPE classification defined in [AD- 2]&[AD- 3].

14.2 Free issue items:

N/A.

15 Project Management

The Contractor shall designate a Contract Responsible Officer, within 5 working days after the award of the contract (AOC), who will be responsible for the overall design, manufacture, factory testing, installation, performance testing, schedule, cost control and resolution of disputes and discrepancies. The Contractor shall also identify specific individuals responsible for each aspect of the Work. The Contractor's proposal shall provide an outline of the management structure and resumes of the team members for the project.

15.1 Project Schedule

The Contractor shall prepare their document schedule using the template available in the GM3S Appendix II ([click here to download](#)) [AD- 1].

The Contractor shall provide a schedule within 10 working days after receipt of each Supply Order. It shall identify the submittals to and approvals from IO of the Contractor's and Subcontractors' specifications, drawings, procedures, and other types of documents as appropriate.

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

The project schedule must be provided to IO for approval prior to the implementation of any Work. The Contractor shall consider potential schedule conflicts due to previous or pending commitments to supply services or material to other customers. Anticipated deviations from the schedule must be identified to IO as soon as possible to evaluate the impact of changes on the master project schedule.

15.2 List of deliverables

The Contractor shall provide IO with the documents and data required in the application of this technical specification, the GM3S [AD- 1] and any other requirement derived from the application of the contract.

Deliverable	Description	Estimated due date
D1.1	Kick-off meeting minutes	T0 +3 days
D1.2	Approval of documents related to the “Contract documentation” (Section 0)	T0 + 1 month
D1.3 (T1)	Approval of documents related to the “Design documentation” (Section 10.2)	T0 + 4 months Target date February 2026 for approval
Completion of Task 1 – Design Phase		
Hold Point (T2)	Approval of the “Manufacturing Readiness Review” (Section 7.10)	Target date June 2026
Completion of Task 2 – Manufacturing Readiness		
D3.1	Completion of the FAT (Section 7.12) Approval of the FAT report	T2 + 4 months
D3.2 (T3)	Approval of the Manufacturing Dossier (Section 10)	T2 + 6 months
Completion of Task 3 – Manufacturing and Testing		
D4.1	IO acceptance of the delivered equipment and handover of the complete approved documentation	T3 + 1 month Target date: January 2027
Completion of Task 4 – Delivery to IO site		

T0 = Commencement Date of the contract

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16 Delivery

The transport of the procurement lots #1 and #2 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- 4][AD- 22] 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- 8], 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- 7]. 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 procurement lot#1 and lot#2 "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- 20] and Packing List [AD- 21] 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.

17 Special Management requirements

Requirement for GM3S section 6 [AD- 1] 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. The content of such Deliverables is described in Section 15.2.

In addition to the contract gates as defined in [AD- 1] Section 6.1.5, the scope of work call for Contract gates as defined in Section 15.2 of this document