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Technical Specifications (In-Cash Procurement)

Technical Specification for the supply of IBED PHTS Pressurizer

This document is the Technical Specification of the supply of IBED PHTS Pressuriser (functional reference: 26PHBD-PZ-1001).

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1 Purpose

IBED PHTS provides cooling water to the First Wall Blanket (FW/BLK) modules; Divertor (DIV) cassettes; Edge Localised Mode (ELM)/Vertical Stabilization (VS) coils; and upper and equatorial port plugs.

The IBED PZR, with proportional and backup heaters, is designed to perform the following functions: (*a*) to regulate the IBED PHTS pressure, and to avoid bulk boiling and critical heat flux in the in-vessel components and cavitation at the pump impeller; (*b*) to provide overpressure protection for the IBED PHTS in conjunction with the relief valve to relieve pressure to the pressure relief tank (PRT).

2 Preamble

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

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

3 Acronyms & Definitions

3.1 Acronyms

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

Abbreviation	Description
MTO	Material Take Off
CRO	Contract Responsible Officer
GM3S	General Management Specification for Service and Supply
IO	ITER Organization
PRO	Procurement Responsible Officer
ALARA	As Low As Reasonably Achievable
ANB	Agreed Notified Body
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASN	Autorité de sûreté nucléaire (French nuclear safety authority)
ASTM	American Society for Testing and Materials
CCPR	Components contributing to the pressure resistance
CVBD	Chemical and Volume Control System (CVCS) of IBED PHTS
DA	Domestic Agency
DN	diameter nominal
DNRE	Dimensions Necessary for Compliance with regulatory requirements

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DO	Design Office Division
DOE	Department of Energy
DRR	Delivery Readiness Report
DS	Datasheet
EN	European Standard
ESPN	French Regulation for NPE
EPMN	(French for) Nuclear Particular Material Appraisal
HT	Heating system of the PZR
HRA	Hazards and Risks Analysis
IAEA	International Atomic Energy Agency
IBED	Integrated Blanket/ELMS/Divertor
IDM	IO's Documentation Management system
ISO	International Organization for Standardization
MIP	Manufacturing and Inspection Plan
MPBP	Main pressure-bearing parts
MSS	Manufacturers Standardization Society
NCR	Non-Conformance Report
NDE	Non-destructive Examination
NPE	Nuclear Pressure Equipment
NPMA	Nuclear Particular Material Appraisal
PBS	Plant Breakdown Structure
PE	Pressure Equipment
PED	Pressure Equipment Directive
PIC	Protection Important Component
PHTS	Primary Heat Transfer Systems
PMA	Particular Material Appraisal
PQR	Procedure Qualification Record
PZR	Pressurizer system (vessel and heaters)
PWHT	Postweld Heat Treatment
SDR	Supplier Deviation Request
SIC	Safety Importance Class
SO	Supply Order
TCWS	Tokamak Cooling Water System
QA	Quality Assurance
QAP	Quality Assurance Program

3.2 Definitions

- After Receipt of Order (ARO): as used in this technical specification, is the time period where the Contractor receives a SO from the IO for the procurement of materials, components or equipment.

- ANB: Notified Body approved by ASN to perform the conformity assessment of a NPE.

- As Low as Reasonably Achievable (ALARA): means making every reasonable effort to maintain exposures to ionizing radiation as far below the dose limits as practical, consistent with

the purpose for which the licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations, and in relation to utilization of nuclear energy and licensed materials in the public interest.

- Award of Contract (AOC): Contractual process after which the Contractor is awarded the Contract.

- Contract: An all-inclusive term used to cover all legal obligations between the IO and the Contractor for the performance of part or whole work defined in the present document. These obligations are enforceable immediately at its date of entry into force, including any amendment(s). Refer to contract conditions for more details.

- Contractor: Legal entity to which the Contract is awarded and to which the supply orders are addressed. The Contractor is responsible for the performance of a portion of the work or the whole work defined in the present document.

- Contractor's Premises: Any location, apart from the Site, where the Contractor or Subcontractors carry out any work defined in the present document.

- Delivery Location: Location specified by the IO where the supplies will have to be delivered by the Contractor.

- Documentation: The procedures, test reports, certifications, manuals, instructions, and other data specified to be delivered by the Contractor.

- Particular Material Appraisal (PMA): document prepared for any component contributing to pressure resistance identified in the Hazards and Risk Analysis as defined in [RR1].

- Evaluation Particulière de matériau propre au domaine nucléaire (EPMN) : Specific assessment of nuclear material.

- Equipements Sous Pression (ESP): French Environmental Code article L557 and R557 ref.[RR2], concerning pressure equipment which is a transposition of PED (2014/68/UE) ref. [RR1].

- Equipements Sous Pression Nucléaires (ESPN): French Order dated 30 December 2015 concerning nuclear pressure equipment ref. [RR3]. The ESPN follows a pressure classification and conformity assessment procedure that is in many cases based on ESP/PED assessment modules. It is the responsibility of the Manufacturer to comply with all requirements of this Order.

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- Heat: a generic term denoting a specific lot of steel, based up on steelmaking and casting considerations.

- Heat number: the alpha, numeric, or alphanumeric designator used to identify a specific heat of steel.

- INCOTERM Named Place: A location specified for the collection/delivery location of the goods.

- ITER Organization (IO): As used in this specification, is the owner and Operator of the ITER research facility. Also, in accordance with ESP and ESPN definitions, IO is the Manufacturer of the component procured per this technical specification.

- ITER Site: ITER construction site located at the following address: ITER WORKSITE RD 952-Entrée Nord - CS 80 001 -13066 Saint Paul les Durance Cedex. FRANCE

- Manufacturer: the IO is The Manufacturer of the PZR. The Manufacturer is the legal entity which assumes responsibility for the design and manufacture of a product to be marketed under its name or trademark following [RR1] and [RR3].

- Notified Body (NB): Technical organization approved in an EU state, either for approval and monitoring of the Manufacturer's quality assurance system or for direct product inspection.

- Nuclear Regulatory Authorities/ Nuclear Regulator: referred to in this Specification are mainly MSNR (Office of the Ministries in charge of nuclear safety and radioprotection), ASN Autorité de Sûreté Nucléaire, French Nuclear regulator) and its technical support IRSN (Institute of nuclear safety and radioprotection).

- Operator: the IO is the Operator of the PZR. For conventional pressure equipment, the operator is the owner of the equipment unless contrary agreement. For nuclear pressure equipment, the Operator is the person holding the permission of creation of the nuclear basic installation in which the nuclear pressure equipment is installed or intended to be installed.

- Plant Breakdown Structure (PBS): The PBS is the hierarchical breakdown of the ITER Plant into distinct ITER elements. The PBS identifies the links between parent/child elements, so that there is only one rooting between a parent element and one of its child elements (and vice versa).

- Product: Any type of deliverable, goods and services resulting from the Technical Specification.

- Protection Important Component (PIC): component important for protecting the interests of public security (including nuclear safety, radioprotection and prevention and fight against malevolent acts and civil security actions in the case of an accident), health and sanitation, the

protection of nature and of the environment, i.e. any structure, equipment, system (programmed or not), material, component or software that is present in the basic nuclear installation or that is under the responsibility of the nuclear operator and that implements a function required for the demonstration mentioned under the second paragraph of Article L. 593-1 of the Environmental Code or that ensures that this function is implemented per articles 1.3 and 2.5.1 of Order 7th February 2012 ref. [RR4].

- Quality Assurance Program: A controlled system of planned and systematic actions required to provide adequate confidence that an item designed and constructed are in accordance with Code requirements.

- Quality Assurance Manual: A written document that describes a Quality Assurance Program.

- Safety Importance Class (SIC): a classification scheme for structures, systems, and components of ITER that perform a safety function and contribute towards meeting the General Safety Objectives at IO during incident/ accident situations.

- Subcontractor: An entity furnishing services, materials, or components required to perform the work to the Contractor.

- Supplier: See definition of “Contractor”.

- Supply Order: Instrument produced by the IO to request supplies from the Contractor. Refer to contract conditions for more details.

- Third Party: Is someone who may be indirectly involved but is not a principal party with a vested interest in carrying out the requirements of this Specification.

4 Applicable Documents & Codes and standards

The following documents are to be respected on the understanding that they prevail on each other in the following order:

- Decrees and Ministerial Orders,
- Standards and Rules whose application has been made mandatory by a Ministerial decision
- Specific rules to the IO
- Standards and Rules whose application has not been made mandatory by a Ministerial decision.

In case of contradiction between two documents of the same category, the Contractor submits the case to the decision of the IO. It is the Contractor's responsibility to ensure compliance with the applicable documents at the time of notification of the contract, and this, from the design of

the equipment until industrial commissioning. In the case where the codes, standards and the relevant regulations would be modified after the base date of the economic conditions of this contract, the Contractor has the obligation to inform IO immediately in order to define by mutual agreement the following decision to take.

4.1 Applicable Reference Regulation Requirements

[RR1] Directive 2014/68/UE of the European Parliament and Council dated 15 May 2014 on the harmonization of the laws of the member states relating to the market availability of pressure equipment (PED)

[RR2] French Regulation for Pressure Equipment (ESP) (transposition of PED in French law), French Environmental Code, Articles L557 and R557

[RR3] French Order dated 30 December 2015 on Nuclear Pressure Equipment (ESPN), modified by order dated 03 September 2018

[RR4] Order 2012 February 7 setting the general rules relative to basic nuclear installations

[RR5] Directive 2014/35/EU of the European Parliament and Council of 26 February 2014 on the harmonization of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits (recast). (known as the Low Voltage Directive)

[RR6] Directive EMC 2014/30/EU of the European Parliament and Council for Electromagnetic Compatibility and Repealing

4.2 Applicable Reference Codes and Standards

For each European standard, the latest version issued by the European Committee for Standardization on the date of contract notification is applicable.

This is the responsibility of the Contractor to procure the relevant Codes and Standards applicable to that scope of work.

[CS1] Conformity Assessment of Nuclear Pressure Equipment, ASN Guide No. 8

[CS2] Application of the order of the 12 December 2005 relative to the nuclear pressure equipment, ASN Guide No. 19

[CS3] EN 13555:2014 – Flanges and their joints – Gasket parameters and test procedures relevant to the design rules for gasketed circular flanges.

[CS4] EN1591-1:2014 flanges and their joints. Design rules for gasketed circular flange connection. Calculation Method

[CS5] Quality Assurance Requirements for Nuclear Facility Applications, ASME NQA-1 2017

[CS6] ASME Boiler and Pressure Vessel Code, Section VIII, Rules for the Construction of Pressure Vessels, Division 2 — Alternative Rules, ASME BPVC.VIII.2-2017

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[CS7] Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard, ASME B16.5-2017
[CS8] Stainless Steel Pipe, ASME B36.19M-2004
[CS9] Thermowells Performance Test Codes, ASME PTC 19.3 TW-2016
[CS10] Metallic Products—Types of Inspection Documents, EN 10204:2004
[CS11] Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems, ASTM A380/A380M 17
[CS12] Test Uncertainty, ASME PTC 19.1-2013
[CS13] Guidelines Related to the Pressure Equipment Directive 2014/68/EU (PED)
[CS14] NF EN ISO 9712:2012 “Non-Destructive Testing – Qualification and Certification of NDT Personnel”
[CS15] EN 1991-1-2: 2005 “Eurocode 1: Actions on structures – Part 1-2: General actions – Actions on structures exposed to fire”
[CS16] International Chamber of Commerce (ICC). Incoterms® 2010. ICC Publication No.715E, 2010 Edition.
[CS17] ASME BPVC Section II - Materials - Part D Properties, 2017 Metric
[CS18] ASME B31.3 – Process piping – ed 2018
[CS19] CLAP Files - https://www.afiap.org/informations-clap
[CS20] Low-Voltage Electrical Installations, NFC 15 100:2002
[CS21] Design and Construction Rules for Electrical Equipment of Nuclear Island, RCC-E 2016
[CS22] IEC/EN 60947-1
[CS23] IEC/EN 60947-5-1
[CS24] IEC/EN 60947-5-5

4.3 Applicable IO 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.

The applicable version of the following documents is the last approved version available at the signature of the contract subject of this Technical Specification.

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4.3.1 *Applicable References General Requirements*

[1] General Management Specification for Service and Supply (GM3S), ITER_D_82MXQK
[2] ITER Abbreviations, ITER_D_2MU6W5
[3] ITER Quality Assurance Program (QAP), ITER_D_22K4QX
[4] Quality Requirements for IO Performers, ITER_D_22MFG4
[5] MQP L2 Overall Surveillance Plan of the Chain of External Actors for Protection Important Components, Structures and Systems and Protection Important Activities, ITER_D_4EUQFL
[6] Procedure for the management of Deviation Request, ITER_D_2LZJHB
[7] IO/In-Cash Contractor Documentation Exchange and Storage Working Instruction, ITER_D_G8UMB3
[8] TDT Cards, https://user.iter.org/?uid=BFF8H7
[9] Procedure for Identification and Controls of Items, ITER_D_U344WG
[10] ITER Numbering System for Components and Parts, ITER_D_28QDBS
[11] Procedure for ITER CAD Data Exchanges, ITER_D_2NCULZ
[12] Diagrams and Drawings Management System Working Instruction, ITER_D_KFMK2B
[13] CAD Manual 08-02 Diagrams - SXP Design Methods, ITER_D_CARVFK
[14] CAD Manual 01 - Instruction for Use and Introduction, ITER_D_AHFDDK
[15] Procedure for CAD Management Plan, ITER_D_2DWU2M
[16] Specification for CAD data Production in ITER direct contracts, ITER_D_P7Q3J7
[17] CAD Manual 07 – CAD Fact Sheet, ITER_D_249WUL
[18] AVEVA E3D CAD Manual, ITER_D_8QZS2R
[19] Template for Structural Analysis Reports, ITER_D_VQVTQW
[20] Software Qualification Policy, ITER_D_KTU8HH
[21] Delivery Report Template, ITER_D_WZPYVZ
[22] Package & Packing List Template, ITER_D_XBZLNG
[23] Template - Equipment Storage & Preservation Requirements Form, ITER_D_WU9636
[24] QP Template for suppliers and subcontractors, ITER_D_2MLX45
[25] Quality Classification Determination, ITER_D_24VQES
[26] Working Instruction for Manufacturing Readiness Review, ITER_D_44SZYP
[27] Procedure for management of Nonconformities, ITER_D_22F53X
[28] Guide for Visual Examination, ITER_D_YPW6MY

4.3.2 *Applicable Reference IO Technical Requirements*

The applicable version of the following documents is the last approved version available at the signature of the contract subject of this Technical Specification.

[29] Technical Specification for Coatings for Equipment, ITER_D_R45ME7
[30] 2 - Compliance ASME Sec VIII Div. 2 and Essential Safety Requirements of PED and ESPN, ITER_D_3E5HKQ
[31] ITER Radiation Protection Professional Guidelines for the Nuclear Pressure Equipment in Application of Order dated 12 December 2005, ITER_D_2LTQ96
[32] Technical Specification for TCWS Water System Vessel Fabrication Cleaning, ITER_D_33YCQ3

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[33] Allowable Values and Limits in Service Level C and D of ITER Mechanical Components, ITER_D_3G3SYJ
[34] Allowable Codes and Standards for ITER Mechanical Components, ITER_D_25EW4K
[35] Chemical Composition and Impurity Requirements for Materials, ITER_D_REYV5V
[36] Impurity controls requirements for PBS26, ITER_D_9LPHJE
[37] TCWS Load Specification, ITER_D_SZE5MR
[38] TCWS pressure vessels ESPN classification & ESP categorization, ITER_D_XP4AFC
[39] PBS26 IBED PHTS pressure vessels ESPN Classification Evaluation, ITER_D_UXKBZL
[40] PBS26 IBED PHTS ESPN Classification for SNJ3LL v5.0, ITER_D_CG4Q7Y
[41] Collection of Input Data to support Qualification Plan in charge of TCWS electro-mechanical equipment supplier, ITER_D_YST3YH
[42] Anticipated use of 2020 radiation maps for TCWS major components, ITER_D_4655X7
[43] Radiation environment for equipment during operations, ITER_D_3FM52L
[44] 3D Extract of Electrical Enclosures in Tokamak Complex, ITER_D_2U6RJP
[45] ACPs inventory for DT-1 scenario, ITER_D_9GLRFZ
[46] Guidelines for the Stress Analysis of TCWS Piping System, ITER_D_LYBRAM
[47] Guidelines for TCWS Piping supports design, ITER_D_LZYV8D
[48] System Requirement (SRD) Document SRD-26-PH,-CV,-DR,-DY (TCWS) from DOORS, ITER_D_2823A2
[49] TCWS System Description Document (SDD), ITER_D_94WLDK
[50] Defined Requirement for PBS26, ITER_D_M369M3
[51] Safety Requirement Room book, ITER_D_KF63PB
[52] Propagation of the Defined Requirements for Protection Important Components Through the Chain of External Interveners, ITER_D_BG2GYB
[53] Design Seismic Floor Response Spectra in the Tokamak Complex, ITER_D_SVBRJZ
[54] Load Specifications (LS), ITER_D_222QGL
[55] TCWS Piping & Valves Proof Test Values, ITER_D_YC3UR5
[56] Protection Important Functions and Components Classification Criteria and Methodology, ITER_D_347SF3
[57] ITER Site Meteorology, ITER_D_2UT36S
[58] IBED-PHBD-PZ-1001 GA-DWR, ITER_D_DXRVFD
[59] Tokamak Complex Magnetic Field L4, ITER_D_2MS9EV
[60] TCWS Equipment insulation, ITER_D_XB5DLJ
[61] Equipment Specification for piping materials used in the design of process piping systems, ITER_D_SJE6S7
[62] Data collection table for PBS62 Tokamak Complex Buildings - Interface Requirements, ITER_D_493BC9
[63] Installation Study for IBED Pressurizer 26PHBD-PZ-1001, ITER_D_DLKHZK
[64] Integration study for IBED Pressurizer 26PHBD-PZ-1001, ITER_D_DCDPSS
[65] Report on the effect of cold work on the corrosion behaviour of 316L(N)-IG steel, ITER_D_G5MDGV
[66] Construction Design - PBS 62.11 - Tokamak Building – Calculation Report – Welding on Embedded Plates - ENG_50_CR_110225_CW, ITER_D_YU29TG
[67] Construction Design - PBS 62.11 - Tokamak Building – Technical Report - Recommendations for Welding on Embedded Plates - ENG_50_TR_110034_CW, ITER_D_YUDA68

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[68] Construction Design - PBS 62.11, 62.14 and 62.74 - Tokamak complex – Design Catalogue of Cast-in-Place Fastening Systems - Structural Calculation Note - ENG_50_CR_110002_CW, ITER_D_AJSMNW
[69] Construction Design – Tokamak complex – PBS 62,11,62.14 and 62.74 – Internal Flooding, ITER_D_QV4FYF
[70] Instructions for Structural Analyses, ITER_D_35BVV3
[71] Instructions for the Storage of Analysis Models, ITER_D_U34WF3
[72] ITER Policy on Safety, Security and Environment Protection Management, ITER_D_43UJN7
[73] List of ITER-INB Protections Important Activities, ITER_D_PSTTZL
[74] List of Protection Important Components (PIC List), ITER_D_JDS5K7
[75] Preliminary Safety Report, ITER_D_3ZR2NC
[76] Project Requirements, ITER_D_27ZRW8
[77] Protection Important Activities and Defined Requirements for all ITER Mechanical PIC Equipment, ITER_D_338G4B
[78] Overall Surveillance Plan of External Interveners Chain for Protection Important Components, Structures and Systems and Protection Important Activities, ITER_D_4EUQFL
[79] Surveillance Plan for PBS 26 - Cooling Water System, ITER_D_CAJTAL
[80] Annex 2 - Detailed list of PIAs, ITER_D_Q8B5C4
[81] Provisions for Implementation of the Generic Safety Requirements by the External Interveners, ITER_D_SBSTBM
[82] Electrical Design Handbook (EDH): EDH Part 1: Introduction, ITER_D_2F7HD2
[83] EDH Part 2: Terminology & Acronyms, ITER_D_2E8QVA
[84] EDH Part 3: Codes & Standards, ITER_D_2E8DLM
[85] EDH Part 4: Electromagnetic Compatibility, ITER_D_4B523E
[86] EDH Part 5: Earthing and Lightning Protection, ITER_D_4B7ZDG
[87] EDH Guide A: Electrical Installations for SSEN Client Systems, ITER_D_2EB9VT
[88] EDH Guide C: Electrical Installations for EPS Client Systems, ITER_D_2F6BBN
[89] Electrical Design Criteria Basis TCWS SRO, ITER_D_25SWBV
[90] Electrical Single Line Diagram (SLD) for IBED PHTS, ITER_D_Y5Y9LM
[91] PBS 26 TCWS Electrical Enclosure Layout in Tokamak complex all levels, ITER_D_6E9PWA
[92] Electrical Load List (ELL) For TCWS SRO, ITER_D_23GDBU
[93] TCWS Control System Design Criteria for 2nd Plasma IBED PHTS, NBI PHTS & CVCS, ITER_D_YJ8Y6L
[94] Plant Control Design Handbook, ITER_D_27LH2V
[95] Technical Specification for LV Electrical Cubicle and Systems for IBED PHTS, NBI PHTS & CVCS, ITER_D_Y4YGUZ
[96] JEG-11-R1-DR-S-1800 - Platform 18, ITER_D_3F4N4W
[97] IBED I&C Functional requirement, ITER_D_UX8CPK
[98] IO Cable Catalogue, ITER_D_355QX2
[99] List of manufacturing documents to prepared and stored for PE and NPE, ITER_D_WDBC7H

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4.3.3 *Reference IO for Information (not provided to Contractor)*

The applicable version of the following documents is the last approved version available at the signature of the contract subject of this Technical Specification.

[100] Load Specification for Buildings with Safety Requirements, ITER_D_2ERTXQ
[101] Assessment of TCWS effluents production, ITER_D_U7YB3K
[102] Relaxation of Embedded plates (EP) Location tolerances, ITER_D_PRH5YJ
[103] Tokamak Complex- L4 Level Construction Design Tolerances IO-PBS, ITER_D_S97UEL
[104] PBS26- Loads Table for Eps substantiation 11-L4 Floor-Walls-Ceiling, ITER_D_T76FW8
[105] Static and transient magnetic field maps at level L4 tokamak complex, ITER_D_QUDEGC
[106] Fluid radioactivity concentration for the ITER Tokamak Cooling Water System, ITER_D_26GLXV
[107] List Safety Defined Requirements (QDs) for Site & Buildings (PBS 61, 62, 63, 65) of ITER Nuclear Facility, ITER_D_FF92TR
[108] Dose rates calculations for CVCS filter, resin tank and sampling system workplace, ITER_D_YK6K7M
[109] Guideline of Common Mode Failure (CMF) protections in TKM, ITER_D_X2ZCJS
[110] Process Flow Diagram (PFD) of IBED PHTS, ITER_D_TRYDJZ
[111] TCWS IBED CVCS (CVBD) Process Flow Diagram (PFD), ITER_D_YFLDNY
[112] TCWS IBED PHTS System Process Loading Conditions, ITER_D_YQCUY5
[113] IBED PHTS System Sizing Calculation, ITER_D_PAVZLW
[114] Piping and Instrumentation Diagram (P&ID) IBED Primary Heat Transfer System (PHTS), ITER_D_SNJ3LL
[115] WP8. Reliability Data Base for TCWS and VVPSS RAMI Analyses, ITER_D_UD6VDR
[116] Hazards & Risks Analysis for TCWS pressure vessels, ITER_D_YRQT3P
[117] Prel NPMA ASTM A240 304L - Pressure Equipment (plates), ITER_D_YHWTYL
[118] Prel NPMA ASTM A182 304L - Pressure Equipment (forgings), ITER_D_YHX2XB
[119] Prel NPMA ASTM A312 304L - Pressure Equipment (pipes), ITER_D_YMWNAD
[120] Prel NPMA ASTM A479 304L - Pressure Equipment (bars), ITER_D_YMWZ56
[121] Template for PE/NPE Nameplate, ITER_D_Y3AZ83
[122] Platform 18 Task #1 - D18.1 Structural Analysis - Structural Technical Report, ITER_D_3F4X5L

5 Scope of Work

This section defines the specific scope of work, including the material, design, procurement, fabrication, inspection, examination, testing, certification, packing and delivery requirements for the IBED PHTS Pressurizer (tag number 26PHBD-PZ-1001), the associated proportional Heater (26PHBD-HT-1001, Class IV Power Supply) and backup Heaters (26PHBD-HT-1002, Class IV Power Supply), and the Control and Electrical Switchboards, in addition to the contract execution requirement as defined in Ref [1].

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The IO is the Operator of the PZR. The contractor as the Manufacturer of the PZR is the legal entity which assumes responsibility for the design, manufacture and delivery of a product to be marketed under its name following [RR1] and [RR3]. The Contractor shall hire an ANB to ensure the conformity assessment of the nuclear pressure equipment under module G. The last operation under the Contractor as the manufacturer's responsibility is when the ANB issues the Declaration of Conformity, after receiving inspection upon arrival of the PZR on IO site or IO's warehouse of the destination port.

In case of non-conformity or in case of divergence of interpretation between the provision of this technical specification and the Regulation, the Contractor is requested to ask the IO for decision. Nothing in this specification shall relieve the Contractor from meeting reference regulation requirements [RR1] to [RR6].

The Contractor is responsible for the design, supply, manufacturing and delivery of:

- The pressurizer with all its constitutive elements (vessel, heads, nozzles, flanges, counter flanges, manways, bolts, gaskets…) and required test coupons
- The supports
- The handling devices for the inspection openings
- The lifting lugs and trunnions
- The anchorage supports, bolts and shims
- The nameplates and its supports
- The insulation, the insulation supports and sheathing
- The grounding (earthing)
- The tapes, gaskets and all temporary devices for the hydraulic test
- The PZR transportation skid and devices (accelerometers, nitrogen blanketing skid…)
- The pressurizer Heater Bundles, sheathing and control and electrical switchboards
- The instrumentation, control and electrical equipment associated to the PZR, proportional and backup heaters (refer to Appendix J for details). Including electrical power connection boxes in the pressurizer field side.
- Spare parts

The services to be provided under the contract are the following:

- The design studies and associated documentation
- The required documentation including all the documentation following PED and ESPN requirements from the design to the commissioning to be approved first by the IO
- Assistance in writing regulatory Manufacturer's documentation (Hazard risk analysis…)
- The procurement of materials (including consumables) following the PMA
- The manufacture and associated controls
- The regulatory hydraulic tests in workshop and FAT of heater bundles and their instrumentation, electrical and control system equipment (as a whole)

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- Site transportation (including packaging)
- Redaction of Storage recommendation guide, handling manual (including supply of related tooling, assembly, adjustment, connection and commissioning) and Operating Manual
- Assistance in handling, assembly, connection, and commissioning operations
- The global contract management including reporting and efficient resource allocation.

5.1 Description

5.1.1 *IBED PHTS System*

The TCWS is the primary coolant system of the ITER machine with the functionality to remove the heat generated by the plasma and transferred to dedicated components of the machine and to release it to the secondary coolant system. It is comprised of the following sub-systems:

- Vacuum Vessel Primary Heat Transfer System (VV PHTS)
- Draining and Refilling System (DRS)
- Drying System (DYS)
- Sampling System (SA)
- Integrated Blanket, ELM, Diverter Primary Heat Transfer System (IBED PHTS)
- Neutral Beam Injection Primary Heat Transfer System (NBI PHTS)
- Chemical & Volume Control System (CVCS)

The IBED PHTS is a pressurized, closed-loop cooling water system with the primary function to provide cooling water to the plasma facing components (blanket modules and divertor cassettes) within the vacuum vessel. It also provides cooling water to the Edge Localized Modes (ELMs) and Vertical Stabilization (VS) coils and to the various clients in the upper, equatorial and lower ports.

The major components of the IBED PHTS are eight pumps, and eight heat exchangers located in L3 level of the Tokamak building, baking train, pressure relief tank (PRT), pressurizer (PZR), which are in the L4 TCWS vault.

The IBED PHTS supplies cooling water to five cooling loops (3 FW/BLK, 1 Divertor (DIV), and 1 Equatorial Port) with a common set of eight parallel primary pump/heat exchanger trains.

These parallel cooling trains are connected to a common supply and return header that feeds the five cooling loops. Each primary train contains a heat exchanger (shell-and-tube type), and one main pump. Heat extracted from the IBED PHTS is rejected to the Heat Rejection System through the CCWS-1 loop. In addition to the eight primary cooling trains, there is a separate

baking train which contains a baking heater, a baking cooler, a baking pump, and associated piping and valves.

The IBED PHTS piping, and components provide the primary confinement for radioactive material and must maintain leak-tight integrity during all operating modes. The IBED PHTS is equipped with a pressurizer (PZR) in combination with a Chemical and Volume Control System (CVCS) to control system pressure and water volume during operations. The IBED PHTS PZR is located on the hot leg of the system, upstream of the main heat exchangers and pumps (called cooling trains). Connections are provided to the CVCS to control water chemistry within the system. Connections to allow for draining, refilling, drying, and gas baking are also provided [113].

5.1.2 *IBED PHTS Pressurizer (PZR)*

The IBED PHTS pressurizer [113] is designed to perform the following functions during the plasma and standby operation as follows. The simplified Process Flow Diagram [100] and the Piping and Instrumentation Diagrams [114] are illustrated in Appendix G – IBED PHTS PFD and PID.

- Pressurize the system to keep the cooling water in a sub cooled liquid state.
- In conjunction with the chemical and volume control system (CVCS), accommodate the system fluid expansion and contraction associated with the different modes of operation.
- During plasma operation and standby modes, the pressurizer is sized to accommodate the system temperature variation. The chemical and volume control system (CVCS) is not credited any action to accommodate the fluid expansion and contraction during this mode.
- The chemical and volume control system (CVCS) is designed to accommodate the fluid expansion and contraction during the transition between different operational modes.
- Control the client inlet pressure within the operational range.
- Perform overpressure protection of the system.

The classification parameters of PZR tank are summarized in the table below.

Table 5-1 Classification Parameters

No.	Classification Parameters	Category/Class[1]	Reference
1	Pressure Category	Cat. IV	[38]
2	ESPN Level	N2	[38][39]

[1] The instrumentation associated with the tank (e.g. thermal sensor MT-1001 & MT-1002) is out of the Contractor's scope. The thermowells shall be integrated with the nozzles N14 & N40, as part of PZR. Thus, they should have the same Classification of Parameters if applicable.

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3	Fluid Group	2[2]	[38]
4	Safety Important Class	SIC-1	[56][114]
5	Fluid Type	Gas[3]	[38]
6	Seismic Classification	SC1(S)[4] for Proportional Heaters SC1(SF)[5] for Backup Heaters	[114]
7	Quality Class	QC-1	[114]
8	No code stamp[6]	ANB stamp	[RR2] [RR3] Section 5.5.3
9	CE marking for Proportional and Backup Heaters		[RR5]

The classification parameters of PZR heater control and electrical switchboards are summarized in the table below.

Table 5-2 Classification Parameters of Control and Electrical Switchboards

No.	Classification Parameters	Category/Class		Reference
		Proportional Heater Control and electrical switchboard (26PHBD-CMC-1001)	Backup Heater Control and electrical switchboard (26PHBD-CMC-1002)	
1	Safety Important Class	Non-SIC	Non-SIC	[56][92][95][89]
2	Seismic Classification	SC2[7]	SC2[7]	[56][92][95][89]
3	Quality Class	QC-2	QC-2	[89][95]
4	CE marking	Yes	Yes	

5.2 Design requirements

The PZR shall be designed for conditions specified and the required operational characteristics, filling, draining, testing, and applicable loading conditions defined within this Specification and

[2] Fluid is group 2 but classified as group 1 for ESPN level N2.
[3] Fluid is demineralized water. But because the max allowable temperature is above the saturation temperature at 0.15 MPa, fluid type is “gas” for PED classification.
[4] SC1(S): Structural stability maintained in the event of an earthquake referring to [56].
[5] SC1(SF): Structural stability and required functional seismic safety performance maintained in the event of an earthquake referring to [56]. For cubicles, it means that seismic test is needed.
[6] Name plate shall have an ANB stamp as per [RR2] and [RR3], see Section 5.5.3 for nameplate requirements.
[7] Mechanical calculation is enough for SL-2 for structural integrity. For SL-1, operability is requested.

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Appendices A, B and C.

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5.2.1 The reference code of construction is American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC) Section VIII, Division 2 [CS6]. The PZR shall be designed, fabricated, examined, and tested in accordance with this code with supplemental requirements per this Specification. Other codes and code cases per Codes and Standards for ITER Mechanical Components [29] may be selected by the Contractor to complete the design, fabrication, examination but must be approved in writing by the IO prior to use.

5.2.2 The PZR shall be harmonized with the Essential Safety Requirements (ESR) as required by the Équipements Sous Pression Nucléaires (ESPN) [RR3].

5.2.3 Flanges (DN 15 through DN 600) shall be in accordance with ASME B16.5 [CS7].

5.2.4 Flanges shall be calculated according EN1591 [CS4] and their gasket shall comply with EN13555 [CS3] in order to ensure the desired leak rate. A leak rate of L0.001 shall be achievable following [101]. The use of the standard EN 1591 [CS4] is needed for flanged joints in which the stress tightening is checked during initial tightening.

5.2.5 The initial tightening torque for the flange bolts considering the seating situation as well as the operating and exceptional situations shall be well indicated in the drawings and the instruction manual to ease the use on site during installation, commissioning, and maintenance.

5.2.6 If the Code of Construction specifies two allowable stresses for the design of pressure parts, the lower value must be used but has also to comply with the formulas provided in the chapter 7.1 of annex 1 of the Directive [RR1].

5.2.7 The PZR will not be ASME BPVC U2 stamped. Conformité Européenne (CE) marking is not required for ESPN equipment. However, Conformité Européenne (CE) marking is requested for electrical components.

5.2.8 Summary of applicable classifications including classification level, category, fluid group and seismic class designations, is provided in Appendix A – IBED PHTS PZR Datasheet.

5.2.9 The environmental conditions (i.e., pressure, temperature, humidity, magnetic field, radiation field) for the PZR are listed in Appendix A – IBED PHTS PZR Datasheet. The PZR shall be designed to be compatible with the environmental conditions provided in the PZR. The PZR design shall meet the requirements of all applicable codes.

5.2.10 The HT electrical, instrumentation and control equipment shall be designed, fabricated, examined, and tested in accordance with Electrical Design Handbook [82]~[87] and shall comply with the following documents: Electrical Design Criteria Basis TCWS SRO [89], Technical Specification for LV Electrical Cubicle and Systems for IBED PHTS, NBI PHTS & CVCS [95] and IBED I&C Functional requirement [97]. Codes not listed in these documents may be selected by the Manufacturer but must be approved in writing by IO prior to use.

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5.2.11 In addition, the PZR electrical, instrumentation and control equipment shall be harmonized with ESR as required by the Low Voltage Directive 2014/35/EC [RR5].

5.2.12 The PZR electrical equipment shall be compatible with electrical power supply parameters (voltage, phase, frequency) specified in the Appendix A – IBED PHTS PZR Datasheet.

5.2.13 The PZR control equipment shall be compatible with ITER control equipment. Control contact ratings are specified in Appendix A – IBED PHTS PZR Datasheet

5.2.14 The PZR shall be designed to meet nozzle loads and seismic requirements specified in Appendices E and F. The PZR shall be designed to meet all load combinations as specified in Appendix C – IBED PHTS PZR Load Combinations.

5.2.15 The PZR shall be designed for an operating life of 20 years at the conditions specified in this document and in the Appendix A – IBED PHTS PZR Datasheet, excluding packing, gaskets, and other normally replaceable parts. 5 years for commissioning and installation shall be considered in addition for the design of PZR.

5.2.16 The PZR design done by the Contractor shall be based on the full design load at the conditions given in the PZR DS (Appendix A) and the loading combinations (Appendix C). The PZR design shall include the factors and margins needed for the fluid conditions and operating conditions specified in the DS (Appendix A) and the process design (Appendix B). The contractor shall specifically study the thermal fatigue occurring at spray line and surge line connection during the various modes, including also thermal turbulence even during steady state (See Appendix B for the different modes and transient).

5.2.17 Pressure boundary thickness shall be in accordance with the Code of Construction, as defined in Requirement 5.2.1. Sufficient allowance will be added to the wall thickness to compensate for corrosion, erosion, and abrasion over the lifetime of the PZR. Wall thickness shall be verified by inspection or testing after forming. (Refer to Section 5.11.2 for Test and Inspection Requirements).

5.2.18 The PZR design shall include required fouling factors and electrical power margins needed for the fluid and operating conditions specified in the PZR DS (Appendix A).

5.2.19 The equipment design shall clearly identify reaction forces and moments at the equipment interfaces to the building and include adequate fastener sizing for installation per Section 5.5.2.

5.2.20 The base material for the PZR shall be defined through EPMN approved by IO. It is strongly recommended to use austenitic stainless steel of either type 304L or 316L.

5.2.21 The PZR design shall avoid unnecessary cavities where particles suspended in the process fluid can settle or collect (e.g., no socket welds or spare connections). The surface finish for wetted surfaces is detailed in Section 5.10.1.17.

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5.2.22 The PZR spray pipe shall terminate near the top of the vessel with a spray nozzle (or spray nozzles) and thermal sleeve, as required. The spray nozzle(s) shall be designed to produce a full cone shaped spray precluding contact with the vessel wall down to the PZR working water levels (Figure 7-2 Ref. [97]). The spray nozzle(s) shall be replaceable through the vessel manway. Spray nozzle design parameters are listed in PZR DS (Appendix A) to support the final design by the Manufacturer. The design requirements and performance evaluation shall be validated by CFD analysis.

5.2.23 Surge line deflectors/baffles shall not physically interfere with heater sheath or sleeves and their design/placement shall ensure that surge flow rates do not induce the potential for flow induced vibration of the heater rods.

5.2.24 The PZR design shall include appropriate measures in order to limit as much as possible the release of activated corrosion products and avoid equipment activation.

5.2.25 The PZR shall be designed to allow complete draining and venting without disassembly of the PZR. Draining and venting nozzles are indicated in Appendix A – IBED PHTS PZR Datasheet.

5.2.26 The PZR shall contain sufficient lifting appurtenances in appropriate positions to guarantee safe loading, lifting, and handling in accordance with Section 5.5.5.

5.2.27 The PZR design shall include the means for application of insulation to address Section 5.5.4 and Appendix A – IBED PHTS PZR Datasheet.

5.2.28 Overpressure protection for the PZR shall be ensured by external devices (i.e., outside of the PZR) and must be able to be connected to the PZR as specified in the general arrangement sketches in Appendix D. The overpressure protection devices will be provided by others during installation.

5.3 Operating and Performance requirements

The pressure of the IBED PHTS is controlled by the PZR for all modes except baking, Idle and Off Modes. During baking, Idle and Off Modes, the IBED PHTS system is water solid, and pressure is controlled by the IBED Chemical and Volume Control System (CVCS).

The IBED PZR shall be able to perform all operations as provided in Appendix B, together with the IBED PHTS I&C functional requirements [97] associated with IBED PZR.

5.4 Interface requirements

The connected process piping lines shall be welded to the nozzles of PZR.

For Instrumentation, control and electrical interface details, please refer to Appendix J.

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5.5 Mechanical Requirements

5.5.1 *Nozzles*

5.5.1.1 Required nozzles, type, size and projection are indicated in the PZR DS (Appendix A) and general arrangement sketches (Appendix D). Orientation and location of all nozzles shall be specified on the Contractor design drawings, which will require review and written approval by IO prior to start of manufacturing. The allowable loads are presented in the appendix E.

5.5.1.2 Gaskets and hardware for all closed ports shall comply with EN 13555 [CS3] and shall be supplied with the PZR. A leak rate class of L0.001 (specific leak rate ≤ 0.001 mg s^{-1} m^{-1}) shall be achievable. Gasketing material shall be compatible with the intended service as stated in the PZR DS (Appendix A).

5.5.1.3 Flanged connections shall be calculated according to EN 13555 [CS3] for the leak rate class. For each flanged nozzle, the Contractor shall provide nozzle flange, counter-flange with 300 mm long pipe stub closed with end cap, bolts, nuts, washers and four gaskets (one installed and three spare).

5.5.1.4 Thermowells shall be provided in accordance with ASME PTC 19.3 TW [CS12]. The outer embossing diameter shall be 70 mm, embossing height 60 mm, and thermowell thread G 1¼. Thermowells' length shall be 250mm.

5.5.1.5 Each nozzle shall have its identification number, as specified in the general arrangement sketch (Appendix D), permanently marked on the outside cylinder surface of the nozzle.

5.5.1.6 The dimensions of all nozzles and pipes shall conform to ASME B36.19M [CS8] with metric dimensions as indicated in the general arrangement sketch (Appendix D – General Arrangement of PZR).

5.5.1.7 All end flanges, if applicable, shall be checked for axial alignment and gasket face flatness after welding to the PZR shell and stress relieving [CS7].

5.5.2 *Supports*

5.5.2.1 The PZR shall be designed to safely withstand all loading requirements, including nozzle loads, in accordance with this Specification. Seismic and nozzle loading requirements are specified in Appendices E and F with the combinations provided in Appendix C. The design shall include the equipment supports their attachment locations and types (i.e., fixed, sliding, etc.) to the building.

5.5.2.2 The PZR supports shall be fixed through the embedded plates (EP) on the concrete (see Appendix D).

5.5.2.3 The design of the attachments shall take into consideration the thermal expansion of the equipment and its supports in the normal, exceptional, and highly improbable situations.

5.5.2.4 The design of the attachments shall be completed by a qualified welding procedure for the supports welds and if shims are needed for the installation, a shimming procedure is also needed.

5.5.2.5 The installation configuration (i.e., footprint and building attachment locations) shall be determined assuming the attachment points are rigid and have adequate capacity. No credit shall be taken for friction between support and foundation.

5.5.2.6 The equipment load for all the situations shall be provided by the Contractor for the attachment locations. The loads shall be provided during the design phase to allow the IO to assess the loads on the embedded plates, to ensure they have adequate capacity.

5.5.2.7 All elements of the PZR support structure are part of the scope of delivery and shall be factory mounted on the PZR when applicable. The parts that need to be mounted on the IO site shall be delivered with the PZR as separate parts.

5.5.3 *Nameplates*

5.5.3.1 All elements of the PZR support structure are part of the scope of delivery and shall be factory mounted on the PZR when applicable. The parts that need to be mounted on the IO site shall be delivered with the PZR as separate parts.

5.5.3.2 The nameplate(s) shall include the unique identification number supplied by IO. A metal nameplate, suitable for the intended service, at least 0.5 mm thick, shall be permanently attached to the PZR components or to a bracket that is permanently attached to them. The nameplate and attachment shall be such that removal shall require wilful destruction of the nameplate or its attachment system. The attachment weld to the PZR shall not adversely affect the integrity of the PZR. The Nameplate shall remain visible after insulation of the pressurizer. TAG numbers are:

- 26PHBD-PZR-1001 (for pressurizer tank)
- 26PHBD-CMC-1001 (proportional heater LV cubicle)
- 26PHBD-CMC-1002 (backup heater LV cubicle)

The heaters are installed onto the PZR vessel, then there is no need to have separate nameplates for them.

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5.5.3.3 The PZR nameplates shall be austenitic stainless steel.

5.5.3.4 The nameplate for the Pressurizer shall be performed according to the requirements defined in the PED [RR2] and ESPN [RR3].

5.5.3.5 In addition to the nameplate contents specified for the pressurizer above, the nameplate for the heater bundle shall include the following minimum information:

- Catalogue or model number
- Part number
- Voltage
- Frequency
- Phase
- Maximum heating capacity
- Manufacturer name and address
- Manufacture date

- CE marking

5.5.3.6 In addition to the nameplate contents specified for the pressurizer and for the heater bundle above, the nameplate for the heater control and electrical switchboards shall include the information prescribed in Ref. [95]. Nameplates for instrumentation shall follow requirements in [93].

5.5.4 *Insulation and Sheathing*

The outside of the PZR will be insulated. The insulation thickness to consider in the design of the PZR in its support shall be determined to resist fire and will limit the metal temperature under the insulation to be up to 263 °C for the fire loads during 2h following Eurocode 1 [CS15] which provides a peak air temperature of 1049 ˚C. The thickness of the insulation shall be minimum possible due to space requirements around the PZR.

Whether the supports will be insulated will be determined by analysis. If the supports are not to be insulated, they will be deemed to be at a temperature of 400 °C during the fire event.

The expected insulation shall have the same characteristics as PROMAT Microtherm Overstitch 1000 to reduce at the minimum the thickness of insulation due to the space restraint. Other insulation material can be used subject to written approval IO prior to use.

The insulation shall be tested and qualified for these different requirements:

- Chemical analysis: Co, Ta and Nb shall be in the limits indicated in Table 5-3 for the insulation product and the sheathing.

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- Free of Halogens (Chlorine, Fluorine Bromine) for the insulation product and the sheathing
- Landa test (thermal conductivity) following ASTM C177
- Density following ASTM C303
- Flammability resistance: minimum classification A2L s3 d0 according to EN 13501-1. The flammability performance shall be equivalent or better than the mentioned classification in other recognized standards (as ASTM E84).
- Resistance to seismic event SL-2. The design of supports for installation of the insulation and its sheathing is included in the design of the PRT. Insulation supports shall be designed such that the insulation remains in place during SL-2 earthquake.
- Radiation ageing qualification will be performed later by IO: coupons shall be sent by the Contractor done in the same batch of the insulation of the tank and provided in the same preservation conditions as the insulation itself.

5.5.5 *Handling, Lifting and Trunnions*

5.5.5.1 The PZR components shall be equipped with handling/lifting lug(s) and trunnions in accordance with the code chosen and designed to support all the handling, lifting loads. The handling/lifting lug(s) shall be clearly identified.

5.5.5.2 The handling/lifting lugs and trunnions shall be located away from welds and nozzles. The minimum distance between the lifting lug location and adjacent welds or nozzles shall be equal to 2t + 51 mm, where t is the maximum thickness of the pressure boundary. This distance shall be measured from the toe of the pertinent weld.

5.5.5.3 Each handling/lifting lug and trunnion shall be designed to support 125% of the dry weight of the PZR.

5.5.5.4 The PZR shall not be lifted using a single handling/lifting lug or trunnion.

5.5.5.5 The handling/lifting lugs and trunnions shall be designed to allow the horizontal lifting, the vertical lifting and the titling from horizontal to vertical position.

5.5.5.6 The lifting could be performed with vertical slings or slings making an angle which must be defined by the Contractor and indicated in the Instruction Manual.

5.5.5.7 The material requirements for the lifting lugs shall be equivalent to those of the pressure boundary materials.

5.5.5.8 If other non-permanent supports or tools are required for the transportation of the PZR, they must be submitted to the IO for approval and be included in the Instruction Manual. Such device is in Contractor’s scope.

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5.5.6 *Manway*

5.5.6.1 Manway shall be designed in accordance with the requirements of the Code of Construction, as defined in Section 5.2.1.

5.5.6.2 The Manhole diameter shall be DN600. Other dimensions may be adapted with written approval of IO.

5.5.6.3 Manway flange shall be calculated in accordance with EN 1591-1 ref. [CS4]. A leak rate class of L0.001 shall be achievable.

5.5.6.4 Manway covers weighing more than 22.5 kilograms shall be provided with a davit and a minimum of two handles located on the horizontal surface of the cover to facilitate the removal of manway cover.

5.5.6.5 Manway shall be designed to minimize retention of contaminated materials within the tank nozzle (i.e. manways that have an interior surface that aligns flush with the internal surface of the tank shell or sloped towards the tank centreline to allow for drainage).

5.5.6.6 Manway shall be provided with gaskets. Manway gaskets shall be spiral wound suitable for process fluids at the design pressures, design temperatures and environmental conditions specified in this Specification.

5.5.6.7 Manway shall be accessible regarding the building space available.

5.6 Electrical and I&C Requirements

5.6.1 *Heater Bundles*

5.6.1.1 The heater bundles shall have a closure designed to the Code of Construction, as defined in Section 5.2.1.

5.6.1.2 Individually replaceable electric heaters shall be installed through the bottom head. The heaters shall be inserted into heater sleeves and Contractor shall design practical connexion to allow for easy maintenance and/or replacement in case of failure. The total number of heaters and sleeves required to provide the heating power in Appendix A shall be determined by the Contractor. The total number of heaters and sleeves will also account for an adequate margin in heating power (Section 5.2.18 of this Specification). Functionally the heaters will be grouped in two bundles called the Proportional Heater and the Backup Heater.

5.6.1.3 Heaters shall have a heated length of approximately 1 m, with a heater sleeve of approximately 0.2 m [113].

5.6.1.4 Heater bundles shall not extend beyond/above the lowest normal operating level to ensure that heater bundles remain submerged.

5.6.1.5 If there is any risk of the temperature of PZR will exceed the maximum operating temperature indicated on the PZR Data Sheet in A.1, the contractor shall design and provide the appropriate over-temperature protection enclosures. These over-temperature protection enclosures are safety accessories as defined in [RR1], so a dedicated conformity assessment (or with the PZR as assembly) shall be performed by the Contractor before delivery of the PZR (see 5.13.1).

5.6.1.6 Only Grade "A" Magnesium Oxide (MgO) shall be used inside the heating elements. The Supplier shall have a quality control plan that will test and verify that the MgO electrical properties are maintained to establish minimum levels to ensure the final quality of the electrical properties of the heating element.

5.6.1.7 Specific material attributes to be tested and qualified shall be particle distribution, compaction density, static/dynamic flow characteristics, and magnetic/electrical properties.

5.6.1.8 Heater bundles shall be provided with a moisture "tight" seal at the terminal ends. Minimum acceptable seals are epoxy filled with ceramic pressed inserts. Epoxy only seals shall not be used. Room-temperature vulcanization silicone seals shall not be used.

5.6.1.9 If heating elements are abrasive cut, then burrs shall be cleaned, and particulates flushed out of the element before proceeding with manufacturing of the heater element.

5.6.1.10 Heaters with moisture resistant enclosures shall be minimally rated for IP66, and CE certified.

5.6.1.11 Heater enclosures shall include openings for appropriately sized National Pipe Thread (NPT) or cable glands.

5.6.1.12 Heater design shall ensure that the active heater element does not extend into the pressurizer penetration heater sleeve. The active heater length shall be entirely contained within the heater sheath.

5.6.2 *Heater Sheath*

5.6.2.1 The heater bundles shall be ungrounded, straight sheath type, with a potted receptacle at the end.

5.6.2.2 The receptacle shall terminate with threaded nut-and-bolt type terminals. Exposed connections shall be protected by a silicon rubber boot. The nuts, bolts and boot.

5.6.2.3 The heater design shall include a seal, internal to the heater sheath that is capable, if the heater sheath should rupture, of retaining the vessel design pressure without leaking to the atmosphere.

5.6.2.4 Heater sheath material shall be 304L or 316L stainless steel.

5.6.2.5 The sheath temperature shall not exceed the specified material limit at all specified flow ranges.

5.6.2.6 The heater sheath shall be hermetically sealed with a weld. No moisture shall be able to penetrate inside the heater rod.

5.6.2.7 The heater sheath, including the end plug to sheath weld, shall be tested with liquid penetrant and X-ray inspected.

5.6.3 *Heater Control and Electrical Switchboards*

5.6.3.1 Proportional heater and backup heater electrical and control switchboards shall be design as per requirements defined in [95]. The main purpose of this section in this document is to summarize the basic requirements for the electrical and control switchboards.

5.6.3.2 All electrical equipment shall be in compliance with the LV Directive 2014/35/EU and duly CE marked.

5.6.3.3 Electromagnetic compatibility shall be in compliance with the EMC Directive 2004/108/CE [RR6] and EDH Part 4: Electromagnetic Compatibility [85].

5.6.3.4 Because of separate primary power feeds, there shall be two (2) heater control and electrical switchboards. One (1) to service the Proportional Heater (26PHBD-CMC-1001) and the other for the Backup Heater (26PHBD-CMC-1002).

5.6.3.5 The Proportional Heater control and electrical switchboard shall be supplied power from the ITER Organization's Steady State Electrical Network (SSEN) via one primary LV Class IV OL power cable (3 PH + N + PE). From a load center in accordance with parameters specified in the Heater Data Sheet (Appendix A).

5.6.3.6 The Backup Heater control and electrical switchboard shall be supplied power from the ITER Organization's Emergency Power System (EPS) via one primary LV Class IV OL power cable (3 PH + N + PE). From a load center in accordance with parameters specified in the Heater Data Sheet (A.1).

5.6.3.7 The heater control and electrical switchboards shall distribute the power to the heater bundles.

5.6.3.8 All heater control and electrical switchboard power requirements shall be derived internally from the SSEN main power supply provided for each control & electrical switchboard.

5.6.3.9 The physical configuration of the primary power from the ITER Organization provided to the Control and Electrical Switchboards shall be a 5-wire system (Three Phase, Neutral and Earth) 400 V, 50 Hz.

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5.6.3.10 The Contractor shall provide properly sized power lugs / busbar connection in the heater control and electrical switchboards to accommodate the incoming power cables / busbars (refer to appendix J for details). Similarly, field power connection boxes shall be properly sized and design to accommodate the power supply cables to the heaters.

5.6.3.11 The heater control and electrical switchboards electrical equipment layout shall include provisions for equipment installation and interconnection of power and instrumentation cabling by others. The supply of the power and instrumentation cables for in-field cabling is not in the scope of the Contractor.

5.6.3.12 The design, procurement and supply of the power cable from the heater bundles field power connection boxes to the heater control and electrical switchboards is out of the Contractor's scope.

5.6.3.13 Each Heater control and electrical switchboard shall be provided with an adequately sized incoming Three Phase, Neutral and Earth (4-pole) Molded Case Circuit Breaker for the primary power input. Proper electrical selectivity shall be assured between heater electrical and control switchboard main incomer circuit breaker and IO circuit breaker upstream in SSEN Distribution.

5.6.3.14 The Contractor shall provide and install the wiring between the power lugs referenced and the primary circuit breaker.

5.6.3.15 Each individual heater element control circuit shall be complete with a Three Phase, 3-pole Molded Case Circuit Breaker. These breakers shall be adequately sized for the element load and provide overload and short circuit protection and selectivity for the individual circuit.

5.6.3.16 All circuit breakers shall have an ultimate interrupt current ICU (thermal and magnetic breaking withstand capacity) of 50 kA for 3 seconds.

5.6.3.17 All circuit breakers shall include a lockable operating mechanism (OPEN/CLOSE) available on the cubicle door. OPEN or CLOSE operation of the breaker shall be possible from outside the switchboard with the door closed.

5.6.3.18 Each circuit breaker shall have an over-current trip and auxiliary dry contacts to indicate if the circuit breaker is OPEN, CLOSED, or TRIPPED. These contacts shall be wired to terminals for easy accessibility by field wiring. In addition, the status of the breaker shall be displayed with indicator lights on the front side of the heater control and electrical switchboard.

5.6.3.19 Each breaker shall have the capability to be tripped and reset remotely by operators.

5.6.3.20 A surge arrester shall be provided for each circuit to protect against overvoltage.

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5.6.3.21 Each heater control and electrical switchboard circuit shall also include a residual current device with an adequate thermal rating for the load and anticipated fault currents. Residual current device trip status shall be wired and available in terminals.

5.6.3.22 Provisions shall be made to ensure that any electrical back feed from the heater elements is not possible.

5.6.3.23 Proportional Heater control shall be variable with full Silicon-Controller Rectifier (SCR) control able to regulate the power output.

5.6.3.24 SCRs shall be zero crossover fired (burst firing). The system shall have SCR short circuit detection and alarm capability.

5.6.3.25 Heater control and electrical switchboards shall allow for continuous detection of welded magnetic contactors.

5.6.3.26 If the heater control and electrical switchboard has multiple circuits and an SCR short occurs, the control and electrical switchboard will open the magnetic contactor on that circuit and send a common alarm signal. The control and electrical switchboard will continue to function without the failed circuit.

5.6.3.27 Short circuit protection shall be in control and electrical switchboards for the SCR equipment, shall follow the SCR manufacturer requirements in their specification.

5.6.3.28 With multiple circuits, the number one (1) circuit shall have the over-temperature sensors and be connected to the over-temperature controller. If the number one circuit is shorted, then power shall be disconnected by the circuit breaker and the magnetic contactors.

5.6.3.29 The supplied duty shall consider wattage design tolerances and field voltage variations and provide a safety factor in the design that takes these considerations into account. Under- and over-voltage requirements are listed in Ref.[89].

5.6.3.30 The heater control and electrical switchboards shall include a standard self-contained fire detection and extinguishing system capable of detecting and extinguishing any fire inside the cubicle.

5.6.4 Heaters Operation and Control Philosophy

5.6.4.1 Proportional heater and backup heater control philosophy shall be design as per detailed requirements defined in [95]. The main purpose of this section in this document is to summarize the basic requirements regarding control philosophy.

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5.6.4.2 The Proportional Heater control shall be variable with full SCR control able to receive 4-20 mA signal to regulate the power output. Synchronous (stepper/SCR) or block (multiple contactors only) control is not allowed unless there are independent and separate over temperature control shutdowns for the first on/last off stepper circuit and the SCR circuit.

5.6.4.3 Proportional Heater control shall be performed by the remote Tokamak Cooling Water System (TCWS) IBED PHTS Programmable Logic Controller (PLC) (PBS 26 PCS).

5.6.4.4 The control output (to SCR control) shall be calculated utilizing a continuous process pressure and temperature feed-back to the TCWS IBED PHTS PLC (PBS 26 PCS).

5.6.4.5 The Proportional Heater system shall be capable of receiving multiple 4-20 mA signals from the TCWS IBED PHTS PLC (PBS 26 PCS) representing process temperature, and setpoint. The heater control system shall also be capable of receiving a temperature sensor signal (PV) from a 3 or 4-wire RTD.

5.6.4.6 The Backup Heater is only switched on and switched off. There is no continuous power regulation for the Backup Heater. The TCWS IBED PHTS PLC (PBS 26 PCS) will provide a digital on/off signal to the heater cubicle.

5.6.4.7 The over-temperature controllers and sensor(s) shall be provided by the heater system supplier for both heater systems and operate independent of the TCWS IBED PHTS PLC (PBS 26 PCS).

5.6.4.8 The temperature limit shall be set at a temperature slightly below the maximum allowable sheath temperature. This is done to avoid too frequent heater trips when the operating conditions slightly deviate from nominal operating conditions).

5.6.4.9 Reset of the over-temperature controller shall be possible both remotely from the TCWS PLC (PBS 26 PCS) with a digital signal and locally on the outside of the heater control and electrical switchboard using a hardware interface.

5.6.4.10 All local controls and interfaces shall be available without opening the heater control and electrical switchboard door.

5.6.4.11 The pushbuttons and selector switches of all control and electrical switchboards and enclosures shall be IEC-rated in compliance with the following standards [CS22] to [CS24].

5.6.4.12 The ability to enter a LOCAL SETPOINT (level of power) shall be available on the outside of the Proportional Heater cubicle. This LOCAL SETPOINT shall be transmitted to the TCWS IBED PHTS PLC (PBS 26 PCS).

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5.6.4.13 The Proportional Heater cubicle shall have the capability to be placed in LOCAL mode (control to panel entered setpoint) or REMOTE mode (control to setpoint received from TCWS PLC (PBS 26 PCS)) using a panel selector switch. In either case the actual control will be performed by the TCWS IBED PHTS PLC (PBS 26 PCS).

5.6.4.14 The Backup Heater cubicle shall have the capability to be placed in LOCAL mode (started locally from control and electrical switchboard) or REMOTE mode (started by the TCWS PLC) using a panel selector switch.

5.6.4.15 START and STOP pushbuttons shall be available on the exterior of both heater control and electrical switchboards to allow the start and stop of the heaters when they are in LOCAL mode.

5.6.4.16 The Proportional Heater control and electrical switchboard shall have displays available on the outside of the cubicle for indicating the SETPOINT, PROCESS VARIABLE, CURRENT and the PERCENT OF POWER (0-100%) being utilized. Displays shall be LED type and be easily visible on the exterior of the heater control and electrical switchboards.

5.6.4.17 Both Heater control and electrical switchboards shall have indicating lights on the outside of the cubicle to signify ALARMS, REMOTE/LOCAL MODE, POWER ENABLED (ON/OFF) status and the status of each circuit breaker as OPEN, CLOSED, or TRIPPED.

5.6.4.18 These indicating lights shall be in accordance with [95].

5.6.4.19 A minimum of one (1) Emergency Stop (E-Stop) pushbutton shall be provided for each heater control and electrical switchboard, be clearly identified and mounted in a logical and easily accessible location on the exterior of the switchboard. Any E-Stop shall be hardwired with safety logic (N.C contact) into the power circuit to stop power from the selected cubicle to the associated heater. Software E-Stops are not allowed.

5.6.4.20 E-Stops shall be of the push-pull type with a RED mushroom head and two (2) Form C contacts (Normally Open / Normally Closed). The contacts shall be wired to terminals clearly identified inside the heater control and electrical switchboards and made available to external system connections.

5.6.5 *Heaters Control System Requirements*

5.6.5.1 The proportional heater control system shall have the capability to transmit all monitored values including instantaneous current usage for heater bundle to a remote-control system in the form of 4-20 mA signals.

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5.6.5.2 The heater control system shall have the capability to receive a “START” and “STOP” hardwired digital command from a remote source. The “START” command shall only be valid when the heater control system is in REMOTE mode.

5.6.5.3 The remote STOP command will always be operational.

5.6.5.4 The heater control system shall terminate power supply to the heater in case of loss of the “START” signal or loss of the control signal when in REMOTE mode.

5.6.5.5 The heater control system shall have the capability to transmit a digital signal indicating ON or OFF status. A dry auxiliary contact shall be provided for this purpose.

5.6.5.6 The heater control system shall have the capability to transmit a digital signal indicating LOCAL or REMOTE status. A dry auxiliary contact shall be made available for this purpose.

5.6.5.7 The heater control system shall have the capability to transmit a minimum of two (2) user-defined ALARMS as a binary signal through the use of dry auxiliary contacts.

5.6.5.8 The heater control system shall have the capability to transmit digital signals indicating OPEN, CLOSED or TRIPPED status of all the circuit protection breakers.

5.6.5.9 The Contractor may propose the use of a communication protocol to transmit the interface control and information defined in this Section. The acceptable protocol shall be Siemens Profinet. Protocol converters such as Modbus to Profinet devices are acceptable. The Contractor shall provide all required hardware, software, software development and mapping required to facilitate this solution along with detailed documentation. Note that main signals required to start/stop/regulate remotely the heaters shall be only hardwired. This means that in the event there is no communication active between heaters control system and PBS26 PCS, the system can be operated remotely via the hardwired interfaced signals.

5.6.5.10 The internal cubicle wiring shall be in accordance with Section 7.32 Ref.[95]. All cable components shall be halogen free.

5.6.5.11 To simplify the design and to allow the two (2) heater control and electrical switchboards to operate independently, it is recommended that all system interfaces associated to a specific switchboard be confined that switchboard. To clarify; there will be one (1) Local/Remote switch, one (1) START PB and one (1) STOP PB installed on each of the (2) control and electrical switchboards. There shall be one (1) place to enter the local setpoint on the Proportional Heater cubicle, but not on the Backup Heater cubicle.

5.6.5.12 There shall be one set of indicator lights installed on each control and electrical switchboard to signify the operating mode and status of that system. Additional signals whether transmitted or received digitally, by analog means or by a communication protocol should also physically interface with the associated cubical. The circuit breaker status lights (OPEN, CLOSED, TRIPPED) shall be installed on the exterior of the specific cubicle where the circuit breakers are installed.

5.6.6 *Instrument Requirements*

5.6.6.1 The TCWS IBED PHTS PLC (PBS 26 PCS) and the process instrumentation are not part of the Contractor's scope (IBED PZR).

5.6.6.2 Instruments that are within the Contractor's scope (IBED PZR) shall be designed in accordance with Ref. [93][94].

5.6.6.3 Contractor shall determine whether sensing elements are necessary for the equipment. If necessary, the sensing elements that are within Contractor's scope shall be PT100 Class A 3 or 4-wire connection RTDs, as well as the requirements in the following chapters.

5.6.6.4 All instruments shall be tagged with the instrument unique identification number supplied by ITER using a stainless-steel plate. Identification number characters shall be a minimum of 3/8 inch in height. Instrument identification number shall be fastened to the instrument with stainless-steel wire so that it can be read after the instrument is mounted, without removing covers or accessories.

5.6.6.5 The Contractor shall provide Data Sheets for all supplied instruments. Data Sheets shall include, as a minimum: Manufacturer, model number, design and operating data, setpoints, calibrated range, ITER identification number, and service description. Calibration curves for each instrument shall be provided by a recognized and accredited calibration laboratory.

5.6.6.6 The measurement uncertainty of each sensing element shall be ±2% or better of the calibrated range. The measurement uncertainty shall be calculated in accordance with ASME PTC 19.1 [CS12] or equivalent. The measurement uncertainty shall be calculated for the complete measurement chain including sensor, connecting cables and electronic signal treatment.

5.6.6.7 All instrumentation and controls shall be located to provide easy access for calibration and maintenance.

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5.6.6.8 All needed sensor elements provided by the Contractor shall have no signal processing, pre-amplifiers, magnetic operators, or any other type of embedded electronics on it. All electronics must be remotely located from the sensor. The distance between sensing element and the associated electronics may be as long as 300 m and the design must consider this distance.

5.6.6.9 The Contractor is not responsible for the supply of the instrument cables and its routing from the heater to the control and electrical switchboard. However, the Contractor shall provide minimum provisions for the connection of the instrument cables with the heaters, and with the control and electrical switchboard.

5.6.7 *Grounding (Earthing)*

5.6.7.1 The Heater elements and the heater control and electrical switchboard shall be grounded per [86].

5.6.7.2 Equipment shall include a minimum of two (2) pads to be used for equipment bonding and grounding (earthing) that allows connection of 4/0-AWG bare copper conductor to the plant grounding grid.

5.6.7.3 The heater control and electrical switchboards shall have a properly sized copper grounding bar running the length of these Control and Electrical Switchboards.

5.6.7.4 The heater control and electrical switchboards grounding bar earthing bars shall include a removable link to facilitate the testing of the earthing network.

5.6.7.5 All instrumentation within the Heater boundary shall be grounded at the heater control and electrical switchboards. Provisions for these connections shall be provided.

5.7 Installation and Assembly

The transport of the PZR from the storage area to the assembly area is not included in this Contract. Nevertheless, the Contractor shall provide devices to facilitate the transportation of the PZR which are compatible with the constraints of the site and shall describe the procedure for the in-site transportation and installation operations. The Contractor will assist the IO during the in-site transportation phase.

No items or devices will be manufactured on the IO site. The site assembly is not included in this contract. Nevertheless, the Contractor shall provide the assembly procedure of the PZR and shall implement the needed protection to allow the good assembly achievement. The Contractor will assist the IO during the assembly phase and the connection phase. The Contractor shall also provide recommendations for on-site commissioning tests needed to verify the correct operation of the PZR after installation.

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5.8 Documentation Requirements

5.8.1 *General Requirements*

Contractual language is English and shall be used in all documentation transmitted to IO. The English text shall take precedence over any other languages in the document. 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.

A specific procedure shall control the accuracy of English language used in document including assessment of level of English of Contractor's employees, internally qualified translator and documented systematic review of English translation.

All the manuals (Instruction Manual, Installation Manual, Transportation Manual…) shall be written in French and in English.

The Contractor shall be responsible for submitting all the required documentation for the IO's approval or review, through IO's Document Management System (hereafter called IDM) following the process of exchanging and storing stated in the working instruction [7].

The Contractor's Responsible Officer will be given access to the Document Exchange area in IDM. The folder structure and the access are an IO responsibility.

Approval of Contractor's documentation by IO does not relieve the Contractor from its obligation to comply with contractual requirements.

All documents shall follow the documentation requirements stated in the working instruction [7], and use the official document type and names for ITER project as per [8], unless agreed with IO in advance. In addition, for the documents submitted in PDF format (version 1.4 or above), the native files shall be provided and uploaded in IDM as an attachment to the PDF file.

All documents shall be clean and legible white prints with uniform background density suitable for electronic scanning and subsequent reproduction from an electronic format. Insofar as practical, documentation shall be typed and arranged in a neat and professional manner. Handwritten documents shall conform to the legibility requirements and quality requirements of this section. Any pen and ink changes necessary after printing will be performed by drawing a single strike through line, preserving the original information, with neat ink text initialled and dated. Material certificates or quality records with white correction fluids on it will not be accepted.

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.

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All documents shall use SI units as primary dimensions. Drawings shall follow all normal ISO conventions and standards, in particular those standards used in the power industry, for orientation and rotation of drawings, plan views, dimensioning, symbols, etc.

The drawings in PDF format are exchanged in the System for the Management of Diagrams and Drawings (SMDD) as defined in [12]. For the other documents

PZR drawings shall, as a minimum, include the following information:

- A Bill of Materials (BOM) with a description of the individual component and the component identified on the drawing
- Loads on nozzles
- Drawing number and its revision
- Part Number of ITER (PNI) [10]
- All information related to NPE
- Weld reference (if any)
- Interface dimensions identified (external dimensions, nozzles, supports…)
- Manufacturing stage and sequence (unitary, assembly, as-built, transportation…)
- IO approval status (i.e. whether the drawing is “approved for construction” or not)

5.8.2 *General Document Submittal Requirements*

Documents which require review and/or approval shall conform to the requirements of Section 5.8.1 of this Specification. Other correspondence and documents shall, as a minimum, meet the quality requirements necessary to provide legible, accurate, and complete information that can be read and understood and be traceable to the associated items or activities for business audit requirements.

The Contractor is required to submit, final and complete documentation, and certifications prior to close of the contract. This documentation shall incorporate all approved and implemented changes and modifications.

5.8.3 *Technical Documentation Supplied by the Manufacturer for PE/NPE*

According to the article L.557-5 [RR2], the Manufacturer shall establish, store, transmit or hold at the disposal of the ANB in the frame of the Conformity Assessment a list of technical documentation to be adapted depending on the relevant modules and to be broken down for each subcontractor.

According to ESPN ref.[RR3], this technical documentation shall be transmitted to the IO. In the frame of this Technical Specification, the documents of the list below shall be submitted by the Contractor to IO for approval and ANB for acceptance.

- List of harmonized standards and solutions adopted to meet the requirements of the order [RR3] (codes, technical standards, etc.). Ref. [30] shall be used as base analysis and be updated by Contractor to be fully relevant and directly applicable for PZR.

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- The list of material supplier as well as any physical or legal persons other than the Contractor who have carried out a design, manufacturing or control action the activity of which may have an impact on the respect of the essential safety requirements following [RR1].
- Essential safety requirement analysis
- Hazards and Risk analysis[8] which lists all the risks associated with potential equipment failures during all phases of its life cycle (design, manufacture, transport, storage, exploitation, maintenance ...) and to provide responses to remove them or reduce if total suppression is not possible. Risks not removed are included in the Instruction Manual which describes the specific maintenance actions to be implemented to monitor them.
- Description of the methods used for in-service inspections, bearing in mind the radioactivity levels.
- Design drawings, production drawings, diagrams of components, subassemblies or circuits.
- Solutions adopted for marking and labelling.
- List of basic materials used and proof that the material is suitable for the given application (EPMN) fully relevant and directly applicable for PZR.
- Notes justifying the calculation thickness in the case of a design by calculation.
- Design notes justifying correct equipment behavior for each possibility of damage from all the different cases of load combinations. The design analysis reports shall follow the requirements provided in the ref. [70] and be edited from the template ref. [19]. The design report shall demonstrate the efficiency and accuracy of software(s) used following ref. [20].
- NCR[9] likely to have an impact on the requirements identified by the hazards and risks analysis and the repair procedures as applicable
- Pressure resistance test procedures as applicable[10]
- Any other document that can be used to show compliance with the requirements identified by the hazards and risks analysis

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[8] The Hazards and Risk Analysis is the responsibility of the Manufacturer. The IO as Operator has the knowledge of all the hazards and risks related to the operation of the pressure equipment. Nevertheless, the Contractor shall write the Hazards and Risk Analysis regarding all the topics related to the design and the manufacture. Whenever an activity performed by the Contractor may affect a requirement arising from the HRA established by the IO, the Contractor shall inform the IO for decision on the way to manage it.

[9] The non-conformity report is to be supplied as soon as a deviation likely to jeopardise a requirement identified in the hazards and risk analysis and in this technical specification is determined prior to implementation of the selected solution.

[10] The procedure must be approved at the design stage if the equipment in particular due to its size or production mode cannot be subject to the entire pressure resistance test.

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- Instructions Manual(s), containing at least as follows. These manuals must be issued as stand-alone documents not requiring the use of other documents for its application. In an Appendix at the end of each manual, all final documents produced during the design and fabrication of the equipment shall be listed.
    - recommendation for in-service inspection and maintenance of wear part
    - shelf-life of wear part/spare parts
    - installation manual
    - transportation, storage and handling manual (including spare parts)
    - operating manual
    - disassembly instruction, including bolting torque, gaskets replacement, lifting/handling of bonnets, etc.
    - a summary of all the design documents produced by the supplier such as calculation notes, drawings, hazard and risk analyses, pressure resistance test procedures etc.
    - cleaning procedures, chemical and/or mechanical, if applicable
    - tube plugging procedure

These documents shall be submitted within a timeframe to allow their assessment before the performance of the relevant operation.

5.8.4 *Manufacturing Readiness Review*

The IO is responsible towards the French Licensing Authorities for the different Protection Important Components (PIC) and, as such, needs to be involved in the approval of all development phases. The Manufacturing Readiness Review (MRR) is the last review before manufacturing.

Any manufacturing activities shall be authorized by the IO supported by the results of an MRR. The MRR can be split in sub-MRR corresponding to the manufacturing schedule for the different parts of the whole equipment.

The Contractor shall submit to the IO the following documents in the framework of the MRR:

- MRR deliverables checklist
- Engineering:
    - List of deliverables to be provided by the Contractor
    - List of Deviation Requests (if any)
    - Hazards and Risks Analysis
    - Essential Safety Requirements Analysis
    - Top assembly description and function
    - Manufacturing drawings (2D) and models (3D)
    - Assembly drawings at the shop, Manufacturing drawings of Control and Electrical Switchboards
    - Handling/transportation drawings

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- Assembly drawings at the ITER site
- Load analysis as part of the Manufacturing Process
- Design description and justification of transportation frameworks
- Design Reports
- Parts and Material lists and detailed Bill of Material (incl. coupons and spare parts)
- List of standards, codes and regulations applicable for each step of manufacturing, assembly and integration
- Verification Compliance Matrix (requirements and evidence)
- Nuclear Particular Material Appraisal

- Manufacturing Process:
  - Manufacturing and Inspection Plan (MIP)
  - Item identification & tagging and physical labelling procedure (ref.[9])
  - Resourced manufacturing schedule and workflow/ assembly sequences including design, qualifications and testing
  - Material procurement technical specification and sub-orders (including consumables)
  - Material management
    - identification and control of material
    - material certificates
    - material traceability procedures
    - storage conditions
    - handling procedures
  - Manufacturing procedures including processes (machining, forming, wiring, brazing, soldering, welding, cleaning, heat treating, others and non-destructive examination):
    - component processing and assembly specifications
    - cleanliness program
    - surface treatment program
    - pipeline inspection program
    - non-destructive testing program
    - labelling program (can be included into the tagging & labelling procedure)
    - coating program
    - preservation, packaging, storage and transportation program
  - Weld data package
    - Welding procedures/welding Procedure Specification (WPS)
    - Welding procedure qualification record (WPQR)
    - Welding quality inspection and procedure plan (WQIPP)
    - Welding map
    - Cleaning procedure and requirements for welded parts
    - Welding repair procedure
  - Provisions to avoid stainless steel contamination
  - Evidence of material conformity

    - Manufacturing working instructions
- Test Methods:
    - Control specifications, Testing plan and Test procedures
    - Qualification of special processes
    - Manufacturing human resources and quality control procedure
    - NDE procedures and templates
    - Factory Acceptance Test (FAT) program identifying all factory acceptance tests as defined at design stage and including details on extent of the tests, type, examinations and inspections of the Items
    - Pressure resistance test procedures
- Quality Acceptance:
    - Quality Plan (to be submitted at AOC) as per [4]
    - List of subcontractors and their attributions
    - Subcontractors Quality Plans
- Tooling:
    - List of test equipment and tools including relevant calibration protocols
    - Calibration status and records of Measuring and test equipment
- Training and Qualification
    - List of qualified welders, welding equipment operators, NDE personnel
    - Certificates for welding and NDE personnel
    - Training records
- Transportation and Preservation
    - Transportation packing and shipping procedure
    - On site preservation procedure
    - Planned delivery list
- Installation and Maintenance
    - Recommendation related to Installation and Use of the equipment, including any required tooling
    - Recommendation related to Maintenance plan

At the start of contract, the list of documents to be produced by the Contractor will be agreed between all parties. This list will identify the documents to be approved by the IO and accepted by the ANB. ANB approval of design is needed to close MRR.

5.8.5 *Documents Provided Prior to Shipment*

5.8.5.1 *End of Manufacturing Report (EMR)*

Prior to final acceptance and issuance of a Delivery Report, an End of Manufacturing Report (EMR) shall be submitted by the Contractor to the IO for review and approval. The EMR shall be submitted in an electronic format, preferably as a pdf. All originals documents shall be safely kept in Contractors premises until written notice by the IO to send the document to ITER site.

The EMR shall have a table of contents listing all sections, drawings, and attachments.

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Each section of the EMR shall have an individual section tab.

The EMR shall be organized in the following manner:

- Section 1: Request for the evaluation of a Nuclear Pressure Equipment
- Section 2: General description of the Nuclear Pressure Equipment
- Section 3: Data supplied by Operator
- Section 4: Technical documentation
- Section 5: Non-conformance reports and Deviation Reports
- Section 6: Final assessment
- Section 7: Certificates

5.8.5.2 *Contractor Release Note (CRN)*

The Release Note is a document which provides confirmation from the Contractor that the PZR being supplied meets the requirements of this ITER Technical Specification.

The recommended format for the Release Note shall follow the guidance given in the MQP Contracts Release Note [4].

Prior to acceptance or delivery, the Contractor shall conduct a review of the PZR status regarding contract requirements and certify in a Contractor Release Note that:

- All required verifications, inspections and tests are complete and satisfactory
- All required documentation is available.

The IO shall have 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 before shipment.

5.8.6 *Exchange and Sharing of CAD Files and Design Models*

For the TCWS components, the Configuration Management Models (CMMs – 3D models where the context of the plant is managed) are created using ENOVIA\CATIA V5 and the detailed design models (DMs) for TCWS components are created out of context using AVEVA E 3 D .

5.8.6.1 *CAD Design Tasks*

The Contractor shall provide a Design Plan to be approved by the IO. Such plan shall identify all design activities and design deliverables to be provided by the Contractor as part of the contract.

The Contractor shall ensure that all CAD Data (Schematics, Models and Drawings) delivered to the IO comply with the Procedures [14][15] and with the AVEVA E3D- IO CAD guide [18] (whenever AVEVA software is used).

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The reference scheme is for the Contractor to work in a fully synchronous manner on the ITER CAD platform (see detailed information about synchronous collaboration in the document [16]. This implies the usage of the CAD software versions as indicated in [17] and the connection to one of the ITER project CAD databases. Considering the scope of work is a detailed design and manufacturing of complicated equipment, AVEVA will likely not be used, the CMM and DM will not be able to be synchronized. In this case, when the Contractor provides the drawing in SMDD (see Section 11.3), the corresponding 3D model (in .stp format if ITER CAD platform is not used) shall also be attached, then IO can update the CMM and DM accordingly.

Alternatively, MultiCAD with specific requirements about CAD models and drawing format/structure (level of granularity), or any other deviations shall be defined in a Design Collaboration Implementation Form (DCIF) prepared and approved by DO and included in the call-for-tender package. Any cost or labor resulting from a deviation or non-conformance of the Contractor regarding the CAD collaboration requirement shall be incurred by the Contractor.

The exchange of the CAD files shall follow the procedure [11].

5.8.6.2 *Calculation Tasks*

All the calculations and their results shall be submitted to the IO in the frame of the design review.

The calculation models if they are Finite Element Models (FEM) shall be submitted to the IO with the results of the calculations in the frame of the design review.

The models shall be submitted through IO's Document Management System (hereafter called IDM) following the process of exchanging and storing stated in the working instruction [7].

All analysis models, macros, spreadsheets, etc. shall be stored on the IO Analysis Model Database in accordance with ref. [71].

5.8.7 Non-paper Materials

Special processed records such as radiographic film, electronic media (such as magnetic media, optical media), archival samples, and photographs shall be handled and stored to preclude damage.

When transmitted to IO for final storage, records in special formats should be converted into high quality digitized documents to allow long-term storage, retrieval and accessibility and submitted in IDM.

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5.9 Software Requirements

5.9.1 The use of computer software to perform a safety basis task activity such as analysis and/or modelling, etc. shall be reviewed and approved by the IO prior to its use, providing the software V&V following qualification Policy [20].

5.9.2 The software V&V 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.

5.9.3 Where necessary to evaluate technical adequacy for verification, the V&V 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.

5.9.4 The following software and versions shall be used by the supplier:

- CFD thermal hydraulic analyses: ANSYS workbench 19.2 – Fluent 19.2 or more recent after IO approval
- Mechanical structural analyses: ANSYS workbench 19.2 – Mechanical 19.2 or more recent after IO approval
- For design calculation: PV Elite 2018 or more recent or other equivalent software after IO approval
- For flange calculation: TEMES 9.0.21 or more recent or other equivalent software after IO approval
- Electrical wiring diagram shall be prepared in SEE Electrical Expert software

5.9.5 GM3S ref. [1] states that the models shall be provided in a ready-to-run state. Any manual operation that is required to rerun the analyses shall be described either in the analysis report or in a document attached to the model.

5.9.6 Excel spreadsheet can be used for calculation by formula, but the native files shall be provided, and the formula shall be readable for review.

5.10 Material, welding and fabrication requirements

5.10.1 *General Requirements*

5.10.1.1 The PZR shall be austenitic stainless-steel of either type 304L or 316L and shall comply with the additional composition requirements shown in Table 5-3 (other material can be used subject to written approval IO prior to use) referred to in [35].

Table 5-3 Stainless Steel Composition

Component	Content (wt%)
Carbon	<0.03
Cobalt	<0.05 (for PP and wet surface parts)
	<0.20 (other parts)
Phosphorous	<0.035
Sulfur	<0.015
Phosphorous plus sulfur	<0.04
Niobium	<0.1
Tantalum	<0.01
Boron	<0.0018
Nitrogen	<0.1

For carbon steel and cast irons (e.g. struts, counter plates, bolts and nuts) provided by the Contractor, the following impurity limits apply (other material can be used subject to written approval IO prior to use) [35][36].

Table 5-4 Carbon Steel Composition

Component	Content (wt%)
Cobalt	<0.01
Nickel	<0.05

5.10.1.2 For the material composing pressure parts (PP) and other parts contributing to pressure resistance (CCPR), inspection certificates as per [CS10] shall be consistent with the NPMA provided by the Contractor as Manufacturer and this technical Specification. NPMA shall be referenced in the material certificates. The editions of the material standards specified in the certificates shall be the same as specified in the NPMA. In addition, for the material composing pressure parts (PP) which are procured or tested after September 1st, 2028, the requirements from ASN decision (2021-DC-0713) relating to Article 8-2 of the ESPN decree ISO/IEC 17025 accreditation of test laboratories shall apply.

5.10.1.3 When the materials manufacturer has an appropriate quality assurance system of at least EN ISO 9001 certified by a competent body established within the European Community, and having undergone a specific assessment for materials, an inspection document from the manufacturer is appropriate. For main pressure-bearing parts (MPBP), pressure parts (PP), and the components contributing to pressure resistance (CCPR), except gaskets and weld materials, the specific assessment of the quality system shall properly cover all the relevant processes and material properties referred to in the material specifications and attested in the material certificates. In this case, material manufacturer can issue material certificate type 3.1 according to [CS10], in any other case material certificate type 3.2 can only be issued. For gaskets and weld materials, material certificates type 2.2 shall be provided. The material certificate shall specify the purchase specifications in accordance with this Specification.

5.10.1.4 The base material for the PZR shall be sufficiently ductile if in a tensile test carried out by a standard procedure, its elongation after rupture is ≥ 25% and its bending rupture energy measured on an ISO V test-piece is ≥ 60 J at the minimal allowable temperature 5°C (50 J for the test coupons). It is not necessary to perform an impact bending test if the elongation after rupture is ≥ 45 %. For bolting materials, the elongation after rupture is not less than 12% and the bending rupture energy by ISO V test-piece is ≥ 40 J at 0°C or ≥ 50 J at 20 °C (room temperature).

5.10.1.5 All water used for cleaning and hydrotesting shall meet the requirements in Table 5-5 in accordance with ASME NQA-1, Part II, Subpart 2.1, Section 304.1, Water [CS5] for hydrotesting and Grade A water quality from RCC-M 2012, Annex F-III for cleaning. Water chemistry requirements for IBED PHTS are provided in Table A- 2 Appendix A.

Table 5-5 Water Quality

SUPPLY

Component	Requirement	
	Cleaning	Hydrotesting
pH at 25°C (77°F)	6.0 – 8.0[11]	6.5 – 8.0
Specific conductivity at 25°C (77°F), uS/cm	<2	-
Chloride, ppm	<0.15	<250
Fluoride, ppm	<0.15	<2
Sulfide, ppm	n/a	<1
Silica, ppm	<0.1	–
Total solids, ppm	<0.1 (suspended)	<500 (dissolved)

5.10.1.6 The design shall address the ITER Radiation Protection Guidelines [31] for the design and manufacturing of nuclear pressure equipment.

5.10.1.7 Following requirement of [RR3], the choice of materials is made considering the possible activation and release of corrosion products that may, after activation, require protective measures in operation. The water chemistry and the radiological requirements are given in appendix A. The fluid radioactivity concentration is given in the ref.[106].

5.10.1.8 Welding materials shall meet the requirements of the Code of Construction, as defined in Section 5.2.1. Welding materials shall comply with the additional composition requirements shown in table 3-1. Additionally, manufacturers of welding consumables shall provide test report “Type 2.2” as an inspection document in accordance with the standard EN 10204 [CS10]. The traceability requirement of PED, Annex I, Section 3.1.5 [RR1] applies also for welding consumables. The material certificate of welding materials shall specify the purchase specifications in accordance with this Specification.

5.10.1.9 The PZR shall be fabricated in accordance with requirements of the Code of Construction, as defined in Section 5.2.1, the ESPN [RR3] the PED [RR1] (insofar it is called upon by the ESPN) and project-specific quality requirements per this Specification. Any conflicts between conformance with required codes and standards and this Specification shall be brought to the attention of IO for resolution. No irreversible steps in design or manufacturing shall be taken before resolution in writing of the conflict by IO.

5.10.1.10 All pressure boundary welds shall be full penetration welds. The full penetration welds shall permit 100% volumetric examination to be performed in accordance with the applicable codes and standards as listed in this Specification.

[11] A drop in the minimum pH level to 5.5 is permissible on the condition that it can be shown that the drop in pH is effectively due to the carbonation of the water.

SUPPLY

5.10.1.11 Temporary weld attachments shall be removed upon completion of their intended purpose. Removal shall be documented and included in a document provided by the Contractor. If thermal cutting is used, the attachment shall be cut no closer than 8 mm from the surface to which it is attached, and the balance material shall be removed by mechanical means.

5.10.1.12 Thermal arc gouging processes are prohibited.

5.10.1.13 A minimum of 8 mm of base material shall be removed from any edge cut by thermal processes.

5.10.1.14 Any heat treatments performed during fabrication or after welding shall be duplicated on the qualification test coupon(s) and are subject to ANB approval before acceptance for use.

5.10.1.15 Grinding, lapping, and surfacing equipment and abrasives for use on corrosion resistant materials shall be new or not previously used on carbon steel or other metals or alloys so contamination of the finished surfaces is completely avoided. All grinding or lapping on base material or welded metal shall be performed with one of the following: carbide or aluminium oxide burrs, silicon carbide, zirconia, or alumina grinding and lapping wheels. All grinding material shall be free of halogens. Any type of grinding wheel bonded with a resin, rubber, or silicate must be submitted for review and written approval of chemical content by the ANB and IO. Excessive pressure that may result in localized heating or smearing of the surface that can invalidate a subsequent liquid penetrant examination shall be avoided.

5.10.1.16 Wire brushes used for cleaning austenitic stainless-steel or nickel-based alloy materials or welds shall be made from stainless-steel and shall not have previously been used on carbon steel.

5.10.1.17 For the purposes of this Specification an expendable material is defined as a non-permanent material that comes in contact with the PZR. Such items shall not cause degradation of the PZR. Use of expendable material shall be controlled by written procedure, which shall be approved by IO and the ANB prior to use of such materials.

5.10.1.18 Surface finish

- Internal wetted surfaces of the PZR, including welds, shall have a surface finish smoother than 6.3 μm (250 μin) roughness. Interior welds shall be ground flush to meet surface finish requirements.
- Gasket sealing surfaces shall have a surface finish recommended by the gasket Contractor. The external weld seams shall have a surface finish of 12.5 μm (500 μin) Ra or better. Surface finish shall extend a minimum distance from the edge of the weld to a distance whichever the greater is of (a) twice the base plate thickness plus 100 mm; (b) 150 mm.

- All burrs and rough edges shall be removed.

5.10.1.19 Welding

- Welding shall be performed in accordance with the requirements of the Code of Construction, as defined in Section 5.2.1, the ESPN, and PED (insofar as it is called upon by the ESPN).
- Each weld shall be identified with a unique weld identification number on the weld control record or equivalent. Weld numbers and weld location shall be shown on the Contractor's drawings.
- For pressure boundary parts, drawings that show fabrication by welding shall indicate the joints, together with the joint geometry and welding process and welding procedure(s).
- Weld seams shall not intersect nozzles or access opening locations.
- Tack welds to be incorporated into the final weld shall have a contour suitable for fusion with the root pass. Tack welds that become part of the finished weld shall be performed by a qualified welder, using a qualified procedure and filler material, and visually examined, as the same level of the main weld. Tack welds that have cracked or are defective shall be removed, and the area re-tacked prior to welding. Tack welds in grooves shall be kept to a minimum.
- Weld joint preparation shall not be performed by thermal processes.
- Welding procedure and welder performance qualification shall be in accordance with the codes, standards and requirements indicated in Section 5.2.1 and with ESR from PED [RR1] and ESPN [RR3].
- The location, depth and area size of all weld repairs, regardless of the depth of the repair, shall be documented in accordance with the Contractor's quality program with the IO approval.

5.10.1.20 Bolts and nuts

The choice of the stainless-steel grades used for the bolts and the nuts shall into account the material compatibility, the seizure phenomena, the radiation protection and the corrosion. The Contractor shall justify that the grades used and/or the surface treatment are acceptable.

5.10.1.21 Cleaning

The PZR shall meet the cleanness requirements set forth in the Technical Specification for TCWS Water System Vessel Fabrication Cleaning [32].

5.10.1.22 Pickling and Passivation

Pickling and Passivation procedures shall be submitted to the IO for review and acceptance prior to the start of production and shall follow the rules of ref. [CS11]. All stainless-steel surfaces of the PZR shall be passivated.

SUPPLY

5.10.1.23 Coating

Stainless steel surfaces shall not be coated but shall be clean metal and free of weld spatter, oil, dirt, and grease.

Other steel surfaces shall be coated. Selection, qualification, and application of coating materials shall be in accordance with the Technical Specification for Coating and Tagging, Zone II [29].

SUPPLY

5.10.2 *Reliability and Maintenance Requirements*

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

5.10.2.2 Equipment and subcomponents of the equipment that are not demonstrated to achieve a design life of 20 years without replacement shall be designed with a replacement interval of no less than 48 months. The scheduling of the verification and replacement of these subcomponents shall be well indicated in the Instruction Manual.

5.10.2.3 An availability target for the Tokamak Cooling Water System (TCWS) has been established and is based on the historical reliability of similar equipment in the nuclear power industry. The design of the PZR should achieve the reliability value listed below ref. [115]. If the reliability value cannot be achieved, an alternate value, and the basis for that value, shall be provided to IO to determine the impact of the reliability on the overall availability of the TCWS: The mean failure rate for the pressure boundary leakage of the PZR shell shall be lowers than 3.26×10^{-8}/h. The failure rate for the loss of PZR heating function shall be lower than 10^{-7} /h. The failure rate for the overheat of PZR heaters shall be lower than 3×10^{-8} /h.

5.11 Quality Control Provisions

5.11.1 *Project–Specific Quality Requirements to Supplement the Design and Construction Code*

5.11.1.1 Quality requirements to supplement the design and construction code are itemized in the appendix 2 of ref. [22] to ensure conformance with the project-specific standards for the Quality class indicated in Appendix A – IBED PHTS PZR Datasheet.

5.11.1.2 Cross-contamination of stainless steel and carbon steel is prohibited. The Contractor shall prepare a documented plan and implementing procedures employing the best practices of ASTM A380 ref. [15], §8.1 for minimizing iron contamination of stainless steels. This plan and implementing procedures are to be submitted to the Technical Responsible Officer (TRO) for review and approval. Manufacturing work on this contract may not begin until notice is received from the TRO that the plan and implementing procedures are approved.

5.11.2 *Test and Inspection Requirements*

5.11.2.1 The examination, testing, and inspection of all pressure retaining and integrally attached materials shall meet the requirements defined by the IO as output from the HRA and in accordance with ASME BPVC Section VIII, Division 2 [CS6], ESPN [RR3], ESP/PED [RR2], and the additional requirements stated herein.

SUPPLY

5.11.2.2 In progress and at the end of the production of the PZR, all the operations are carried out making it possible to check the dimensions and their compatibility with the tolerances indicated on the plans. Dimensional and geometric controls allow establish the as-built plans "In accordance with execution" of the PZR.

5.11.2.3 A visual inspection in accordance with ASN Guide 8 [CS1] shall be completed prior to hydrostatic testing. The procedure must be established by the Contractor and approved by IO.

5.11.2.4 Proof testing (i.e., hydrostatic testing) shall be conducted on the PZR in the Contractor's workshop before the shipping with the presence of the IO representative and the ANB. The Proof testing shall be conducted in accordance with the Code of Construction, as defined in Section 5.2.1 and approved by the ANB. The selected code shall be harmonized with the ESPN hydrostatic testing requirements. The hydrostatic test shall be performed with all covers and counterflanges in place and bolts fastened with the prescribed torque. Covers, counterflanges and gaskets shall be the ones that will be delivered with the PZR. If covers counter-flanges need to be disassembled after the hydrostatic test, they will be reinstalled with new gaskets. The situation of proof test in workshop shall be analysed in the design report with the right position of the tank horizontal/vertical).

5.11.2.5 The PZR shall be completely filled with water and completely drained. Any water that appears to have pooled or collected in the PZR shall be clearly indicated on the test report and reported to the IO. The inspection may be performed while draining the PZR after proof testing is completed.

5.11.2.6 The PZR shall be subject to a load test of the handling/lifting lugs with empty tank in accordance with the mechanical design report in order to ensure that no modification of the dimensions nor permanent deformation occur during the test.

5.11.2.7 All instruments used in the testing shall have a recent calibration sheet and shall have an evaluation of the measurement accuracy following Test Uncertainty, ASME PTC 19.1 ref. [CS12]. Another equivalent measurement uncertainty standard can be used subject to prior acceptance by the IO.

5.11.2.8 Testing of the electrical equipment will be performed to the applicable Codes and Standards identified for the applicable low voltage equipment in EDH Part 3: Codes & Standards [84]. Inspections and testing shall be completed to confirm the following:

a. Resistance to heat, shock, impact, seismic vibration, electromagnetic, ferromagnetic and electro thermic conditions
b. Insulation and dielectric qualities (2500 volts AC applied for 1 minute).
c. Visual check to confirm the organization of the components, spatial compatibility, identification of the components, operation of the components, quality of manufacture.

d. Physical and visual inspection; verification of gland plates and physical operation of switches; labelling of switches and space for cable glanding.
e. Polarity test of the current and voltage transformers, three-pole switches and if applicable single pole switches to verify fuses and switches are only in the phase conductor. (NA for heating rods)
f. Operation of all meters & instruments. (NA for heating rods)
g. Verification of earthing continuity.
h. Verification against direct contact.
i. Verification of all circuit breaker/switch fuse/fuse switch operation. (NA for heating rods)

5.11.2.9 The PZR heater sheath, including the end plug to sheath weld, shall be tested with liquid penetrant and X-ray inspected.

5.11.2.10 The PZR heater sheath and end plug shall be checked for straightness by inserting the heater bundle into the vessel. The heater shall slide into the vessel with no force other than the weight of the heater with the vessel in the vertical position. With the vessel in horizontal position, the heater shall slide into the vessel by hand and without any resistance. Prior to any straightening operation being performed after the final solutions anneal heat treatment, the procedure shall be submitted to IO for review and acceptance.

5.11.2.11 The verification of design and performance of the PZR heater control and electrical switchboards shall be performed in accordance with [95].

5.11.2.12 A full load performance test of the heaters shall be performed. For this test, the PZR must be partially filled with sufficient water to cover the heaters. The Contractor shall issue the test procedure for IO to approve.

5.11.2.13 A final visual inspection shall be completed in accordance with ASN Guide 8 [CS1] to ensure the conformity of the PZR to all specified requirements before the Certificate of Conformity is issued.

5.12 Spare Parts

PZR including Control and Electrical Switchboards shall be delivered with enough spare parts to ensure they can be replaced during the life of the equipment for gaskets, bolts, nuts, cable glands, etc. A first assessment is to provide 10% as spare parts in addition of these items on the drawing.

SUPPLY

5.13 PED/ESPN Regulation Requirements

5.13.1 The PZR shall be delivered with a Conformity Assessment under Module G. The Contractor as Manufacturer shall hire an Agreed Notify Body (ANB) to perform this conformity assessment. For the safety accessories in the Contractor's scope, which are the devices designed to protect PZR against the allowable limits being exceeded, shall have a conformity assessment according to [RR1], either as a dedicated equipment, or as a pressure equipment assembly assembled by the manufacturer to constitute an integrated and functional whole. The pressure accessories are out of the Contractor's scope.

5.13.2 The documents needed for the module G shall be forwarded to the ANB after approval from IO. If after ANB review, the documents are requested to be updated, they shall be re-submitted to IO in their last version informing the reviewers the new version is only related to the ANB review.

5.13.3 All the formal reports issued by the ANB for the design, manufacture, and controls of the PZR shall be submitted to IO for information through IDM.

5.13.4 The ESR gap analysis summarizes all the harmonised standards and solutions adopted to meet the requirements of the directive [RR1], ESPN [RR3] (codes, technical standards, etc.) and radioprotection guide [31]. The Contractor will adapt the gap analysis between the construction code ref. [30] (or other codes if not harmonized) and the requirements of the PED [RR1] and ESPN [RR3].

5.13.5 The manufacturer is under an obligation to perform the hazards and risks analysis (HRA) to identify those which apply to his equipment on account of pressure; he shall then design and construct it taking account of his analysis. This HRA shall cover all phases of equipment's life; from design to decommissioning all parts of equipment. The classification of the parts of an equipment is described in the CLAP File X207 ref. [CS19] and shall be included in the Hazard and Risk Analysis (HRA). The Final Inspection using the as-built drawings shall be performed according to a procedure established by the contractor and approved by IO prior to hydrostatic testing. The purpose is to assure the conformity of the PZR to all specified requirements before the Declaration of Conformity is issued. All internal and external surfaces shall be visually inspected. If some areas cannot be inspected during the Final Visual Inspection (shell surface covered with pad, internal welds of a nozzle for example), they shall be identified at the design phase and identified in the MIP. IO and the ANB shall be notified to inspect these areas as part of the formal visual inspection and the results shall be recorded in visual inspection reports.

5.13.6 Proof testing (i.e., hydrostatic testing) shall be conducted on the PZR in the Contractor's workshop before the shipping with the presence of the IO representative and the ANB with the value indicated in the Appendix B. The Proof testing shall be conducted in accordance with a procedure established by the contractor that meet the requirements defined by the IO and approved by IO and the ANB. The hydrostatic test shall be performed with all covers and counter-flanges in place and bolts fastened with the prescribed torque or with caps welded on the nozzle pipes. Covers and counter-flanges shall be the ones that will be delivered with the PZR. If covers or counter-flanges need to be disassembled after the hydrostatic test, they will be reinstalled with new gaskets. Pressure accessories shall be used during the hydrostatic test to ensure that the value of P_{test} is not exceeded during the whole test duration.

5.13.7 The PZR shall be filled with water and completely drained. Any water that appears to have pooled or collected in the PZR shall be clearly indicated on the test report and reported to the IO. The inspection may be performed while draining the PZR after proof testing is completed.

5.13.8 The hydrostatic test procedure shall be approved at the design stage if the equipment in particular due to its size or production mode cannot be subject to the entire pressure resistance test.

5.14 Packing, preservation & shipping

5.14.1 The PZR packaging shall meet the minimum requirements in ASME NQA-1, Level C [CS5] for overseas shipment and the additional requirements stated in this technical specification.

5.14.2 The PZR internals shall be preserved with a nitrogen gas purge and pressurization in accordance with ASME NQA-1, Part II, Subpart 2.2, Section 304.2, Inert Gas Blankets [CS5]. A local manometer shall be provided and connected to allow periodic monitoring of the blanket nitrogen. Range of the manometer shall be at least 1.5* the desired pressure and no more than 3* the desired pressure with an accuracy not higher than 5%. The PZR shall be kept under nitrogen since the end of the hydraulic test in factory until its installation and connection to its final location.

5.14.3 The protection of the surfaces of the various parts is ensured during manufacture and during storage before shipment. The provisions are taken to ensure the preservation of protection under nitrogen and coatings during transport and handling. Accelerometers shall be included in the packaging to confirm the absence of drop during handling and shipping.

5.14.4 Weld nozzles shall be fitted with a welded cap for transportation. The nozzles shall have sufficient extra straight length to allow for the removal of the cap at the site and prepare the nozzle end for welding. Caps shall be designed for hydrostatic test and transportation loads and must be removed during installation.

5.14.5 Flanged nozzles shall be fitted with their counter-flange and gasket fully assembled for transportation. Alternatively, the flanged nozzles can be closed with a temporary blind flange for transportation and the counter flange with parts delivered as separate packages, packaged and marked.

5.14.6 Covers shall be mounted in place with their gasket.

5.14.7 The shipping and storage of the PZR shall occur only after the completion of the conformity assessment signed by the IO.

5.14.8 The Contractor shall provide all the provisions to ensure the regulatory requirements are respected during transportation, installation and commissioning of the PZR.

5.14.9 The place of storage on site of the PZR between the delivery phase and the installation phase will be the Storage Area at the IO. The Contractor shall consider storage outside buildings. The PZR will be delivered with a packaging to withstand the usual weather (wind / snow) provided in appendix A.4.

5.14.10 A manual of storage recommendation shall be provided by the Contractor.

5.15 In-Service Inspection and Periodic Requalification

The PZR as well as associated safety accessories connected to them shall be designed to meet the in-service inspection and periodic requalification requirements of the ESPN level N2 described in [RR3]. The Contractor shall consider all the data transmitted by the IO to ensure the possibility of in-service inspection by putting in place all the devices needed for internally inspection and requalification.

An in-service inspection up to 40 months following initial commission and every 40 months then shall be performed. Visual inspection of all pressure bearing parts of the pressure vessel, for internal and external surface shall be carried out during these inspections. The external verifications, operational verifications and tests adapted to the nature and function of the safety accessories associated to the PZR shall be carried out.

Periodic requalification including a visual inspection of all pressure bearing parts of the pressure vessel for internal and external surface, a pressure test with Prequal=120%*PS of the PZR and of the safety accessories, verification of the safety accessories protecting the PZR, shall occur every 10 years. This requalification pressure test shall be included in the design of the PZR and of the safety accessories.

SUPPLY

The Contractor shall design the manway (see Section 5.5.6) and its means of accessibility. If a temporary access platform is planned outside the PZR, it shall be indicated in the instruction manual.

Internal ladder shall be designed and provided to facilitate the in-service inspections and to avoid damaging the internal surface. It shall be designed to support the weight of an inspector during maintenance without causing unacceptable stress on the vessel.

The insulation shall be removable to allow external visual inspection including welded joints. The removal and the reinstallation of the insulation shall be integrated in the Instruction Manual.

5.16 Support for Site Issue

The installation of the PZR on IO site is not in Contractor's scope. Nevertheless, the contractor is responsible for the technical supports if a technical issue occurs at site due to the design and/or fabrication done by Contractor. When required, the contractor also shall accredit qualified personnel to the site for the technical supports and serve consumable parts until the issue is closed.

6 Location for Scope of Work Execution

The Contractor can perform the work at their own location from the KOM to the shipment of the IBED PZR. The list of main manufacturing activity locations shall be communicated to IO in the qualified supplier list. Change of one of location shall be timely notified to IO.

7 IO Documents

Under this scope of work, IO will deliver the applicable documents in §4.3 within 1 week of the Kick-off meeting (KOM). In addition, IO will deliver the following documents by the stated date:

Table 7-1 IO Documents

Ref.	Title	Doc ID	Expected Timing
1	As-built position of the embedded plates[12]	Drawing	KOM

[12] Drawings with as-built position of the embedded plates will be provided by IO to ensure the support can be designed accordingly. These drawings will be submitted for the KOM as a design input.

SUPPLY

2	Installation study[13]	Presentation	KOM
3	Maintenance space reservation[14]	Drawings	KOM
4	Integration studies[15]	Presentation	After PZR drawing submission
5	Verification Compliance Matrix[16]	Table	MRR
6	List of Clarifications[17]	List	MRR

8 Deliverables and Schedule Milestones

8.1 Schedule for delivery

The maximum expected duration from the contract signature to the supply of the scope of work is 24 months.

The delivery schedule of the main gates is provided in Appendix I.

8.2 List of deliverable documentation

The Contractor shall provide IO with the documents and data required in the application of this technical specification, the GM3S [1] and any other requirement derived from the application of the contract. Some other documents can be identified during the kick-off Meeting or during the project and will be added to the list presented in the Appendix I – List of Deliverable Supplies.

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[13] Preliminary installation study [63] will be provided by IO with the detailed path of transport inside the Tokamak building and as-built dimensions of the final space reservation for PZR. This study will be submitted for the KOM to design the temporary supports and transport/lifting items.

[14] Drawings for the space around the PZR to be used for the in-service inspection will be provided by IO for each PZR to ensure the equipment can be designed and inspected accordingly. These drawings will be submitted for the KOM as a design input.

[15] After submission of assembly drawings of PZR by the Contractor, IO verify the potential clashes using the step file of the pressure equipment attached with the drawing. An integration study is created with the PZR in its environment to verify the accessibility and the remaining space to the other items in the vicinity of PZR.

[16] For the MRR, IO will provide the Verification Compliance Matrix part 1 which lists all the main requirements from this Technical Specification and GM3S ref. [1]. The requests of clarifications raised by the Contractor and answered by IO during the design phase are also listed in this Verification Compliance Matrix. The Contractor shall fill the part 2 and 3 of this document for the end of the Contract and provide it as a deliverable.

[17] The list of clarifications is updated during the design phase by IO to record all the requests of clarifications from the Contractor and the answers from IO to complete the Technical Specifications requirements. This list is completed for the MRR.

SUPPLY

Supplier shall prepare their document schedule based on the above and using the template available in the GM3S Ref [1] appendix II.

9 Quality Assurance requirements

For the Protection Important Components (PIC) of the nuclear facility, the Contractor or any of its Subcontractors shall implement a specific management system for work on protection important activities, based on activities defined and executed by the Contractor and its Sub-contractor. This system could be included in the Quality Assurance (QA) Plan.

The list of critical quality activities will be provided by the Contractor for acceptance by the IO prior to award of each contract.

9.1 Quality Assurance Program (QAP)

The Contractor's QAP shall be applied to the entire Product under this Specification and shall be submit to the IO. The ITER QAP is the document ref. [3].

The Contractor shall ensure that their subcontractors carrying out the Specification are in compliance with the QA requirements of a Quality Class 1 component. GM3S [1] section 8 applies in line with the defined Quality Class.

A project Specific Quality Plan that meets the requirements of the IO procedure for a project specific Quality Plan (referring to [4] and its derived documents) shall be submitted for IO review and approval. 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, subject to agreement by the IO.

Similar control of quality activities for all levels of subcontractors supplying material or services is requested when inspection or certification is required.

The Quality Plan shall identify:

- The critical quality activities
- The specific allocation of resources, duties, responsibilities and authority
- The details of all suppliers/subcontractors and how interfaces will be managed
- The specific procedures, methods and work instructions to be applied
- The specific methods of communication, both formal and informal, to be established between working groups

9.2 Traceability

The Contractor shall have traceability procedures in place that will guarantee traceability between materials delivered and the EN10204 [CS10] Certificates.

SUPPLY

Procedures shall be submitted to and approved by the IO prior to the start of manufacturing operations.

Traceability shall be maintained by procedural methods that cover receipt, identification, storage, and transfer to production, temporary storage, and use in production.

9.3 Responsibilities

The Contractor shall be fully responsible for quality with respect to all services, materials, manufacturing, and testing, etc. The Contractor shall be responsible for imposing all technical and quality requirements as applicable to all the Contractor's sub-contractor furnishing hardware or services in accordance with all applicable Specifications.

The technical and quality requirements of all applicable specifications shall be passed down to all levels of subcontractors. These include, but are not limited to requirements for handling, packaging, shipping, storage, and inspections and testing. Contractor shall identify to its

Subcontractors all applicable QA requirements imposed by the supply order and this Specification, and shall ensure Subcontractor's compliance thereto and shall include the requirements in procurement documents.

The Contractor shall conduct internal audits of its own facilities and external audits of its subcontractor.

QA and QC activities by the IO shall not relieve the Contractor and their sub-contractors from responsibility to perform all inspections and tests required by the contract and governing codes and standards.

9.4 Third Party

The IO has the option to require the use of a third party to evaluate the Contractor's quality assurance program. The third party is the technical organization that is responsible for the approval and monitoring of the Contractor's quality assurance system and direct inspection of the product.

The third party may perform the compliance through [CS1]:

- Design checks (e.g. calculation notes, plans)
- Inspection of various manufacturing stages
- Monitoring of final inspections and tests
- Approval of procedures and qualifications of workers (e.g. welding procedures and welder qualifications)
- Approval of NDE personnel
- Approval of materials

SUPPLY

The Contractor shall provide access and information required by the third party to perform the necessary evaluations and tests to fulfil its responsibilities. The minimum information required to be reviewed is provided for in ASN guide No. 8 section 2.4.3 [CS1].

9.5 Qualification of NDE Personnel

Personnel for non-destructive examination (NDE) must be approved by a recognized organization (RTPO) by a Member State.

All NDE personnel qualifications shall conform to the following requirements:

- Personnel shall be qualified in accordance with NF EN ISO 9712 [CS14].
- IO will 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.

9.6 Qualification of Welding Process and Personnel

Welding procedures qualification record (WPQR) and the personnel applying them must be approved by a Notified Body or a third-party recognized by a Member State as per [RR1].

9.7 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 must be submitted to the IO.

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

9.8 Technical Qualifications

When a technical qualification is required (forming or stamping for example), 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.

9.9 Manufacturing and Inspection Plan (MIP)

A Manufacturing and Inspection Plan (MIP) shall only be prepared by the Contractor for materials that are considered fabricated materials (components made from manufacturing operations capable of altering mechanical properties).

A MIP shall be prepared by the Contractor that meets the requirements of ITER Manufacturing and Inspection Plan (MIP) [4], and the requirements of PIA surveillance referring to [5]. 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 the PZR as it is a PIC, the MIP also clearly identifies the PIA. A list of the PIA for ITER is presented in ref. [73]. The MIP will be used to monitor quality control and acceptance tests. It is permissible for the Contractor to submit multiple MIPs that are more succinct and manageable to the particular operation. In that case, these multiple MIPs must be parts of one overarching MIP.

Prior to Manufacturing operations, the MIP shall be generated in accordance with the procedure provided in [4] in conjunction with [5] and shall be sent to the IO for approval. This requirement is to be passed down to all levels within the procurement chain.

MIP will mark up any intended intervention point. MIP is used to monitor Quality Control and acceptance tests during the execution of the Contract. 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 Supplier. The overseeing of the quality control operation by the IO shall not release the Supplier from his responsibility in meeting any aspect of this Technical Specification.

The level of detail in a MIP shall be sufficient to prevent the inadvertent bypassing of critical operations and to enable adequate planning, monitoring and verification of critical operations.

This document shall be submitted to the IO for review. 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 Manufacturing & Inspection Plans, subject to agreement by the IO.

The IO may add hold (HP), witness (W), or notification points (NP) to the MIP and identify tests or inspections that must be witnessed by the IO representative. The Contractor shall indicate intervention points that must be notified to the IO representative with appropriate code (HP, W or NP) at the appropriate locations in the MIP. The MIP template is provided in ref.[4].

The IO approved MIP is a prerequisite to the Contractor proceeding with the work contained. It is permissible for the IO to indicate partial approval to authorize operations that would be constrained due to issues with subsequent operations.

The contractor shall issue a weekly notification schedule covering all intervention points that shall occur one month ahead. Formal notification to IO or its representative and/or ANB shall be sent at least 10 calendar days prior to the operation unless a specific arrangement is defined in written between the Contractor and notified parties.

The IO, its representatives and ANB shall not be responsible for any manufacturing delay incurred by late notification of intervention point.

9.10 Access to Contractor's Premises

The Contractor shall grant access to the IO (and its representatives) to its facilities, records, proprietary processes and/or information and those of its Subcontractors for the purposes of 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.

In the frame of the conformity assessment, the Contractor shall grant access rights to its facilities and documentations to the IO and the ANB as well as to their selected representatives for their inspections and audits at all levels in all the supply chain. Contractor shall ensure its subcontractors and suppliers (if any) grant the IO and its representatives and the ANB the same access to their facilities.

The Contractor shall ensure an acceptable level of safety at any time for the IO and ANB representatives. Special provisions shall be taken to secure work at heights, work in confined space, radiological protection etc. The Contractor shall provide the necessary training and safety apparatus to IO and ANB representatives whenever required by inspection activity.

9.11 Quality Records

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

9.11.1 *Document Retention Requirements*

Documentation records listed in section 5.8 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 Product.

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 [9][10].

9.11.2 *Test Sample Retention Requirements*

The test coupons and specimens used for acceptance per lot shall be available. The IO shall have an opportunity to acquire possession of such test samples prior to disposal.

9.11.3 *Nonconformities and Deviation Requests*

The nonconformities are the product or process which does not fulfil or fail in meeting IO specified requirements. The management of the nonconformities regarding the design and the

manufacturing of the PZR is described in the document ref. [27]. The Contractor shall ensure that they implement a system fully compliant with this document to control the nonconformities.

The non-conformities reports shall be opened, identified, solved, closed and recorded in line with the IO agreement.

The deviation requests are the request for deviation from a formal agreement between the Contractor and the IO. The Deviation requests should be issued by the Contractor or by the IO.

The procedure for the management of Deviation Request and the responsibilities of the stakeholders are described in the document ref.[6].

If the conformity assessment of the NPE could not be 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 costs.

9.12 Verification and Validation of Software

Contractor must perform the Verification and Validation of all the software(s) used within the framework of this contract according to ASME NQA-1 [CS5] and depending on the Quality Classes to Software Qualification Policy ref. [20].

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 should 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 should 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

9.13 Patrolling Inspection in the Workshop

Contractor must implement his own patrolling inspection in the workshop. These inspections should be performed by qualified personnel and formalized into specific daily reports detailing the nature of inspection performed (welding parameters, heat treatment device…) and the result of the inspection.

SUPPLY

As a strict minimum, following items shall be systematically checked. Any deviation should lead to a stop of the activity, be recorded in the inspection report and be analyzed for corrective actions implementations (with potential NCR opening when needed):

- Applicable documentation is present at the workstation (including MIP and drawing)
- Traceability of material is ensured (including consumables)
- Operators are qualified/ aware of jobs
- Equipment and tooling are calibrated/ operational
- Workstation environment is safe and tidy
- Risk of carbon steel contamination is under control
- Intervention points have been correctly notified

Main findings shall be dealt with according to QA procedures and reported inside weekly report.

10 Safety requirements

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

10.1 Propagation of Safety Requirements

Under Order 7 February 2012 [RR4], the PICs require control and guaranty of the quality of the PICs during the design and manufacturing phase to ensure its safety functions can be maintained in all postulated situations. This is accomplished through the guidelines provided for in the Management of Propagation of Nuclear Safety Requirements in the Contractor Chain [52] regarding:

- Policy on Protection of the Interests
- Quality management system
- Supervision
- Execution and supervision of the PIA
- Skills and qualification of the interveners
- Records
- Non conformities
- Lesson learned
- Safety demonstration

In the contracts passed down to the subcontractors, it is clearly stated that in addition to technical requirements, defined requirements on Protection Important Components (PIC) and Protection Important Activities (PIA) must be monitored by the IO.

The subcontractor must possess a quality system in agreement with the importance of the equipment being delivered and in particular for the follow-up of the PIA corresponding to the PIC to be provided under the contract. This system shall be included in the MIP or Quality Plan.

10.2 Documentation

The Contractor must ensure that each PIA and the related technical controls:

- Are documented to demonstrate a priori that they comply with the Defined Requirements
- Are tracked to check a posteriori that they comply with the Defined Requirements

This applies to every PIA and technical control performed by the Contractor or any of its subcontractors. Throughout the execution of this work, the Contractor must keep up to date records of the results of implemented PIA and their technical control, the related action of verification and the assessment.

These records shall be made available to the IO upon request.

Upon completion of the work, all documentation related to the design and other activities of a PIC shall be provided to the IO.

11 Special Management requirements

Requirement for GM3S [1] section 6 applies completed/amended with the below specific requirements.

The Contractor shall designate a Project Manager within 5 working days after award of 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, and at least for Quality, Technical, Workshop and Project. These four key project personnel must be dedicated to the work throughout the contract duration and have relevant qualifications and/or experience. The Contractor's proposal shall provide an outline of the management structure and resumes of the team members for the project. After AOC, this document shall be updated into a Project organization chart including all project organization chart with their duty’s description.

11.1 Contract Gates

The contract gates as defined in [1] section 6.1.5, in line with the scope of work as defined in Section 5 of this document, and in line with the schedule of Deliverables as listed in Appendix I.

11.2 CAD design requirements

This contract requires for CAD activities, [Ref 1] GM3S section 6.2.2.2 applies in agreement with the requirement in Section 5.8.6.

SUPPLY

Regarding the electrical parts (e.g. Control and Electrical Switchboards), the CAD design requirements in [13] shall apply.

11.3 Engineering/Design Review

The Contractor shall make available to the IO, through IDM and SMDD, notice, drawings, design calculation reports, documents and other data ("Design Data") and technical assistance sufficient to allow the IO to conduct a design review of the equipment to be supplied under the Supply Order. This Design Review may have maximum duration of up to 20 workdays depending on the type of documents.

The Contractor shall send all drawings and other documents of engineering/ design nature directly to the IO's Project Manager or the Engineering Representative using the exchange folder in IDM following ref. [7] and SMDD following ref. [12]. When the documents are reviewed/ approved by the IO, the Contractor is notified of the status of the documents by receiving an email notification (action available directly in IDM).

At the end of the design review, the document can be finally approved without comments (ACC), approved with comments (COM) or refused (REF). If the document is approved with comment or refused, the Contractor shall have five working days to update the document according to these comments and to re-submit it in version 2.0 (or higher) for approval following the circuit described above. Contents of the modification must be explicitly stated and highlighted.

In case an approved document would need update, Contractor should explain the reason and study the potential impact of the obsolete revision (if any).

When the document is approved by the IO, the contractor should send it to the ANB for review whenever required in the frame of the conformity assessment. If the ANB provides comments, the Contractor shall have five more working days to update the document according to the ANB’s comments and to re-submit it to IO then to the ANB in a new version for approval.

All the approved formal reports issued by the ANB for the design, manufacture, and controls of the equipment shall be submitted to IO for information through IDM.

The Contractor shall present the ANB review status progress during the project meetings with IO and ensure the ANB review progress does not impact the project schedule.

Appendices

Appendix A – IBED PHTS PZR Datasheet

All pressures are absolute pressures unless specifically noted otherwise.

A.1 Sizing Requirements and Design Conditions

Table A- 1 Sizing Requirements and Design Conditions

Parameter/Component	Value (plasma operation)	Reference
Thermohydraulic		
Fluid type	Demineralized water	[39]
Saturation temperature at 1.67 MPa, ˚C	203.45	[113]
Starting or standby operating pressure at the free surface of water (supposing it at 24800 mm over the relative 0 which is the bottom of IBED system in Divertor), MPa	1.67	
Saturation temperature at upper limit pressure, ˚C	210.33	
Upper limit pressure, MPa	1.92	
Design temperature, ˚C	270	[112]
Design pressure, MPa	5	
Vessel Construction		
Space constraints, height/outer diameter (max), m	11.68 / 3.48	[58]
Pressurizer total volume (min), m^3	56.9	[113][64]
Inner diameter, m	3.2	
Upper and lower head height, m	0.8	
Total outer height, m	7.8	
Aspect ratio (min)	2.0	
Heaters		
Heating power, proportional heaters (total), MW	0.4	[113]
Heating power, backup heaters (total), MW	2.4	
Max heated length of heater sheath extending inside cylinder, m	1.3m (about 20%-cylinder height)	
Fouling, m^2K/W	0.00005 [18]	
Spray		
Spray flow temperature, ˚C	50 +/- 5	[113]
Continuous spray flowrate, kg/s	0.22	
Max Spray rated flowrate, kg/s	4.1 [19]	
Max static pressure drop, MPa	0.1	[111]
Max K spray loss factor	3	

[18] Typical fouling factors: the manufacturer shall propose adequate fouling factors for the water chemistry of the IBED PHTS water, for the materials and technology used.

[19] The max spray rated flowrate may exceed 5.2 kg/s depending on the available CVBD flow (Chapter 7.9 [97]). This will be finally confirmed with the up-to-date IBED PHTS sizing calculation [113] at the KOM.

Parameter/Component	Value (plasma operation)		Reference
Turn over time, h	48.0		[113]
Electrical			
Voltage, V	400 (+1/-10%)		[90]
Incomer Configuration	3 Phases + N + PE		
Frequency, Hz	50 (± 1%)		
Short circuit current value at CMC busbar	50 kA		
Control Contact Ratings			
5 Amps at 24 VDC			
2 Amps resistive at 250 VDC			
2 Amps resistive at 120 VAC			
Nozzles			
Service	**ID**	**DN/Schedule**	[114]
CVBD Pressure Spray	N1	50 / 40S	
PORV	N2	40 / 40S	
Relief Valve	N4	50 / 40S	
Connection to PRT	N8	50/ 40S	
Spare Nozzle (Capped)	N10	150 / 80S	
Manway	N12	600 /TBD [20]	
Sensor MT	N14 N15	Thermowell	
Sampling	N16	15 / 40S	
Surge Line	N18	200 / 80S	
Proportional Heater	N20	TBD	
Backup Heater	N22	TBD	
Sensor ML (bottom)	N24 N26 N28 N36	15 / 40S	
Sensor ML (top)	N30 N32 N34 N38	15 / 40S	
Sensor MT	N40 N41	Thermowell	

[20] Other dimensions of manway can be adapted after written approval of IO.

A.2 Water Chemistry Requirements

A.2.1 *IBED PHTS Water Chemistry*

The table below gives the requirements on the PZR water chemistry [48].

Table A- 2 IBED PHTS Water Chemistry Specification

Parameter	Value
Conductivity @25°C, µS/ cm	<= 0.2
pH @25°C	7.0 - 9.0
Sodium, ppb	<= 5
Chloride, ppb	<= 5
Hydrogen, ppb	<= 80
Catalyzed Hydrazine, ppb	<= 30
Ammonia, ppb	<= 1,000
Oxygen, ppb	<= 10
ORP @25°C, mV	(-400) - (-100)
Iron, ppb	<= 10
Copper, ppb	<= 13

A.2.2 *Corrosion Allowance*

Corrosion allowances needed for the material choice and water chemistry shall be selected by the Contractor and clearly justified for the lifetime for this technology.

A.3 Environmental Conditions

A.3.1 *Environmental Conditions for PZR tank*

The temperature and ambient pressure and other environmental conditions are bounded from the reference values from the documents [112] and [43][41]. They are summarized below:

For Normal Operating Situations (Cat. I events),

- Ambient temperature: 5°C to 35°C
- Ambient pressure: 86 kPa to 106 kPa
- Relative humidity: 20% to 60% RH

For Incident Operating Situations (Cat. II events),

- Ambient temperature: 5°C to 100°C
- Ambient pressure: 90 kPa to 200 kPa
- Relative humidity: 20% to 100% RH

For Exceptional and Highly Improbable Situation (excluding the fire event),

- Ambient temperature: 5°C to 130°C
- Ambient pressure: 100 kPa to 200 kPa

- Relative humidity: 0% to 100% RH

PZR shall be qualified to function under the magnetic fields for which its service is required (during normal conditions or accidental conditions). The magnetic loads can be mitigated by the usage of paramagnetic material such as austenitic stainless steel. They should be accounted and added to the dead weight for the supporting structures whenever they are made of ferromagnetic materials. During the design lifetime, PZR will also be subject to both neutron and gamma radiation. The magnetic field and radiation dose are summarized below:

- Static magnetic field: <= 75 mT [41]
- Accumulated radiation dose: ≤ 10 kGy @ 4700h, silicon dose [42] (enveloped with IBED PRT)
  Note: operating life is 20 years, but total irradiation time is only 4700 h.

For the fire event, the detail temperature distribution per room elevation is not available and the fire to be modelled is following the “Nominal Temperature-Time curves” according Eurocode 1 for a duration of 2h, leading to a final temperature of 1049°C in the air [CS15].

A.3.2 *Environmental Conditions for Heater Control & electrical switchboards*

The location of the PZR heater control and electrical switchboards is 11-R1-01E [91], shown in Appendix D – General Arrangement of PZR.

All electrical equipment shall be designed for continuous and short-term operation in the site conditions specified in Section 5 in [95]. For invest protection reason, the Proportional Heater Control and electrical switchboard shall be designed to withstand and required to be fully operational during both normal and incident operating situations (Cat.I & II events). During exceptional and highly improbable situation (Cat.III & IV events), the Proportional Heater Control and electrical switchboard is not expected to be operational, but shall be ensured no collapse, falling, dislodgement or other spatial response which could jeopardize the functioning of other components providing a safety function. The Backup Heater Control and electrical switchboard shall be functional during both normal and accident conditions, and no damage to the Backup Heater Control and electrical switchboard shall result from accident conditions. The environmental condition at the location of PZR Control and Electrical Switchboards is summarized as follows [41]:

<u>For Normal Operating Situations (Cat. I events)</u>,

- Ambient temperature: 5°C to 35°C
- Ambient pressure: 86 kPa to 106 kPa
- Relative humidity: 30% to 65% RH

<u>For Incident Operating Situations (Cat. II events)</u>,

- Ambient temperature: 5°C to 60°C
- Ambient pressure: 90 kPa to 115 kPa
- Relative humidity: 20% to 100% RH

For Exceptional and Highly Improbable Situation (excluding the fire event),

- Ambient temperature: 18°C to 60°C
- Ambient pressure: 100 kPa to 115 kPa
- Relative humidity: 20% to 100% RH

During the design lifetime, the magnetic field and radiation dose are:

- Static magnetic field: <= 30 Mt [41]
- Accumulated radiation dose: ≤ 100 Gy @ 4700h, silicon dose [41]
  Note: operating life is 20 years, but total irradiation time is only 4700 h.

A.4 Weather Conditions

Weather conditions for the IO outside storage come from the document [41].

- The external temperatures are -25°C / +45°C
- The maximum solar flux is 1 kW/m^2
- The extreme winds are 166 km/h
- The extreme absolute humidity is 30g/kg
- The exceptional mass of snow is 150 daN/m^2.

Appendix B – IBED PHTS PZR Process Loading Conditions

The purpose of this appendix is to provide the process loading conditions of the PZR, referred from the IBED process loading condition [112], as listed in Table B- 1. The transient loading conditions are provided for each operating mode, in the spreadsheet attachment of [112] in IDM. These loading conditions shall be combined with mechanical loading conditions according to TCWS Load Specification [37] as seismic effect and nozzle loads (see appendix C).

The fatigue analysis shall consider the number of cycles describes in this appendix. The thermal conditions indicated in this appendix can be used for the fatigue analysis to optimise the design and the minimum required thickness.

As required in Section 5.2.16 and 5.2.22, the spray and the surge nozzles need to be designed with the transient process loading condition as provided in Table B- 2 to Table B- 4.

For conservativism the in surge is taken at 65 °C (70 °C ± 5 °C of tolerances) because at the beginning, the water in the linear header will be pushed in the pressurizer.

The out surge is taken at 209 °C which is the saturation of the pressurizer at 1.9 MPa (the max pressure to which the pressurizer is subjected during the pulse).

For the spray line there are 2 bounding cases to be considered: Plasma (CAT I event) and LOOP (CAT II event).

CAT I PLASMA - During plasma the mass flow rate of the spray changes “cooling” more the nozzle itself, while the temperature of the pressurizer is quite stable at 209 degrees (saturation temperature at 1.0 MPa). 65 °C is considered as conservative respect (70 °C ± 5 °C).

CAT II LOOP - During LOOP in plasma, the spray flow rate falls to 0 kg/s. Duration of the short-term LOOP is 1 hr. 75 °C is considered as conservative respect (70 °C ± 5 °C).

Table B- 1 Process Loading Condition of PZR

	Loading Conditions	Cycles	PT8 = PZR	Comment	Equivalent Loading Condition from TCWS Load Specification SZE5MR v2.6	
					Inside Cryostat	Outside Cryostat
I.S0	Design Conditions	-	5.0 MPa 270 °C		Section 10.2	
I.S1	Standby Mode (Low Flow)	-	1.9 MPa 209 °C		x	x
I.S2	Water Baking Operation at 240 °C	-	1.9 MPa 209 °C		Section 11.1, I.1.2	Section 12.1, I.1.2
I.S3	Idle Mode	-	0.1 MPa Tamb		x	x
I.S4	Off Mode	-	0.6 MPa Tamb		x	x
I.S5	Maintenance Mode	-	0.1 MPa Tamb		x	x
I.S6	Standby Mode	-	1.9 MPa 209 °C		x	x

	(Nominal Flow)					
~~I.S7~~	~~Gas Baking Operation at 390 °C~~	-	~~1.9 MPa 209 °C~~	do not exist anymore	~~Section 11.1, I.1.3~~	~~Section 12.1, I.1.3~~
I.S8	Water Baking Operation at 18 °C	-	0.1 MPa Tamb		Section 11.1, I.1.2	Section 12.1, I.1.2
~~I.S9~~	~~First Plasma Gas Baking Operation at 240 °C~~	-	~~0.1 MPa Tamb~~	do not exist anymore	~~x~~	~~x~~
I.T1	Plasma Operation	30000	1.9 MPa 209 °C		Section 11.1, I.1.1	Section 12.1, I.1.1
I.T2	Standby Mode (Low Flow) to Water Baking Operation	500	1.9 MPa 209 °C		x	x
I.T14	Idle Mode to Water Baking Operation		0.1 MPa Tamb		x	x
I.T3	Water Baking Operation to Standby Mode (Low Flow)	500	1.9 MPa 209 °C			
I.T15	Water Baking Operation to Idle Mode		0.1 MPa Tamb		x	x
I.T4	Standby Mode (Low	500	[0.1, 1.9] MPa [10, 209] °C		x	x

	Flow) to Idle Mode					
I.T5	Idle Mode to Standby Mode (Low Flow)	500				
I.T6	Off Mode to Maintenance Mode	500	[0.1, 0.6] MPa T_{amb}		x	x
I.T7	Maintenance Mode to Off Mode	500				
I.T8	Off Mode to Idle Mode	500	[0.1, 0.6] MPa Tamb		x	x
I.T9	Idle Mode to Off Mode	500				
I.T10	Clients Dryout during Maintenance Mode	50	0.1 MPa Tamb		x	x
I.T11	Clients Blowout during Maintenance Mode	**See comment**	0.1 MPa Tamb	**These 50 cycles are decomposed in 900 sub-cycles for PT5 (18groups of 3 x divertor cassettes), 1800 sub-cycles for PT6 (36 x half a FW/BLK sector), & 1200 sub-cycles for PT7 (24 EQ port clients).**	x	x
~~I.T12~~	~~Maintenance Mode to Gas Baking Operation~~	~~15~~	~~[0.1, 0.6] MPa Tamb~~	do not exist anymore	~~x~~	~~x~~
~~I.T13~~	~~Gas Baking Operation to Maintenance Mode~~	~~15~~				
I.T16	Standby Mode (Low Flow) to Standby Mode	4000	1.9 MPa 209 °C		x	x

	(Nominal Flow)					
I.T17	Standby Mode (Nom. Flow) to Standby Mode (Low Flow)	4000				
I.T18	MD Category I	2600	I.T1 → I.T1 + MD I → I.T1	This loading condition is only applicable to IBED PHTS divertor piping inside cryostat.	Section 11.1, I.2	x
I.T19	~~Maintenance Mode to First Plasma Gas Baking Operation~~	~~18~~	~~0.1 MPa Tamb~~	do not exist anymore	~~x~~	~~x~~
T.T20	~~First Plasma Gas Baking Operation to Maintenance Mode~~	~~18~~				
II.S1	DEG1 Degraded Environmental Conditions	-	Environmental pressure: [95, 200] kPa Environmental temperature: [5, 100] °C Environmental air humidity: [0, 100] %		Section 13.1.2	
II.T1	Short-Term LOOP	50	[1.9, 5.0] MPa [199, 209] °C		x	x
~~II.T2~~	~~Cat. II Break within In-Vessel LOCA Boundaries~~	~~50~~		N/A the PRZ is two phase. Only applicable to the surge line.	~~Section 10.8~~	

II.T4	Loss of HVAC Incident	50	[-0.2] MPa [18, 100] °C	-0.2 is differential pressure (supposing Tamb 0.1 Mpa)	Section 13.1.2	
II.T5	SL-1 Seismic Event	50	1.9 MPa 209 °C		Sections 10.3 & 11.1, II.10.1, II.10.2, & II.10.3	Sections 10.3 & 12.1, II.1.1, II.1.2, & II.1.3
N.A	~~Combination I.T18 + II.T5 = SL-1 + MD I~~		~~I.T1 → I.T1 + MD I + SL-1 → I.T1~~	This loading condition is only applicable to IBED PHTS divertor piping inside cryostat. N/A for PRZ	~~Section 10.3 & 11.1, II.10.4~~	~~x~~
~~II.T6~~	~~WH Pump Trip~~	~~50~~	~~Primary pumps: I.T1 + PL-19x0 common trip (Impulse case 4 from TYHFYX v2.1)~~ ~~Baking pump: I.S2 + PL-1900 trip (Impulse case 13 from TYHFYX v2.1)~~	N/A for PRZ (see II.WH)	~~Section 11.1, II.13.a & II.13.b~~	~~Section 12.1, II.2.a & II.2.b~~
~~II.T7~~	~~CrICE Category II~~	~~15~~		Only applicable to Divertor pipings. N/A for PRZ	~~Sections 10.4 & 11.1, II.8.1 & II.8.2~~	~~x~~
~~II.T8~~	~~VDE Category II~~	~~300~~	~~I.T1 → I.T1 + VDE II → I.T1~~	~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	~~Section 11.1, II.2~~	~~x~~

~~II.T9~~	~~WH Spurious LOCA Isolation Valve Closure~~	~~5~~	~~For in-vessel LOCA valves: During plasma: I.T1 + simultaneous closure of in-vessel LOCA isolation valves (Impulse case 1b from TYHFYX v2.1) During baking: I.S2 + simultaneous closure of in-vessel LOCA isolation valves (Impulse case 5 from TYHFYX v2.1)~~ ~~For ex-vessel LOCA valves: During plasma: I.T1 + simultaneous closure of ex-vessel LOCA isolation valves (Impulse case 2 from TYHFYX v2.1) During baking: I.S2 + simultaneous closure of ex-vessel LOCA isolation valves (Impulse case 6 from TYHFYX v2.1)~~	N/A for PRZ (see II.WH)	~~Section 11.1, II.13.a & II.13.b~~	~~Section 12.1, II.2.a & II.2.b~~
II.WH	Bounding Case for Category II Water Hammer Events (II.T6 & II.T9)	55	[1.9, 5.0] MPa 209 °C	100% design pressure is never exceeded for category II water hammer events (II.T6 & II.T9). Their initial operating conditions are based on I.S2 & I.T1. A bounding case is thus defined based on sudden pressure variation from lowest operating pressure to design pressure at constant highest operational temperature, and vice-versa.	Section 11.1, II.13.a & II.13.b	Section 12.1, II.2.a & II.2.b
II.T11	OPP Category II	50	[0.6, 5.0] MPa 270 °C	0.6 Mpa is conservative (lowest pressure in IBED). The PRZ nominal pressure is min/max 1.67/1.9 MPa.	Section 10.9.2	
~~II.T12~~	~~HX Tube Leakage~~	~~1~~	~~1.9 MPa 209 °C~~	N/A for PRZ	~~x~~	~~Section 10.9.2~~
III.S1	DEG2 Highly Degraded	-	Environmental pressure: [95, 200] kPa Environmental temperature: [5, 130] °C		Section 13.1.2	

	Environmental Conditions		Environmental air humidity: [0, 100] %			
III.T1	Long-Term LOOP + Failure of DHR Operation	1	$T = 209 \xrightarrow{-10\,°C/hr} 18 \rightarrow 209$ $P = 1.9 \xrightarrow{1\,ms} 5.0 \xrightarrow{32\,hr} 0 \xrightarrow{1\,ms} 1.9$		Section 11.1, III.14	Section 12.1, III.1
III.T2	Short-Term LOOP + Loss of HVAC Incident	1	II.T1 → II.T1 + II.S1 → II.T1	This loading condition is covered by the bounding case suggested for loss of HVAC incident (II.T4), and the bounding case for short-term LOOP (II.T1).	x	x
III.T3	LOCA Outside Cryostat	1	[-0.2] MPa 18 → 130 → 18 °C	$T = 18 \xrightarrow{+50\,°C/hr} 130 \xrightarrow{1\,hr} 130 \xrightarrow{-50\,°C/hr} 18$	Section 13.1.2	
~~III.T4~~	~~WH Pump Seizure~~	~~1~~	~~Baking pump: I.S2 + 1 ms PL-1900 seizure (Impulse case 10 from TYHFYX v2.1)~~	-	~~Section 11.1, III.29.a & III.29.b~~	~~Section 12.1, III.5.a & III.5.b~~
III.T5	SMHV Seismic Event	1	1.9 MPa 209 °C	SMHV is cumulated to this bounding case.	Section 11.1, III.25	Section 12.1, III.3
~~III.T6~~	~~CrICE Category III~~	~~1~~	~~During plasma: I.T1 → I.T1 + CrICE III → I.T1 With guard external pressure from 1E-7 to 140 kPa in 1 ms and guard temperature from 101.4 to -90.6 °C in 1 s~~ ~~During water baking: I.S8 → I.S8 + CrICE III → I.S8 With guard external pressure from 1E-7 to 140 kPa in 1 ms and guard temperature from 194.1 to -77.2 °C in 1 s~~	~~This loading condition is only applicable to IBED PHTS piping inside cryostat. For detailed process loading condition for each PT zone (divertor, FW/BLK and EQ) see "Temperatures of TCWS In-Cryostat Piping during CrICE and Normal Operation" ITER_D_RJQXE7 v3.1~~	~~Section 11.1, III.15~~	~~x~~

~~III.T7~~	~~VDE Category III~~	~~1~~	~~I.T1 → I.T1 + VDE III → I.T1~~	~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	~~Section 11.1, III.2~~	~~x~~
~~III.T8~~	~~Helium Leak in CSR~~	~~1~~	~~This loading condition is not considered for IBED PHTS guard pipes in CSR as they are insulated with 50 mm of Microtherm or equivalent. But it must be considered for supports (if any). See SZE5MR v2.6 Section 10.5 for further details.~~	~~This loading condition is only applicable to IBED PHTS supports in CSR (= interspace between cryostat and bioshield).~~	~~x~~	~~Section 10.5~~
III.T9	WH Break Propagation	1	Linear return header break: I.T1 + Linear return header break (Impulse case 16 from TYHFYX v2.1 & Impulse case 10 from X9AZZL v5.1)		x	x
III.T10	OPP Category III	1	0.6 → 5.5 Mpa (t = 1ms) 270 °C		Section 10.9.2	
III.T11	WH Spurious & Simultaneous LOCA Isolation Valves Closure with a Single Failure	1	I.T1 + simultaneous closure of all LOCA isolation valves except one (Impulse case 1a from X9AZZL v5.1)		Section 11.1, III.29.a & III.29.b	Section 12.1, III.5.a & III.5.b
III.WH	Bounding Case for Category III Water Hammer Events (III.T4 & III.T11)	1	1.9 → 5.5 → 1.9 MPa 209 °C	110% design pressure is never exceeded for category III water hammer events (III.T4 & III.T11). Their initial operating conditions are based on I.S2 & I.T1. A bounding case is thus defined based on sudden pressure variation from lowest operating pressure to design pressure at constant highest operational temperature, and vice-versa.		

III.T12	Cat. III Pipe Break within In-Vessel LOCA Boundaries	1	1.9 → 5.5 → 1.9 MPa 18 °C	In case of category III pipe break, significant hydraulic loads may be generated outside of the in-vessel LOCA boundaries of the affected client. The in-vessel LOCA boundaries of the affected client consist of 2 redundant inlet in-vessel LOCA isolation valves and 2 redundant outlet in-vessel LOCA check-valves.	Section 10.8	
~~III.T13~~	~~Helium Leak in Galleries~~	~~1~~	~~This loading condition is not considered for IBED PHTS guard pipes (for primary side) and process pipes (for secondary side) in galleries as they are insulated with 50 mm of Microtherm or equivalent. But it must be considered for supports (if any). See SZE5MR v2.6 Section 10.5 for further details.~~	~~This loading condition is only applicable to IBED PHTS supports in galleries.~~	~~x~~	~~Sections 10.5 & 12.1, III.2~~
~~N.A~~	~~Combination II.T5 + II.T8 = SL-1 + VDE Category II~~	~~1~~	~~I.T1 → I.T1 + SL-1 + VDE II → I.T1~~	~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	~~Section 11.1, III.24~~	~~x~~
~~N.A~~	~~Combination III.T5 + III.T6 = SMHV + CrICE Category III~~	~~1~~	~~During plasma: I.T1 → I.T1 + SMHV + CrICE III → I.T1 With guard external pressure from 1E-7 to 140 kPa in 1 ms and guard temperature from 66 to -63 °C in 1 s During water baking: I.S8 → I.S8 + SMHV + CrICE III → I.S8 With guard external pressure from 1E-7 to 140 kPa in 1 ms and guard temperature from 221 to -48 °C in 1 s~~	~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	~~Section 11.1, III.26.1 & III.26.2~~	~~x~~

~~N.A~~	~~Combination III.T5 + III.T8 / III.T13 = SMHV + Helium Leak in CSR or Galleries~~	~~1~~	~~During plasma: I.T1 → I.T1 + SMHV + Helium Leak in CSR → I.T1 During water baking: I.S2 → I.S2 + SMHV + Helium Leak in CSR → I.S2~~ ~~During plasma: I.T1 → I.T1 + SMHV + Helium Leak in Galleries → I.T1 During water baking: I.S2 → I.S2 + SMHV + Helium Leak in Galleries → I.S2~~	~~This loading condition is only applicable to IBED PHTS supports in CSR and in galleries.~~	~~x~~	~~Sections 10.5 & 12.1, III.4.a & III.4.b~~
N.A	Combination III.WH + III.T5 = SMHV + WH Cat. II or III	1	1.9 → 5.5 → 1.9 MPa 209 °C	SMHV is cumulated to bounding case III.WH. Note that this covers any combination of category II / III water hammer events with SMHV.	Section 11.1, III.29.a & III.29.b	Section 12.1, III.5.a & III.5.b
IV.S1	Fire Design Basis	1	The fire design basis event is based on Eurocode 1 EN 1991-1-2:2002. Environmental temperature increases up to 1049 °C for a fire duration of 2 hr. IBED PHTS fire insulation is sized to ensure that the maximum process temperature in case of fire never exceeds the saturation temperature at design pressure.		x	Sections 10.10
IV.T1	Fire Exposure	1	0.6 → 5.5 → 0.6 MPa 18 → 263 → 18 °C			
IV.T2	SL-2 Seismic Event	1	1.9 MPa 209 °C	SL-2 is cumulated to this bounding case.	Section 11.1, IV.10	Section 12.1, IV.1

~~IV.T3~~	~~CrICE Category IV~~	~~1~~	~~During plasma: I.T1 → I.T1 + CrICE IV → I.T1 With guard external pressure from 1E-7 to 200 kPa in 1 ms and guard temperature from 101.4 to -91.2 °C in 1 s~~ ~~During water baking: I.S8 → I.S8 + CrICE IV → I.S8 With guard external pressure from 1E-7 to 200 kPa in 1 ms and guard temperature from 194.1 to -79.5 °C in 1 s~~	~~This loading condition is only applicable to IBED PHTS piping inside cryostat. For detailed process loading condition for each PT zone (divertor, FW/BLK and EQ) see "Temperatures of TCWS In-Cryostat Piping during CrICE and Normal Operation" ITER_D_RJQXE7 v3.1~~	~~Section 11.1, IV.9.1 & IV.9.2~~	~~x~~
~~IV.T4~~	~~VDE Category IV~~	~~1~~	~~I.T1 → I.T1 + VDE IV → I.T1~~	~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	~~Section 11.1, IV.2~~	~~x~~
IV.T5	Cat. IV Pipe Break within In-Vessel LOCA Boundaries	1	1.9 → 6.0 → 1.9 MPa 18 °C	In case of category IV pipe break, significant hydraulic loads may be generated outside of the in-vessel LOCA boundaries of the affected client. The in-vessel LOCA boundaries of the affected client consist of 2 redundant inlet in-vessel LOCA isolation valves and 2 redundant outlet in-vessel LOCA check-valves.	Section 10.8	
~~IV.T6~~	~~WH Severe Pump Seizure~~	~~1~~	~~Baking pump: I.S2 + 1 ms PL-1900 seizure (Impulse case 10 from TYHFYX v2.1) => Same as III.T4~~	-	Section 11.1, IV.18.a & IV.18.b	Section 12.1, IV.6.a & IV.6.b
IV.WH	Bounding Case for WH Severe Pump Seizure (IV.T6)	1	1.9 → 6.0 → 1.9 MPa 209 °C	120% design pressure is never exceeded for WH severe pump seizures (IV.T6). Their initial operating conditions are based on I.S2. A bounding case is thus defined based on sudden pressure variation from lowest operating pressure to design pressure at constant highest operational temperature, and vice-versa.		

~~N.A~~	~~Combination IV.T3 + IV.T2 = SL-2 + CrICE Category IV~~	~~1~~	~~During plasma: I.T1 → I.T1 + SL-2 + CrICE IV → I.T1 With guard external pressure from 1E-7 to 200 kPa in 1 ms and guard temperature from 66 to -64 °C in 1 s~~ ~~During water baking: I.S8 → I.S8 + SL-2 + CrICE IV → I.S8 With guard external pressure from 1E-7 to 200 kPa in 1 ms and guard temperature from 221 to -51 °C in 1 s~~	~~This loading condition is only applicable to IBED PHTS piping inside cryostat.~~	~~Section 11.1, IV.12.1 & IV.12.2~~	~~x~~
~~N.A~~	~~Combination IV.T2 + III.T8 / III.T13 = SL-2 + Helium Leak in CSR or Galleries~~	~~1~~	~~During plasma: I.T1 → I.T1 + SL-2 + Helium Leak in CSR → I.T1 During water baking: I.S2 → I.S2 + SL-2 + Helium Leak in CSR → I.S2~~ ~~During plasma: I.T1 → I.T1 + SL-2 + Helium Leak in Galleries → I.T1 During water baking: I.S2 → I.S2 + SL-2 + Helium Leak in Galleries → I.S2~~	~~This loading condition is only applicable to IBED PHTS supports in CSR and in galleries.~~	~~x~~	~~Sections 10.5 & 12.1, IV.3.a & IV.3.b~~
N.A	Combination IV.WH + IV.T2 = SL-2 + WH Cat. II, III, or IV	1	1.9 → 6.0 → 1.9 MPa 209 °C	SL-2 is cumulated to bounding case IV.WH. Note that this covers any combination of category II / III / IV water hammer events with SL-2.	Section 11.1, IV.18.a & IV.18.b	Section 12.1, IV.6.a & IV.6.b

U.S1	Storage Env. Conditions	-	OUTDOORS Environmental pressure: atmospheric Environmental temperature: [-25, 45] °C Environmental air humidity: 30 g/kg (=> 100% at 32 °C and 50% at 45 °C) Extreme winds up to 166 km/hr Maximum mass of snow: 150 daN/m2 INDOORS Environmental pressure: atmospheric Environmental temperature: [-8, 45] °C Environmental air humidity: 30 g/kg (=> 100% at 32 °C and 50% at 45 °C)		Section 13.1.1
U.T1	Hydrostatic Pressure Test	10	0.1 → 8.6 → 0.1 MPa [5, 45] °C		Section 13.2
U.T2	Containment Leak-Tightness Test	10	Environmental pressure: [95, 200] kPa Environmental temperature: [18, 35] °C Environmental air humidity: [0, 60] %		Section 13.1.2

Table B- 2 Transient Loading Condition of Surge Line

Time [s]	Surge Line Nozzle Flow [kg/s] positive when SL → PZR	Flow Temperature [°C]
0	0	209
0.1	40	65
249.9	40	65
250	-30	209
499.9	-30	209
500	0	209
1800	0	209
30000 cycles		

Table B- 3 Transient Loading Condition of Spray Line in CAT. I Plasma

Time [s]	Spray Line Nozzle Flow [kg/s] positive when spray → PZR	Flow Temperature [°C]
0	0.22	65
1	4.1	65
499	4.1	65
500	0.22	65
100 cycles		

Table B- 4 Transient Loading Condition of Spray Line in CAT. II LOOP

Time [s]	Spray Line Nozzle Flow [kg/s] positive when spray → PZR	Flow Temperature [°C]
0	4.1	75 (if it is supposed the LOOP during plasma)
0.1	0	N/A
59.99	0	N/A
60	0.22	75 (when power is back CVBD can be assumed to be back, but
100 cycles		

Appendix C – IBED PHTS PZR Load Combinations

C.1 Classification and Requirements

This appendix describes all the combinations of loads to use for the normal, exceptional, and highly improbable conditions needed for the design of the PZR.

The PZR safety important classification is SIC-1. The heater bundles, and heater electrical control switchboards are Non-SIC. Per ref. [37], loading conditions from categories I & II should remain within normal damage limits (service level = A), loading conditions from category III should remain within emergency damage limits (service level = C), and loading conditions from category IV should remain within faulted damage (service level = D) with the allowable values from ref.[33] (levels C and D).

From the ESPN classifications, according to the ASN guide 19 [CS2], the classification of events is divided into 4 categories:

- Normal operating conditions (corresponding to cat I and II),
- exceptional situations (cat III)
- testing conditions
- highly improbable situations (cat IV)

The table below summarizes the classification, the requirements and the criteria for the maximum allowable pressure and the maximum allowable temperature.

Table C- 1 Situations Classification and associated requirements

<table>
<tr><th colspan="3">Classification of the situation following the harmonised standards</th><th>PS/TS</th></tr>
<tr><td rowspan="3">conditions of use which can be reasonably foreseen</td><td rowspan="2">normal situations</td><td>normal situations during normal operating conditions</td><td rowspan="2">T≤TS
P≤PS</td></tr>
<tr><td>situations corresponding to usual operational incidents</td></tr>
<tr><td colspan="2">exceptional situations</td><td>P≤110%PS and short time excess
- verification of the equipment (except if adequate design defined)
- adequate protection device when T>TS</td></tr>
<tr><td colspan="2">test situations</td><td>Proof test pressure carried out at the final assessment (envelop of all the pressure tests during operation)</td></tr>
<tr><td colspan="3">highly improbable situations</td><td>avoid the risk of loss of integrity in case of excess of PS ad TS related to the requirements defined in the safety report.</td></tr>
</table>

C.2 Units

The following units are used:

- Pressures, stresses are given in kPa abs, MPa abs and bar g
- Temperatures are given in Celsius degrees ºC
- Dimensions and displacements are in meters or mm
- Mass is in kilograms kg
- Acceleration is in m/s^2 or in g

C.3 Coordinate System

The ITER global reference axes are used for the global reference coordinate system of PZR.

For the ITER plant the reference axes are:

- X = East; Y = North; Z = Vertical

C.4 Loads

The loads acting on the PZR can be divided into 5 independent categories:

- Pressure loads: these include the internal pressure and the water height pressure on the bottom head. See Appendix B – IBED PHTS PZR Process Loading Conditions.
- Inertial loads: these are caused by accelerations due to gravity and seismic events on the equipment itself and on the contained water (sloshing). See Section C.4.1.
- Thermal loads: applied temperature on pressure equipment and its support structure result in thermal stresses. See Appendix B – IBED PHTS PZR Process Loading Conditions.
- Nozzle loads: the connected pipes provide loads at the connection nozzles
- Maintenance loads: the transportation, lifting, installation and in-site inspection during the lifetime of the pressure equipment provides additional loads and stresses
- Fire case as a highly improbable situation

The TCWS load specification [37] indicates many types of loads for the TCWS systems. However, the PZR is not subject to the loads as below. However, the connected piping system may be subject to these loads, and they will be included in the nozzle loads.

- Electromagnetics loads
- Vertical displacements events
- Water hammer loads
- Major disruptions
- Helium leak outside cryostat
- CrICE event (leak of Cryogenic pipes inside Cryostat)
- VV ICE (ingress of coolant inside the Vacuum vessel)

C.4.1 *Seismic Loads*

Following the loads specification [37], the PZR is subject to seismic loads.

Three different seismic events must be considered during the life time for the PZR:

- SL-1 (event category II), with 50 cycles (5 x SL-1, each generating 10 cycles);
- SMHV (event category III), with 1 cycle;
- SL-2 (event category IV), with 1 cycle.

Due to the quantity of water, the sloshing shall be also analysed during seismic events.

The sloshing mode damping equals 0.5% of critical damping. Sloshing should be studied to determine the worst tank filling configuration, and calculation based on this configuration.

The floor response may be amplified by any supporting structure between FRS locations and the equipment.

The damping value for pressure vessels is 3% for SL-2 and SMHV and 2% for SL1 according to [37]. SL1 is equal to 0.34 x SL2 at 3% damping. SMHV is equal to 0.73 x SL2 at 3% according to TCWS load specification [37].

The damping value for electrical components is 3% for SL-2 but conservatively round-up to a damping of 2% as per [95]. Thus, SL1 is equal to 0.34 x SL2 at 2% damping. SMHV is equal to 0.73 x SL2 at 2%.

The number of occurrences for the seism events SL1 is 50 during the lifetime of the PZR.

The number of occurrences for the seism events SMHV is 1 during the lifetime of the PZR.

The number of occurrences for the seism events SL-2 is 1 during the lifetime of the PZR.

The values for the floor response spectra are provided in Appendix F.

C.4.2 *Nozzle Loads*

The nozzle loads are located at the connection flange with the pipe connected.

The values are provided in the appendix E for the situations A/B (cat II and II normal situations) and C/D (cat III and IV exceptional and highly improbable situations).

C.4.3 *Transportation and Maintenance Loads*

The transportation, lifting, installation and in-site inspection during the lifetime of the pressure equipment provides additional loads and stresses. These loads shall be identified by the contractor and be considered in the design of PZR. The maximum allowable acceleration during transportation and lifting needs to be defined in the related documentation (calculation reports, transportation drawings, transportation quality plan, etc.)

C.4.4 *Fire Loads*

During a fire event as highly improbable situation, environmental temperature increases up to 1049 °C for a fire duration of 2 hours based on Eurocode 1 EN 1991-1-2:2005 [CS15]. The

design pressure and temperature of the PZR vessel protected by the selected insulation are 5.5 MPa and 263°C, according to the ref.[112].

Whether the supports will be insulated will be determined by analysis. If the supports are not to be insulated, they will be deemed to be at a temperature of 400 °C during the fire event as per Section 5.5.4.

Per ref.[109], a seismic SL2 then a fire which is not concomitant, should occur as an event category IV (highly improbable situation). Then, a replica SMHV concomitant to the fire shall occur.

When the fire is cumulated with SMHV, it shall be verified that, after the deformation of fire, the PZR can withstand the service level C nozzles loads provided in the Appendix C.

C.4.5 *Summary of Loading Combinations*

The single loads to be considered for PZR design are listed in the table below.

Table C- 2 Summary of Single Loads

Load	Description
P	Internal and external specified pressure (including static head from liquid)
P_t	Test Pressure to be determined by Contractor. Indicative value is given for ref only
D_w	Dead weight including all sustained loads (piping, insulation, aluminium jacket, fluid, etc)
D_t	Same as D_w, except for conditions during pressure test. This can be different from D_w in case of no insulation during the test
T	Temperature or Thermal Loads due to: - piping thermal expansion/contraction when subjected to maximum temperature differences between the fluid and the surrounding environment, - anchor movements due to thermal movements of the equipment
SL1	Seismic event level due to operating basis earthquake, SL2 x 0.34
SMHV	Seismic event level due to operating basis earthquake, SL2 x 0.73
SL2	Seismic event level due to safe shutdown earthquake
Sloshing	Movement of the liquid inside the tank during a seismic event
Nozzle loads	The nozzle loads at the flange with the pipe connected provided for the levels A/B (normal situation) and C/D (exceptional and highly improbable situation)
Transportation and maintenance loads	The loads on PZR during transportation, lifting and in-service inspection.

The load combinations except transportation and maintenance loads to be considered for the PZR design are listed below. The transportation and maintenance loads shall be identified by the contractor.

Table C- 3 Summary of Load Combinations

	Loads	Normal Situation		Exceptional Situation		Highly Improbable Situation			Test Situation
		I/II	I/II	III	III	IV	IV	IV	Test
		N1	N2	E1	E2	HI1	F1	F2	T1
Static	Dead weight	yes	yes	yes	yes	yes	yes	yes	yes
	Pressure (MPa)	5.0	-0.2	5.5	-0.2	6.0	5.5	5.5	8.6
	Volume Water (m^3)	35.7	0	35.7	0	35.7	35.7	35.7	59.6
	Water height pressure	yes	-	yes	-	yes	yes	yes	yes
	Temperature of vessel (°C)	270	100	270	130	209	263	263	T_{amb}
	Temperature of supports (°C)	270	100	270	130	209	263	263	T_{amb}
	Restrained thermal expansion	yes	yes	yes	yes	yes	yes	yes	-
	Nozzle loads (A/B)	yes	yes	-	-	-	-	-	-
	Nozzle loads (C)	-	-	yes	yes	-	-	-	-
	Nozzle loads (D)	-	-	-	-	yes	yes	yes	-
Dynamic	Sloshing	yes	yes	-	-	-	-	-	-
	SL1	yes	yes	-	-	-	-	-	-
	SMHV	-	-	yes	yes	-	-	yes	-
	SL2	-	-	-	-	yes	-	-	-
Fatigue	Cycles	See Appendix B	See Appendix B	-	-	-	-	-	-

Appendix D – General Arrangement of PZR, Control and Electrical Switchboards

D.1 General Arrangement of PZR and Location of Embedded Plates

The general arrangement drawings of the PZR are preliminary drawings, as shown below [58]. They are a support for the Contractor to know the expected global dimensions of the PZR and the position of the embedded plates where the PZR shall be anchored.

Note that the position of the nozzles and the manway is preliminary but will require review and written approval by the IO during the design step.

The lateral lug position shall be optimized to allow the lifting from horizontal position to the vertical position.

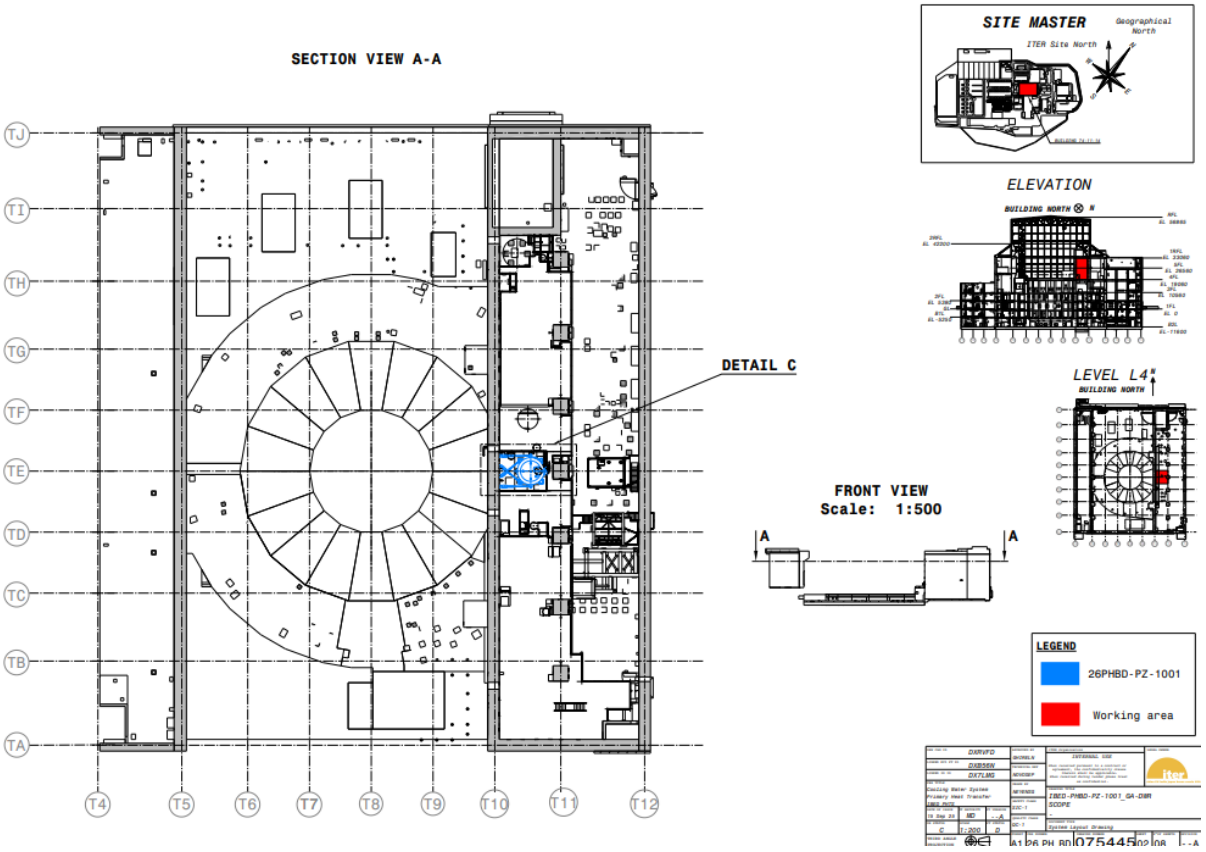


Figure D- 1 Location of IBED PZR in 11 L4 – Elevation 19060 mm

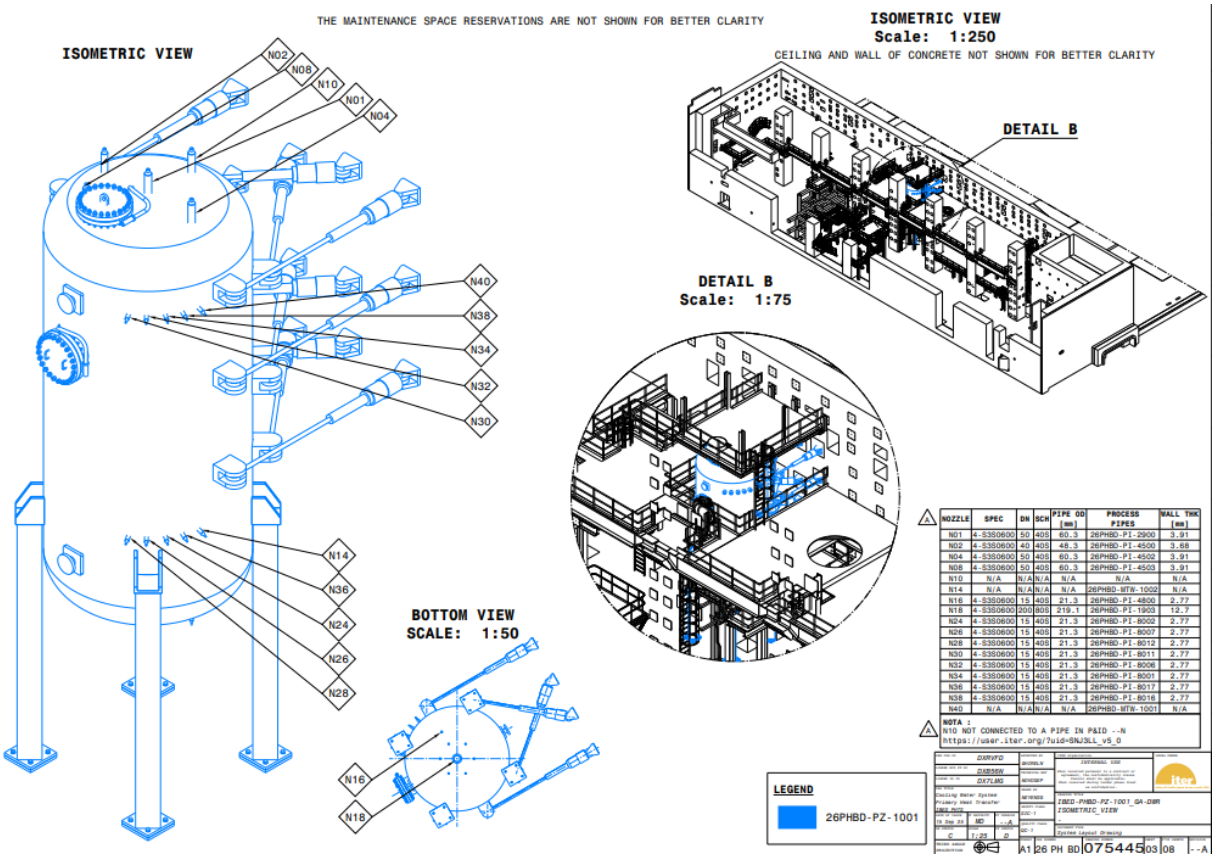


Figure D- 2 Isometric View of General Arrangement of PZR

The PZR can be supported onto the four embedded plates on the floor, and it is also possible to be supported onto the twelve embedded plates on the wall, as shown in Figure D- 3. The dimension of these embedded plates is 900x900x35mm, in carbon steel S355. Dimensions, types and locations of the support on Figure D- 3 are preliminary and shall be designed by the Contractor.

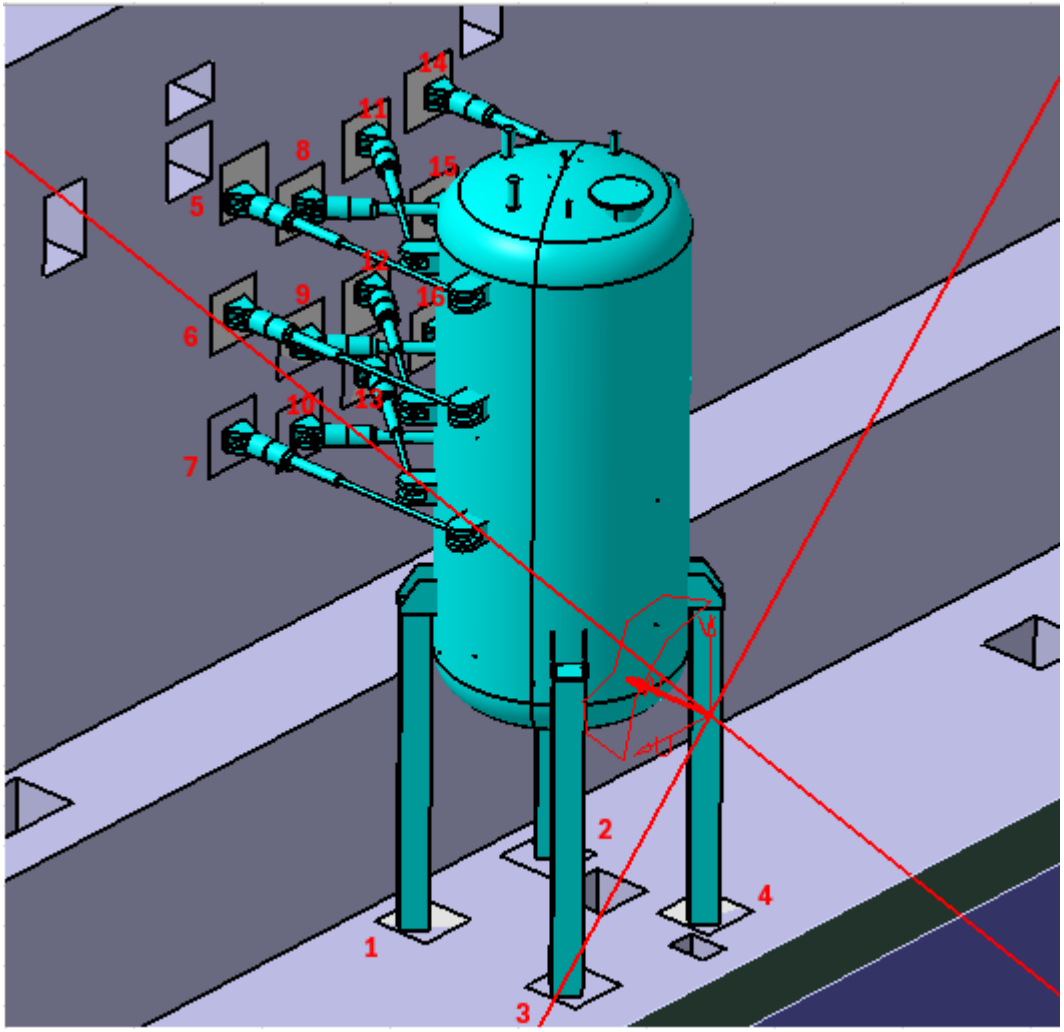
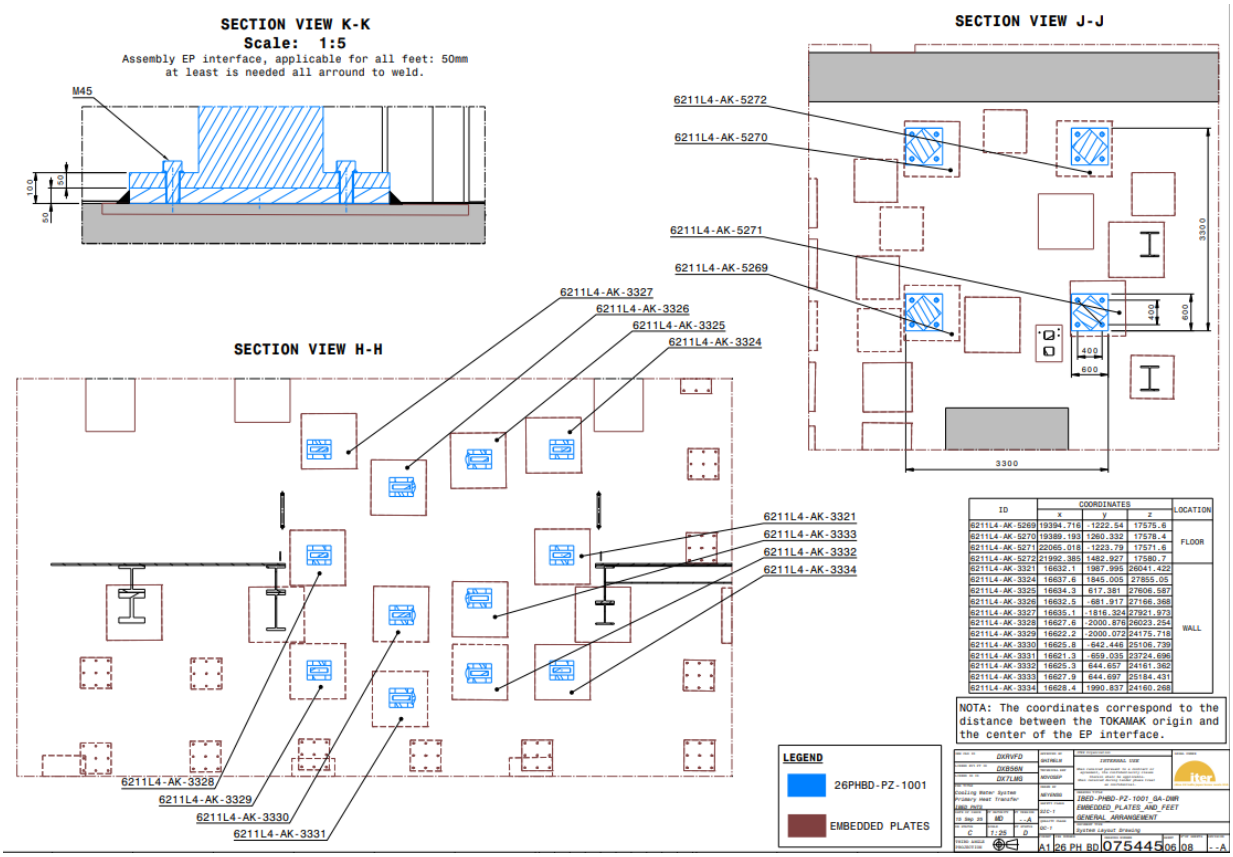


Figure D- 3 IBED PZR Location of Embedded Plates

The as-built information of these embedded plates is shown in Table D- 1and Figure D- 4.

Table D- 1 EP Tags

#1, 6211L4-AK-5269	#2, 6211L4-AK-5270	#3, 6211L4-AK-5271	#4, 6211L4-AK-5272
#5, 6211L4-AK-3327	#8, 6211L4-AK-3326	#11, 6211L4-AK-3325	#14, 6211L4-AK-3324
#6, 6211L4-AK-3328	#9, 6211L4-AK-3330	#12, 6211L4-AK-3333	#15, 6211L4-AK-3321
#7, 6211L4-AK-3329	#10, 6211L4-AK-3331	#13, 6211L4-AK-3332	#16, 6211L4-AK-3334



ID	COORDINATES x	y	z	LOCATION
6211L4-AK-5269	19394.716	-1222.54	17575.6	FLOOR
6211L4-AK-5270	19389.193	1260.332	17578.4	
6211L4-AK-5271	22065.018	-1223.79	17571.6	
6211L4-AK-5272	21992.385	1482.927	17580.7	
6211L4-AK-3321	16632.1	1987.995	26041.422	WALL
6211L4-AK-3324	16637.6	1845.005	27855.05	
6211L4-AK-3325	16634.3	617.381	27606.587	
6211L4-AK-3326	16632.5	-681.917	27166.368	
6211L4-AK-3327	16635.1	-1816.324	27921.973	
6211L4-AK-3328	16627.6	-2000.876	26023.254	
6211L4-AK-3329	16622.2	-2000.072	24175.718	
6211L4-AK-3330	16625.8	-642.446	25106.739	
6211L4-AK-3331	16621.3	-659.035	23724.696	
6211L4-AK-3332	16625.3	644.657	24161.362	
6211L4-AK-3333	16627.9	644.697	25184.431	
6211L4-AK-3334	16628.4	1990.837	24160.268	

Figure D- 4 EP layout and coordinates

D.2 General Arrangement of Control and Electrical Switchboards and Steel Platform

The general arrangement drawings of PZR heater control and electrical switchboards are shown as below [91].

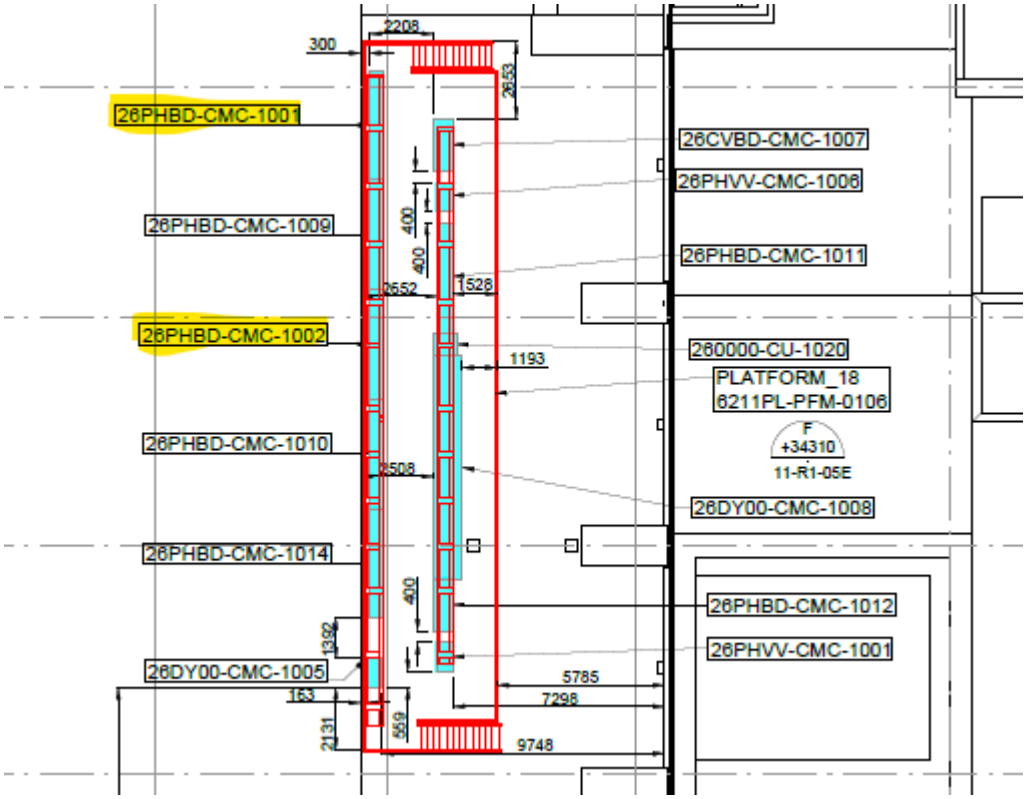


Figure D- 5 Location of PZR Control and Electrical Switchboards

The Control and Electrical Switchboards are attached to the steel platform structure, where the PZR heater control and electrical switchboards are the #1 (26PHBD-CMC-1001), #3 (26PHBD-CMC-1002), as highlighted in yellow below.

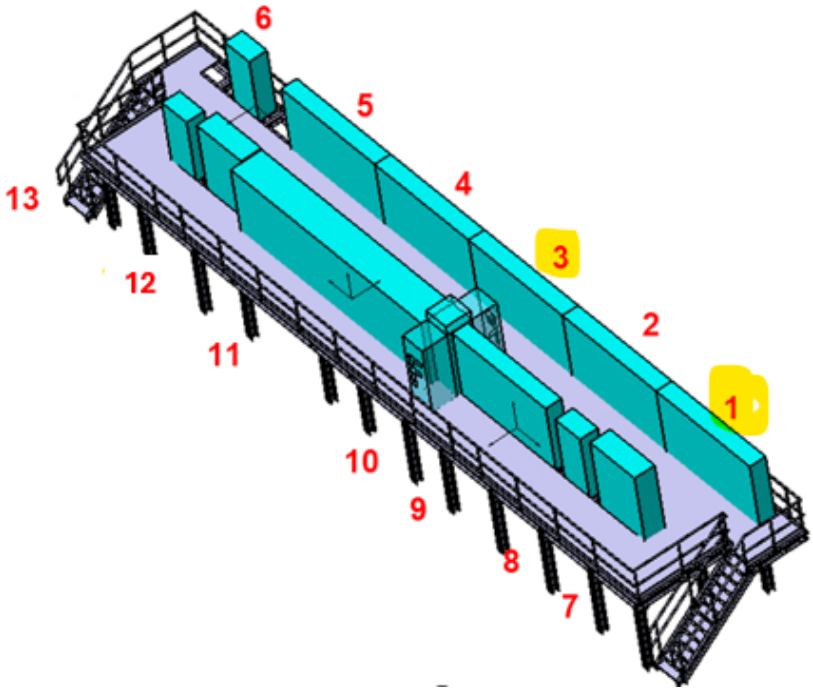


Figure D- 6 Steel Platform of Control and Electrical Switchboards

The general arrangement drawing of the steel platform refers to [96], partially shown below.

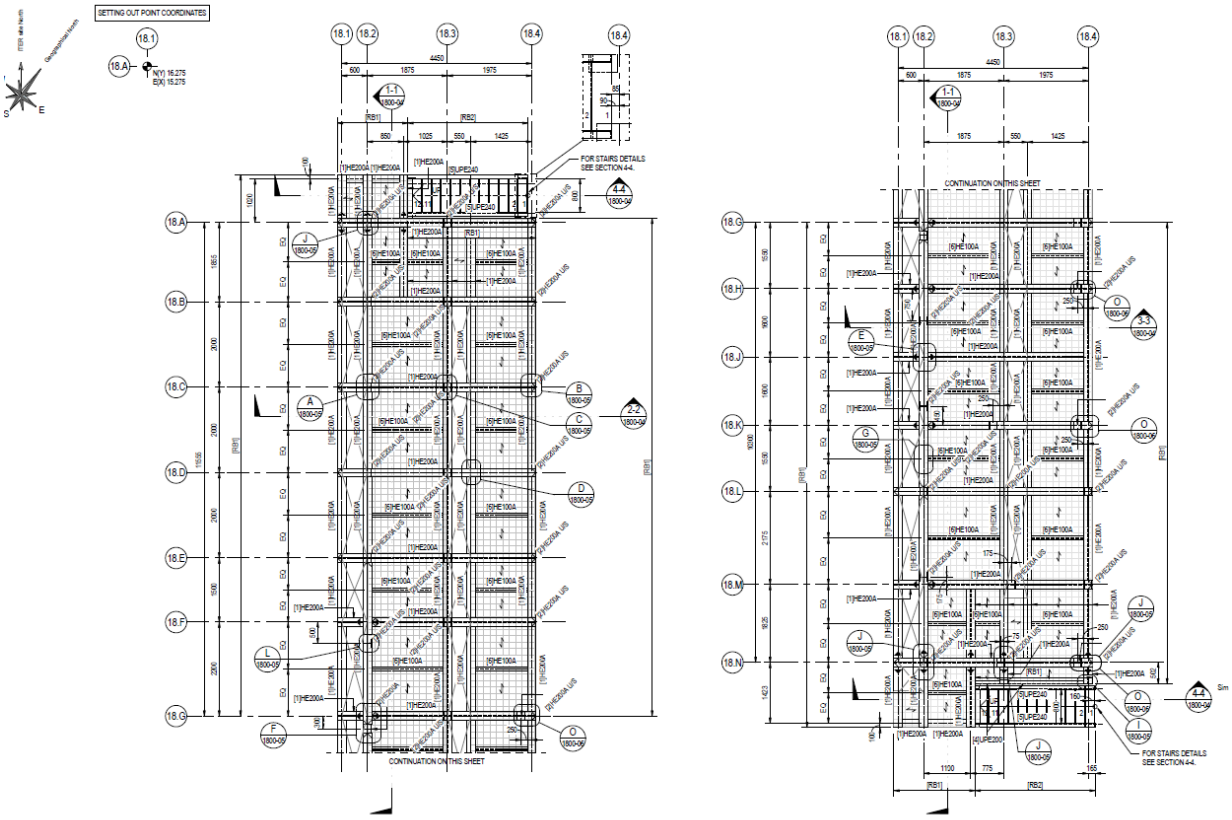


Figure D- 7 Drawing of Steel Platform for Control and Electrical Switchboards

Appendix E – Nozzle Loads for PZR

The nozzle loads from the connected piping system for the PZR shall be the loads provided in the tables below for the situations A/B (normal situations), and C/D (exceptional and highly improbable situations). The nozzle loads shall be applied at the connection between the piping and the nozzle (not at the connection nozzle/vessel).

For other nozzles N12 (Manway), N14 and N40 (Thermowell), N20 and N22 (Heater penetrations), there are no connected piping nozzle loads and are to be designed by Contractor.

Nozzles on head

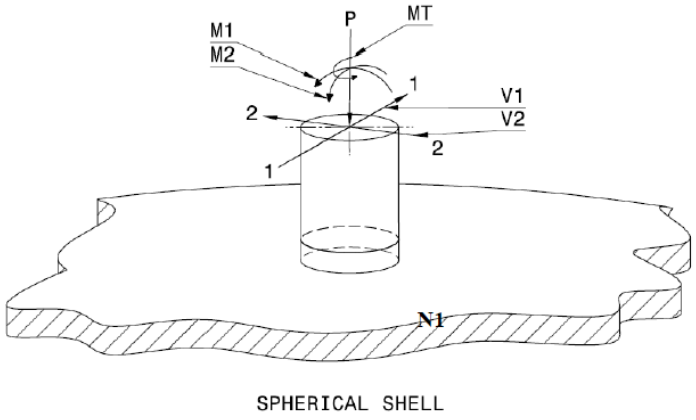


Table E- 1 Allowable Loads for Nozzles on Head

Nozzle	DN	Load Combination	P	Fr = SRSS (V1, V2)	MT	Mr = SRSS (M1, M2)
	(mm)		(N)	(N)	(Nm)	(Nm)
N16	15	A/B	830	1020	150	160
		C	1245	1530	225	240
		D	1660	2040	300	320
N02	40	A/B	3290	4080	580	610
		C	4935	6120	870	915
		D	6580	8160	1160	1220
N01, N04	50	A/B	5840	7250	1030	1080
		C	8760	10875	1545	1620
		D	11680	14500	2060	2160
N18	200	A/B	15920	19910	14790	15450
		C	23880	29865	22185	23175
		D	31840	39820	29580	30900

Nozzles on shell

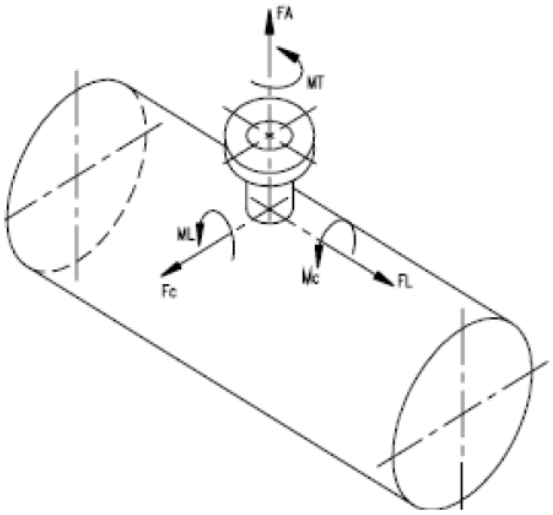


Table E- 2 Allowable Loads for Nozzles on Shell

Nozzle	DN (mm)	Load Combination	FL (N)	FA (N)	FC (N)	MC (Nm)	MT (Nm)	ML (Nm)
N24, N26, N28, N30, N32, N34, N36, N38	15	A/B	830	830	610	100	150	120
		C	1245	1245	915	150	225	180
		D	1660	1660	1220	200	300	240

Appendix F – Design Floor Response Spectra for PZR

F.1 FRS for PZR Tank

The PZR tank is supported onto the concrete wall and floor of 11-L4, as shown in Appendix D – General Arrangement of PZR, Control and Electrical Switchboards.

The floor response spectra (FRS) are provided in the document [53]. These spectra are enveloped from the data points adjacent to the equipment locations (nodes 76590, 76686, 76368, 76360, 76375, 145126 as highlighted in yellow below). Since the orientation of the horizontal earthquake excitation may vary, the X & Y spectra shall be grouped by SRSS rule and shall be used for both horizontal directions. The Z-spectra are the vertical floor responses.

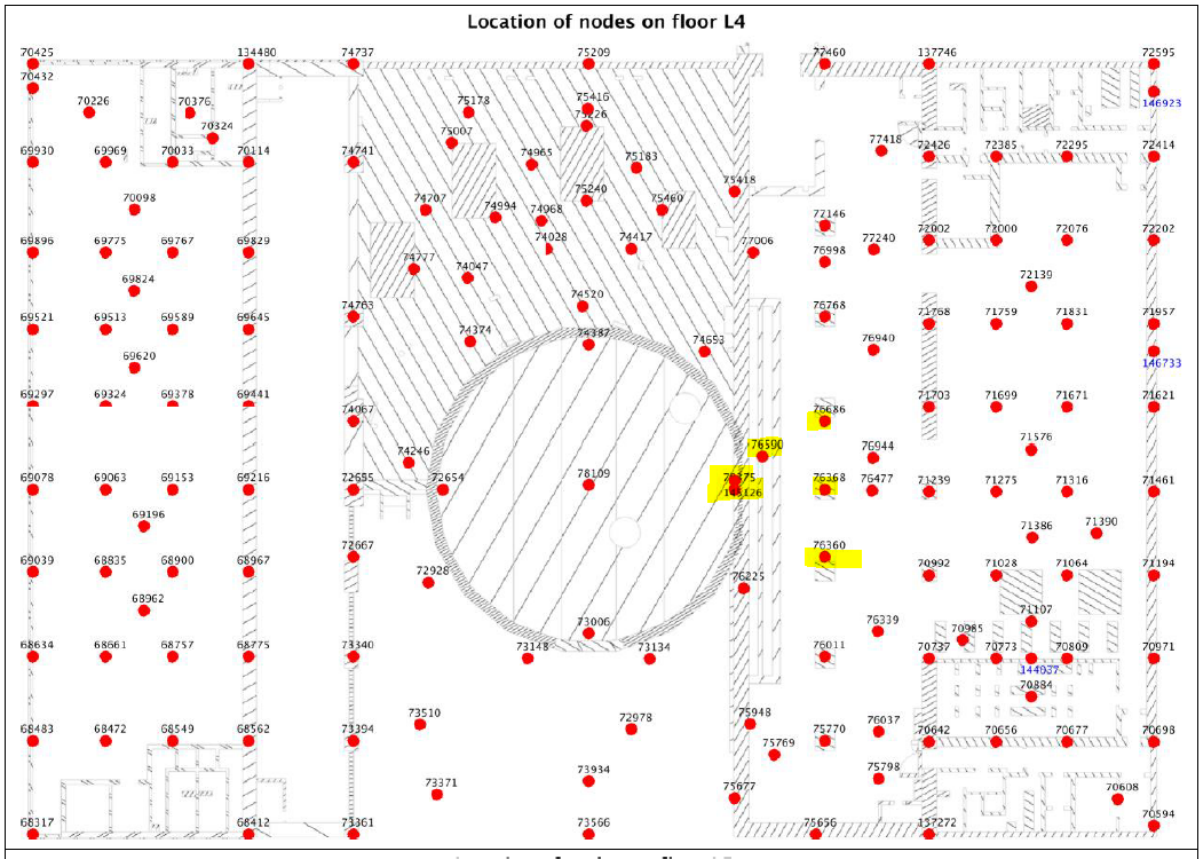


Figure F- 1 Monitoring Nodes of PZR

The design FRS for PZR at SL-2 level with damping 3% is provided in the tables and figures below.

Table F- 1 Design FRS of PZR at SL-2 level (3% damping)

Frequency	SL2 Design FRS (3% damping)		
	X-direction	Y-direction	Z-direction
[Hz]	[m/s²]	[m/s²]	[m/s²]
0.1	0.089277	0.08851	0.0297
0.105	0.1013	0.100001	0.033918

Frequency	SL2 Design FRS (3% damping)		
	X-direction	Y-direction	Z-direction
[Hz]	[m/s²]	[m/s²]	[m/s²]
0.11025	0.110645	0.109523	0.038615
0.115763	0.115636	0.116428	0.040472
0.121551	0.129071	0.129395	0.0449
0.127628	0.145182	0.146312	0.057871
0.13401	0.165805	0.164622	0.065941
0.14071	0.190713	0.188989	0.075021
0.147746	0.216154	0.216076	0.088602
0.155133	0.24775	0.248251	0.097351
0.162889	0.304991	0.306177	0.112647
0.171034	0.385749	0.38613	0.126925
0.179586	0.44345	0.444097	0.149714
0.188565	0.523482	0.525615	0.171281
0.197993	0.595	0.595238	0.190559
0.207893	0.635013	0.635534	0.216091
0.218287	0.723224	0.723512	0.241945
0.229202	0.852845	0.857504	0.272435
0.240662	1.043852	1.047416	0.316862
0.252695	1.268833	1.277884	0.348996
0.26533	1.318816	1.324463	0.354625
0.278596	1.535251	1.551324	0.383315
0.292526	1.869193	1.895131	0.440797
0.307152	2.343162	2.380239	0.44527
0.32251	3.133058	3.172959	0.487836
0.338635	3.94213	4.001392	0.597755
0.355567	4.59984	4.637679	0.652851
0.373346	5.25755	5.273975	0.701981
0.392013	5.922168	5.910312	0.751111
0.411614	6.586892	6.546648	0.800241
0.432194	7.251617	7.182985	0.85332
0.453804	7.916341	7.819321	0.915163
0.476494	8.581066	8.455657	0.981137
0.500319	8.809877	8.455657	1.052289
0.525335	8.809877	8.455657	1.128301
0.551602	8.809877	8.455657	1.204923
0.579182	8.809877	8.455657	1.281546
0.608141	8.809877	8.455657	1.358168
0.638548	8.809877	8.455657	1.451042
0.670475	8.809877	8.401047	1.543916
0.703999	8.039901	7.676324	1.646773
0.739199	7.269925	6.967	1.765902
0.776159	6.557398	6.295416	1.88503

Frequency	SL2 Design FRS (3% damping)		
	X-direction	Y-direction	Z-direction
[Hz]	[m/s²]	[m/s²]	[m/s²]
0.814967	5.85482	5.673935	2.006712
0.855715	5.24888	5.092384	2.13905
0.898501	4.642941	4.510833	2.278683
0.943426	4.061393	3.954595	2.418316
0.990597	3.566213	3.477067	2.545172
1.04013	3.20818	3.153697	2.672029
1.09213	3.025271	2.974993	2.798886
1.14674	2.853911	2.805984	2.929965
1.20408	2.68255	2.636974	3.143429
1.26428	2.51119	2.475833	3.356893
1.32749	2.352946	2.319322	3.593965
1.39387	2.207885	2.153513	3.846115
1.46356	2.08327	2.01522	4.111462
1.53674	1.882682	1.854976	4.377595
1.61358	1.779103	1.751613	4.643727
1.69426	1.773441	1.744361	5.036819
1.77897	1.706209	1.673743	5.434796
1.86792	1.66267	1.632694	5.836755
1.96131	1.655245	1.615867	6.248151
2.05938	1.655245	1.615867	6.66365
2.16235	1.655245	1.615867	7.288219
2.27047	1.665277	1.60968	8.096038
2.38399	1.651527	1.579579	8.952301
2.50319	1.627039	1.56044	10.0071
2.62835	1.565445	1.526182	11.22869
2.75977	1.563853	1.503233	12.57569
2.89775	1.631879	1.527081	14.09641
3.04264	1.738614	1.536012	15.86427
3.19477	1.938789	1.544942	18.35233
3.35451	2.563268	1.553872	22.29572
3.52224	2.982529	1.562803	26.46305
3.69835	3.406414	1.731483	30.63037
3.88327	3.834922	1.901055	34.7977
4.07743	4.442279	2.09825	38.96503
4.2813	5.469384	2.319112	43.13236
4.49537	6.635856	2.54231	43.26673
4.72014	7.798945	2.752551	43.4011
4.95614	7.798945	2.962793	43.53546
5.20395	7.798945	3.012576	43.66983
5.46415	7.798945	3.012576	43.80419
5.73736	7.798945	3.012576	43.80419

Frequency	SL2 Design FRS (3% damping)		
	X-direction	Y-direction	Z-direction
[Hz]	[m/s²]	[m/s²]	[m/s²]
6.02422	7.798945	3.012576	43.74383
6.32544	7.798945	3.012576	43.68346
6.64171	7.65515	3.012576	43.6231
6.97379	7.496429	3.012576	43.56273
7.32248	7.764415	2.86919	43.50236
7.68861	7.764415	2.725804	42.78127
8.07304	7.764415	2.582417	39.03563
8.47669	7.764415	2.439031	35.29
8.90052	7.764415	2.295645	31.74134
9.34555	7.764415	2.187519	28.22373
9.81283	7.764415	2.079393	25.13659
10.3035	7.345032	1.971267	23.12084
10.8186	6.92565	1.863141	21.15954
11.3596	6.506267	1.76349	19.25559
11.9276	6.086885	1.676311	17.35164
12.5239	5.667502	1.664047	15.44769
13.1501	5.248119	1.682372	13.54374
13.8076	4.908123	1.682372	12.62695
14.498	4.568126	1.682372	11.85926
15.2229	4.20464	1.673026	11.09158
15.9841	3.854976	1.663679	10.37727
16.7833	3.532797	1.654333	9.894462
17.6224	3.254634	1.644986	9.465858
18.5035	3.010371	1.528585	8.930719
19.4287	2.779113	1.5068	8.436891
20.4002	2.565211	1.468026	8.128892
21.4202	2.270281	1.413698	7.93036
22.4912	2.001036	1.405478	7.708655
23.6157	1.818109	1.36081	7.548368
24.7965	1.655789	1.338401	7.495693
26.0363	1.627573	1.324052	7.122278
27.3382	1.592585	1.313134	7.07287
28.7051	1.567906	1.302468	6.983053
30.1403	1.552528	1.292708	6.916262
31.6473	1.534199	1.291056	6.8835
33.2297	1.531875	1.289636	6.844095
34.8912	1.528162	1.288726	6.805804
36.6358	1.52545	1.288726	6.762772
38.4675	1.521533	1.287298	6.738308
40.3909	1.519213	1.286679	6.709227
42.4105	1.5171	1.285861	6.683026

Frequency	SL2 Design FRS (3% damping)		
	X-direction	Y-direction	Z-direction
[Hz]	[m/s²]	[m/s²]	[m/s²]
44.531	1.514462	1.28568	6.667472
46.7575	1.51251	1.285061	6.646062

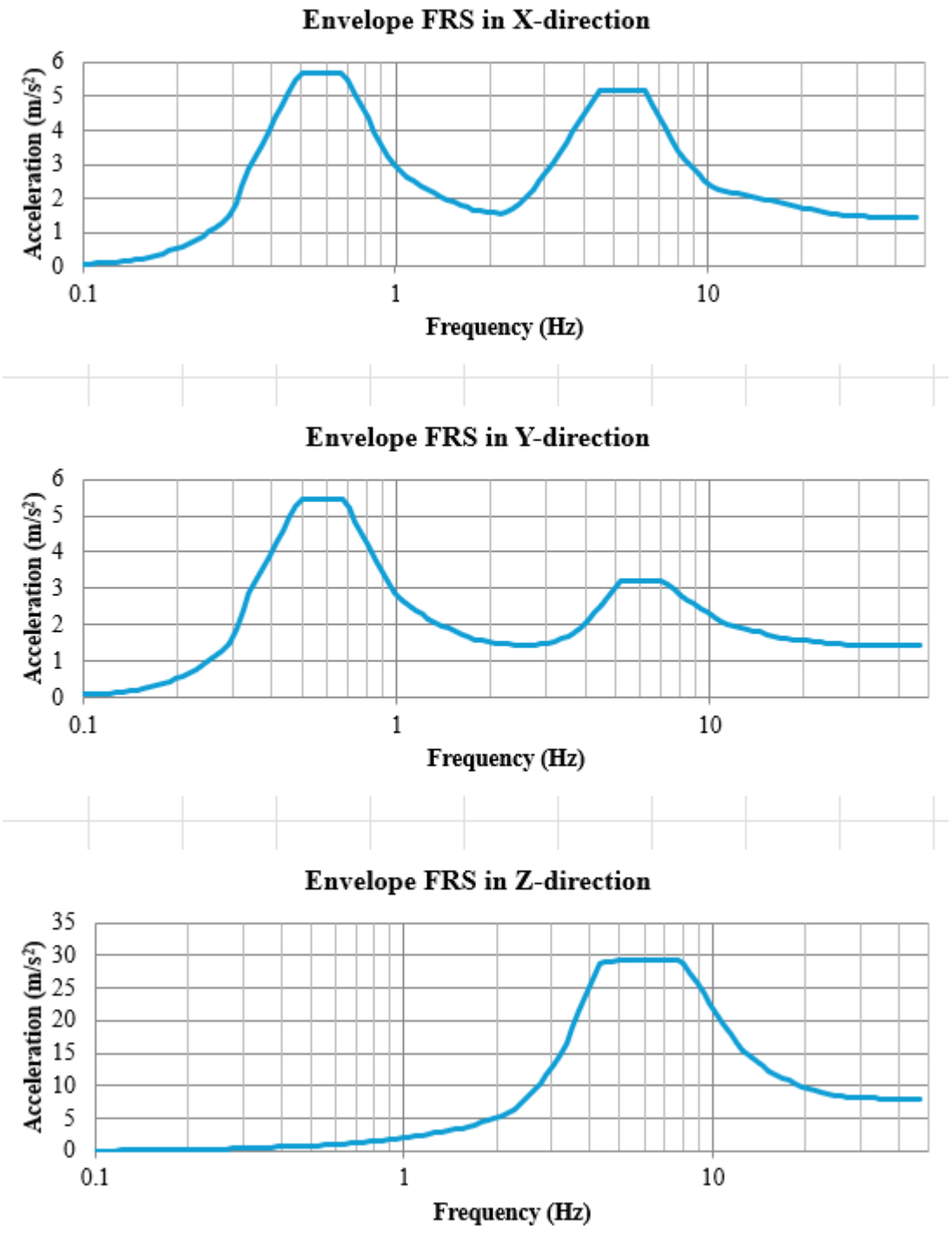


Figure F- 2 Design FRS of PZR at SL-2 level (3% damping)

F.2 FRS for PZR Heater Control and Electrical Switchboards

The heater control and electrical switchboards are located on a steel platform in the room of 11-R1-01E, as shown in Appendix D.

The floor response spectra (FRS) of the concrete are provided in the document [53]. These spectra are enveloped from the data points adjacent to the locations of the steel platform (nodes 86391, 86991, 86517, 86573 as highlighted in yellow below).

Figure F- 3 Monitoring Nodes of Concrete at the Location of Steel Platform

As the FRS of the steel platform is not available, to estimate the amplification of the steel platform for the structural dynamic response, the design acceleration of seismic event SL-2 for the Heater Control and Electrical Switchboards is conservatively considered as the envelope of:

(1) general reference FRS at 2% damping in Ref.[95];

(2) X or Y direction = a_x, a_y * 3; Z direction = $a_{z\_natural}$ * 3 at 2% damping

Where a_x, a_y are the peak acceleration of the FRS of the concrete in X and Y direction, $a_{z\_natural}$ is the vertical acceleration at the natural frequency of the platform as provided in Ref.[122].

The final design acceleration is as follows:

$$Ax = Ay = 32\ m/s^2;\ Az = 53\ m/s^2$$

Since the orientation of the Control and Electrical Switchborads may vary, the X & Y acceleration shall be grouped by SRSS rule and shall be used for both horizontal directions. The Z acceleration is the vertical floor response.

Appendix G – IBED PHTS PFD and PID

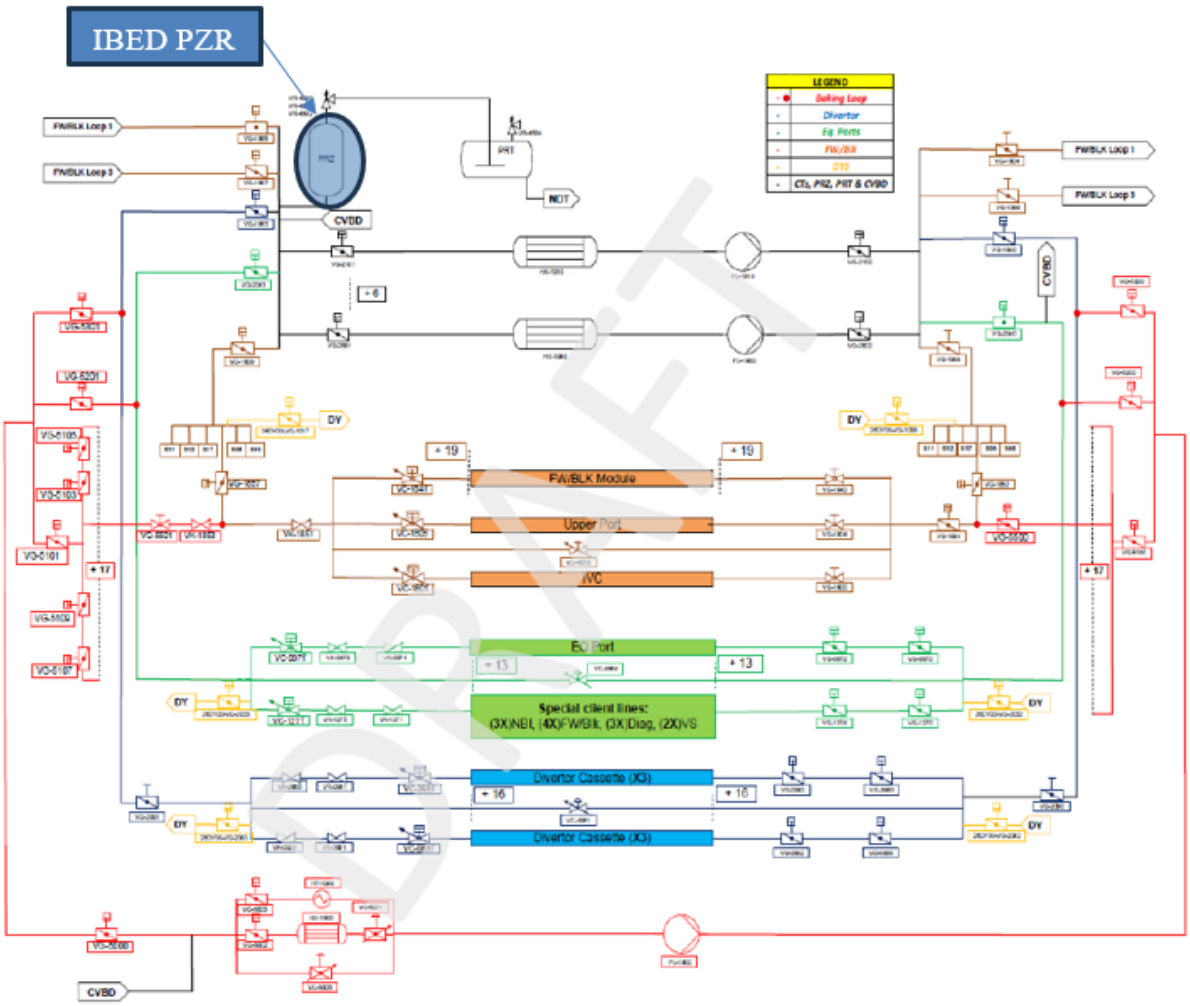
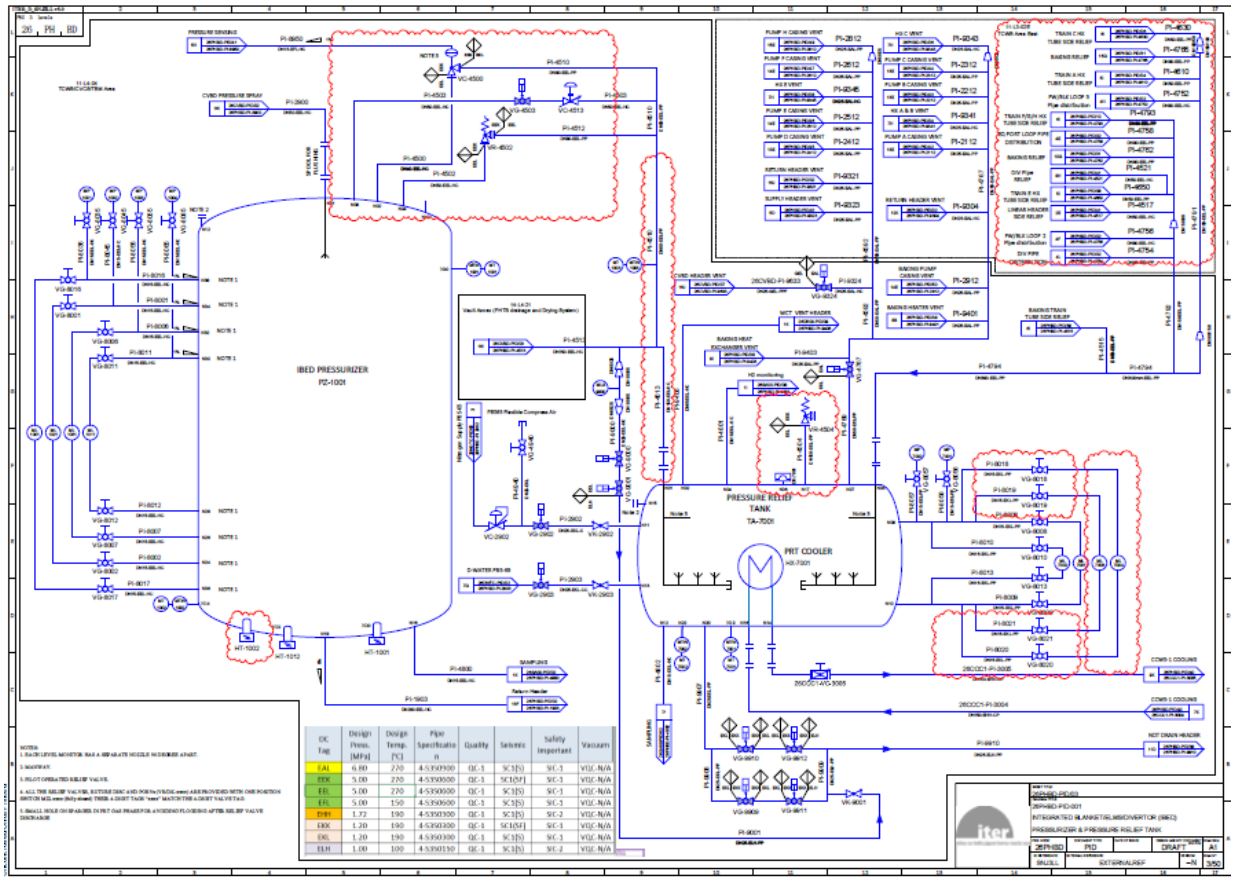


Figure G- 1 Simplified PFD



Note: The heater HT-1012 does not exist anymore. It should not be considered.

Figure G- 2 IBED PHTS P & ID (part)

Appendix H – Installation and Integration of PZR

The installation and integration of the PZR is an important stage that requires high prevision during transportation to the level L4 in a crowded context. The installation and integration of IBED PZR is on IO's responsibility. However, the contractor shall design the equipment considering the installation trajectory and the integration environment.

In the installation study [63] performed by IO, the IBED PZR will be transported from the crane hall via the cargo lift in the north corner of 11L4, then to be installed to the permanent location, as shown in the figure below. Considering the limited space of installation, the four vertical support legs of PZR shall be designed to be cable to dismantle during the installation and re-install them after the PZR is lifted at its final elevation. The contractor shall design and provide necessary devices required by the installation, if not available from the installation contractor.

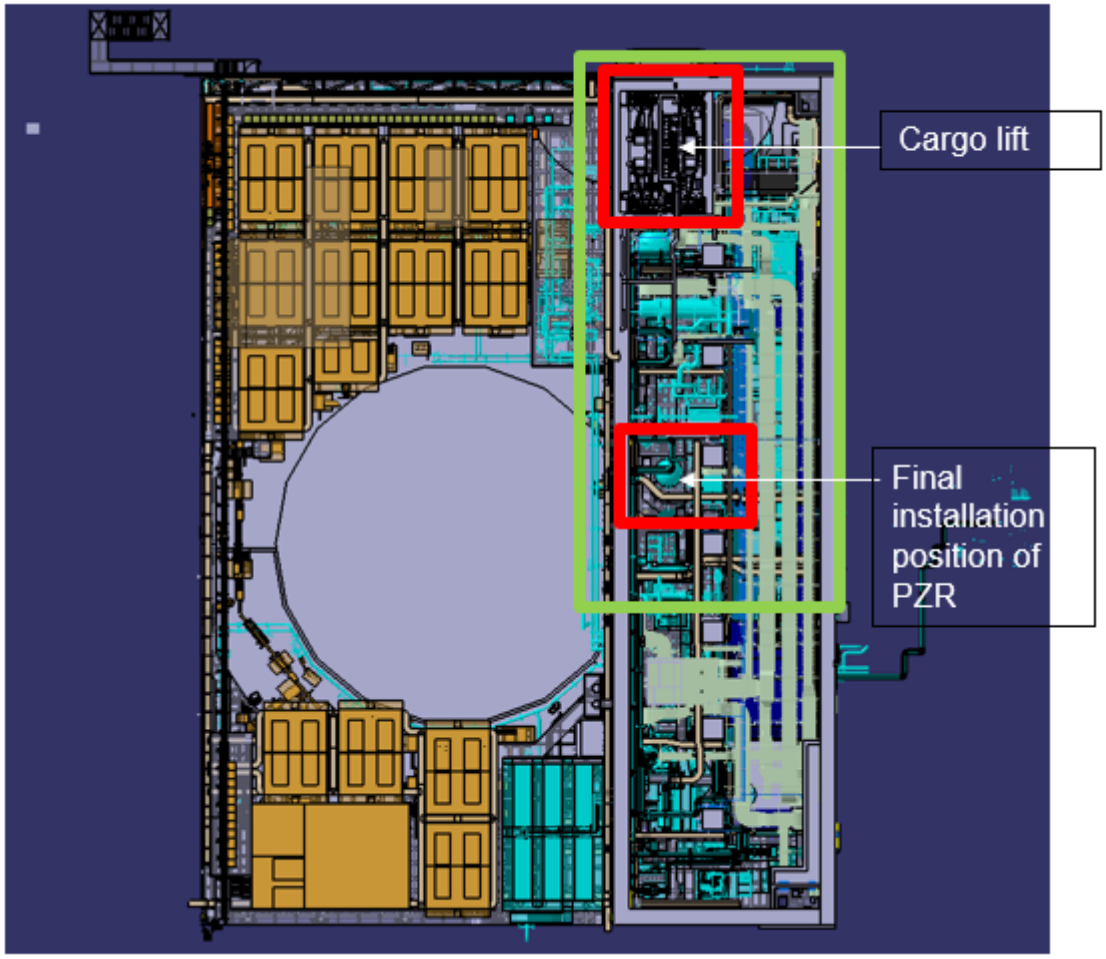


Figure H- 1 3D Context (Top view of 11L4)

In the integration study performed by IO [64], the IBED PZR preliminary 3D model has been checked in the environment for clashes. The final 3D model after designing by the contractor will also be checked by the integration study, and it should be clash-free considering the manway open trajectory, corridor circulation access, and the maintenance space requirement etc.

Appendix I – List of Deliverable Supplies

The delivery schedule of the main gates shall follow the table below.

Table I- 1 Delivery Schedule

Ref.	Deliverables	Deliverable due date
D1.1	MRR approval of PZR (including heaters) by IO according to the technical specification	T0* + 6 months
D1.2	MRR approval of insulation by IO according to the technical specification	
D1.3	MRR approval of Heater Control and Electrical Switchboards by IO according to the technical specification	
D2.1	Hydrotest and FAT successful report of PZR (including heaters)	T0* + 17 months
D2.2	FAT successful report of insulation	
D2.3	FAT successful report of Heater Control and Electrical Switchboards	
D3.1	Delivery of PZR with heaters and final documentation approval	T0* + 23 months
D3.2	Delivery of insulation and final documentation approval	
D3.3	Delivery of Heater Control and Electrical Switchboards and final documentation approval	

T0 = Commencement Date of the contract; X in months*

The Contractor shall issue at minimum the documents (for IO review) indicated in the Tables below. The required time for completion expressed in weeks before or after the gate will be decided during the KOM. The documents for the PZR are listed in Table I- 2. The other components including heaters, control and electrical switchboards, and insulation are presented in the following separate tables and can be managed concomitantly with the PZR main project progress.

Applicable documents listed can be added/modified/merged during the KOM or during the project and will be included to the list presented in this appendix.

Table I- 2 Applicable Documents for IBED PZR

Category	Document Type	Further Description	Gate
Contract Management	Contract Management Plan		KOM
	KOM Minutes		KOM
	Progress Meeting Presentation and Minutes		KOM

	Contract schedule		KOM
	MRR Plan		KOM
	List of Deliverables		KOM
PED/ESPN	Hazard and Risk Analysis of PZR	See 5.8.3	Design review
	Essential Safety Requirements Gap Analysis	See 5.8.3	Design review
Design	NPMA	Nuclear Particular Material Appraisal (NPMA/EPMN) for the materials used for the PZR.	Design review
	Description and Plan of Design, Verification and Validation		Design review
	Manufacturing Drawings	General arrangement drawing, detailed drawing for PZR	Design review
	Assembly Drawings	Assembly drawings at the shop for PZR	Design review
	Transportation Drawings	Drawings for the shipping structure for PZR	Design review
	Installation Drawings	Installation drawings at the ITER site	Design review
	Design calculation sheet	Preliminary calculation in accordance with ASME BPVC VIII Div.2 to determine the thickness of equipment resulting from pressure loads. More detailed calculation will be done in FEM analyses hereafter.	Design review
	Structural Analysis of PZR	FEM analysis report for PZR in accordance with the design requirements defined in 0.	Design review
	Transportation Analysis	FEM analysis report for the PZR and the shipping structure under transportation loads.	Design review
	Flange calculation with EN 1591-1		Design review
	List of Materials	This material list provides the bills of material for the PZR, shipping parts, coupon and spare parts. The purpose of this document is to identify the parts and material list of the PZR.	Design review

Manufacturing	MIP	Manufacturing and Inspection Plan for PZR, heaters, heater control and electrical switchboards, insulation etc. See 9.9 for details.	MRR
	MPS	Material Purchase Specifications for base material, weld material, gaskets and all other materials/components used for PZR including heaters, heater control and electrical switchboards, insulation, etc.	MRR
	Weld data package	WPS, WPQR, WQIPP, welding map, cleaning procedure and requirements for welded parts, weld repair procedure including documentation to record weld defects, etc. See 5.8.4 for more details.	MRR
	Manufacturing Process and Procedure	Describes the manufacturing process and procedures which are applied on the manufacturing operations of PZR. It shall include a list of single procedures provided separately hereafter.	MRR
	Material Identification Control Procedure	This document provides the details describing the authority, responsibilities and prescribes the methods to be implemented to ensure that items and material are correctly identified upon receipt or manufacture and that the identity is maintained and traceable to the product in which it is used when required by the applicable code, standard, regulation or customer contract.	MRR
	Assembly Identification Control Procedure	This instruction provides assembly identification marking system for assembly during the manufacturing of the PZR and its appurtenances. Identification of a part or a material before assembly to other item shall be identified in accordance with	MRR

		material identification marking work instruction.	
	Lifting Test Procedure		MRR
	Coating Procedure		MRR
	Pickling and Passivation Procedure		MRR
	Cleaning Procedure		MRR
	Procedure for cutting, bending, forming, surface finishing	Machining and forming procedure for PZR.	MRR
	Heat Treatment Procedure	Procedure for solution annealing and other needed heat treatment of PZR.	MRR
Material	Material certificates	Material test certificates for steel and non-steel materials used for PZR as per the requirements in Section 5.10.	MRR
Test	Patrolling Inspection Procedure	Describes patrolling (monitoring) process such as monitoring target, interval, findings handling and reporting. See 9.13 for details.	MRR
	Heater Electrical Test Procedure	Describes the process and requirements of the electrical test before installing the heaters to the PZR, and after the PZR hydrostatic test.	MRR
	Visual and Dimensional Inspection Procedure	Describes the requirements and process for certification of inspectors, selection of measuring instruments, visual inspection, marking inspection, forming inspection, welding inspection, and machining inspection	MRR
	Liquid Penetration Examination Procedure		MRR
	Radiographic Examination Procedure		MRR
	Ultrasonic Examination Procedure		MRR
	Indirect Visual Examination Procedure	Provides the method and acceptance standards for visual examination of carbon steel, low alloy steel, stainless steel, or high nickel alloy steel materials as used in welds	MRR

		surfaces when required indirect(remote) visual testing.	
	Equipment Qualification Plan	The plan for the activities to be performed to qualify the PZR, heater bundles and associated control and electrical switchboards.	MRR
	Final Acceptance Test Program	Factory Acceptance Test (FAT) program identifying all factory acceptance tests as defined at design stage and including details on extent of the tests, type, examinations and inspections of the Items	MRR
	Pressure Test Procedure	Describes the process and requirements of the hydrostatic test of PZR.	MRR
Quality Acceptance	Project Quality Plan	See 9.1 for details	MRR
	Subcontractor's Quality Plans	Subcontractors who perform CQA shall be provided and get approved by IO.	MRR
	List of subcontractors	List of subcontractors and their attributions	MRR
	Procedure for Control of Non-conformities and Deviation Requests		MRR
	List of Non-conformities and Deviation Requests	List of NCRs and DRs with their status, actions. If they impact manufacturing, they must be closed and/or approved before MRR.	MRR
Manufacturing	End of Manufacturing Report (EMR)	See 5.8.5.1 for details.	FAT readiness review
	Reports and records	Reports and records of tests, qualifications, inspections, as defined in the MIP.	FAT readiness review
	As built drawing	Drawings with as built dimensions. It shall include the dimensions necessary for compliance with regulatory requirements (DNRE), list of NCR and weld defects during the manufacturing process.	FAT readiness review
PED/ESPN	ANB review reports	For IO's information only.	FAT readiness review

Tooling	List of measurement and test equipment and tools	List of equipment and tools including relevant calibration protocols, status and records	FAT readiness review
Training and Qualification	List of qualified welders, welding equipment operators, NDE personnel	List of qualified welders, welding equipment operators, NDE personnel, with their certificates.	FAT readiness review
	Training records	Training records of Contractor's and Subcontractor's personnel who participate PZR project, for propagation of Project Quality Plan and IO requirements, training of software used for design analysis, etc.	FAT readiness review
Transportation and Preservation	Transportation, packing and shipping procedure	This procedure can be integrated into instruction manual.	DRR
	On-site preservation procedure/instructions	This procedure can be integrated into instruction manual.	DRR
Installation and Maintenance	Instruction Manual	Recommendation related to installation, use of the equipment, maintenance plan, including any required tooling. The instruction manual of heaters, Control and Electrical Switchboards, and insulations can be provided separately from the one for PZR. It shall be in both English and French.	DRR
Quality Acceptance	Verification Compliance Matrix	See Table 7-1 for details.	DRR
PED/ESPN	Declaration of conformity of the manufacturer		DRR
	Certificate of Conformity from ANB		DRR
Transportation and Preservation	Contract Release Note		DRR
	Transportation Quality Plan		DRR
	Packing List		DRR
	Delivery Report		DRR

Table I- 3 Applicable Documents for Heaters

Category	Document Type	Further Description	Gate

Design	NPMA	Nuclear Particular Material Appraisal (NPMA/EPMN) for heater's material	Design review
	Manufacturing Drawings	Manufacturing drawings of heaters	Design review
	Assembly Drawings	Assembly drawings of heaters	Design review
Manufacturing	MIP	Manufacturing and Inspection Plan for heaters. See 9.9 for details.	MRR
	MPS	Material Purchase Specifications for base material and weld material used for heater manufacturing.	MRR
	Weld data package	Weld data package for heaters. WPS, WPQR, WQIPP, welding map, cleaning procedure and requirements for welded parts, weld repair procedure including documentation to record weld defects, etc. See 5.8.4 for more details.	MRR
	Manufacturing Process and Procedure	Describes the manufacturing process and procedures which are applied on the manufacturing operations of heaters. It shall include a list of single procedures provided separately hereafter.	MRR
	Cleaning Procedure	Cleaning and cleanliness control procedure for heaters.	MRR
	Procedure for Machining and Forming	Machining and forming procedures of heaters, such as cutting, bending, polishing, swaging	MRR
	Procedure for Heate Treatment	Defines the process and requirements for the stress relieving of heaters	MRR
	Marking Procedure	Marking procedure of heaters	MRR
Material	Material certificates	Material test certificates for base material and weld material used for heater manufacturing.	MRR
Test	Heater Electrical Test Procedure	The process to be followed for heater electrical tests to be done in the heater's manufacturer's shop, including Wattage, Insulation Resistance, Dielectric Strength (Hipot), Water Immersion, and Resistance.	MRR

	Procedure for Ultrasonic Thickness Gauge Test	Defines the procedure to measure sheath tube wall thickness with ultrasonic thickness gauge.	MRR
Quality Acceptance	Project Quality Plan	Design and manufacturing of heaters is CQA, therefore the PQP of heaters shall be provided and get approved by IO.	MRR
	Subcontractor's Quality Plans	Subcontractors of heaters (if any) who perform CQA shall be provided and get approved by IO.	MRR
	Procedure for Control of Non-conformities and Deviation Requests	Can be merged with the main procedure for control of NCR and DR for the PZR, if applicable.	MRR
	List of Non-conformities and Deviation Requests	List of NCRs and DRs with their status, actions. If they impact manufacturing, they must be closed and/or approved before MRR.	MRR
Manufacturing	End of Manufacturing Report (EMR)	See 5.8.5.1 for details.	FAT readiness review
	Reports and records	Reports and records of tests, qualifications, inspections, as defined in the MIP.	FAT readiness review
	As built drawing	Drawings with as built dimensions. It shall include the dimensions necessary for compliance with regulatory requirements (DNRE), list of NCR and weld defects during the manufacturing process.	FAT readiness review
Tooling	List of measurement and test equipment and tools	List of equipment and tools including relevant calibration protocols, status and records	FAT readiness review
Training and Certification	Training records	Training records for heater manufacturing.	FAT readiness review
Installation and Maintenance	Instruction Manual of Heaters	Recommendation related to installation, use of the equipment, maintenance plan, including any required tooling. It shall be in both English and French.	DRR

Note: Heaters are not independent equipment but a component of PZR as per PED/ESPN, therefore the applicable documents for heaters can be combined with PZR's documents or be provided separately if the heaters are manufactured independently from the PZR.

Table I- 4 Applicable Documents for Heater Control and electrical switchboards

Category	Document Type	Further Description	Gate
Design	Diagrams	System block diagrams (Electrical, I&C), schematic internal diagrams of cubicles, cause & effect diagrams	Design review
	Outline and Assembly Drawings	Outline drawing and Assembly drawings of Control and Electrical Switchboards, PZR's layout with Electrical and I&C Equipment	Design review
	List	List of instruments & alarms, electrical load list, interconnection cable list, input/output list hardwired and communicated (between field and heaters control system, between heaters control system and IO PLC-PBS26 PCS)	Design review
	Software	Complete software documentation linked to Control system Controllers, SCR parametrization, Electrical protections parameters (including native codes)	Design review
Manufacturing	MIP	Manufacturing and Inspection Plan for Control and Electrical Switchboards. See 9.9 for details.	MRR
	MPS	Material purchase Specifications for Control and Electrical Switchboards.	MRR
Material	List of Material	List of Material for Control and Electrical Switchboards, including spare parts	MRR
	Datasheet	Electrical equipment data sheet, Instruments datasheet, control equipment data sheet	MRR
Test	Performance Test Procedure	Performance test procedure and acceptance criteria for verifying the function and performance of each PZR Heater Control system.	MRR
	Other tests	Static Magnetic Field test procedure, seismic test procedure	MRR
Quality	Project Quality Plan	PQP of heaters.	MRR

Acceptance	Subcontractor's Quality Plans	Subcontractors of Control and Electrical Switchboards (if any) who perform CQA shall be provided and get approved by IO.	MRR
	Procedure for Control of Non-conformities and Deviation Requests	Can be merged with the main procedure for control of NCR and DR for the PZR, if applicable.	MRR
	List of Non-conformities and Deviation Requests	List of NCRs and DRs with their status, actions. If they impact manufacturing, they must be closed and/or approved before MRR.	MRR
Manufacturing	End of Manufacturing Report (EMR)	See 5.8.5.1 for details.	FAT readiness review
	Reports and records	Reports and records of tests, qualifications, inspections, as defined in the MIP.	FAT readiness review
Tooling	List of measurement and test equipment and tools	List of equipment and tools including relevant calibration protocols, status and records	FAT readiness review
Transportation and Preservation	Transportation, packing and shipping procedure	This procedure can be integrated into instruction manual of Control and Electrical Switchboards.	DRR
	On-site preservation procedure/instructions	This procedure can be integrated into instruction manual of Control and Electrical Switchboards.	DRR
Installation and Maintenance	Instruction Manual of Control and Electrical Switchboards	Recommendation related to installation, use of the equipment, maintenance plan, including any required tooling. It shall be in both English and French.	DRR
Delivery	Contract Release Note		DRR
	Transportation Quality Plan		DRR
	Packing List		DRR
	Delivery Report		DRR

Table I- 5 Applicable Documents for Insulation

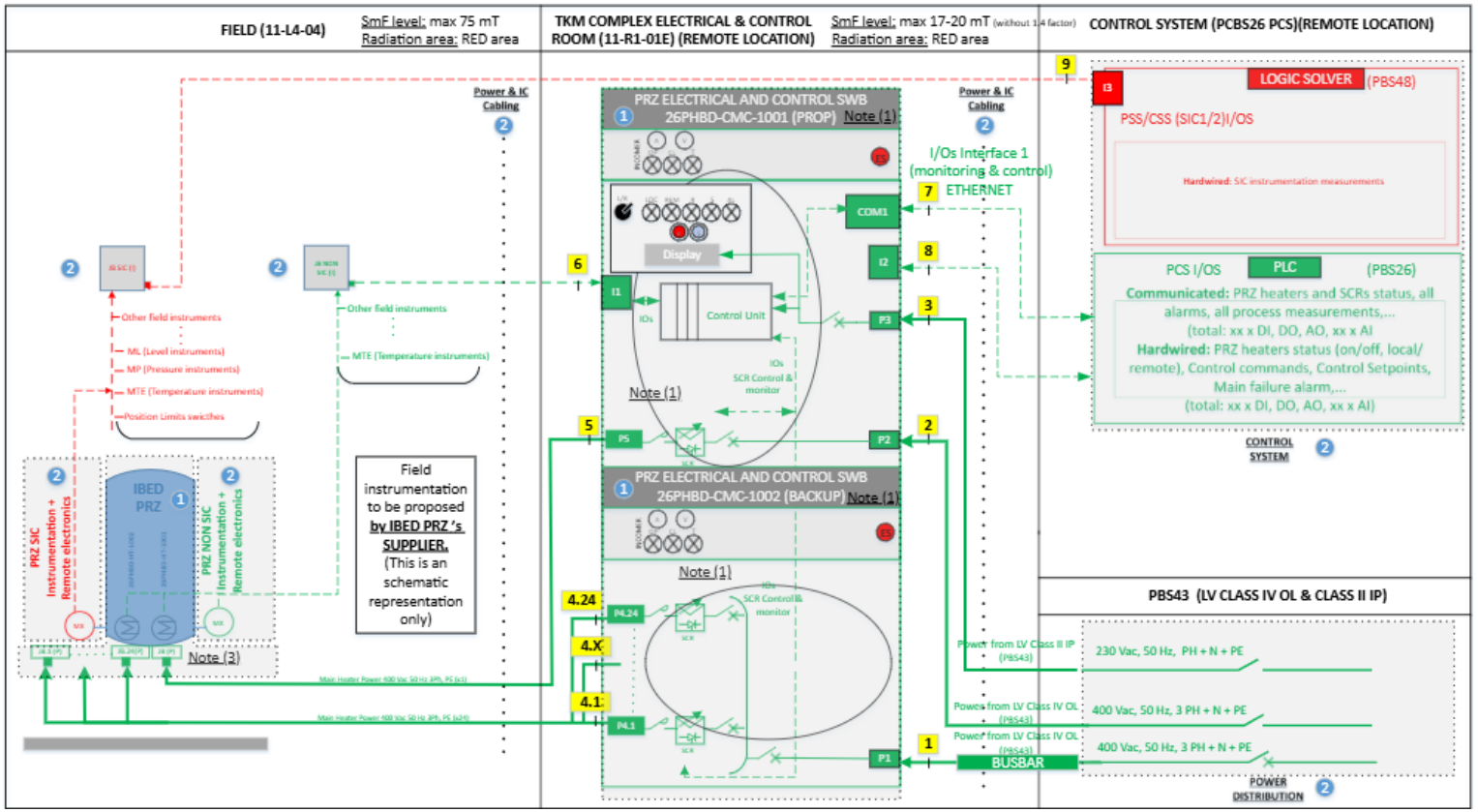
Category	Document Type	Further Description	Gate

Design	Manufacturing Drawings	General arrangement drawing, detailed drawing for insulation	Design review
	Assembly Drawings	Assembly drawings at the shop for insulation	Design review
	Installation Drawings	Installation drawings of insulation at the ITER site	Design review
	Calculation Report	Calculation report for thermal performance, structural integrity and other design requirements as per purchase specification.	Design review
Manufacturing	MIP	Manufacturing and Inspection Plan for insulation. See 9.9 for details.	MRR
	MPS	Material purchase specifications for insulation.	MRR
Material	List of Material	List of Material for insulation, including spare parts	MRR
Test	Performance Test Procedure	Test procedure to verify the performance of insulation as required by the purchase specification.	MRR
Quality Acceptance	Project Quality Plan	PQP of insulation.	MRR
	Subcontractor's Quality Plans	Subcontractors of Control and Electrical Switchboards (if any) who perform CQA shall be provided and get approved by IO.	MRR
	Procedure for Control of Non-conformities and Deviation Requests	Can be merged with the main procedure for control of NCR and DR for the PZR, if applicable.	MRR
	List of Non-conformities and Deviation Requests	List of NCRs and DRs with their status, actions. If they impact manufacturing, they must be closed and/or approved before MRR.	MRR
Manufacturing	End of Manufacturing Report (EMR)	See 5.8.5.1 for details.	FAT readiness review
	Reports and records	Reports and records of tests, qualifications, inspections, as defined in the MIP.	FAT readiness review
	As built drawing	As built drawing for insulation	
Tooling	List of measurement and test equipment and tools	List of equipment and tools including relevant calibration protocols, status and records	FAT readiness review

Installation and Maintenance	Instruction Manual of Insulation	Recommendation related to installation, use of the equipment, maintenance plan, including any required tooling. It shall be in both English and French.	DRR
Delivery	Contract Release Note		DRR
	Transportation Quality Plan		DRR
	Packing List		DRR
	Delivery Report		DRR

Appendix J – IBED PZR system Electrical, I&C: SCOPE LIMITS AND INTERFACE SCHEME

Selector in MCC	Mode	Operation from	
		PCS	MCC
LOCAL	MCC Local	No	Yes
REMOTE	PSS	Yes	No



Notes :

(1) **Internal design of Electrical switchboard** as per IBED PRZ Technical specification (UID: E32L6X) and to be agreed between IO and supplier

(2) **Interface notes** applicable to **Electrical and Control Switchboards 26PHBD-CMC-1001 & 26PHBD-CMC-1002**:

Item No.	Item Descripcion	Requirement	Drawing interface reference
26PHBD-CMC-1001			
1	**Busbar/Cable (s) access & terminals quantity, size, type**	Adequate for the related designed incoming/outgoing cables	P2/P3/P5
2	**Busbar/Cable (s) access location**	Bottom side of the switchboard	P2/P3/P5
3	**Switchboard access**	Front access only	NA
4	**Switchboard dimensional limits (HeightxWidthxDepth)**	2185x3784x508	NA
5	**Switchboard fixing**	Adequate for installation on steel platform	NA
6	**Electrical incoming Power supplies:**		
(a)	**Class**	IV OL	2
	Quantity	1	
	Electrical data	3 Phases + N + PE, 400 (+10/-10%) Vac, 50 (± 1%) Hz	
	Power	As per main Appendix A.1	
(b)	**Class**	II IP	3
	Quantity	1	
	Electrical data	1 Phase + N + PE, 230 (+10/-10%) Vac, 50 (± 1%) Hz	
	Power	To be defined by Contractor (Maximum 3 Kw)	
26PHBD-CMC-1002			
1	**Busbar/Cable (s) access & terminals quantity, size, type**	Adequate for the related designed incoming/outgoing cables	P1
2	**Busbar/Cable (s) access location**	Bottom side of the switchboard	P1
3	**Switchboard access**	Front access only	NA
4	**Switchboard dimensional limits (HeightxWidthxDepth)**	2185x3784x508	NA
5	**Switchboard fixing**	Adequate for installation on steel platform	NA
6	**Electrical incoming Power supplies**		
(a)	**Class**	IV OL	1
	Quantity	1	
	Electrical data	3 Phases + N + PE, 400 (+10/-10%) Vac, 50 (± 1%) Hz	
	Power	As per main Appendix A.1	
Common IBED PRZ Heaters Control unit			
1	**I&C interfaces between PBS26 PCS - IBED PRZ Heaters Control unit**		
(a)	**Type**	Profinet Communication	7/COM1
	Media	Fiber Optic or Copper cable (TBD)	7/COM1
	Quantity	1	7/COM1
(b)	**Type**	Hardwired I&C signals transfer	8/I2
	Media	Hardwired point to point	8/I2
	Quantity	1 (amount of cables to be decided based on Input/Output list and signals type)	8/I2
2	**I&C interfaces between Field IBED PRZ - IBED PRZ Heaters Control unit**		6/I1
(a)	**Type**	To be defined by contractor	6/I1
	Media	To be defined by contractor	6/I1
	Quantity	To be defined by contractor	6/I1
3	**I&C interfaces between Field IBED PRZ - PBS48 Logic Solver**		9/I3
(a)	**Type**	Hardwired I&C signals transfer	9/I3
	Media	Hardwired point to point	9/I3
	Quantity	1 (amount of cables to be decided based on Input/Output list and signals type)	9/I3

(3) **Interface notes** applicable to **Field power JB**:

Item No.	Item Descripcion	Requirement	Drawing interface reference
FIELD POWER CONNECTION BOXES (JB)			
1	**Cable (s) access & terminals: quantity, size, type**	Adequate for the related designed incoming cables (Cable glands included in scope)	4/5
2	**Cable (s) access location**	Adequate for proper cables installation and connection	4/5
3	**Cable (s) termination location**	Adequate for proper cables installation and connection	4/5

Abbrevations:	**Scope definition**	**Lines:**
JB (I): Junction Box instrumentation JB (P): Junction Box power IC: Instrumentation and Control TR: Temperature Relay SWB: Switchboard HW logic: Hardwired logic	1 IBED PRZ system supplier scope 2 IO Scope	Power line SIC Power line Non SIC Instrumentation line SIC Instrumentation line Non SIC n Cable number