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Technical Specifications (In-Cash Procurement)

Technical Specification for Mechanical Engineering Services of TCWS EWP production

This Technical Specification specifies the scope of services for the mechanical and piping engineering support to be provided to IO Tokamak Cooling Water System Section in order to complete and update the design of the TCWS post FDR to reach Construction design maturity and more precisely for the EWP preparation.

Technical Specification

Technical Specification for the Engineering Services for to support TCWS for EWP production

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1 Purpose

This Technical Specification specifies the scope of services for the mechanical and piping engineering support to be provided to IO Tokamak Cooling Water System Section in order to complete and update the design of the TCWS post FDR to reach Construction design maturity and more precisely for the EWP preparation.

2 Background and Scope

2.1 The ITER Cooling Water System

The ITER Cooling Water System (CWS) is designed to control the main thermal hydraulic parameters of the systems (e.g. in-Vessel Components and Power Supplies) and to reject their heat loads to the environment when the plasma will be heated at 50 MW and the D-T fusion power heat will reach 500 MW with an amplification factor Q 10. In that condition, CWS shall remove a peak heat load of about 1150 MW.

The CWS is divided in main parts:

- Tokamak Cooling Water System – Primary closed circuits;
- Component Cooling Water System – Secondary closed circuits;
- Chilled Water System – Secondary closed circuits;
- Heat Rejection System – Tertiary open circuit.

The CWS main functions are to:

- Remove heat deposited in the in-vessel components, the vessel, additional heating systems, and diagnostics during the burn cycle.
- Maintain coolant temperatures, pressures, and flow rates to limit component temperatures and retain thermal margins during the operating campaign as required.
- Remove decay heat also during shutdown periods.
- Provide baking for the VV and the In-vessel components.
- Maintain water chemistry as required.
- Accommodate draining, and provide refilling and drying for maintenance periods.
- Provide confinement of radioactive inventories.
- Maintain radioactive inventory as required.
- Measure heat removed from the in-vessel components and vacuum vessel.
- Remove heat from components of plant auxiliary systems.
- Reject all the above heat to the environment.

The CWS (WBS 2.6) activity is divided in two in-kind procurement packages based on functional specifications as follows:

- 2.6.P1A_B.US.01.0 for TCWS assigned to US-DA.
- 2.6.P2A.IN.01.0 for CCWS, CHWS and HRS assigned to IN-DA.

IO is responsible for two other separate packages for the assembly of the CWS as follows:

- 2.6.P1C.IO for the TCWS Engineering, On-Site Assembly and Test.
- 2.6.P2B.IO for the CCWS, CHWS and HRS Engineering, On-Site Assembly and Test.

As the scope of this Contract is the primary circuit (TCWS), the other circuits are not mentioned in this technical specification.

2.2 Design status:

IO and USDA have already progressed in the final and Construction design of the TCWS. The IO has already completed the final design phase of the TCWS systems for both first plasma configuration (including captive components) and post first plasma configuration. The IO has the responsibility to bring the design to the level of Construction design, and it is the scope of this Contract. It is to be noted that part of the design has been already brought to the level of Construction design but it has to be updated in order to include changes impacting the layout or the input data of the design justification.

The IO will provide to the Contractor the piping stress analysis reports and models used for the previous qualification before the modification at the KoM, this will facilitate the Contractor to get familiar with the work to be performed and to set up the analysis models. In these models most of the key points have been defined as per current design status.

Concerning supports, the support are designed (layout available), and in some cases the final design of the previous configuration is available (structural report using enveloping\grouping of supports, and models). It does not include all details (e.g. beam joint, connections to interfaces) when the design was not brought to the level of Construction design. In any case it has to be adapted to the new configuration and justified by calculations. The design status of penetrations, specific equipment supports or platforms is at the same level as the one of piping supports. Consequently, IO considers very important that the tenderer takes into account that the design will be an update and completion and not a start from zero.

2.3 System Classifications

Each subsystem of the TCWS is assigned a Safety Importance Classification (SIC), Quality Classification (QC) and Seismic Classification (SC).

System	Safety Importance Classification	Quality Classification	Seismic Classification
IBED PHTS	SIC-1	QC-1	SC1 (S)*
VV PHTS	SIC-2	QC-1	SC1 (S)*
NBI PHTS	SIC-2	QC-1	SC1 (S)*
CVCS IBED	SIC-1	QC-1	SC1 (S)*

System	Safety Importance Classification	Quality Classification	Seismic Classification
CVCS NBI	SIC-2	QC-1	SC1 (S)*
DYS	SR	QC-2	SC1(S)*
DRS (including Vent Collection)	SIC-2	QC-1	SC1 (S)*

Table 1 – List of TCWS systems SIC, QC and SC classifications

*Active equipment that performs a Safety Function (i.e. Decay Heat Removal and pressure protection) is classified SC1 (SF).

Some components within the TCWS are exposed to vacuum conditions which necessitate additional design considerations. Descriptions of these classifications are noted in [51].

Vacuum Classification	Components
VQC-3A	• Process pipes
VQC-2A	• Guard pipes (for VV-PHTS, IBED-PHTS and VV safety draining)
VQC-2B	Supports for VQC-2A piping and components
VQC-1A	• In-vessel IBED Divertor Supply & Return Pipes • DR00 Safety Drain Lines up to 2[nd] Isolation Valve
VQC-1B	Supports for VQC-1A piping and components
VQC-N/A	All TCWS piping and components not exposed to vacuum • DR00Safety Drain Tanks • DR00 Vacuum Pump lines

Table 2: TCWS Vacuum Classifications

2.4 General scope of work

The final design of the TCWS piping systems has to be brought to the level of construction\execution design, in order to produce the EWPs. To fulfil this target, IO needs the support of a specialized Engineering Company to perform the following general tasks:

[1] Task 0: Water Hammer loads calculation – optional activity.
If this activity is activated, the activation will be done before the task 1, piping stress analysis. It is expected by the Contractor to perform an update of the calculation and to optimize the loads in order to reduce the impact on the piping network and associated components. So the iterations between water-hammer calculation/piping stress analysis/support calculations/EPs verification (or other activities performed in the Contract) are included in the contract. Each WP in task 0 is an option in the Contract and will be activated independently of others.

[2] Task 1: Piping stress analyses.
Piping stress analysis with CAESAR II ® Nuclear software according to ASME B31.3 Ed. 2010 (if the qualification is performed with a more recent version of the code, a justification shall be provided including comparison of the code versions, justification of meeting PED and ESPN regulation is mandatory in any cases) including verification of interfaces (e.g. nozzle allowable loads) and layout updates with the software AVEVA E3D.

[3] Task 2: Piping support design.
Piping supports selection and design with the software GT STRUDL ® according to ANSI/AISC N690 code. This task includes the design of the supports with the software AVEVA E3D in context (using the software CATIA) and the generation of construction drawings. As the building structures on ITER sites are already erected, the verification of Embedded Plates (or other supporting structures on which the piping supports are attached) are included in this phase, as well as the production of the list of loads at interfaces. The selection of the supports shall be done taking into account the context (layout/accessibility/radiological filed), notably reducing to the minimum extent (and duly justified) the use of supports requiring ISI and maintenance (e.g. snubbers).

[4] Task 3: EWP documentation – optional activity.
The production of GA drawings, isometrics and bill of materials for pre-fabrication and construction (assembly on-site\installation), as part of the EWPs, is included as an optional activity. Each WP in task 3 is an option in the Contract and will be activated independently of others.

[5] Task 4: Local thermo-hydraulic phenomena.
The purpose of this task is to provide solutions to the local thermo-hydraulic phenomena identified by IO on screening. The solutions consist in mitigation measures (e.g. thermal sleeve) and, when possible, on appropriate changes of the pipes routing and supports configuration, knowing that such changes have to be minimized. If this is not possible (due to functional or space constrains), the Contractor shall produce a detailed study to evaluate the structural effects due to such thermo-hydraulic issues. The iterations due to changes introduced in this task impacting other task of the Contract are in charge of the Contractor.

[6] Task 5: Piping supports thermal load cases – optional activity.
The piping supports of TCWS have been already designed for the systems to be installed for the first operation phase (first plasma) and for some captive (with regards to installation constraints) components. The mechanical justification was performed with the software GT STRUDL ® according to ANSI/AISC N690 code. This design justification was conducted without the implementation of the fire case (as defined in ref. [53]) in the analysis. For the LOCA IV (as defined in ref. [53] and [24]), the design justification was conducted including the material properties of the steel structures at the LOCA IV temperature but the stresses induced by the thermal expansion were not verified. Those two additional justifications have to be performed.

3 Definitions

3.1 Acronyms:

BoM	Bill of Materials
CCWS	Component Cooling Water System
CFD	Computational Fluid Dynamics
CHWS	Chilled Cooling Water System
CotS	Commercial of the Shelf
CMM	Configuration Management Model
CV	Curriculum Vitae
CVBD	Chemical and control volume system dedicated for IBED PHTS.
CVCS	Chemical and Volume Control System
CVNB	Chemical and control volume system dedicated for NBI PHTS
CWP	Construction Work Package
CWS	Cooling Water System
DCIF	Design Collaboration Implementation Form
DEGB	Double End Guillotine Break
DM	Detailed Model
DR	Draining system.

DY	Drying System.
EP	Embedded plate
EWP	Engineering Work Package
FEM	Finite Element Method
HEL	High Energy Line
HELB	High Energy Line Breakage
HRS	Heat Rejection System
IBED	Integrated Blanket / ELMs / Divertor
IBS	In – Bio Shield
IC	In - Cryostat
IO	Iter Organization
IN DA	India Domestic Agency
KoM	Kick off Meeting
LPC	Lower Pipe Chase
MTO	Material Take Off
NBI	Neutral Beam Injector
PHTS	Primary Heat Transfer System
PIA	Protection Important Activity
PIC	Protection Important Component
PNI	Part Number of ITER
QC	Quality Class
SA	Allowable displacement stress range (see ASME B31.3)
SE	Computer displacement stress range (see ASME B31.3)
SC	Seismic Class
SIC	Safety Important Class Component
SMDD	System for Management of Diagrams and Drawings
SR	Safety Relevant
SSE	Safe Shutdown Earthquake
TCWS	Tokamak Cooling Water System
UPC	Upper Pipe Chase
US DA	US Domestic Agency
V&V	Verification and Validation
VS	Vertical Shaft
VV	Vacuum Vessel
WBS	Work Breakdown Structure
WP	Work Package
WRC	Welding Research Council

For a complete list of ITER abbreviations see: ITER_D_2MU6W5 - ITER Abbreviations

3.2 Terminologies

"Contract" means the contract signed between IO and the entity in charge of performing all or part of the Services.

"Contractor" means the entity to which a Contract is awarded and which is responsible for performing all or part of the Services.

"External Contractor" is a Contractor as defined in article 1.3 of the Order 7th February 2012. In these specifications, "Contractor" is used in all the cases and have these meaning when the activities they perform are Protection Important Activities

"Services" means the engineering services and works to be performed by the Contractor under the Contract.

"Construction design" means that the level of detail is sufficient for procurement, manufacturing (or pre-assembly) and installation on ITER site of the Components of the system. No further design work is required after completion of this Construction design and the deliverables contain sufficient information to initiate the manufacturing and installation of pipelines, supports and other components included in the scope.

4 References

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 quality rules from the IO
- Standards and Rules whose application has not been made mandatory by a Ministerial decision

The Contractor will have to comply with all requirements defined by the IO and arising from the four above mentioned documents.

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

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

4.1 Applicable Regulations

[1] Order dated of the 7th February 2012 relating to the general technical regulations applicable to INB (7M2YKF)

[2] Conformity of the ITER-INB to the INB Order -7th February 2012-list of applicable documents-EN (JL2GBL)

[3] Act 2006-686 of 13 June 2006 on Transparency and Security in the Nuclear Field _ TSN Law (2ZQJVW) codified in the French "Environmental Code" also available on http://www.french-nuclear-safety.fr/.

[4] Decree 2007-1557 of 2nd November 2007 application decree of TSN law (2EXE3W)

[5] Decree No. 2012-1248 dated 9 November 2012 authorizing IO to create a basic nuclear facility called «ITER» (CZK7M5)

[6] ASN Decision 2013-DC-0379 dated 12 November 2013 establishing the requirements applicable to ITER Organization for the design and construction of the licensed nuclear facility INB No. 174 called ITER (MU6PP3)

[7] 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)

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

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

Note: The applicable regulations are not limited to those listed above.

4.2 Codes and Standards

[10] ASME B31.3-2010, "Process Piping"

[11] ASME B&PV Code, Section III, Division 1, Subsection NC, "Rules for Construction of Nuclear Facility Components, Class 2 Components," 2010 Edition including 2011 Addenda.

[12] ASME B&PV Code, Section III, Subsection NF "supports ", 2010 Edition.

[13] NRC Document, NUREG 1061, Volume 4, "Report of the U.S. Nuclear Regulatory Commission Piping Review Committee, Evaluation of Other Loads and Load Combinations," December 1984

[14] AISC 690/12 Specification for Safety – Related Still Structures for Nuclear Facilities.

[15] WRCB 448 (2000). Evaluation of welded attachments in pipe and elbows.

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

4.3 Nuclear Safety References

[17] ITER Procurement Quality Requirements, ITER_D_22MFG4

[18] List of ITER-INB Protections Important Activities, ITER_D_PSTTZL

[19] Preliminary Safety Report, ITER_D_3ZR2NC

[20] Project Requirements, ITER_D_27ZRW8

[21] Propagation of the Defined Requirements for Protection Important Components through the Chain of External Interveners, ITER_D_BG2GYB

[22] Protection Important Activities and Defined Requirements for all ITER Mechanical PIC Equipment, ITER_D_338G4B

[23] Procedure for management of Nonconformities, ITER_D_22F53X

[24] Safety Requirement Room Book, ITER_D_KF63PB

[25] Defined Requirement for PBS26, ITER_D_ M369M3

[26] Overall Surveillance Plan of External Interveners Chain for Protection Important Components, Structures and Systems and Protection Important Activities, ITER_D_4EUQFL

[27] Surveillance Plan for PBS 26 - Cooling Water System, ITER_D_CAJTAL

[28] Safety Important Functions and Components Classification Criteria and Methodology, ITER_D_347SF3

[29] Annex 2 - Detailed list of PIAs, ITER_D_Q8B5C4

[30] PBS 26 PIC Detailed list, ITER_D_JEB768

[31] Provisions for Implementation of the Generic Safety Requirements by the External Interveners, ITER_D_SBSTBM

4.4 General References

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

[32] ITER Abbreviations , ITER_D_2MU6W5,
[33] ITER Quality Assurance Program (QAP), ITER_D_22K4QX,
[34] Quality Management System Audits, ITER_D_2DQTA8,
[35] Requirements for Producing a Quality Plan ,ITER_D_22MFMW,
[36] Procedure for the management of Deviation Request , ITER_D_2LZJHB,
[37] IO / In-Cash Contractor Documentation Exchange and Storage Working Instruction, ITER_D_G8UMB3
[38] Procedure for ITER CAD Data Exchanges, ITER_D_2NCULZ
[39] Procedure for the Management of Diagrams and Drawings in pdf format using the SMDD Application, ITER_D_KFMK2B
[40] Procedure for the Usage of the ITER CAD Manual, ITER_D_2F6FTX
[41] Procedure for CAD Management Plan, ITER_D_2DWU2M
[42] General requirements for CAD activities for PA, TA and Contracts, ITER_D_TLAAJR
[43] Specification for CAD data Production in ITER direct contracts, ITER_D_P7Q3J7
[44] CAD Manual 07 – CAD Fact Sheet, ITER_D_249WUL
[45] AVEVA E3D-IO CAD Guide, ITER_D_TL7SMR
[46] Procedure for Analyses and Calculations, ITER_D_22MAL7
[47] Instructions for Structural Analyses, ITER_D_35BVV
[48] Template for Structural Analysis Reports, ITER_D_VQVTQW
[49] Quality Classification Determination, ITER_D_24VQES
[50] Software Qualification Policy, ITER_D_KTU8HH

4.5 IO Technical References

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

[51] System Design Description Document (DDD) of TCWS, ITER_D_94WLDK
[52] ITER Load Specifications, ITER_D_222QGL
[53] TCWS Load Specification, ITER_D_SZE5MR
[54] Codes and Standards for ITER Mechanical Components, ITER_D_25EW4K
[55] Allowable Values and Limits in Service Level C and D of ITER Mechanical Components, ITER_D_3G3SYJ
[56] ITER Seismic Nuclear Safety Approach, ITER_D_2DRVPE
[57] Guidelines for the Stress Analysis of TCWS Piping System, ITER_D_LYBRAM
[58] Guidelines for TCWS Piping support design, ITER_D_LZYV8D
[59] Generic Allowable Nozzle Loads for TCWS Static and Rotating Equipment, ITER_D_NA2TJ4
[60] TCWS pressure vessels ESPN classification & ESP categorization, ITER_D_XP4AFC
[61] Equipment Specification for piping materials used in the design of process piping systems, ITER_D_SJE6S7
[62] TCWS Pipe Wall Thickness Calculation, ITER_D_94HXVE
[63] ITER Vacuum Handbook, ITER_D_2EZ9UM
[64] Local Thermo-Hydraulic phenomena applicable for TCWS in regards to thermal fatigue, ITER_D_YQBAYV

[65] Calculation Book Tool Validation - Standard and Special Embedded Plates Interaction Diagram Check - ENG_04_QQ_0D0012_CW, ITER_D_4HMAAT
[66] Practical approach to secondary stresses within secondary support structures ITER_3DY5CQ

4.6 Drawings and P&IDs References:

Tokamak Complex GA drawings:
[67] 01-TKM complex : cover page, equipment arrangement drawings (TUA2BT v1.6)
[68] 02-TKM complex : level B2, equipment arrangement drawings (TSZN34 v1.7)
[69] 03-TKM complex : level B2M, equipment arrangement drawings (TU46WD v1.8)
[70] 04-TKM complex : level B1, equipment arrangement drawings (TU47N9 v1.7)
[71] 05-TKM complex : level L1, equipment arrangement drawings (TU482P v1.5)
[72] 06-TKM complex : level L2, equipment arrangement drawings (TU9XJR v1.4)
[73] 07-TKM complex : level L2 platform, equipment arrangement DRAWINGS (TU9Y48 v1.4)
[74] 08-TKM complex : level L3 equipment arrangement drawings (TU7BH7 v1.4)
[75] 09-TKM complex : level L3 platform, equipment arrangement DRAWINGS (TU7G9S v1.4)
[76] 10-TKM complex : level L4, equipment arrangement drawings (TU7GXP v1.6)
[77] 11-TKM complex : level L4 platform, equipment arrangement drawings (TU7S9F v1.5)
[78] 12-TKM complex : level L5, equipment arrangement drawings (U32HKV v1.4)
[79] 13-TKM complex : level L5 platform, equipment arrangement DRAWINGS (U3BJSP v1.5)
[80] 14-TKM complex : level R1, equipment arrangement drawings (VCXTD5 v1.2)
[81] 15-TKM complex : level R2, platform equipment arrangement drawings (VLK4EG v1.0)
[82] 16-TKM complex : level R2, equipment arrangement drawings (VE2JNF v1.1)
[83] 17-TKM complex :elevation N/S equipment arrangement drawings (VLKBNS v1.1)

TCWS P&IDs

[84] Piping and Instrumentation Diagram (P&ID) IBED Primary Heat Transfer System (SNJ3LL)
[85] Piping & Instrumentation Diagram (P&ID) of VV PHTS (SQ5QL7)
[86] TCWS NBI PHTS (PHNB) Piping & Instrumentation Diagram (XH2WUB)
[87] TCWS NBI CVCS (CVNB) Piping & Instrumentation Diagram (XJ36P5)
[88] TCWS IBED CVCS (CVBD) Piping & Instrumentation Diagram (XGXS95)
[89] Piping and Instrumentation Diagram (P&ID) for the Drying System (RCZE7F)
[90] Draining & Refilling System Piping & Instrumentation Diagram (SK63RS)
[91] TCWS Sampling System (SA) Piping & Instrumentation Diagrams (PF8GUB)

TCWS GAs drawings:
[92] GA_DWG TCWS inside Bioshield (T7DNZ6)
[93] GA DWG TCWS in Vertical Shafts (VJKUGF)
[94] GA DWG TCWS in Drain Tank Room (VMKKRF)
[95] GA DWG TCWS in 14-L4 (VJKQRL)
[96] GA DWG TCWS in 11-L4 (VMJRPT)
[97] GA DWG TCWS in 11-L3 (VMKKCM)
[98] GA DWG TCWS in 11-B2M (VMJTXG)
[99] CVBD and CVNB Second Plasma GA Drawing (2CYH8W)

[100] IBED PHTS Second Plasma GA Drawing (28GJQZ)
[101] NBI PHTS Second Plasma GA Drawing (2CYPM2)

<u>TCWS piping isometrics</u>

- VV PHTS

[102] Isometrics for TCWS VV PHTS 11-V08 (ITER_D_V5REVX)
[103] Isometrics for TCWS VV PHTS 11-V03 (ITER_D_VLEHF4)
[104] Isometrics for TCWS VV PHTS 11-L4-04 (ITER_D_VHFULH)
[105] Isometrics for TCWS VV PHTS 11-L3-03 (ITER_D_V55LZU)
[106] Isometrics for TCWS VV PHTS 11-L1-CNB (ITER_D_VHFMHV)
[107] Isometrics for TCWS VV PHTS 11-InterCryoBioUp (ITER_D_VV42G5)
[108] Isometrics for TCWS VV PHTS 11-InterCryoBioLow (ITER_D_VV3BZX)
[109] Isometrics for TCWS VV PHTS 11-CryoUp (ITER_D_VV3PJF)
[110] Isometrics for TCWS VV PHTS 11-CryoLow (ITER_D_VV34CX)
[111] Isometrics for TCWS VV PHTS 11-B2M-01 (ITER_D_V3N8K4)
[112] Isometrics for TCWS VV PHTS 11-B2-02N (ITER_D_VNY94K)
[113] Isometrics for TCWS VV PHTS 11-B2-01-DTR (ITER_D_VNYBA9)
[114] ISOMETRICS_26CCC1_11-B1-to-L4_FOR_VV_USDA (ITER_D_VV42PY)

- IBED PHTS

[115] ISOMETRICS for IBED PHTS Second Plasma FDR (ITER_D_28QSPH)
[116] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P18 (ITER_D_VV6MBN)
[117] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P17 (ITER_D_VV6L6C)
[118] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P16 (ITER_D_VV6K2J)
[119] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P15 (ITER_D_VV6AFA)
[120] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P14 (ITER_D_VV6G6F)
[121] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P13 (ITER_D_VV6DKY)
[122] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P12 (ITER_D_VV6BGK)
[123] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P11 (ITER_D_VV5GVG)
[124] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P10 (ITER_D_VV4LCP)
[125] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P09 (ITER_D_VCGGVS)
[126] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P08 (ITER_D_V8WQD6)
[127] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P07 (ITER_D_V5U53Y)
[128] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P06 (ITER_D_UYV73K)
[129] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P05 (ITER_D_UVGQ42)

[130] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P04 (ITER_D_UVFBZF)
[131] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P03 (ITER_D_UVF4HZ)
[132] ISOMETRICS FOR 26PHBD_IN-BIO-CRYO_UPPER-PIPES_P02 (ITER_D_UVF353)
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[134] ISOMETRICS FOR 26PHBD_11-L3-03W_SEC_11 (ITER_D_VV4S62)
[135] ISOMETRICS FOR 26PHBD_11-L3-03W_SEC_10 (ITER_D_VV5D7A)
[136] ISOMETRICS FOR 26PHBD_11-L3-03W_SEC_09 (ITER_D_VV33VX)
[137] ISOMETRICS FOR 26PHBD_11-L3-03W_SEC_08 (ITER_D_VV5HQJ)
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[147] ISOMETRICS FOR 26PHBD_11-L3-03E_SEC_17 (ITER_D_VV3PTT)
[148] ISOMETRICS FOR 26PHBD_11-L3-03E_SEC_16 (ITER_D_VV3U3G)
[149] ISOMETRICS FOR 26PHBD_11-L3-03E_SEC_03 (ITER_D_VV6DWA)
[150] ISOMETRICS FOR 26PHBD_11-L3-03E_SEC_02 (ITER_D_VV6HWB)
[151] ISOMETRICS FOR 26PHBD_11-L3-03E_SEC_01 (ITER_D_VV6PSX)
[152] ISOMETRICS FOR 26PHBD_11-L3-03E UPC (ITER_D_VV6Q2B)
[153] ISOMETRICS FOR 26PHBD_11-L3-03 BAKING (ITER_D_VV6PZG)
[154] ISOMETRICS FOR 26PHBD_11-L3-02E (ITER_D_TFJTTM)
[155] ISOMETRICS FOR 26PHBD_11-L2-V18 (ITER_D_VKYESE)
[156] ISOMETRICS FOR 26PHBD_11-L2-V17 EQUATORIAL (ITER_D_TFK498)
[157] ISOMETRICS FOR 26PHBD_11-L2-V17 (ITER_D_VNYKWD)
[158] ISOMETRICS FOR 26PHBD_11-L1-V18 (ITER_D_VSZXWN)
[159] ISOMETRICS FOR 26PHBD_11-L1-V17 (EQUATORIAL) (ITER_D_V3QRBC)
[160] ISOMETRICS FOR 26PHBD_11-L1-V17 (ITER_D_TFK4LW)
[161] ISOMETRICS FOR 26PHBD_11-L1-V16 (ITER_D_VV6QN5)
[162] ISOMETRICS FOR 26PHBD_11-L1-V08 (ITER_D_V3QYXC)
[163] ISOMETRICS FOR 26PHBD_11-INTERCRYOBIOLOW (ITER_D_VV3AJ4)
[164] ISOMETRICS FOR 26PHBD_11-CRYOLOW (ITER_D_VH7ZQ7)
[165] ISOMETRICS FOR 26PHBD_11-B2M-01 EQUATORIAL (ITER_D_V6AZGC)
[166] ISOMETRICS FOR 26PHBD_11-B2M-01 (DIVERTOR) (ITER_D_VV2ZGN)
[167] ISOMETRICS FOR 26PHBD_11-B1-V18 (ITER_D_VV72LK)
[168] ISOMETRICS FOR 26PHBD_11-B1-V17 (EQUATORIAL) (ITER_D_VG9V3P)
[169] ISOMETRICS FOR 26PHBD_11-B1-V17 (ITER_D_VT2LNQ)
[170] ISOMETRICS FOR 26PHBD_11-B1-V16_EQUATORIAL (ITER_D_VV72HH)
[171] ISOMETRICS FOR 26PHBD_11-B1-V16 (ITER_D_VV6W6T)
[172] ISOMETRICS FOR 26PHBD_11-B1-V15 _EQUATORIAL (ITER_D_VV6UU9)
[173] ISOMETRICS FOR 26PHBD_11-B1-V15 (ITER_D_VV6E9E)
[174] ISOMETRICS FOR 26PHBD_11-B1-V14 (ITER_D_VV722S)
[175] ISOMETRICS FOR 26PHBD_11-B1-V13_EQUATORIAL (ITER_D_VV6XPB)
[176] ISOMETRICS FOR 26PHBD_11-B1-V13 (ITER_D_VV6VG7)

[177] ISOMETRICS FOR 26PHBD_11-B1-V12 (ITER_D_VV6UGF)
[178] ISOMETRICS FOR 26PHBD_11-B1-V11 (ITER_D_VV6TEN)
[179] ISOMETRICS FOR 26PHBD_11-B1-V10 (ITER_D_VV6S5D)
[180] ISOMETRICS FOR 26PHBD_11-B1-V09_EQUATORIAL (ITER_D_VV6RDN)
[181] ISOMETRICS FOR 26PHBD_11-B1-V09 (ITER_D_VV6R65)
[182] ISOMETRICS FOR 26PHBD_11-B1-V08 _EQUATORIAL (ITER_D_VV6Q3T)
[183] ISOMETRICS FOR 26PHBD_11-B1-V08 (ITER_D_VV6GDU)
[184] ISOMETRICS FOR 26PHBD_11-B1-V07 _EQUATORIAL (ITER_D_VV6PAP)
[185] ISOMETRICS FOR 26PHBD_11-B1-V07 (ITER_D_VV6KPC)
[186] ISOMETRICS FOR 26PHBD_11-B1-V06 _EQUATORIAL (ITER_D_VV6JR5)
[187] ISOMETRICS FOR 26PHBD_11-B1-V06 (ITER_D_VV665E)
[188] ISOMETRICS FOR 26PHBD_11-B1-V05_BD_EQUATORIAL (ITER_D_VV5P9Y)
[189] ISOMETRICS FOR 26PHBD_11-B1-V05 (ITER_D_VMZU79)
[190] ISOMETRICS FOR 26PHBD_11-B1-V04_BD_EQUATORIAL (ITER_D_VMEZJU)
[191] ISOMETRICS FOR 26PHBD_11-B1-V04 (ITER_D_VLJ8PR)
[192] ISOMETRICS FOR 26PHBD_11-B1-V03_BD_EQUATORIAL (ITER_D_VLFSU2)
[193] ISOMETRICS FOR 26PHBD_11-B1-V03 (ITER_D_VK4JRH)
[194] ISOMETRICS FOR 26PHBD_11-B1-V02 (ITER_D_VJL8ND)
[195] ISOMETRICS FOR 26PHBD_11-B1-V01 _EQUATORIAL (ITER_D_VJKFQW)
[196] ISOMETRICS FOR 26PHBD_11-B1-V01 (ITER_D_VHBJA2)
[197] ISOMETRICS IBED PHTS 11_B1_PORT CELL (ITER_D_RBAMUP)

- NBI PHTS

[198] ISOMETRICS for NBI PHTS Second Plasma FDR (ITER_D_28QV3X)

- DRS

[199] ISOMETRICS_26DR00_14-L4-22_VENT (ITER_D_VV4EBM)
[200] ISOMETRICS_26DR00_11-VS-03_VENT (ITER_D_VESJG5)
[201] ISOMETRICS_26DR00_11-VS-03 (ITER_D_VESKDT)
[202] ISOMETRICS_26DR00_11-V2-V17-AND_V18 (ITER_D_VF5KFR)
[203] ISOMETRICS_26DR00_11-L4-04_VENT (ITER_D_VV3LUK)
[204] ISOMETRICS_26DR00_11-L4-04 (ITER_D_VV3MGM)
[205] ISOMETRICS_26DR00_11-L3-03_VENT (ITER_D_VV3UYK)
[206] ISOMETRICS_26DR00_11-L3-03 (ITER_D_VV3VRF)
[207] ISOMETRICS_26DR00_11-IN-BIO-CRYO (ITER_D_VNY4X9)
[208] ISOMETRICS_26DR00_11-CRYOLOW (ITER_D_VNYD35)
[209] ISOMETRICS_26DR00_11-B2-V5-V6-AND_V7 (ITER_D_VEXM3S)
[210] ISOMETRICS_26DR00_11-B2-to-L2-V03 (ITER_D_VV4CRF)
[211] ISOMETRICS_26DR00_11-B2-PIT (ITER_D_VNYDYW)
[212] ISOMETRICS_26DR00_11-B2M-01_VENT (ITER_D_VV42SA)
[213] ISOMETRICS_26DR00_11-B2M-01_SAFETY (ITER_D_VMFGNJ)
[214] ISOMETRICS_26DR00_11-B2M-01 (ITER_D_VV4BBU)
[215] ISOMETRICS_26DR00_11-B2-02N_VENT (ITER_D_VJKSP2)
[216] ISOMETRICS_26DR00_11-B2-02N (ITER_D_VJHPXN)
[217] ISOMETRICS_26DR00_11-B2-01_DTR_VENT (ITER_D_VLHHQM)
[218] ISOMETRICS_26DR00_11-B2-01_DTR (ITER_D_VLHDR4)
[219] ISOMETRICS_26DR00_11-B1-V5-V6-AND_V7 (ITER_D_VV4QMA)
[220] ISOMETRICS_26DR00_11-B1-V05-V06-V07-SAFETY (ITER_D_VNYKUA)
[221] ISOMETRICS_26DR00_11-B1-to-L2-V18_VENT (ITER_D_VV4JZZ)
[222] ISOMETRICS_26DR00_11-B1-to-L2-V17_VENT (ITER_D_VV4JDP)

[223] ISOMETRICS_26DR00_11-B1-to-L2-V03_VENT (ITER_D_VV4C4R)
[224] ISOMETRICS_26DR00_11-B1-to-L2-V02_VENT (ITER_D_VV4JVX)
[225] ISOMETRIC_26DR00_14-L3-23_VENT (ITER_D_VV4EUC)

- DYS

[226] ISOMETRICS_26DY00_14-L4-20-21-22 (ITER_D_VLEL7B)
[227] ISOMETRICS_26DY00_11-L4-04 (ITER_D_VKYCXH)
[228] ISOMETRICS_26DY00_11-L3 (ITER_D_VHM7NA)
[229] ISOMETRICS_26DY00_11-L2-V02 (ITER_D_VFYAX8)
[230] ISOMETRICS_26DY00_11-L1-V02 (ITER_D_VLFB84)
[231] ISOMETRICS_26DY00_11-B2M-01 (ITER_D_VET3U3)
[232] ISOMETRICS_26DY00_11-B1-V02 (ITER_D_VF5UM4)
[233] ISOMETRICS_26CCC1_14-L4-20-21-22_FOR_DY_USDA (ITER_D_VSXQTN)
[234] ISOMETRICS_26CCC1_11-L4-04_FOR_DY_USDA (ITER_D_VMEP5K)
[235] ISOMETRICS 26DY00 – CCWS-1A PART (ITER_D_37FDNM)

- CVCS for IBED PHTS

[236] ISOMETRICS for CVCS for IBED Second Plasma FDR (ITER_D_235HJ4)

- CVCS for NBI PHTS

[237] ISOMETRICS for CVCS for NBI Second Plasma FDR (ITER_D_235TKX)

- Sampling system

[238] Isometrics for TCWS Sampling System (ITER_D_UH822W)

<u>TCWS support drawings:</u>

- VV PHTS

[239] Collection of Support Drawings of VV PHTS process lines routed at level B2M (ITER_D_THUM2J)
[240] Collection of Support drawings for VV PHTS lines routed at Level 3 Upper Pipe Chase (UPC) and Vertical Shaft (VS) (ITER_D_THU9KF)
[241] Collection of Support Drawings for Vacuum Vessel PHTS in NB Cell (ITER_D_UDWEK6)
[242] Collection of Support Drawings for VV PHTS Process Lines at DTR Upper Level and Remaining Areas (ITER_D_THUWS9)
[243] Collection of Support Drawings of VV PHTS Process Lines Routed Inside Bio-shield (IBS) and Inside Cryostat (IC) from Lower Levels (ITER_D_THUAZK)
[244] Collection of Support Drawings for VV PHTS process lines routed to IBS and IC from Lower Levels (ITER_D_THULYR)
[245] Collection of Support Drawings for Vacuum Vessel PHTS Process Lines Routed In-Bioshield (IBS) and In-Cryostat (IC) From Upper Levels (ITER_D_THUGSM)

- IBED PHTS

[246] Collection of Support Drawings IBED PHTS process lines routed IBS and IC belonging to Equatorial ports (ITER_D_THU4P8)
[247] Collection of Support Drawings for IBED PHTS lines routed inside lower port and port cells belonging to Divertor Loops (ITER_D_Y5Y6WE)
[248] Collection of Support Drawings for IBED PHTS process lines belonging to FW/BLK Loop to Chimney (ITER_D_THUMPC)

[249] Collection of support drawings for IBED PHTS module at L3 sector 1 (ITER_D_UZ9VA5)
[250] Collection of support drawings for IBED PHTS Water Supply and Return, and CCWS-1 process lines (ITER_D_XBQVTR)
[251] Supports drawings for EWP B2M Area 1.1 in B11 – VS 18 (ITER_D_2Z3GUC)
[252] Supports drawings for EWP B2M Area 1.1 in B11 – VS 17 (ITER_D_2Z2YQA)
[253] Supports drawings for EWP B2M Area 1.1 in B11 – VS 16 (ITER_D_2Y5Z73)
[254] Supports drawings for EWP B2M Area 1.1 in B11 – VS 15 (ITER_D_2Y662K)
[255] Supports drawings for EWP B2M Area 1.1 in B11 – VS 14 (ITER_D_2ZCDVQ)
[256] Supports drawings for EWP B2M Area 1.1 in B11 – VS 13 (ITER_D_2Z3BEW)
[257] Supports drawings for EWP B2M Area 1.1 in B11 – VS 12 (ITER_D_2Y6SD5)
[258] Supports drawings for EWP B2M Area 1.1 in B11 – VS 11 (ITER_D_2RQ7NV)
[259] Supports drawings for EWP B2M Area 1.1 in B11 – VS 10 (ITER_D_2R7LB2)
[260] Supports drawings for EWP B2M Area 1.1 in B11 - VS 09 (ITER_D_2N5N8A)
[261] Supports drawings for EWP B2M Area 1.1 in B11 – VS 08 (ITER_D_2P2D57)
[262] Supports drawings for EWP B2M Area 1.1 in B11 – VS 07 (ITER_D_2Y6JB4)
[263] Supports drawings for EWP B2M Area 1.1 in B11 – VS 06 (ITER_D_2Y7D8P)
[264] Supports drawings for EWP B2M Area 1.1 in B11 – VS 05 (ITER_D_2Z3C72)
[265] Supports drawings for EWP B2M Area 1.1 in B11 – VS 04 (ITER_D_2Z3FMG)
[266] Supports drawings for EWP B2M Area 1.1 in B11 – VS 03 (ITER_D_2Y67TX)
[267] Supports drawings for EWP B2M Area 1.1 in B11 – VS 02 (ITER_D_2Y65ZH)
[268] Supports drawings for EWP B2M Area 1.1 in B11 – VS 01 (ITER_D_2Z3EP9)
[269] WP1.5 SUPPORT DRAWINGS FOR EWP VS TO L3 VS18 (ITER_D_3LZT7E)
[270] WP1.5 SUPPORT DRAWINGS FOR EWP VS TO L3 VS17 (ITER_D_3LZSCX)
[271] WP1.5 SUPPORT DRAWINGS FOR EWP VS TO L3 VS16 (ITER_D_3LZS9M)
[272] WP 1.5 Support Drawings for EWP VS to L3 VS 08 (ITER_D_3N4SCA)
[273] WP 1.5 SUPPORT DRAWINGS FOR EWP B2M (LPC) WEST SECTOR C08 AND C09 (ITER_D_4GFGC4)
[274] WP 1.5 SUPPORT DRAWINGS FOR EWP B2M (LPC) SOUTH WEST SECTOR C10 TO C13 (ITER_D_4MA8Q5)
[275] WP 1.5 SUPPORT DRAWINGS FOR EWP B2M (LPC) SOUTH SECTOR C14 (ITER_D_3PEN3M)
[276] WP 1.5 SUPPORT DRAWINGS FOR EWP B2M (LPC) SOUTH EAST SECTOR C15 TO C17 (ITER_D_3PEP6T)
[277] WP 1.5 SUPPORT DRAWINGS FOR EWP B2M (LPC) NORTH WEST SECTOR C06 AND C07 (ITER_D_4GEJL9)
[278] WP 1.5 SUPPORT DRAWINGS FOR EWP B2M (LPC) NORTH SECTOR C04 AND C05 (ITER_D_4G9Q9B)
[279] WP 1.5 SUPPORT DRAWINGS FOR EWP B2M (LPC) NORTH EAST SECTOR C01 TO C04 (ITER_D_49JDSX)
[280] WP 1.5 SUPPORT DRAWINGS FOR EWP B2M (LPC) EAST SECTOR C18 (ITER_D_3PHC4B)
[281] Collection of Support Drawings for IBED PHTS remaining process lines at L4 for FDR 2sd plasma. (236DVU)
[282] Collection of Support Drawings for IBED PHTS remaining process lines at L3 for FDR 2sd plasma (YURPX8)

- NBI PHTS

[283] Collection of Support Drawings for NBI PHTS for FDR 2sd plasma (253V65)

- DRS

[284] Collection of support drawings for draining system process lines at DTR and remaining areas (ITER_D_THUGV4)
[285] Collection of support drawings for safety draining system (ITER_D_WDW2X9)
[286] Collection of support drawings for Draining system process lines at Level 3 (UPC), B2M (LPC), VS, Tunnel to DTR and IC and IBS Included (ITER_D_THUEKR)

- DYS

[287] Collection of support drawings for drying system process lines at Level 3 (UPC), B2M (LPC), and VS (ITER_D_THUEW3)
[288] Collection of support drawings for drying system process lines at L4 and remaining areas part 1 (ITER_D_THU7G4)
[289] Collection of support drawings for drying system process lines at l4 and remaining areas part 2 (ITER_D_WLSEP5)

- CVCS for IBED PHTS

[290] Collection of Support Drawings for CVCS for IBED PHTS for FDR 2sd plasma. (ITER_D_27SMB8)

- CVCS for NBI PHTS

[291] Collection of Support Drawings for CVCS for NBI PHTS for FDR 2sd plasma. (ITER_D_27VHDJ)

4.7 TCWS Analysis\Calculations Reports References

<u>Piping stress analysis reports</u>

[292] Pipe Stress Analysis of IBED PHTS Baking Lines (ITER_D_YRVAWL)
[293] Pipe Stress Analysis of IBED PHTS Pressure relief Lines (ITER_D_YU3U2T)
[294] Pipe Stress Analysis of NBI PHTS (ITER_D_YRN9V9)
[295] Pipe Stress Analysis of CVCS for IBED PHTS (ITER_D_YRKG5P)
[296] Pipe Stress Analysis of CVCS for NBI PHTS (ITER_D_YQ3EGM)
[297] Pipe Stress Analysis reconciliation report of WP 1.6.1 IBED PHTS Water Supply lines with new HX for FDR 2nd plasma systems (ITER_D_YU3VXH)
[298] Pipe Stress Analysis reconciliation report of WP 1.6.2 IBED PHTS Water Return lines with new HX for FDR 2nd plasma systems (ITER_D_YUFKGP)
[299] Pipe Stress Analysis reconciliation report of WP 1.6.3 IBED PHTS CCWS-1 lines with new HX for FDR 2nd plasma systems (ITER_D_YUTCBC)
[300] WP 1.18 PIPING STRESS ANALYSIS REPORT FOR IBED PHTS MODULE LINES AT L3 Sector 1 D1.18.2 (ITER_D_UXLYBA)
[301] WP 1.12 IBED PHTS Piping stress analysis of process lines routed IBS and IC belonging to FW/BLK loops (ITER_D_THV7KT)
[302] WP 1.2 Piping Stress Analysis Report for VV-PHTS lines routed at Level 3 (UPC) and VS (ITER_D_THVAU9)
[303] WP 1.2 Piping Stress Analysis Report for VV-PHTS in NBI Cells lines (ITER_D_THVARK)
[304] D.1.9.2 Part 1: WP 1.9 “Piping Stress Analysis VV-PHTS process lines routed Inside Bio-shield (IBS) and Inside Cryostat (IC) from upper levels” (ITER_D_THVJDT)
[305] D.1.9.2 Part 2: WP 1.9 Piping Stress Analysis VV-PHTS process lines routed Inside Bio-shield (IBS) and Inside Cryostat (IC) from upper levels (ITER_D_THVSCD)
[306] D.1.9.2 Part 3: WP 1.9 Piping Stress Analysis VV-PHTS process lines routed Inside Bio-shield (IBS) and Inside Cryostat (IC) from upper levels (ITER_D_V8VXF3)

Support stress analysis reports
[307] Support Structural Analysis of IBED PHTS Baking and pressure relief lines (ITER_D_27FQZU)
[308] Support Structural Analysis of NBI PHTS (ITER_D_27FMT6)
[309] Support Structural Analysis of CVCS for IBED PHTS (ITER_D_YRKRRK)
[310] Support Structural Analysis of CVCS for NBI PHTS (ITER_D_26FUTW)
[311] D3.6.4 WP 1.6 Support Structural Report for IBED PHTS CCWS -1 and Water Supply and Return process lines (ITER_D_XCH6ZC)
[312] WP 1.18 SUPPORT STRUCTURAL ANALYSIS REPORT GROUPING FOR FDR D3.18.4 (ITER_D_UXMUYQ)
[313] WP 1.2 Support Structural analysis report for VV-PHTS lines routed at Level 3 (UPC) and VS (ITER_D_THVQUJ)
[314] WP 1.2 Support Structural analysis report for VV-PHTS in NBI Cells lines (ITER_D_THVDMD)
[315] W.P.1.9. SUPPORT STRUCTURAL ANALYSIS REPORT FOR VV PHTS process lines routed IBS and IC from upper levels (ITER_D_THVTSC)
[316] W.P.1.9. SUPPORT STRUCTURAL ANALYSIS REPORT for VV PHTS process lines routed IBS and IC from upper levels (ITER_D_THVTQF)

System sizing calculations
[317] ITER_D_PAVZLW - IBED PHTS System Sizing Calculation
[318] ITER_D_XF9LCC - TCWS NBI PHTS (PHNB) System Sizing Calculations
[319] ITER_D_WEP5KL - TCWS IBED CVCS (CVBD) Hydraulic Sizing Calculation
[320] ITER_D_UDKM38 - TCWS NBI CVCS (CVNB) Hydraulic Sizing Calculation

Water hammer screenings
[321] ITER_D_XJ8NBP - WP4.2.1 NBI PHTS. Screening of the water hammer and hydraulic load cases
[322] ITER_D_Y5X3FK - WP4.11.1 IBED CVCS Screening of the water hammer and hydraulic load cases
[323] ITER_D_Y5XF68 - WP4.12.1 NBI CVCS Screening of the water hammer and hydraulic load cases
[324] ITER_D_WUMC8Q - WP4.10 IBED PHTS. Screening of the water hammer and hydraulic load cases for L3 & L4

Water hammer reports
[325] ITER_D_X9AZZL - WP4.10 IBED PHTS. Output of the analysis
[326] ITER_D_XJ8VV9 - WP4.2 NBI PHTS- Output of the Analyses
[327] ITER_D_Y5XEMP - WP4.11.2/3 IBED CVCS Output of the analysis
[328] ITER_D_Y5XSJ3 - WP4.12.2/3 NBI CVCS Output of the analysis

4.8 Additional references:

[329] ITER_D_28QDBS - ITER Numbering System for Components and Parts
[330] ITER_D_ JKT5KN How to use the SMDD Application (System for the Management of Diagrams and Drawings)
[331] ITER_D_ WKRHM5 - BOM Template-piping discipline

[332] ITER_D_ YH3HJR - BOM Mechanical Discipline
[333] ITER_D_2ABW98 - Template for Construction Equipment Tagged Item List
[334] ITER_D_28NSHN - Template for Construction Lines Tagged Item List
[335] ITER_D_2CSXHN - Template for Construction Support Tagged Item List
[336] ITER_D_2AC3GV - Template for Construction Valve Tagged Item List
[337] ITER_D_2AC7MG - Template for Tagged Item List (5) Instrumentation List

5 Estimated duration

The duration of the engineering support services will be for approximately two years. The detailed schedule and scope is described in following paragraphs. The expected starting date of the Contract is by January 2021.

6 Tasks Description

6.1 Task 0: Water Hammer analyses

The task will be organized in Work Packages, the WP breakdown correspond to the different systems to be analyzed. The estimated amount of work is provided to Contractor via the P&IDs, the layout and the operation modes defined in the sizing calculations. At this stage those documents are provided for information only. This amount will be refined during the Contract execution depending on the design. However the Contractor shall not be entitled to claim for an extension of the time or additional cost for the completion of the related Work Package and Deliverables provided in the Technical Specifications for any such variation.

6.1.1 Subtask 0.1: Water Hammer analyses

Pressure waves are generated when equipment cause a fast change in the velocity of the flowing water. These pressure waves can have an impact on the structural design of the system. Some examples of possible events generating pressure waves are: valve opening, valve closing, pump start, pump trip, etc.

Water Hammer analysis have been already performed for the final design of the TCWS, but design changes have been implemented and they need to be updated. In addition an optimization of the loads is needed in order to improve the piping qualification and to optimize the design of the TCWS components. The existing WH analysis reports are available in ref. [321] to [328].

The Contractor shall perform a screening of water hammer possible scenarios and locations in the system. The screening shall also include other possible hydraulic loads as those ones caused by steam condensation in pressure relief tanks and by water slugs. Accidental cases as the sudden closure of valves pump shaft seizure or pressure wave propagation after a pipe break shall also be considered during the screening.

Then, for each selected case the output of the analysis shall be the time history of the force induced by the pressure shock wave along the pipes at each change in direction and terminal locations.

The software for the water hammer analyses involving single phase events shall be Impulse. For other possible hydraulic loads involving two phase water hammer, it is up to the Contractor to select and justify a proper tool to perform the analyses. The output of the analysis should be suitable to be an input to a piping stress analysis (task 1). Note that normal iterations performed during the stress analysis (piping and supports) to optimize the water hammer loads are considered part of the Contractor scope in task 1 and 2.

The IO will provide the following input data to the Contractor in order to perform the analysis:

- P&IDs of the concerned system,
- Sizing calculation of the of the concerned system,
- Layout (isometrics, general arrangement drawings and\or 3D models) of the concerned system,
- Components characteristics (valves types, valve closure times, pump type, etc.).
- Previous version of the WH analysis reports and related calculation files, if existing.

6.1.2 Deliverables for Task 0

The following deliverables have to be prepared by the Contractor for each WP:

- Input data record (report listing the input data received for the task – native file and PDF)
- Screening of the water hammer and hydraulic loads cases. Description of the geometry for the selected cases. Methodology, assumptions and input data;
- Output of the analysis with the water hammer time history (draft final report) and explanation of the obtained results;
- Final report incorporating outcomes of the technical discussion with IO.

6.2 Task 1: Piping Stress Analysis

The task will be organized in Work Packages, the WP breakdown is defined per system and areas respecting logical boundaries between mechanical analyses (anchor points or zone of influence) aiming at minimizing overlaps between analyses. This boundaries and the amount of work will be refined during the Contract execution depending following Contractor's proposals. However the Contractor shall not be entitled to claim for an extension of the time or additional cost for the completion of the related Work Package and Deliverables provided in the Technical Specifications for any such variation. It is to be notes that some WPs are included as optional activities in the contract, they are identified in section 8.

<u>Note:</u> Contractor shall use guidelines, references [57] and [58] for task 1 piping stress analysis and task3 support design. Nevertheless, it is in Contractor's responsibility to identify any deviations between the references [57] and [58], and design codes or standard industrial practice, and to provide corrections to the methodologies defined in references [57] and [58] to comply with design codes or standard industrial practice. This verification of the IO guidelines shall be done prior to any analysis, the Contractor shall provide evidence of his verification, propose corrections to the guidelines to the IO and implement in the analysis after IO approval.
During analysis and design, any deviations identified to the guidelines shall be identified and the related corrective actions shall be approved by the IO before implementation.

6.2.1 Subtask 1.1 Production of models, analysis and optimization

The purpose of the task is to provide static and dynamic piping stress analyses performed by CAESAR II ® Nuclear software for TCWS piping systems according to ASME B31.3 2010 Edition, ASME code cases, or by using FEA tools ® or equivalent methods (to be approved by IO). The activity shall follow the methodologies described in the guidelines document [57]. The loads and load cases to be analyzed are available in the load specification ref. [53].

The Contractor will be responsible for all load cases including thermal gradients, stratification, helium leak, relief valve blow down, water or steam hammer, pipe uplift, etc.

Furthermore, within this activity the Contractor shall propose re-routing or support configuration re-arrangement if needed (working with the plant context and without creating and interferences with other systems), aiming at reducing the stress level below that used by the relevant criterion keeping a margin of 20% minimum. If the stress level is not sufficiently reduced, the Contractor shall provide justification; this justification should be validated by the IO before the completion of the stress analysis activity. Note that normal iterations performed during the stress analysis procedure are considered part of the Contractor scope.

The subsystems requiring stress analysis are listed in section 8 (refer to section 7 for a description of the layout).

In order to have a better control of the different engineering analysis, each subsystem is further divided into different sub models constituting a single engineering analysis. The list of engineering analysis and their boundaries are gathered in the references [292] to [296].

IO will define discrete Work Packages that will include several engineering analysis, for which the Contractor will have to provide a deliverable package. The current content of these WP is described later in section 8. The analysis included in one WP can be grouped in one deliverable (e.g. piping stress analysis report) or divided in several based on the IO request.

The piping stress analysis have been already performed and the pipelines are qualified for the final design phase, but design changes have been implemented and impact the existing analysis. The piping stress analysis reports are available in references [292] to [296].The new layout has to be qualified in terms of code stress by the analyses included in this Contract. The IO can provide the stress analysis reports (and related calculations files) of the previous calculations based on the previous layout.

For each WP, IO will provide the following information:

- AVEVA E3D model incorporating location of supports (ATTA) as design models, from which the Contractor can extract neutral files (*.cii).
- 3D models integrated in context in CATIA V5 format or lighter format openable with CATIA V5 (3DXML, exe file, etc.).
- Boundaries definition (on P&IDs),
- Line list.
- Valves list (and drawings\datasheets if available).
- Piping specification.
- Insulation specification.
- P&IDs.
- Connected equipment GA drawings when available.
- Generic allowable nozzle loads, ref. [59] or if available, the actual allowable loads based on supplier’s data.
- Loads specifications, ref. [52].
- Details of the penetrations in order to include behavior in the model.
- List of EP’s and loads used for sizing.
- Previous version of piping stress analysis reports and related calculation files – not for all WPs or analysis.

It has to be noted that the ITER project is in construction phase and therefore, the support design and location is already fixed in most of the cases. In fact the building construction is already complete for the Tokamak Complex, where TCWS is located. Thus, the analyst has to take into account that any potential routing iteration or support modification to reduce stress levels or nozzle loads, has the limitation of the existing embedded plates or other types of interfaces with the building (e.g. platform). Post drilled anchorage\supports could be accepted in some (few) specific locations but the validation by the IO is mandatory for each case and should be provided before the analysis is performed by the Contractor.

Note: Embedded plates loads impose a constraint on the design, since their allowable load cannot be exceeded during final design. This verification is included in the Contract (task 2).

Note 2: During piping stress analysis the supports are considered rigid. This assumption has to be validated during task 2 support design, to do so the Contractor must perform a deflection check for each support location. This procedure is detailed in 6.3.2.

6.2.2 Subtask 1.2: Penetrations modelling

The TCWS piping for the different subsystems is routed through different areas in the Tokamak Complex for which the environmental conditions are different (e.g. penetrations through confinement zones such as penetrations from galleries to TCWS vault, from TCWS vault to cryostat, or from Tokamak to Tritium building). Therefore there is the need to provide special types of pipe penetrations through the walls penetrating such areas in order to mechanically separate different environments.

The design of some penetrations is already completed by the IO, in this case the needed information will be provided to the Contractor to perform the piping stress analysis. In some other cases the detailed design of the penetration is not yet completed, in such case the IO will provide to needed information on the penetration to the Contractor to perform the piping stress analysis.

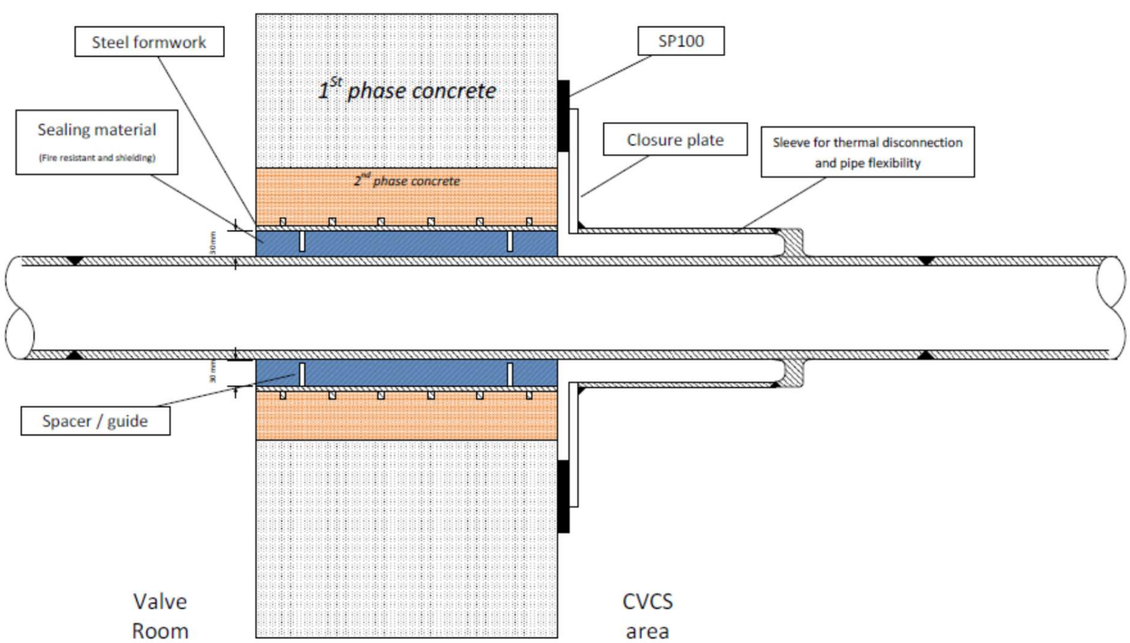

Figure 1: Example of penetration design

In any case the Contractor has responsibility to perform the piping stress analysis of pipelines in the penetrations, including the thermal sleeves, the “forged piece” (connection between thermal sleeve and pipelines) or any other transition component from the pipeline to the closure plate of the penetration. Therefore the Contractor must implement the required penetrations into the analysis models. The technical implementation of the penetration into the piping stress analysis models will be provided by the IO at KoM.

Note: Penetrations impose a constraint on the design, since their allowable loads cannot be exceeded during piping design. The iterations on the piping stress analysis in order to reduce the loads below the allowable limits of the penetrations are part of the Contract.

6.2.3 Subtask 1.3 Production of stress analysis reports

The purpose of the task is to prepare a report for each Work Package, containing at least:

- Description of the system studied.
- Assumptions, limits of applicability, calculation methods and acceptance criteria
- Input Data collected and confirmed by Contractor such as:
  - Coordinates System.
  - P&ID's.
  - 3D Models references and evidence of coherence with the model.
  - Piping Characteristics.
  - Process conditions, materials, insulation thickness and type.
  - Allowable stresses.
  - Code equations.
  - First tentative support location and restraint type.
  - In line elements characteristics.
  - Loading Specification (Individual loads and load cases, seismic spectra, etc.).
  - Other modelling details, like SIF's calculation, thermal displacements considered, etc.
  - Details of the node pattern, lumped mass, and valves models used for dynamic analysis and main parameters of the Caesar dynamic analysis (modal and spatial combinations method, static and dynamic combination method, static load case used for linearization, etc.).
- Output data of piping stress analyses:
  - Summary of code stress compliance.
  - Summary of the modifications performed on the initial configuration (configuration provided by the IO) implemented in order to qualify the piping.
  - Evidence of longitudinal stress check.
  - Summary of loads on supports.
  - Evidence of trust loads acceptability (to equipment, to penetrations, etc.).
  - Output listing from Caesar II and Input echo. (Annexed, not part of main report body).
  - Evidence of local stress check when applicable (welded attachments like trunnions, stanchions, lugs at support location, etc.).
  - Evaluation of valves accelerations and cross check against the manufacturer's qualification.
  - Evidence of flange analysis when applicable.
  - List of locations where SE>0,8SA and justifications (prior agreement with the IO required).
  - Integration analysis: confirmation that, due to displacements, pipes do not come in contact with other piping and structures available in the 3D models integrated in context during operation or other events.
- Piping Analysis checklist: Contractor shall develop such check list to sign by checker.
- Handmade calculations (if any).

6.2.4 Subtask 1.4 Implementation of modifications into 3D model

The purpose of this task is to update the piping routing or support design directly in 3D model (AVEVA E3D) following the potential modifications performed to qualify the systems. To support this activity IO will provide to Contractor the following files:

- 3D editable CAD model in AVEVA E3D including TCWS models (process lines and equipment) and a partial context (building and related interfaces such as EPs);
- 3D Non editable (no modifications allowed) CAD model in CATIA V5 or lighter format openable with CATIA V5 (3DXML, stp file, exe file, etc. – for information), showing the full context around the system.

Any modification to TCWS layout must respect the space available and must take into account the interferences with other systems and buildings, for that Contractor shall use the contextual models. The Contractor shall export from AVEVA E3D to CATIA the TCWS models to verify the integration in the context in simplified models (stp files) using AVEVA ITER specific functions, on a frequent basis. The Contractor must hold a fluent communication with the IO Responsible Officer to coordinate the strategies and interferences with other plant systems and users. The procedure for this communication will be established during KoM.

The Contractor can propose an alternative strategy to perform the design in AVEVA E3D that doesn't require the export of data from AVEVA E3D to CATIA. IO reserves the right to adopt\accept Contractors proposed strategy or to set the IO proposed one. Therefore Contractors must have the capacity to assume IO strategy.

IO does not expect many routing modifications in general due to the current maturity of the design and the tight space allocation for the system; however some adjustment may be required. For the modifications that may impact the interfaces with the buildings please refer to section 6.2.1, it is to be noted that the building interfaces are already frozen (the building construction is completed in most areas). Note that normal iterations performed during the stress analysis and related activities (support design, penetration design etc.) in charge of the Contractor, are considered part of the Contractor scope.

Concerning the supporting structures, at this stage, it is requested to the Contractor to demonstrate the feasibility by designing it in the 3D models and to verify the integration and in particular the interface for supports (e.g. EPs, platforms). The support design will be justified in the task 2.

6.2.5 Deliverables for Task 1

- Input data record (report listing the input data received for the task – native file and PDF)
- Caesar II models before analysis (native file and explanatory note in PDF)
- Caesar II models after final qualification (native file and explanatory note in PDF)
- Final reports on the stress analysis (native files and PDF)
- Standard components in AVEVA E3D models updated to include the modifications performed on the layout for the qualification of the piping systems, ready to be re-integrated in the AVEVA E3D IO platform.

6.3 Task 2: Piping Support Design

The task will be organized in Work Packages, following the WP breakdown of the piping stress analysis. The deliveries of the supports can be broken down in different batches following construction priorities, in this case sub-WP will be introduced. The estimated amount of supports is provided for information only (in the GA drawings and existing support drawings). This amount will be refined during the Contract execution depending on the design performed by the Contractor. However the Contractor shall not be entitled to claim for an extension of the time or additional cost for the completion of the related Work Package and Deliverables provided in the Technical Specifications for any such variation. It is to be notes that some WPs are included as optional activities in the contract, they are identified in section 8.

Note: Contractor shall use guidelines, references [57] and [58] for task 1 piping stress analysis and task3 support design. Nevertheless, it is in Contractor's responsibility to identify any deviations between the references [57] and [58], and design codes or standard industrial practice, and to provide corrections to the methodologies defined in references [57] and [58] to comply with design codes or standard industrial practice. This verification of the IO guidelines shall be done prior to any analysis, the Contractor shall provide evidence of his verification, propose corrections to the guidelines to the IO and implement in the analysis after IO approval.
During analysis and design, any deviations identified to the guidelines shall be identified and the related corrective actions shall be approved by the IO before implementation.

6.3.1 Subtask 2.1 3D Design of supports and CotS hardware selection

The purpose of this task is to provide piping supports design according to the available space, the design included in IO 3D model and restraint type and loads obtained from the stress analysis calculation (Task 2). The Contractor must use commercial type supports from the manufacturer's catalogues (manufacturer already selected by the IO) and standard beam shapes (manufacturer already selected by the IO) for the associated secondary structures aiming at overall standardization (Contractor shall minimize the types of supports used). Commercial Supports selection and design of secondary structures must be implemented in the 3D editable model (AVEVA E3D) which will be provided by IO, following the IO CAD manuals and guidelines. Note that normal iterations performed during the stress analysis and support calculation procedures are considered part of the Contractor scope.

The subsystems requiring stress analysis are listed in section 8 (refer to section 7 for a description of the layout).

The support design must respect the space available and the supporting strategy established by IO and must take into account the interferences with other systems and buildings, for that IO will provide CATIA 3D models (or lighter format for example 3DXML or stp files or 3DVIA for information) with the all plant integrated systems and buildings (no modifications are allowed on the context models). The 3D editable models in AVEVA E3D will only include TCWS and a partial context (building and related interfaces such as EPs); however the Contractor will be able to export from AVEVA E3D to CATIA the piping and supports models to verify the integration in the context using simplified models (stp files) using AVEVA ITER specific functions, on a frequent basis. The Contractor must hold a fluent communication with the IO Responsible Officer to coordinate the strategies and interferences with other plant systems and users. The procedure for this communication will be established during KoM.

The Contractor can propose an alternative strategy to perform the design in AVEVA E3D that doesn't require the export of data from AVEVA E3D to CATIA. IO reserves the right to adopt\accept Contractors proposed strategy or to set the IO proposed one. Therefore Contractor must have the capacity to assume IO strategy.

For the modifications that may impact the interfaces with the buildings please refer to section 6.2.1, it is to be noted that the building interfaces are already frozen (the building construction is completed in most areas). Therefore the Contractor must use the existing interfaces with the building to support the piping systems, and it is very unlikely that there is no possibility of using existing EPs (or other types of interfaces) or there's no EP (or other type of interfaces) available, in that case the supplier must propose alternatives, following the sequence defined hereafter:

1. Layout adaptation: change the layout to find another piping routing having sufficient EPs.
2. Attach to a non-used EP. Some EPs are not used and therefore could be re-allocated to TCWS if needed.
3. Post drilled EP: propose to add an EP with post drilled anchors, reserved for pipes bellow DN50 (small bore pipe). This is applicable only in some (few) specific areas (the identification of the areas where post drilling is allowed will be provided to the Contractor),
4. Swapping of EP: propose to exchange an EP allocated to TCWS by an EP allocated to another system,
5. Shared EP between 2 systems: propose to use an EP allocated to another system (even though the system uses it),
6. Shared\common support: propose to share the existing supporting structure with another system (support design to be done taking into account the frames and loads needed for the other system),

Before launching this procedure of alternative solutions the Contractor has to inform the IO of the issue faced and, in a second stage communicate to IO responsible person the proposed solution in order to obtain the validation before moving forward with the calculations.

The Supplier must be especially careful with this topic, since the building construction is completed and most of the interfaces are fixed. The EP's (and other types of interfaces) have been sized according to preliminary calculations. The maximum allowable loads of the interfaces will be provided by IO, as well as the methodology to verify the interfaces which is in the full responsibility of the Contractor, including the iteration on the support design to ensure that the capacity of the EPs (or other types of interfaces) are not exceeded.

This deliverable can be combined with the update of the AVEVA E3D models following piping stress analysis (task 1) completion.

Normal iterations performed during the stress analysis and related activities (support design, penetration design etc.) in charge of the Contractor, are considered part of the Contractor scope.

Note 1: For liquid pipes, High Energy Line Breaks are postulated for circuits with pipes at pressure higher than 20 bar (abs) or at a temperature higher than 100°C. Indeed components at High energy could lead a pipe whip effect following a guillotine break. The motion of the pipe may impact neighbouring component and so, PIC and related functions could be challenged like a consequence of the first event. The TCWS piping and other piping systems of the ITER plant are categorized as high energy lines. Therefore, HELB shall be taken into account for the TCWS piping lines and related supports included in this contract. The consequences on the TCWS components in specific locations included in this contract are the following:

- In TCWS piping lines are identified as a target for HELB of other systems. In this case the pipelines have to be protected against the other systems. The contractor shall implement protection devices such as "cages" (made of standard beams) around the TCWS pipelines facing the source of the HELB. The design of those cages has to be integrated with the support design object of this task. The IO will provide to the contractor the input data (e.g. location of the impact of the pipe whip with the loads and/or velocity to be considered) to size the "cages".
- The TCWS piping lines are identified as aggressors for other PIC. In this case, one potential effect is pipe whip and the contractor shall implement pipe whip restraints around TCWS pipelines. Those anti pipe whip restraints have to be integrated with the support design object of this task.

For both scenarios, the IO will provide to the contractor the list of the locations where cages or pipe whip restraints have to be implemented, knowing that it represent a small fraction of the overall system included in the contract.

Note 2: The numbering system in ref. [329] shall be used to define the identifiers for components and parts in the ITER project, and thus rigorously ensuring the traceability of each item throughout the ITER Project life cycle. The contractor has to follow his procedure for any component identification.

6.3.2 Subtask 2.2 Structural analysis of designed support

The purpose of this task is to provide structural analysis by using GT STRUDL developed by INTERGRAPH, according to AISC 690 - 2012 or ASME Section III, NF – 2013 for nuclear class supports and AISC 360 – 2010 for Non – nuclear class. This process has a certain degree of iteration with the previous one; the supplier will be responsible of updating the 3D model in AVEVA E3D software with the appropriate shapes, sizes, stiffeners, plates, etc., once the calculation is finished. The proper integration of the supports shall be checked as well using the contextual models provided by IO as already defined in section 6.3.1. This subtask includes the structural analysis of the "cages" and pipe whip restraints for HELB defined in section 6.3.1.

Within this task, the Contractor must also size, qualify and design the welds following the AWS applicable code.

The analysis of welded attachments to pipe pressure boundary (Lugs or similar) shall be performed by the piping stress analysis team, consequently, the support designer must communicate to both the concerned pipe stress engineer and IO the size and location of this attachments, that have to be checked and updated.

The loads and loads combinations to be used shall be in accordance with reference [52].

Note: In order to validate the assumption on the stiffness of the support used task 1 piping stress analysis, the Contractor must perform a deflection check for each support location. If the deflection is larger than the maximum value the supplier must consider the stiffness of the concerned secondary structures in the piping stress analysis. It then create a required iteration between task 1 and 2. This iteration is classified as normal iteration performed during the stress analysis and related activities and it is part of the Contractor scope.

The deflections limits are fixed to:

- Level A/B maximum deflection < 1.6 mm
- Level C/D maximum deflection < 4.0 mm
- Minimum stiffness > 200 EI/L3

The Contractor can propose to analyse the support creating envelope cases or families if it can be justified. This approach has to be validated case by case by the IO, the Contractor will have to provide to the IO the proposal of support families before proceeding with the calculations for approval. When grouping the support per families the Contractor shall ensure that the grouping do not result with excessive oversizing of the supports.

6.3.3 Subtask 2.3 Technical report on the support calculation

The purpose of this task is to prepare technical report for each TCWS Work Package. Each report must show evidence of:

- List of Supports concerned
- Assumptions, limits of applicability, calculation methods and acceptance criteria.
- Input Data
  - Coordinate system.
  - Geometry of the support.
  - Design Code applied.
  - Actions, Loads & Load Combinations.
  - Allowable Stresses or Design Stresses
  - Welds to be calculated
- Output of the analysis:
  - Summary of maximum stresses and code compliance.
  - Displacements and deflections at critical points.
  - Stiffness of the secondary structure seen by the contact point of the pipe support.
  - Print out of the model with the color scales representing stresses and deflections.
  - Welds qualification.
  - Input Echo.
  - Load transmitted to Embedded Plates (EPs) or other type of building interfaces, included in the report in a specific table (Excel format that will be provided by the IO).
  - Verification of the EPs.
- Handmade calculations discussion (if any).

6.3.4 Subtask 2.4 Production of Support Drawings

The purpose of this task is to produce a detailed drawing of each support which must contain at least the following information:

- General 3D view (isometric view).
- All dimensions and coordinates needed for fabrication and installation.
- Elevation, top and side views.
- Bill of material with parts names for commercial supports.
- Bill of material for secondary structure.
- Welds details.
- Integrally welded attachments to pipe. (Lugs, etc.).
- Sliding plates details when applicable.
- Support loads at different load cases (at least: sustained case, operating case, earthquake SSE case, whipping case if applicable and the maximum/minimum load in each direction for each Service Level).
- Support displacements for all translation degrees of freedom and for the previous mentioned load cases.
- Support TAG, location (in line and coordinates) and line temperature.
- Reinforcing pads or stiffening plates when applicable.

The Contractor shall produce also a complete list of supports with TAG, location, restraint type and associated drawing name.

For secondary structures shared among several pipe supports, only one of the drawings must show the full design and BoM of the secondary structure, while the rest of pipe supports drawings will only show the primary attachment (pipe show, hanger, strut, etc.) and associated BoM, being the secondary structure shown dashed and with the appropriated reference to the drawing in which it is displayed.

6.3.5 Subtask 2.5 Completion of BoM and List of supports

The purpose of this task is to produce for each Work Package, a complete and exhaustive Bill of Material, by listing separately the commercial supports and the secondary structure. The Bill of material corresponding to commercial supports must include real Items from manufacturer's fabrication program (the supplier has already been selected). The list of supports shall identify the report where the support is calculated, the drawing(s) related and the computer file where the model is included, as well as tag and line to which it belongs. In addition an overall list of items (one for primary supports and one for secondary shall be maintained by Contractor and deliver to the IO).

6.3.6 Deliverables for Task 2

- AVEVA E3D models updated with the proposed support configuration in order to obtain the validation of the IO before proceeding with the calculations.
- Structural calculation software models before calculation (not for each single support but per family\group\type of support).
- Reports on the structural calculation and related structural calculation software models after supports qualification.
- AVEVA E3D models updated with the qualified supports (several updates of the design models should be sent to IO in order to monitor the progresses, frequency of exchange to be set for each WP).
- Final supports drawings (including a BoM on each sheet).
- Bill of materials (per support and MTO), support list, overall BoM updated.

All the native files used by the Contractor shall be delivered to the IO in attachment of the related deliverable in IDM.

6.4 Task 3: Optional task for the construction documentation (for EWPs)

The construction documentation consists in drawings, isometrics and bill of materials produced for pre-fabrication and construction (assembly on-site\installation), and it is included as an optional activity. If this activity is activated, the activity will start after the task 3 completion in order to ensure that the construction drawings are issued after the design verification.

The task will be organized following the Engineering Work Packages (EWP), which is a different organization of the WP breakdown included the previous tasks, the detailed breakdown is provided in section 8. The estimated amount of drawing sheet for each WP is provided for in appendix A. This amount will be refined during the Contract execution depending on the design performed by the Contractor. However the Contractor shall not be entitled to claim for an extension of the time or additional cost for the completion of the related Work Package and Deliverables provided in the Technical Specifications for any such variation.

6.4.1 Subtask 3.1: Production of GA drawings

The supplier will update the general arrangement drawings available in reference [92] to [101] following the activities performed in task 2 and 3. In addition it is expected that the GA drawings produced by the Contractor reach the maturity required to launch pre-fabrication and construction of the components.

The following items shall be present on the GA drawings:

- The building structures (or any other relevant structure were the TCWS components are supported, e.g. cryostat, VV).
- Identification of the building structures (buildings, level, room), and interfaces.
- All TCWS components located in the area bounded by the concerned WP.
- Identification of all TCWS components (tags) including pipelines, thermal insulation, supports, valves, instrumentations, equipment etc.
- Identification of EPs and penetrations related to TCWS systems
- All TCWS clients located in the area bounded by the concerned WP
- Identification of the client of the TCWS systems (tags)
- The color code used in existing drawings should be kept
- A top view of the whole area bounded by the concerned WP, or several is one is not sufficient to include all the information
- Section views and isometric views in order to describe exhaustively the layout of the TCWS components
- References to specifications and detail drawings
- References to the calculation reports
- List of components
- Dimensions
- Scale(s)

6.4.2 Subtask 3.2: Production of Piping Isometrics

The supplier will update the piping isometrics available in reference [102] to [238] following the activities performed in task 2 and 3. In addition it is expected that the piping isometrics produced by the Contractor reach the maturity required to launch pre-fabrication and construction of the components.

The following items shall be present on the Isometrics:

- Identification of the location (buildings, level, room, and coordinates)
- The TCWS pipe related to this piping isometric
- Identification of the TCWS pipeline (tag)
- Identification of all components belonging to this pipeline
- Identification of the supports on this pipeline
- Identification of the flow direction, from and to
- Fabrication (pre-assembly) and construction related information (shop welds, site welds, type of welds, etc.)
- Identification of penetrations
- References to specifications , support drawings and GA drawing
- Reference to the calculation report (stress analysis and support design)
- BoM of the pipes, fittings, valves, supports, instrumentation, etc.
- Dimensions

- Design conditions and classes
- Scale(s)

6.4.3 Subtask 3.3 Production of Support Drawings

This sub task is included only in the case the components in the WP for construction documentation are not covered in task 2 of the present specification. Otherwise the support drawings are included in task 2 and this subtask is not due by the Contractor. The purpose of this task is to produce a detailed drawing of each support which must contain at least the following information:

- General 3D view (isometric view).
- All dimensions and coordinates needed for fabrication and installation.
- Elevation, top and side views.
- Bill of material with parts names for commercial supports.
- Bill of material for secondary structure.
- Welds details.
- Integrally welded attachments to pipe. (Lugs, etc).
- Sliding plates details when applicable.
- Support loads at different load cases (at least: sustained case, operating case, earthquake SSE case, whipping case if applicable and the maximum/minimum load in each direction for each Service Level).
- Support displacements for all translation degrees of freedom and for the previous mentioned load cases.
- Support TAG, location (in line and coordinates) and line temperature.
- Reinforcing pads or stiffening plates when applicable.

For secondary structures shared among several pipe supports, only one of the drawings must show the full design and BoM of the secondary structure, while the rest of pipe supports drawings will only show the primary attachment (pipe show, hanger, strut, etc.) and associated BoM, being the secondary structure shown dashed and with the appropriated reference to the drawing in which it is displayed.

6.4.4 Subtask 3.4: Production of BoMs

The supplier will provide BoMs for the equipment, for piping and fittings, for the instrumentation, for the valves, for the piping supports and for the secondary structures related to the supports, and the line list. In addition it is expected that the BoMs produced by the Contractor are ready for pre-fabrication\installation. The templates are provide to the contractor with examples in separate files. Those template can be refined during the Contract execution depending on the needs for pre-fabrication\installation. However the Contractor shall not be entitled to claim for an extension of the time or additional cost for the completion of the related Work Package and Deliverables provided in the Technical Specifications for any such variation.

Note: BoMs shall be issued following the references [331], [332], [333], [334], [335], [336], and [337]. Those templates have to be followed by the contractor and are made available in the design software (AVEVA E3D) by the IO to the contractor within the AVEVA ITER environment. In case of evolution of those templates, the Contractor will have to use the latest version and the Contractor shall not be entitled to claim for an extension of the time or additional cost for the completion of the related Work Package and Deliverables.

6.4.5 Deliverables for Task 3

- GA Drawings produce with AVEVA E3D (and updated if necessary with another software such as AUTOCAD)
- Piping support drawings produce with AVEVA E3D (and updated if necessary with another software such as AUTOCAD)
- Piping isometrics drawings produce with AVEVA E3D (and updated if necessary with another software such as AUTOCAD)
- BoMs

All the native files used by the Contractor shall be delivered to the IO in attachment of the related deliverable in IDM.

Note: The drawing and BoM templates required to be followed by the Contractor includes the PNI for each components, PNI are mandatory information on drawings and BoMs. The PNI will be made available by the IO to the Contractor.

6.5 Task 4: Local thermo-hydraulic phenomena

The local thermo-hydraulic phenomena can cause cracks, thermal fatigue, unexpected piping deformation and pipe support damage. IO performed a screening of the local thermo-hydraulic phenomena including thermal stratification, dead zones and mixing zones according to the operation of each TCWS sub-system (see ref. [64]). The purpose of this subtask is to consider this screening and provide a solution to the local thermo-hydraulic phenomena based on possible mitigation measures (e.g. thermal sleeve) and, when possible, on appropriate changes of the pipes routing and supports configuration. If this is not possible (due to functional or space constrains), the Contractor shall produce a detailed study to evaluate the structural effects due to such thermo-hydraulic issues. The Contractor can follow the procedure below or propose a different approach based on their experience, which has to be agreed by IO.

The task will be organized in Work Packages, the WP breakdown correspond to the different systems to be analyzed. The work could be further divided in different batches following construction priorities (e.g. per area), in this case sub-WP will be introduced. The estimated amount of work is provided to Contractor via the screenings. At this stage those documents are provided for information only. This amount will be refined during the Contract execution depending on the design. However the Contractor shall not be entitled to claim for an extension of the time or additional cost for the completion of the related Work Package and Deliverables provided in the Technical Specifications for any such variation.

6.5.1 Subtask 4.1 Evaluation of fatigue effects.

The purpose of this subtask is to evaluate the fatigue effects produced by the local thermo-hydraulic phenomena identified by IO.

The Contractor shall propose a methodology based on his experience for such analysis. It is expected to perform an analysis in three steps:

a) CFD analysis to determine the thermal profile of the affected lines;
b) Fatigue Stress analysis by FEM based on the results of previous step and on the operation of the system. In this case, the use of ASME III or other nuclear code with specific calculation model (analytical formula) is also acceptable;
c) Evaluation of the stress results according to ASME B31.3 code and definition of mitigating measures (rerouting, supports configuration, etc.).

As mentioned above, before to proceed with the detailed CFD analysis reported in step a), the Contractor shall evaluate the possibility of implementing mitigations measures (including but not limited to the mitigations measures proposed in ref. [64]) or, when possible, changes of the pipes routing and supports configuration able to solve the local thermo-hydraulic issue. In case this is not feasible, the analysis in three steps described above shall be followed.

6.5.2 Subtask 4.2 Report on the local thermo-hydraulic phenomena

Contractor shall prepare a final report for this task in which gathers the work done to solve the local thermo-hydraulic issues and, in case, the subsequent analyses. The report should contain at least the following information:

- Initial engineering evaluation of possible measures to solve the issue without performing detailed analysis.
- Assumptions, limits of applicability, calculation methods and acceptance criteria.
- Discussion on the input data
  - 3D Layout and material properties
  - Process conditions, description of the operational parameters.
  - Support type and location
  - Description of FEM and CFD models: type (axisymmetric, thermal, static...), solve (linear, nonlinear…), materials, element types, element properties (real constants, sections), FE Mesh (orientation, duplication, density, and shape), units, rigid elements, couple eqs (translations or rotations free).
  - Boundary conditions of FEM model: displacements constraints (fixed, imposed…), contacts, gaps, symmetries.
  - Loading conditions: gravity, forces, pressure, heat transfer, seismic spectrum, modes, loads combinations, etc.
  - Detailed print outs of the meshed bodies / surfaces.
  - Physical model discussion for CFD.
- Discussion on the results: View of deformed shape, view of displacements, verification of reaction forces, view of stresses distribution, irregular stress concentrations, view strain, messages warnings discussions, allowable stresses with respect to code, view of fluid temperature maps and its evolution, view of velocities, discussion on the interaction fluid structure.
- Discussion on the CFD models about the thermo-hydraulic issues;
- Discussion on the FEM models and stress / fatigue issues;
- Final solution implemented to mitigate the previous issues.

Note: In the case of implementation of mitigation measured (such as thermal sleeve), the contractor shall perform the sizing of this devices in order to ensure the feasibility of the mitigation. The contractor shall bring the design of such components to the level of final design, which means the IO can proceed with the procurement of the components without any additional engineering activities.

6.5.3 Subtask 4.3 Implementation of mitigating measures in E3D and transfer of loads for lines / supports final qualification.

For the TCWS subsystems included in the task 1 and 2 of the present specification, the mitigation solutions for the local thermo-hydraulic phenomena shall be implemented in the 3D model and the new loads or routing shall be transmitted to the concerned team (support design / stress analysis) in order to update and qualify the systems affected consequently. The scope of this task includes the issuance of a new updated version of the stress report for piping and supports and new support drawings in case of modifications performed in lines already qualified.

For the TCWS systems not included on the scope of task 1 and 2 of the present specification, the implementation of the mitigation solutions for the local thermo-hydraulic phenomena will be performed by the IO. For the layout\3D models, the Contractor shall request the approval of each solutions to the IO before the approval of the final report. In the same the impact on the piping and support calculations will be checked by the IO and the Contractor shall wait for the approval of the IO before submitting the final report. The maximum time for the IO to provide this feedbacks is set to 3 weeks. Iterations performed in case the solution cannot be implemented are considered part of the Contractor scope.

Note: the iterations performed on the stress analysis and related activities (support design, penetration design etc.) due to the implementation of the mitigation solutions for the local thermos-hydraulic phenomena are charge of the Contractor, are considered part of the Contractor scope.

6.5.4 Deliverables for Task 4

- Record of input data and design information provided by IO.
- Short report on the mitigation measures able to solve the local thermo-hydraulic issues without performing detailed analysis (First issue of final report).
- Final report on the studied lines.
- Computer model for CFD analysis.
- Computer model for fatigue analysis.
- AVEVA PDMS models update.
- Stress reports for Pipes and supports, along with support drawings if required for already qualified lines and supports.

6.6 Task 5: Optional task for piping supports thermal load cases

The task will be organized in Work Packages, grouping piping supports which are part of the same construction package. The deliveries of the WPs can be broken down in different batches following construction priorities, in this case sub-WP will be introduced. The estimated amount of supports is provided for information only (in the GA drawings, existing support drawings and in the layout). This amount will be refined during the Contract execution depending on the design evolutions, however the variations between quantities defined at this stage and for contract execution are supposed to be less than 5%. The Contractor shall not be entitled to claim for an extension of the time or additional cost for the completion of the related Work Package and Deliverables provided in the Technical Specifications for any such variation. It is to be noted that all WPs of task 5 are included as options in the contract and each WP can be activated independently, they are identified in section 8.

6.6.1 Subtask 5.1 Production of models and analysis

The purpose of this task is to perform the additional verification on the piping supports for which the design justification has been completed. Those additional verifications aim at demonstrating that the current design is valid without introducing any modifications. Indeed the piping supports of TCWS have been already designed for the systems to be installed for the first operation phase (first plasma systems and captive components). The mechanical justification was performed with the software GT STRUDL ® according to ANSI/AISC N690 code (as described in section 6.3). This design justification was conducted without the implementation of the fire case (as defined in ref. [53]) in the analysis. For the LOCA IV (as defined in ref. [53] and [24]), the design justification was conducted including the material properties of the steel structures at the LOCA IV temperature and the piping loads but the stresses induced by the thermal expansion were not verified. Those two additional justifications have to be performed.

The additional design justification has to be performed with a FEM analysis using the software ANSYS Workbench version 18.2 or latest versions. The analyses and calculation shall follow the requirements indicated in the procedure ref. [46]. The full models including input data and results shall be submitted through IO's Document Management System (hereinafter called as IDM) following the process of exchanging and storing stated in the working instruction ref. [37]. The analysis has to be conducted according to AISC 690 - 2012 or ASME Section III, NF – 2013 for nuclear class supports and AISC 360 – 2010 for Non – nuclear class. Other codes and code cases per Codes ref. [54] may be selected by the Contractor to complete the design but must be approved in writing by the IO prior to use. Within this task, the Contractor must also size, qualify and design the welds following the AWS applicable code. The loads and loads combinations to be used shall be in accordance with reference [53]. This approach has already been conducted by the IO for a few representative cases of supports and reported in the ref. [66].

Note: In order to validate the assumption on the stiffness of the support used in the piping stress analysis, the Contractor must perform a deflection check for each support location. As the design of the support is frozen and no modifications\iterations on the piping stress analysis are possible, the contractor shall ensure that the following limits are met. The deflections limits are fixed to:

- Level A/B maximum deflection < 1.6 mm
- Level C/D maximum deflection < 4.0 mm
- Minimum stiffness > 200 EI/L3

It has to be noted that the interfaces loads (e.g. loads on EPs, platforms) of the supports have been already delivered for verification and are frozen. Thus, the analyst has to take into account the loads already delivered (taking into account all the load case already evaluated) as maximum allowable. The verification of the interface loads is included in the Contract. In case the loads generated by the additional verifications performed by the Contractor for the thermal load case would exceed the initial ones, and no solutions are feasible to reduce below the allowable, the contractor is in charge of performing the re-verification of the loads using the dedicated tool and procedure, as defined in ref. [65]. The contractor shall informed the IO without any delays of the issue.

The Contractor can propose to analyse the supports creating envelope cases or families if it can be justified. This approach has to be validated case by case by the IO, the Contractor will have to provide to the IO the proposal of support families before proceeding with the calculations for approval. When grouping the support per families the Contractor shall ensure that the grouping do not result with excessive oversizing of the supports.

In order to size the amount of effort needed, the IO provides to the contractor the piping support drawings from ref. [239] to [291] as well as 3D models (delivered for the purpose of the quotation only) in 3DXML format within the tender package.

6.6.2 Subtask 5.2 Production of thermal case analysis reports

The purpose of this task is to prepare technical report for analysis of the thermal case on the piping supports. Each report must show evidence of:

- List of Supports concerned
- Assumptions, limits of applicability, calculation methods and acceptance criteria.
- Input Data
  - Coordinate system.
  - Geometry of the support.
  - Interfaces (EPs or others)
  - Design Code applied.
  - Actions, Loads & Load Combinations.
  - Allowable Stresses or Design Stresses
  - Welds to be calculated
- Output of the analysis:
  - Summary of maximum stresses and code compliance.
  - Displacements and deflections at critical points.
  - Stiffness of the secondary structure seen by the contact point of the pipe support.
  - Print out of the model with the color scales representing stresses and deflections.
  - Welds qualification.
  - Load transmitted to Embedded Plates (EPs) or other type of building interfaces, included in the report in a specific table (Excel format that will be provided by the IO) and comparison to loads already transmitted.
  - Verification of the Eps (if required)
- Handmade calculations discussion (if any).

6.6.3 Deliverables for Task 6

- Record of input data and design information provided by IO.
- Draft reports before analysis including the grouping for families for analysis
- Computer model for FEM analysis.
- Final analysis reports for supports.

7 System Arrangement

This chapter describes briefly the TCWS sub systems arrangement in order to give the tenderers an overview of the complexity, size and location of the piping and components. For a more detailed explanation of the system functions, parameters and arrangements please refer to reference [51], for precise information on the quantities please refer to the drawings referenced in the present specification. The following picture shows an integrated model of all the TCWS sub systems for the baseline configuration.

Note: Some of the models hereafter only show pipe sizes larger than DN25.

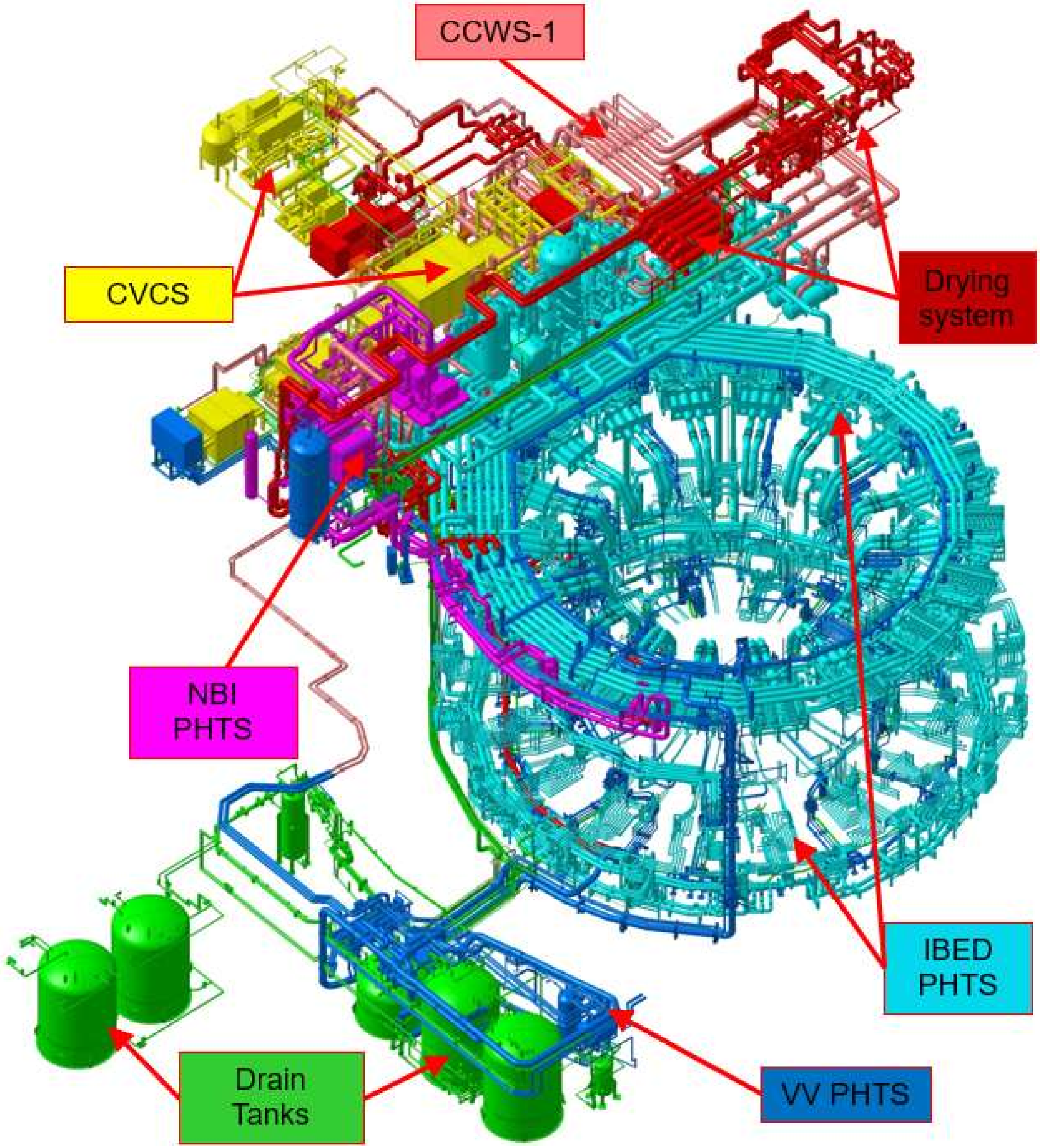

Figure 2: Overall TCWS

The areas mentioned within this document are located always inside the Tokamak Building (B11) or Tritium Building (B14).

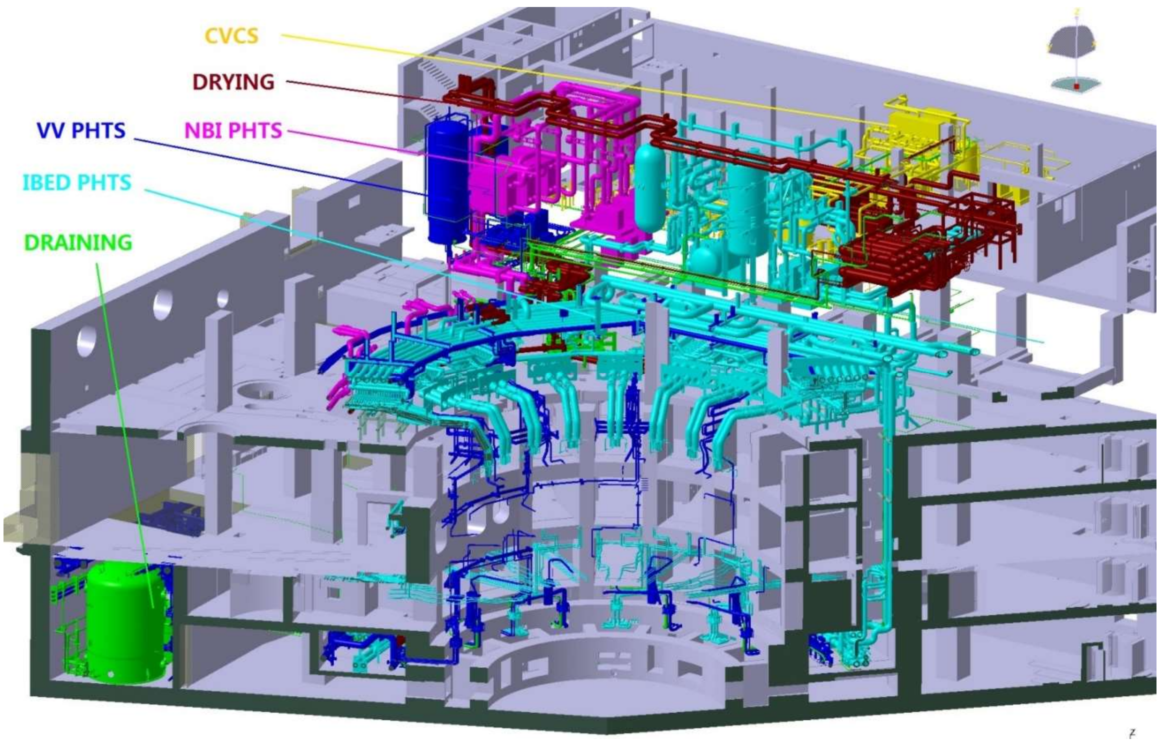

Figure 3: Tokamak Complex Building section view wit TCWS

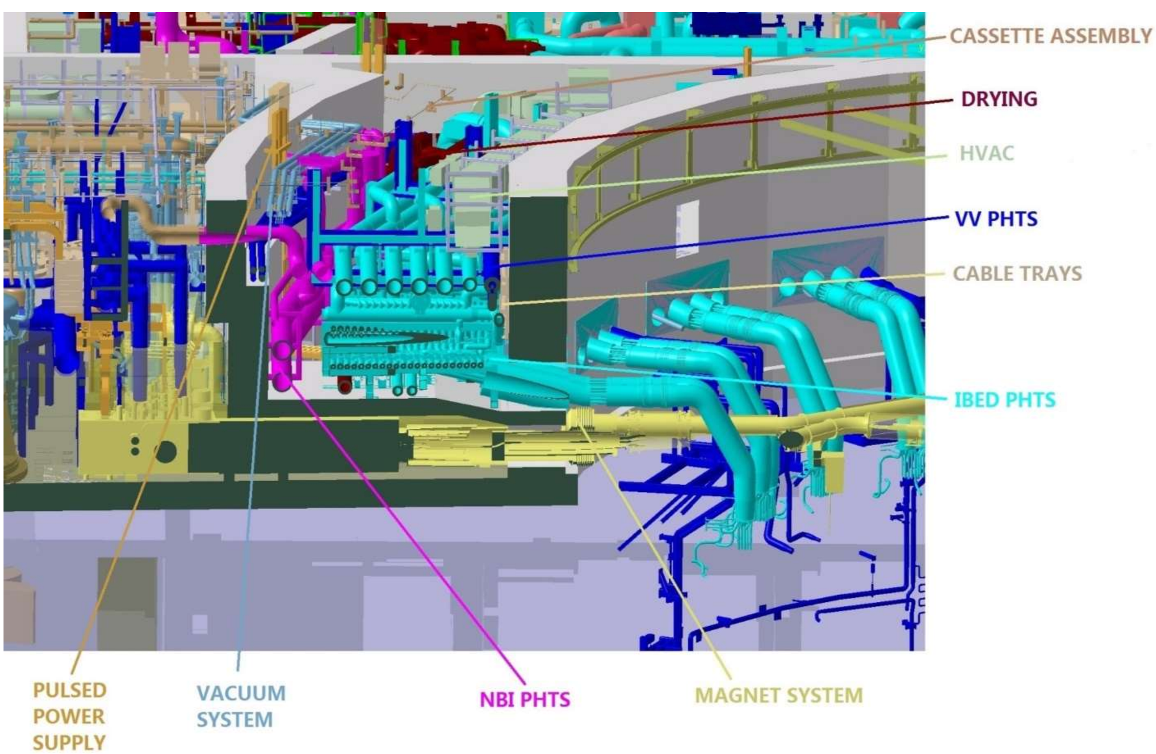

Figure 4: 11-L3 Upper Pipe Chase section view

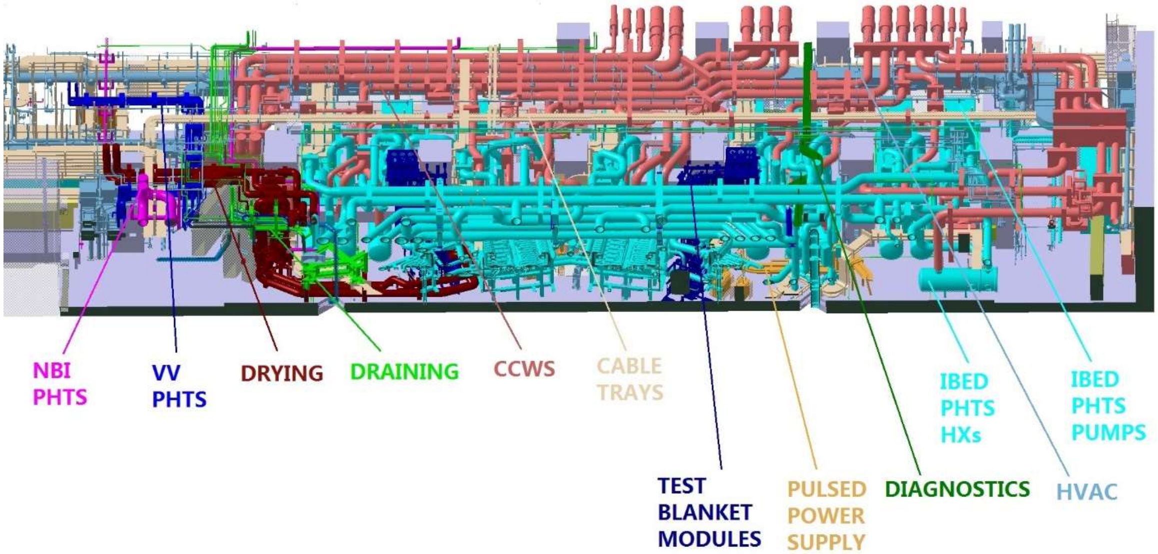

Figure 5: 11-L3 east top view IBED cooling trains

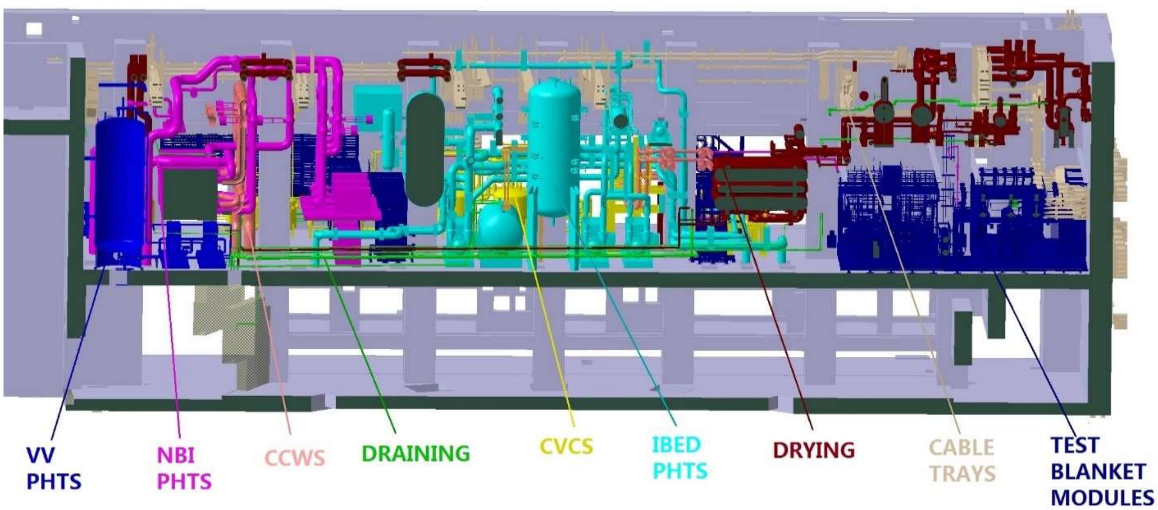

Figure 6: 11-L4 TCWS vault

7.1 IBED PHTS

This chapter provides general pictures\views of the IBED PHTS arrangement. Precise information on the layout are available in the reference [51], the quantities please refer to the drawings referenced in the present specification.

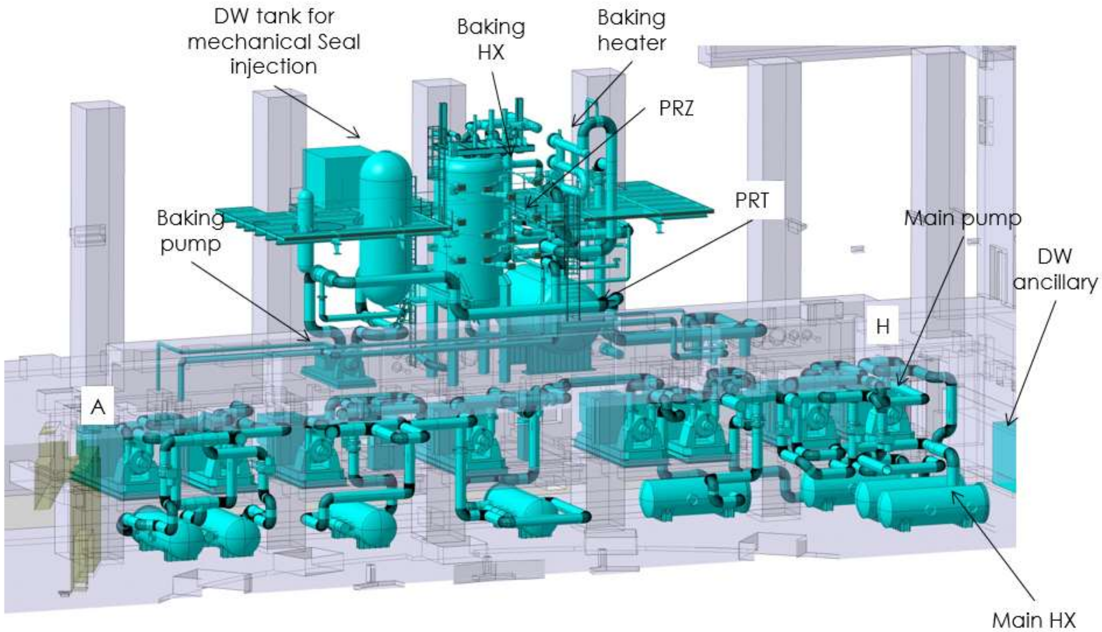

Figure 7: IBED PHTS process in B11-L3 and L4

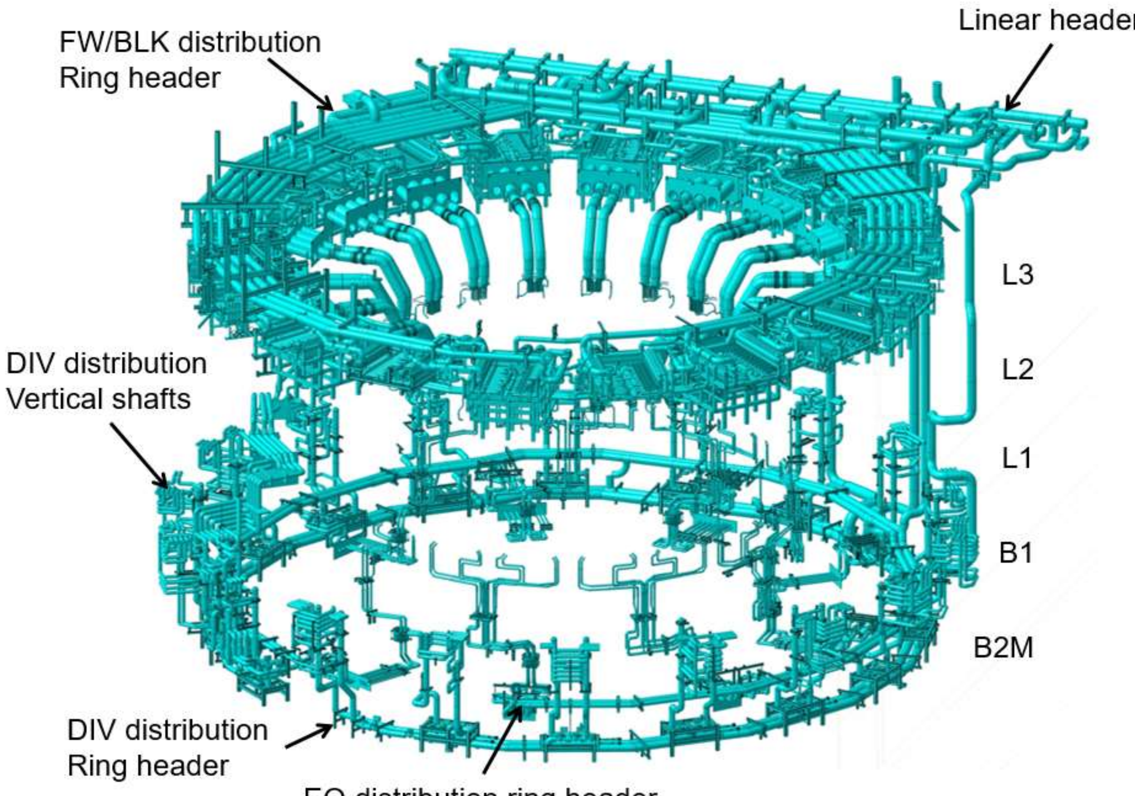

Figure 8: IBED PHTS distribution

7.2 VV PHTS

This chapter provides general pictures\views of the VV PHTS arrangement. Precise information on the layout are available in the reference [51], the quantities please refer to the drawings referenced in the present specification.

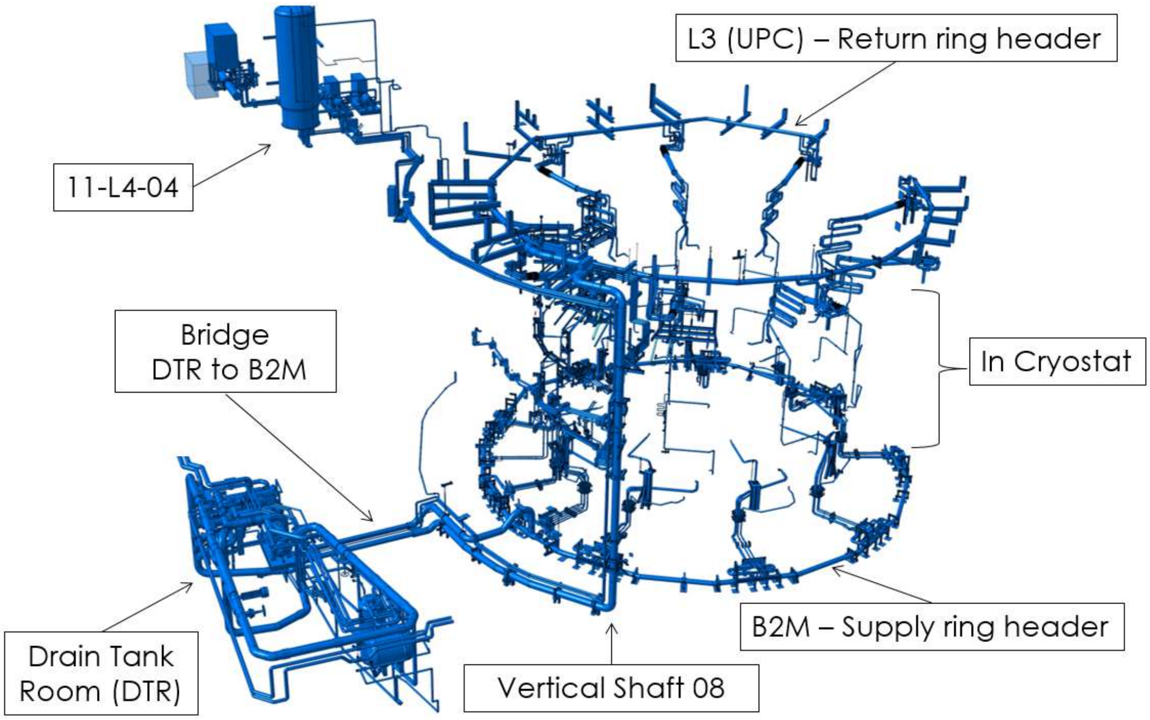

Figure 9: Global view of VV PHTS

7.3 NBI PHTS

This chapter provides general pictures\views of the NBI PHTS arrangement. Precise information on the layout are available in the reference [51], the quantities please refer to the drawings referenced in the present specification.

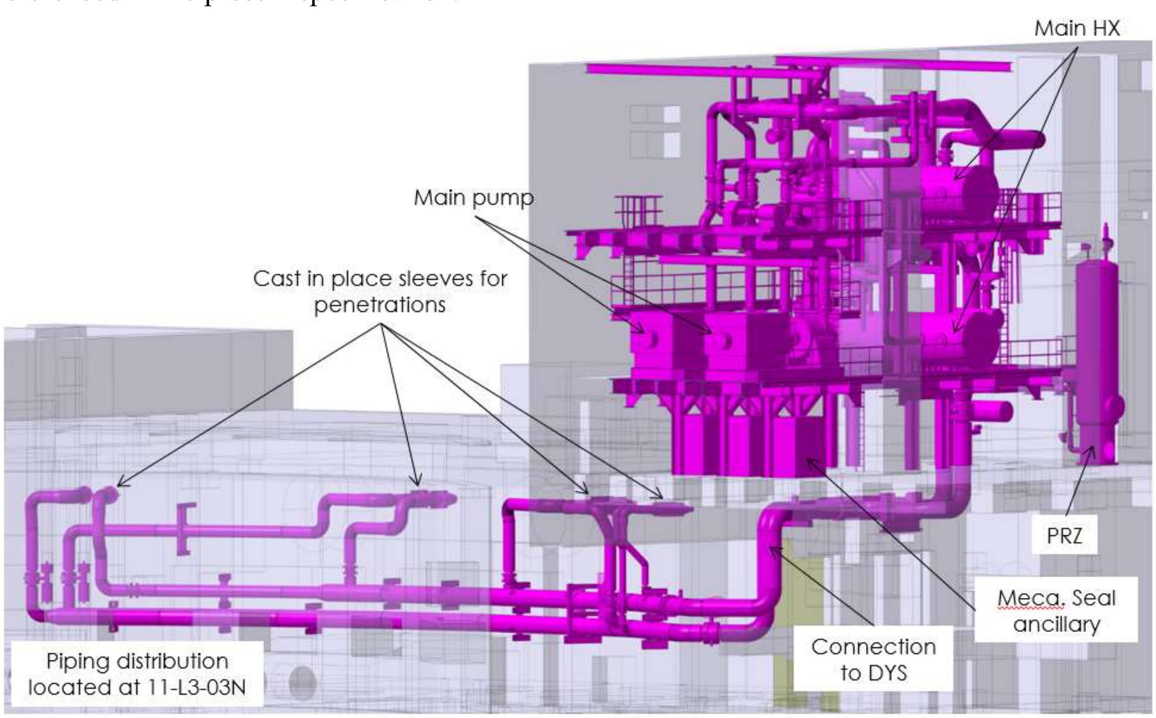

Figure 10: Global view of the NBI PHTS

7.4 CVCS for IBED PHTS and CVCS for NBI PHTS

This chapter provides general pictures\views of the arrangement of CVCS for IBED PHTS and the one of CVCS for NBI PHTS. Precise information on the layout are available in the reference [51], the quantities please refer to the drawings referenced in the present specification.

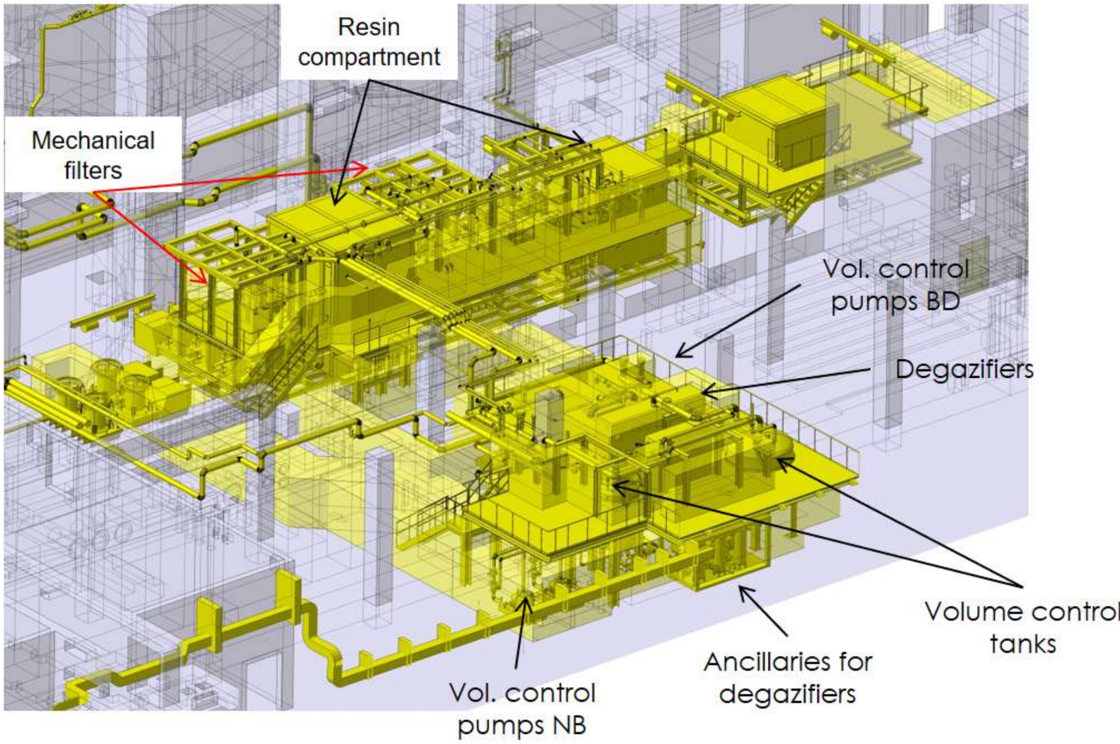

Figure 11: Global view of CVCS for IBED and CVCS for NBI

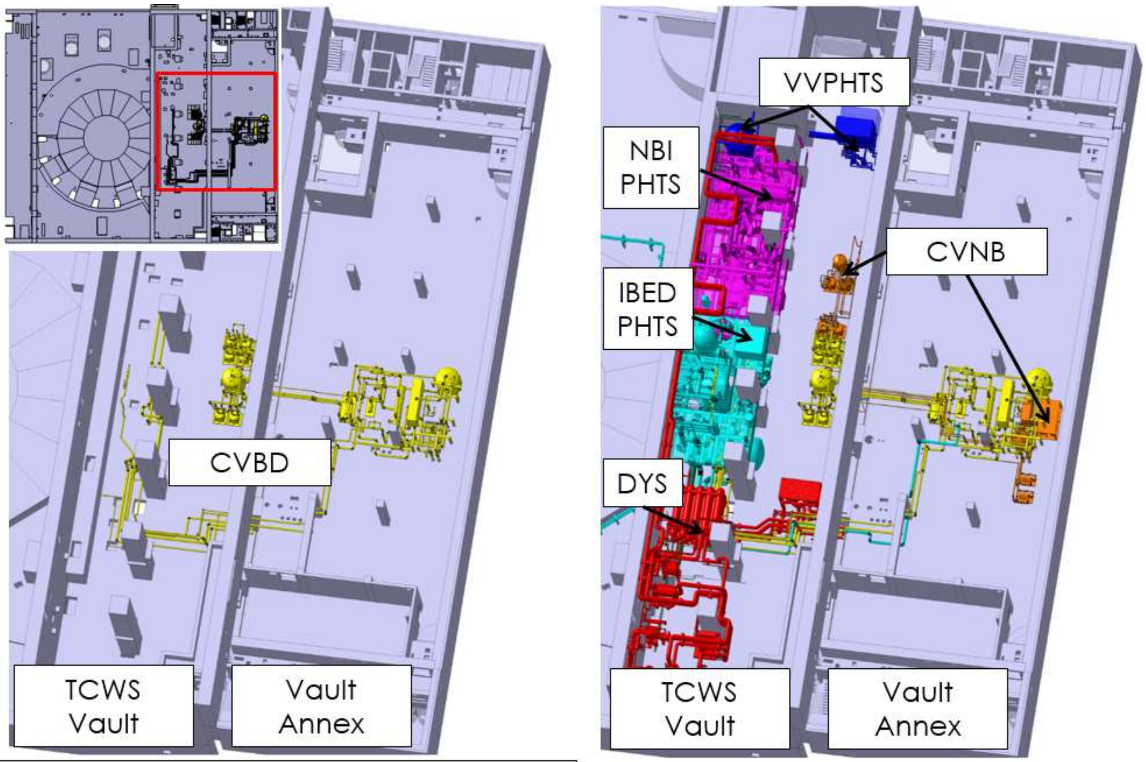

Figure 12: Positions of CVCS for IBED and CVCS for NBI in B11

7.5 Drying System

This chapter provides general pictures\views of the arrangement of the drying system. Precise information on the layout are available in the reference [51], the quantities please refer to the drawings referenced in the present specification.

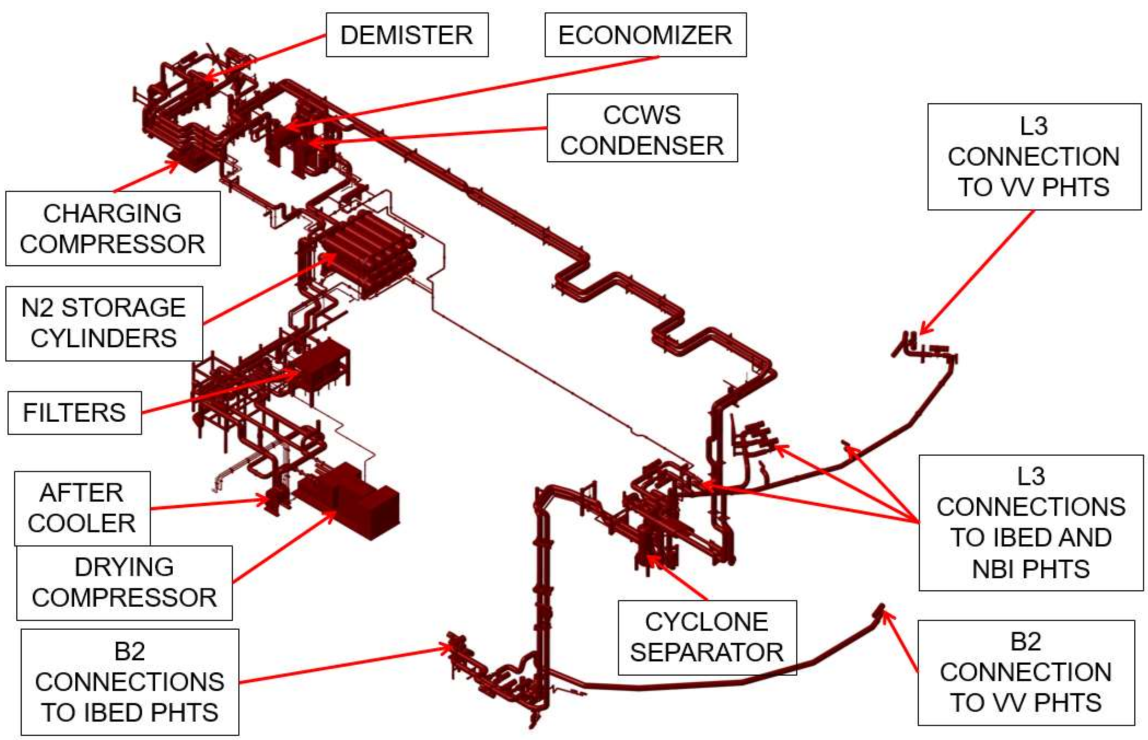

Figure 13: DYS global view

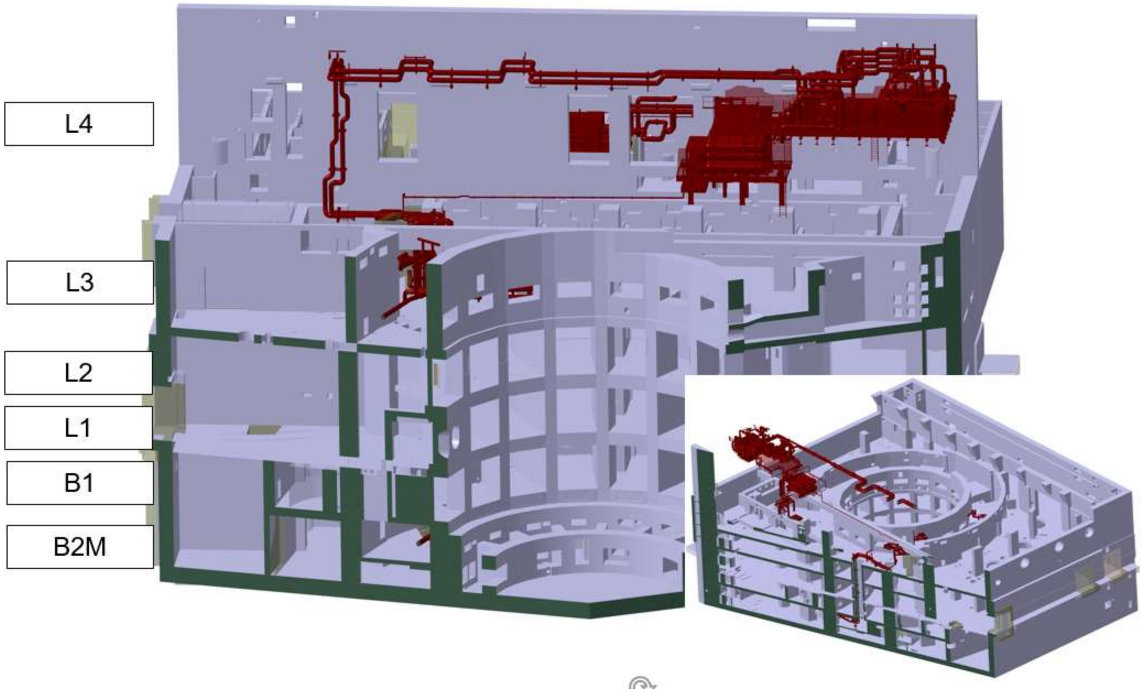

Figure 14: DYS position in B11

7.6 Draining System

This chapter provides general pictures\views of the arrangement of the draining system. Precise information on the layout are available in the reference [51], the quantities please refer to the drawings referenced in the present specification.

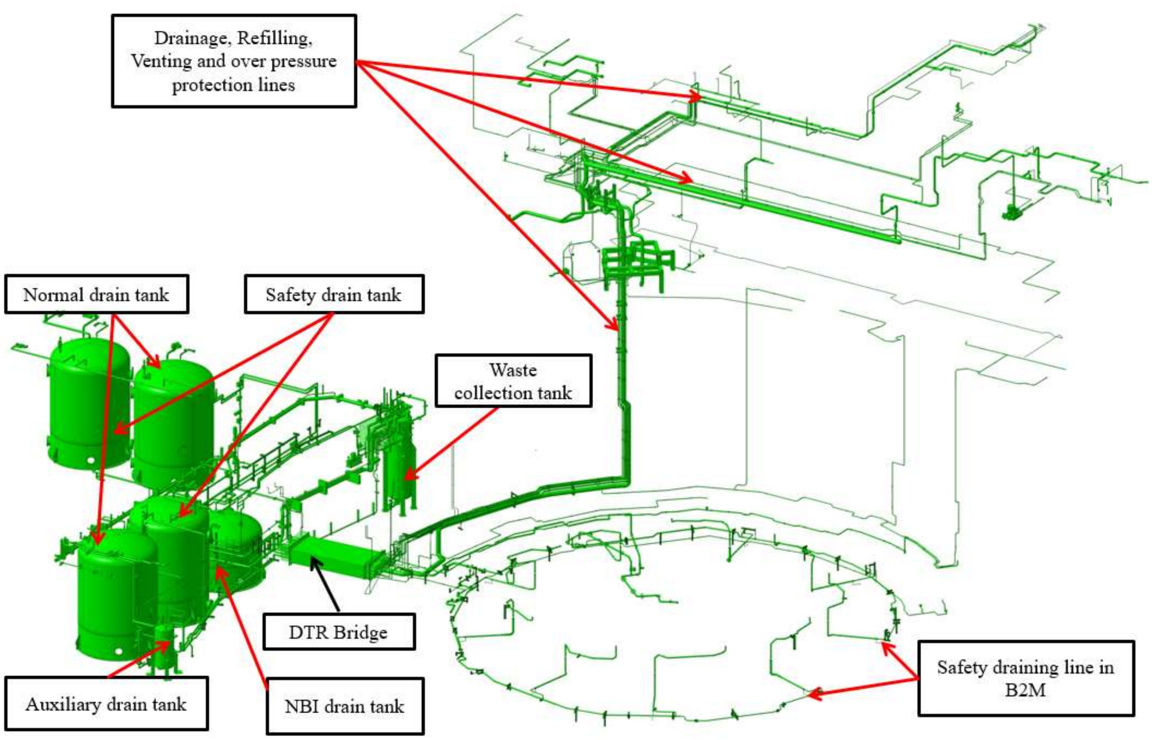

Figure 15: Draining system overview

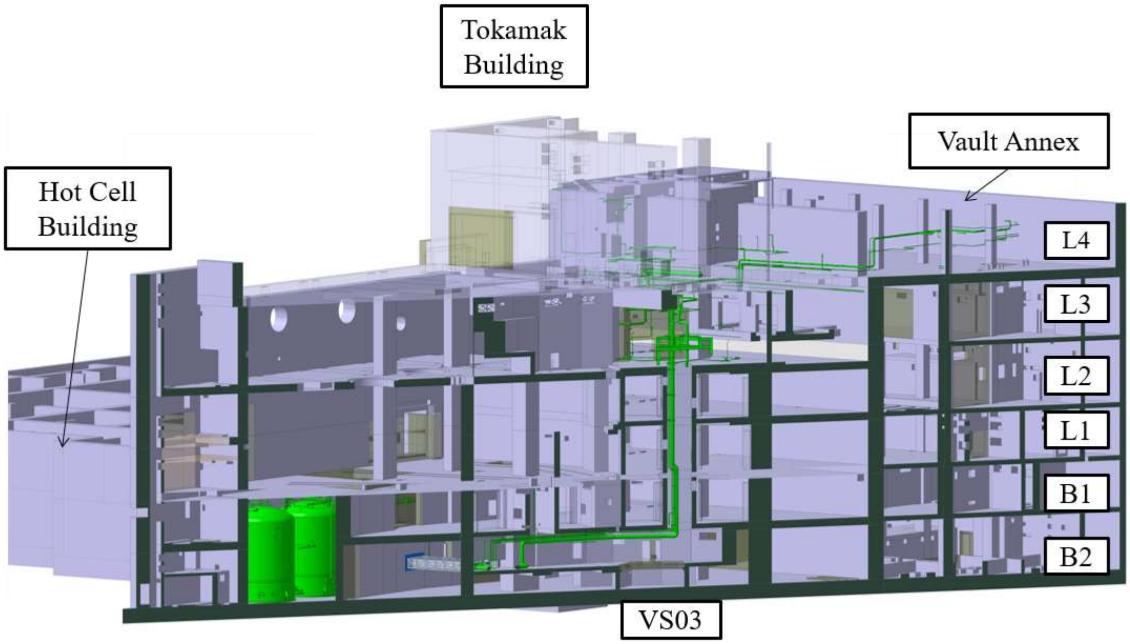

Figure 16: Draining system positions in B11

7.7 TCWS Sampling system

This chapter provides general pictures\views of the arrangement of the sampling system. Precise information on the layout are available in the reference [51], the quantities please refer to the drawings referenced in the present specification.

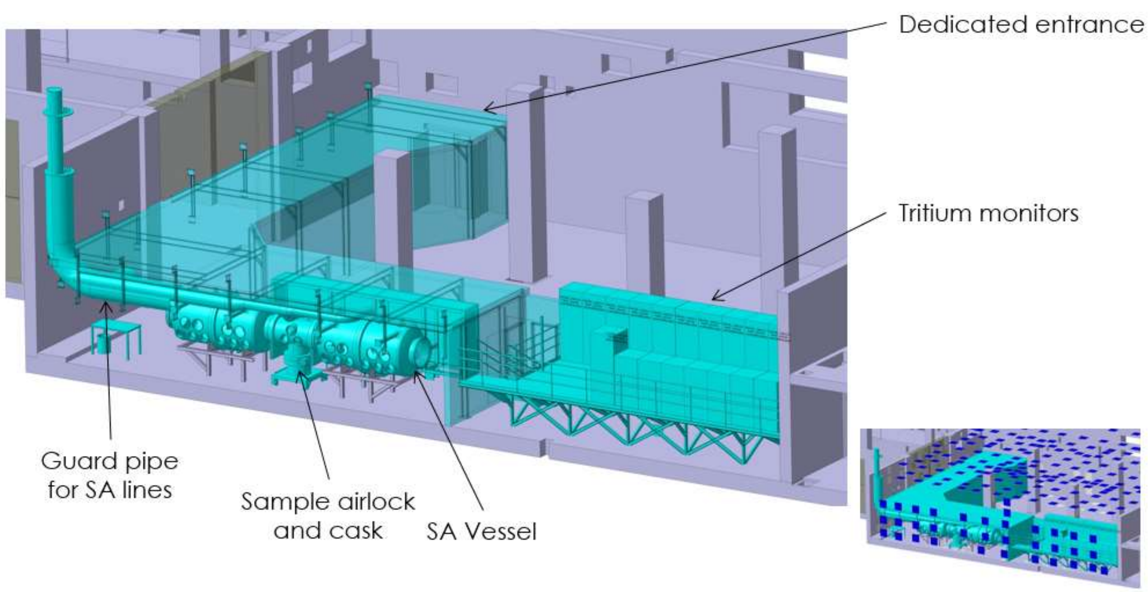

Figure 17: Overview of the sampling station without piping connection to each sampling location

8 Work Packages deliverables and time schedule.

The Services are broken down in several Work Packages (WPs). Each WP corresponds to the application of one or several tasks as defined in section 6 on a defined set of TCWS system, or portion of this system.

For each WP the Contractor shall produce the Deliverables listed in the following sub-sections for which the content has been defined in the related task description section 6.

The following sub-sections provide expected starting dates and required time for completion for each WP, as well as time for completion for each Deliverable. The starting date of each WP corresponds to the effective date for the start of the Services covered by the WP. IO will provide the Contractor with all the necessary input data at this starting date. Time for completion of each Deliverable means the time required for the submission of the Deliverable by the Contractor to the IO for review. Each Deliverable shall be approved in less than one month considering the IO and Contractor's tasks as described in the Validation Circuit for Contractor's Documents (see Section 9.5). Time for completion of each Work Package means the time required for the last deliverable submission in that Work Package. After this submission, the validation circuit shall extent a maximum of one month according to what is explained at section 9.5.

The provisions for the management of variation of the WP starting dates are provided in the Contract conditions. The starting date of each WP might vary during the Contract implementation and will be confirmed not later than 1 month before the effective start instructed by the IO to the Contractor. However the Contractor shall not be entitled to claim for an extension of WP duration for any such variation.

Note: The levels and locations where each particular process line is routed are marked both in the P&ID's included within references [84] to [91]. This information, the general arrangement drawings, the piping isometrics, the supports drawings, the 3D models provided and the existing analysis, permit to evaluate the size of each Work Package for task 0, 1, 2 and 3, and therefore enables the Contractor to quote the work for each single WP. For what regards task 4, the screenings are provided to enable the Contractor to quote the work to be performed.

8.1 WP for Task 0: Water Hammer analyses

8.1.1 WP 0.1 Water Hammer analysis of NBI PHTS

Scope: NBI PHTS located in B11 level 3 and 4.

WP Expected starting date (T0.1): T0

WP Time for Completion: T0.1 + 11 weeks

WP 0.1			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
0	0.1.1	WP 0.1 Design Input Record	T0.1+1
0	0.1.2	WP 0.1 Screening	T0.1+4
0	0.1.3	WP 0.1 Draft WH loads report	T0.1+8
0	0.1.4	WP 0.1 Final WH loads report	T0.1+11

8.1.2 WP 0.2 Water Hammer analysis of IBED PHTS second plasma portions

Scope: IBED PHTS in L3 and L4 installed after first plasma

WP Expected starting date (T0.2): T0 + 11 Weeks

WP Time for Completion: T0.2 + 11 weeks

WP 0.2			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
0	0.2.1	WP 0.2 Design Input Record	T0.2+1
0	0.2.2	WP 0.2 Screening	T0.2+4
0	0.2.3	WP 0.2 Draft WH loads report	T0.2+8
0	0.2.4	WP 0.2 Final WH loads report	T0.2+11

8.1.3 WP 0.3 Water Hammer analysis of CVCS for IBED PHTS

Scope: CVCS for IBED PHTS

WP Expected starting date (T0.3): T0 + 22 Weeks

WP Time for Completion: T0.3 + 11 weeks

WP 0.3			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
0	0.3.1	WP 0.3 Design Input Record	T0.3+1
0	0.3.2	WP 0.3 Screening	T0.3+4
0	0.3.3	WP 0.3 Draft WH loads report	T0.3+8
0	0.3.4	WP 0.3 Final WH loads report	T0.3+11

8.1.4 WP 0.4 Water Hammer analysis of CVCS for NBI PHTS

Scope: CVCS for NBI PHTS

WP Expected starting date (T0.4): T0 + 33 Weeks

WP Time for Completion: T0.4 + 11 weeks

WP 0.3			
Task	Deliverable	Document	Time for completion (Weeks)
0	0.4.1	WP 0.4 Design Input Record	T0.4+1
0	0.4.2	WP 0.4 Screening	T0.4+4
0	0.4.3	WP 0.4 Draft WH loads report	T0.4+8
0	0.4.4	WP 0.4 Final WH loads report	T0.4+11

8.2 WP for Task 1: Piping Stress Analysis

8.2.1 WP 1.1 Piping stress analysis of NBI PHTS

Scope: NBI PHTS located in B11 level 3 and 4.
WP Expected starting date (T1.1): T0 + 11 Weeks
WP Time for Completion: T1.1 + 8 weeks

WP 1.1			
Task	Deliverable	Document	Time for completion (Weeks)
1	1.1.1	WP 1.1 Design Input Record	T1.1+1
1	1.1.2	WP 1.1 Caesar model before lines qualification	T1.1+3
1	1.1.3	WP 1.1 Caesar model after lines qualification	T1.1+6
1	1.1.4	WP 1.1 3D model update	T1.1+7
1	1.1.5	WP 1.1 Piping stress analysis report	T1.1+8

8.2.2 WP 1.2 Piping stress analysis of IBED PHTS second plasma portions

Scope: IBED PHTS in L3 and L4 installed after first plasma
WP Expected starting date (T1.2): T0 + 22 Weeks
WP Time for Completion: T1.2 + 14 weeks

WP 1.2			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
1	1.2.1	WP 1.2 Design Input Record	T1.2+1
1	1.2.2	WP 1.2 Caesar model before lines qualification	T1.2+3
1	1.2.3	WP 1.2 Caesar model after lines qualification	T1.2+10
1	1.2.4	WP 1.2 3D model update	T1.2+10
1	1.2.5	WP 1.2 Piping stress analysis report	T1.2+14

8.2.3 WP 1.3 Piping stress analysis of CVCS for IBED PHTS

Scope: CVCS for IBED PHTS

WP Expected starting date (T1.3): T0 + 36 Weeks

WP Time for Completion: T1.3 + 8 weeks

WP 1.3			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
1	1.3.1	WP 1.3 Design Input Record	T1.3+1
1	1.3.2	WP 1.3 Caesar model before lines qualification	T1.3+3
1	1.3.3	WP 1.3 Caesar model after lines qualification	T1.3+6
1	1.3.4	WP 1.3 3D model update	T1.3+7
1	1.3.5	WP 1.3 Piping stress analysis report	T1.3+8

8.2.4 WP 1.4 Piping stress analysis of CVCS for NBI PHTS

Scope: CVCS for NBI PHTS

WP Expected starting date (T1.4): T0 + 44 Weeks

WP Time for Completion: T1.4 + 8 weeks

WP 1.4			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
1	1.4.1	WP 1.4 Design Input Record	T1.4+1
1	1.4.2	WP 1.4 Caesar model before lines qualification	T1.4+3
1	1.4.3	WP 1.4 Caesar model after lines qualification	T1.4+6
1	1.4.4	WP 1.4 3D model update	T1.4+7
1	1.4.5	WP 1.4 Piping stress analysis report	T1.4+8

8.2.5 WP 1.5 Piping stress analysis of Sampling system

Scope: Sampling system

WP Expected starting date (T1.5): T0 + 51 Weeks

WP Time for Completion: T1.5 + 8 weeks

WP 1.5			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
1	1.5.1	WP 1.5 Design Input Record	T1.5+1
1	1.5.2	WP 1.5 Caesar model before lines qualification	T1.5+3
1	1.5.3	WP 1.5 Caesar model after lines qualification	T1.5+6
1	1.5.4	WP 1.5 3D model update	T1.5+7
1	1.5.5	WP 1.5 Piping stress analysis report	T1.5+8

8.2.6 WP 1.6 optional piping stress analysis of IBED PHTS in L3 headers up to piping modules

Scope: IBED PHTS in L3 headers up to piping modules (WP 1.8)

WP Expected starting date (T1.6): T0 + 15 Weeks

WP Time for Completion: T1.6 + 11 weeks

WP 1.6			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
1	1.6.1	WP 1.6 Design Input Record	T1.6+1
1	1.6.2	WP 1.6 Caesar model before lines qualification	T1.6+3
1	1.6.3	WP 1.6 Caesar model after lines qualification	T1.6+8
1	1.6.4	WP 1.6 3D model update	T1.6+8
1	1.6.5	WP 1.6 Piping stress analysis report	T1.6+11

8.2.7 WP 1.7 optional piping stress analysis of IBED PHTS piping modules at L3

Scope: IBED PHTS piping modules at L3 up to bio-shield penetrations

WP Expected starting date (T1.7): T0 + 26 Weeks

WP Time for Completion: T1.7 + 11 weeks

WP 1.7			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
1	1.7.1	WP 1.7 Design Input Record	T1.7+1
1	1.7.2	WP 1.7 Caesar model before lines qualification	T1.7+3
1	1.7.3	WP 1.7 Caesar model after lines qualification	T1.7+8
1	1.7.4	WP 1.7 3D model update	T1.7+9
1	1.7.5	WP 1.7 Piping stress analysis report	T1.7+11

Note: in order to evaluate the quantity of work the contractor has to consider that the initial piping stress analysis includes only one of the sectors to be analyzed among the 18. The contractor shall also consider the symmetries and similarities among the 18 sectors in order to group the analysis and reduce the amount of work to be performed.

8.2.8 WP 1.8 optional piping stress analysis of IBED PHTS piping in-cryostat upper part

Scope: IBED PHTS piping in-cryostat upper part up to piping modules (WP 1.7)

WP Expected starting date (T1.8): T0 + 37 Weeks

WP Time for Completion: T1.8 + 11 weeks

WP 1.8			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
1	1.8.1	WP 1.8 Design Input Record	T1.8+1
1	1.8.2	WP 1.8 Caesar model before lines qualification	T1.8+3
1	1.8.3	WP 1.8 Caesar model after lines qualification	T1.8+8
1	1.8.4	WP 1.8 3D model update	T1.8+9
1	1.8.5	WP 1.8 Piping stress analysis report	T1.8+11

Note: in order to evaluate the quantity of work the contractor has to consider that the initial piping stress analysis includes only one of the sectors to be analyzed among the 18. The contractor shall also consider the symmetries and similarities among the 18 sectors in order to group the analysis and reduce the amount of work to be performed.

8.2.9 WP 1.9 optional piping stress analysis of VV PHTS in VS, NB Cell, L3 and In-cryostat upper parts

Scope: VV PHTS in VS, NB Cell, L3 and In-cryostat upper parts

WP Expected starting date (T1.9): T0

WP Time for Completion: T1.9 + 15 weeks

WP 1.9			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
1	1.9.1	WP 1.9 Design Input Record	T1.9+1
1	1.9.2	WP 1.9 Caesar model before lines qualification	T1.9+4
1	1.9.3	WP 1.9 Caesar model after lines qualification	T1.9+12
1	1.9.4	WP 1.9 3D model update	T1.9+12
1	1.9.5	WP 1.9 Piping stress analysis report	T1.9+15

Note: in order to evaluate the quantity of work the contractor has to consider that the initial piping stress analysis was divided in two parts: VV PHTS in VS, NB Cell and L3, and VV PHTS in-cryostat upper parts. Piping stress analysis reports are available in references.

8.3 WP for Task 2: Support design

8.3.1 WP 2.1 Support design of NBI PHTS

Scope: NBI PHTS located in B11 level 3 and 4.
WP Expected starting date (T2.1): T0 + 19 Weeks
WP Time for Completion: T2.1 + 10 weeks

WP 2.1			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
2	2.1	WP 2.1 Design Input Record	T2.1+1
2	2.2	WP 2.1 AVEVA E3D proposed support configuration	T2.1+3
2	2.3	WP 2.1 Supports structural models before qualification	T2.1+5
2	2.4	WP 2.1 Supports structural qualification report	T2.1+10
2	2.5	WP 2.1 Support drawings	T2.1+10
2	2.6	WP 2.1 Support list and BoM	T2.1+10
2	2.7	WP 2.1 3D model update with final supports	T2.1+10

8.3.2 WP 2.2 Support design of IBED PHTS second plasma portions

Scope: IBED PHTS second plasma portions
WP Expected starting date (T2.2): T0 + 36 Weeks
WP Time for Completion: T2.2 + 14 weeks

WP 2.2			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
2	2.2.1	WP 2.2 Design Input Record	T2.2+1
2	2.2.2	WP 2.2 AVEVA E3D proposed support configuration	T2.2+3
2	2.2.3	WP 2.2 Supports structural models before qualification	T2.2+5
2	2.2.4	WP 2.2 Supports structural qualification report	T2.2+14
2	2.2.5	WP 2.2 Support drawings	T2.2+14

2	2.2.6	WP 2.2 Support list and BoM	T2.2+14
2	2.2.7	WP 2.2 3D model update with final supports	T2.2+14

8.3.3 WP 2.3 Support design of CVCS for IBED PHTS

Scope: CVCS for IBED PHTS
WP Expected starting date (T2.3): T0 + 50 Weeks
WP Time for Completion: T2.3 + 10 weeks

WP 2.3			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
2	2.3.1	WP 2.3 Design Input Record	T2.3+1
2	2.3.2	WP 2.3 AVEVA E3D proposed support configuration	T2.3+3
2	2.3.3	WP 2.3 Supports structural models before qualification	T2.3+5
2	2.3.4	WP 2.3 Supports structural qualification report	T2.3+10
2	2.3.5	WP 2.3 Support drawings	T2.3+10
2	2.3.6	WP 2.3 Support list and BoM	T2.3+10
2	2.3.7	WP 2.3 3D model update with final supports	T2.3+10

8.3.4 WP 2.4 Support design of CVCS for NBI PHTS

Scope: CVCS for NBI PHTS
WP Expected starting date (T2.4): T0 + 58 Weeks
WP Time for Completion: T2.4 + 10 weeks

WP 2.4			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
2	2.4.1	WP 2.4 Design Input Record	T2.4+1
2	2.4.2	WP 2.4 AVEVA E3D proposed support configuration	T2.4+3
2	2.4.3	WP 2.4 Supports structural models before qualification	T2.4+5

2	2.4.4	WP 2.4 Supports structural qualification report	T2.4+10
2	2.4.5	WP 2.4 Support drawings	T2.4+10
2	2.4.6	WP 2.4 Support list and BoM	T2.4+10
2	2.4.7	WP 2.4 3D model update with final supports	T2.4+10

8.3.5 WP 2.5 Support design of sampling system

Scope: Sampling system

WP Expected starting date (T2.5): T0 + 60 Weeks

WP Time for Completion: T2.5 + 8 weeks

WP 2.5			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
2	2.5.1	WP 2.5 Design Input Record	T2.5+1
2	2.5.2	WP 2.5 AVEVA E3D proposed support configuration	T2.5+3
2	2.5.3	WP 2.5 Supports structural models before qualification	T2.5+5
2	2.5.4	WP 2.5 Supports structural qualification report	T2.5+8
2	2.5.5	WP 2.5 Support drawings	T2.5+8
2	2.5.6	WP 2.5 Support list and BoM	T2.5+8
2	2.5.7	WP 2.5 3D model update with final supports	T2.5+8

8.3.6 WP 2.6 optional support design of IBED PHTS in L3 headers up to piping modules

Scope: IBED PHTS in L3 headers up to piping modules

WP Expected starting date (T2.6): T0 + 26 Weeks

WP Time for Completion: T2.6 + 10 weeks

WP 2.6			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
2	2.6.1	WP 2.6 Design Input Record	T2.6+1
2	2.6.2	WP 2.6 AVEVA E3D proposed support configuration	T2.6+3
2	2.6.3	WP 2.6 Supports structural models before qualification	T2.6+5
2	2.6.4	WP 2.6 Supports structural qualification report	T2.6+10
2	2.6.5	WP 2.6 Support drawings	T2.6+10
2	2.6.6	WP 2.6 Support list and BoM	T2.6+10
2	2.6.7	WP 2.6 3D model update with final supports	T2.6+10

8.3.7 WP 2.7 optional support design of IBED PHTS piping modules at L3

Scope: IBED PHTS piping modules at L3 up to bio-shield penetrations (WP 2.8)
WP Expected starting date (T2.7): T0 + 37 Weeks
WP Time for Completion: T2.7 + 10 weeks

WP 2.7			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
2	2.7.1	WP 2.7 Design Input Record	T2.7+1
2	2.7.2	WP 2.7 AVEVA E3D proposed support configuration	T2.7+3
2	2.7.3	WP 2.7 Supports structural models before qualification	T2.7+5
2	2.7.4	WP 2.7 Supports structural qualification report	T2.7+10
2	2.7.5	WP 2.7 Support drawings	T2.7+10
2	2.7.6	WP 2.7 Support list and BoM	T2.7+10
2	2.7.7	WP 2.7 3D model update with final supports	T2.7+10

Note: in order to evaluate the quantity of work the contractor has to consider that structural qualification includes only one of the sectors to be analyzed among the 18. The contractor shall also consider the symmetries and similarities among the 18 sectors in order to group the analysis and reduce the amount of work to be performed.

8.3.8 WP 2.8 optional support design of IBED PHTS piping in-cryostat upper part

Scope: IBED PHTS piping in-cryostat upper part up to piping modules (WP 2.7)

WP Expected starting date (T2.8): T0 + 48 Weeks

WP Time for Completion: T2.8 + 10 weeks

WP 2.8			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
2	2.8.1	WP 2.8 Design Input Record	T2.8+1
2	2.8.2	WP 2.8 AVEVA E3D proposed support configuration	T2.8+3
2	2.8.3	WP 2.8 Supports structural models before qualification	T2.8+5
2	2.8.4	WP 2.8 Supports structural qualification report	T2.8+10
2	2.8.5	WP 2.8 Support drawings	T2.8+10
2	2.8.6	WP 2.8 Support list and BoM	T2.8+10
2	2.8.7	WP 2.8 3D model update with final supports	T2.8+10

Note: in order to evaluate the quantity of work the contractor has to consider the symmetries and similarities among the 18 sectors in order to group the analysis and reduce the amount of work to be performed.

8.3.9 WP 2.9 optional support design of VV PHTS in VS, L3 and In-cryostat upper parts

Scope: VV PHTS in VS, NB Cell, L3 and In-cryostat upper parts

WP Expected starting date (T2.9): T0 + 15 Weeks

WP Time for Completion: T2.9 + 10 weeks

WP 2.9			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
2	2.9.1	WP 2.9 Design Input Record	T2.9+1
2	2.9.2	WP 2.9 AVEVA E3D proposed support configuration	T2.9+3

2	2.9.3	WP 2.9 Supports structural models before qualification	T2.9+5
2	2.9.4	WP 2.9 Supports structural qualification report	T2.9+10
2	2.9.5	WP 2.9 Support drawings	T2.9+10
2	2.9.6	WP 2.9 Support list and BoM	T2.9+10
2	2.9.7	WP 2.9 3D model update with final supports	T2.9+10

Note: in order to evaluate the quantity of work the contractor has to consider that the initial support design was divided in two parts: VV PHTS in VS, NB Cell and L3, and VV PHTS in-cryostat upper parts. Support structural qualification reports and support drawings are available in references.

8.4 WP for Task 3: Construction documentation

8.4.1 WP 3.1 Construction documentation for EWP L3-03 first delivery

Scope: EWP L3-03 first delivery

- IBED PHTS headers at L3M Level North, West and South
- VV PHTS Headers at L3M Level North, West and South. And connection to VS.
- DYS Ceiling level in L3M Level North
- NBI PHTS on north wall

WP Expected starting date (T3.1): T0 + 4 weeks

WP Time for Completion: T3.1 + 4 weeks

WP 3.1			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
3	3.1.1	WP 3.1 GA drawings	T3.1+3
3	3.1.2	WP 3.1 Support drawings	T3.1+4
3	3.1.3	WP 3.1 Piping isometrics	T3.1+3
3	3.1.4	WP 3.1 Bill of materials	T3.1+2

8.4.2 WP 3.2 Construction documentation for EWP TCWS at NB Cell in B11

Scope: EWP TCWS at NB Cell in B11

- IBED PHTS in NB Cell
- VV PHTS in NB Cell

WP Expected starting date (T3.2): T0 + 8 weeks

WP Time for Completion: T3.2 + 4 weeks

WP 3.2			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
3	3.2.1	WP 3.2 GA drawings	T3.2+3
3	3.2.2	WP 3.2 Support drawings	T3.2+4
3	3.2.3	WP 3.2 Piping isometrics	T3.2+3
3	3.2.4	WP 3.2 Bill of materials	T3.2+2

8.4.3 WP 3.3 Construction documentation for EWP L3-03 second delivery

Scope: EWP L3-03 second delivery
- IBED PHTS linear headers and connecting pipes to RH at L3M East (all L3 remaining part)
- VV PHTS bioshield penetrations in temp. position from C04 to C15 at L3M level
- IBED PHTS bioshield penetrations in temp. position from C04 to C15 at L3M level

WP Expected starting date (T3.3): T0 + 12 weeks

WP Time for Completion: T3.3 + 4 weeks

WP 3.3			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
3	3.3.1	WP 3.3 GA drawings	T3.3+3
3	3.3.2	WP 3.3 Support drawings	T3.3+4
3	3.3.3	WP 3.3 Piping isometrics	T3.3+3
3	3.3.4	WP 3.3 Bill of materials	T3.3+2

8.4.4 WP 3.4 Construction documentation for EWP B2M in B11 C10-C18

Scope: EWP B2M in B11 C10-C18
- IBED PHTS in B2M - Equatorial port RH and branch lines (RH to bioshield penetration) south side (C10) to C18) - Divertor RH and connections to VS.
- VV PHTS in B2M - branch lines (RH to bioshield penetration) south side (C10 to C18)
- DYS in B2M

WP Expected starting date (T3.4): T0 + 16 weeks

WP Time for Completion: T3.4 + 4 weeks

WP 3.4			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
3	3.4.1	WP 3.4 GA drawings	T3.4+3
3	3.4.2	WP 3.4 Support drawings	T3.4+4
3	3.4.3	WP 3.4 Piping isometrics	T3.4+3
3	3.4.4	WP 3.4 Bill of materials	T3.4+2

8.4.5 WP 3.5 Construction documentation for EWP 55 Install Upper VV PHTS Pipework

Scope: EWP 55 Install Upper VV PHTS Pipework

- VV PHTS in cryostat upper part

WP Expected starting date (T3.5): T0 + 20 weeks

WP Time for Completion: T3.5 + 4 weeks

WP 3.5			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
3	3.5.1	WP 3.5 GA drawings	T3.5+3
3	3.5.2	WP 3.5 Support drawings	T3.5+4
3	3.5.3	WP 3.5 Piping isometrics	T3.5+3
3	3.5.4	WP 3.5 Bill of materials	T3.5+2

8.4.6 WP 3.6 Construction documentation for EWP 54 Install Upper IBED PHTS Pipework

Scope: EWP 54 Install Upper IBED PHTS Pipework

- IBED PHTS in cryostat upper part

WP Expected starting date (T3.6): T0 + 24 weeks

WP Time for Completion: T3.6 + 4 weeks

WP 3.6			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**

3	3.6.1	WP 3.6 GA drawings	T3.6+3
3	3.6.2	WP 3.6 Support drawings	T3.6+4
3	3.6.3	WP 3.6 Piping isometrics	T3.6+3
3	3.6.4	WP 3.6 Bill of materials	T3.6+2

8.4.7 WP 3.7 Construction documentation for EWP 53 Lower & EQ PHTS

Scope: EWP 53 Lower & EQ PHTS

- IBED PHTS in cryostat lower part
- VV PHTS in cryostat lower part
- DRS PHTS in cryostat lower part

WP Expected starting date (T3.7): T0 + 28 weeks

WP Time for Completion: T3.7 + 4 weeks

WP 3.7			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
3	3.7.1	WP 3.7 GA drawings	T3.7+3
3	3.7.2	WP 3.7 Support drawings	T3.7+4
3	3.7.3	WP 3.7 Piping isometrics	T3.7+3
3	3.7.4	WP 3.7 Bill of materials	T3.7+2

8.4.8 WP 3.8 Construction documentation for EWP B1 in B11

Scope: EWP B1 in B11

- IBED PHTS divertor pipes in port cells and lower port

WP Expected starting date (T3.8): T0 + 32 weeks

WP Time for Completion: T3.8 + 4 weeks

WP 3.8			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
3	3.8.1	WP 3.8 GA drawings	T3.8+3
3	3.8.2	WP 3.8 Support drawings	T3.8+4

3	3.8.3	WP 3.8 Piping isometrics	T3.8+3
3	3.8.4	WP 3.8 Bill of materials	T3.8+2

8.4.9 WP 3.9 Construction documentation for EWP L4 in B14

Scope: EWP L4 in B14

- Drying compressor at connections to it, including bridge to 14-L4.

WP Expected starting date (T3.9): T0 + 36 weeks

WP Time for Completion: T3.9 + 4 weeks

WP 3.9			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
3	3.9.1	WP 3.9 GA drawings	T3.9+3
3	3.9.2	WP 3.9 Support drawings	T3.9+4
3	3.9.3	WP 3.9 Piping isometrics	T3.9+3
3	3.9.4	WP 3.9 Bill of materials	T3.9+2

8.4.10 WP 3.10 Construction documentation for EWP L3-03 -Third delivery

Scope: EWP L3-03 -Third delivery

- IBED PHTS all piping modules and related maintenance platforms.
- IBED PHTS ring headers east portion.
- IBED PHTS All baking and relief lines.
- VV PHTS ring headers at east and piping connections from RH to bioshield penetrations.
- VV PHTS bioshield penetrations in temporary positions from C16 to C03 at L3M
- DYS drying separator and north wall L3M.
- DRS in L3

WP Expected starting date (T3.10): T0 + 40 weeks

WP Time for Completion: T3.10 + 4 weeks

WP 3.10			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
3	3.10.1	WP 3.10 GA drawings	T3.10+3
3	3.10.2	WP 3.10 Support drawings	T3.10+4

3	3.10.3	WP 3.10 Piping isometrics	T3.10+3
3	3.10.4	WP 3.10 Bill of materials	T3.10+2

8.4.11 WP 3.11 Construction documentation for EWP L4 VV PHTS

Scope: EWP L4 VV PHTS

- VV PHTS in B11 L4

WP Expected starting date (T3.11): T0 + 44 weeks

WP Time for Completion: T3.11 + 4 weeks

WP 3.11			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
3	3.11.1	WP 3.11 GA drawings	T3.11+3
3	3.11.2	WP 3.11 Support drawings	T3.11+4
3	3.11.3	WP 3.11 Piping isometrics	T3.11+3
3	3.11.4	WP 3.11 Bill of materials	T3.11+2

8.4.12 WP 3.12 Construction documentation for EWP DTR in B11

Scope: EWP DTR in B11

- VV PHTS in DTR
- DRS in DTR

WP Expected starting date (T3.12): T0

WP Time for Completion: T3.12 + 4 weeks

WP 3.12			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
3	3.12.1	WP 3.12 GA drawings	T3.12+3
3	3.12.2	WP 3.12 Support drawings	T3.12+4
3	3.12.3	WP 3.12 Piping isometrics	T3.12+3
3	3.12.4	WP 3.12 Bill of materials	T3.12+2

8.5 WP for Task 4: Local thermo-hydraulic phenomena

8.5.1 WP 4.1: Local Thermo-hydraulic phenomena for VV PHTS

Scope: VV PHTS

WP Expected starting date (T4.1): T0

WP Time for Completion: T4.1 + 16 weeks

WP 4.1 Local thermo-hydraulic phenomena for VVPHTS			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
4	4.1.1	WP 4.1 Design Input Record	T4.1+4
4	4.1.2	WP 4.1 Draft report	T4.1+4
4	4.1.3	WP 4.1 Computer model for CFD analysis	T4.1+9
4	4.1.4	WP 4.1 Computer models for fatigue analysis	T4.1+12
4	4.1.5	WP 4.1 Final report	T4.1+16

8.5.2 WP 4.2: Local Thermo-hydraulic phenomena for IBED PHTS

Scope: IBED PHTS

WP Expected starting date (T4.2): T0 + 16 weeks

WP Time for Completion: T4.2 + 21 weeks

WP 4.2 Local thermo-hydraulic phenomena for IBED PHTS			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
4	4.2.1	WP 4.2 Design Input Record	T4.2+4
4	4.2.2	WP 4.2 Draft report	T4.2+4
4	4.2.3	WP 4.2 Computer model for CFD analysis	T4.2+9
4	4.2.4	WP 4.2 Computer models for fatigue analysis	T4.2+12
4	4.2.4	WP 4.2 Final report	T4.2+16
4	4.2.6	WP 4.2 AVEVA 3D Model update	T4.2+16
4	4.2.7	WP 4.2 Piping stress analysis report	T4.2+19
4	4.2.9	WP 4.2 Supports structural qualification report	T4.2+21

Note: Deliverable 4.2.7 and 4.2.9 are due only for the IBED PHTS portions included in tasks 1 and 2 of the present specification.

8.5.3 WP 4.3: Local Thermo-hydraulic phenomena for DYS

Scope: DYS

WP Expected starting date (T4.3): T0

WP Time for Completion: T4.3 + 12 weeks

WP 4.3 Local thermo-hydraulic phenomena for DYS			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
4	4.3.1	WP 4.3 Design Input Record	T4.3+4
4	4.3.2	WP 4.3 Draft report	T4.3+4
4	4.3.3	WP 4.3 Computer model for CFD analysis	T4.3+6
4	4.3.4	WP 4.3 Computer models for fatigue analysis	T4.3+10
4	4.3.5	WP 4.3 Final report	T4.3+12

8.5.4 WP 4.4: Local Thermo-hydraulic phenomena for CVBD

Scope: CVBD

WP Expected starting date (T4.4): T0 + 36 weeks

WP Time for Completion: T4.4 + 17 weeks

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WP 4.4 Local thermo-hydraulic phenomena for CVBD			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
4	4.4.1	WP 4.4 Design Input Record	T4.4+4
4	4.4.2	WP 4.4 Draft report	T4.4+4
4	4.4.3	WP 4.4 Computer model for CFD analysis	T4.4+6
4	4.4.4	WP 4.4 Computer models for fatigue analysis	T4.4+10
4	4.4.4	WP 4.4 Final report	T4.4+12
4	4.4.6	WP 4.4 AVEVA 3D Model update	T4.4+12
4	4.4.7	WP 4.4 Piping stress analysis report	T4.4+15
4	4.4.9	WP 4.4 Supports structural qualification report	T4.4+17

8.6 WP for Task 5: Piping supports thermal load cases

8.6.1 WP 5.1: Piping supports thermal load cases: B2M area 1.1

Scope: IBED PHTS in VS B1 (EWP B2M area 1.1)

WP Expected starting date (T5.1): T0 + 0 Weeks

WP Time for Completion: T5.1+ 7 weeks

WP 5.1			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
5	5.1.1	WP 5.1 Design Input Record	T5.1+1
5	5.1.2	WP 5.1 Draft report support grouping	T5.1+2
5	5.1.3	WP 5.1 FEM model(s) (ANSYS)	T5.1+5

5	5.1.4	WP 5.1 Final analysis reports	T5.1+7

This WP includes the supports defined in ref. [251] to [268].

8.6.2 WP 5.2: Piping supports thermal load cases: B2M VS to L3

Scope: IBED PHTS, VV PHTS, DRS, DYS in VS from B2M to L3

WP Expected starting date (T5.2): T0 + 0 Weeks

WP Time for Completion: T5.2+ 7 weeks

WP 5.2			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
5	5.2.1	WP 5.2 Design Input Record	T5.2+1
5	5.2.2	WP 5.2 Draft report support grouping	T5.2+2
5	5.2.3	WP 5.2 FEM model(s) (ANSYS)	T5.2+5
5	5.2.4	WP 5.2 Final analysis reports	T5.2+7

This WP includes the supports defined in ref. [269] to [272], [240] (only the ones located in the VS), [242] (only the ones located in the VS), [284] (only the ones located in the VS), [287] (only the ones located in the VS).

8.6.3 WP 5.3: Piping supports thermal load cases: Drain Tank Room (DTR)

Scope: VV PHTS and DRS in DTR

WP Expected starting date (T5.3): T0 + 8 Weeks

WP Time for Completion: T5.3+ 12 weeks

WP 5.3			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
5	5.3.1	WP 5.3 Design Input Record	T5.3+1
5	5.3.2	WP 5.3 Draft report support grouping	T5.3+3
5	5.3.3	WP 5.3 FEM model(s) (ANSYS)	T5.3+10
5	5.3.4	WP 5.3 Final analysis reports	T5.3+12

This WP includes the supports defined in ref.

8.6.4 WP 5.4: Piping supports thermal load cases: Safety drainage Ring Header

Scope: DRS safety drainage ring header in B2M

WP Expected starting date (T5.4): T0 + 8 Weeks

WP Time for Completion: T5.4+ 7 weeks

WP 5.4			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
5	5.4.1	WP 5.4 Design Input Record	T5.4+1
5	5.4.2	WP 5.4 Draft report support grouping	T5.4+2
5	5.4.3	WP 5.4 FEM model(s) (ANSYS)	T5.4+5
5	5.4.4	WP 5.4 Final analysis reports	T5.4+7

This WP includes the supports defined in ref. [285].

8.6.5 WP 5.5: Piping supports thermal load cases: B2M C01-C09

Scope: IBED PHTS ring header at ceiling level (Equatorial port cooling) and VV PHTS branch lines.

WP Expected starting date (T5.5): T0 + 14 Weeks

WP Time for Completion: T5.5+ 7 weeks

WP 5.5			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
5	5.5.1	WP 5.5 Design Input Record	T5.5+1
5	5.5.2	WP 5.5 Draft report support grouping	T5.5+2
5	5.5.3	WP 5.5 FEM model(s) (ANSYS)	T5.5+5
5	5.5.4	WP 5.5 Final analysis reports	T5.5+7

This WP includes the supports defined in ref. [273] to [280] (for the ones related to equatorial port cooling at the ceiling) and [239] (for the ones supporting the VV PHTS branch lines in sectors C01 to C09).

8.6.6 WP 5.6: Piping supports thermal load cases: Drying System at L4

Scope: Drying system (DYS) at L4.

WP Expected starting date (T5.6): T0 + 19 Weeks

WP Time for Completion: T5.6+ 7 weeks

WP 5.6			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
5	5.6.1	WP 5.6 Design Input Record	T5.6+1
5	5.6.2	WP 5.6 Draft report support grouping	T5.6+2
5	5.6.3	WP 5.6 FEM model(s) (ANSYS)	T5.6+5
5	5.6.4	WP 5.6 Final analysis reports	T5.6+7

This WP includes the supports defined in ref. [288] and [289].

8.6.7 WP 5.7: Piping supports thermal load cases: L3-03 First delivery

Scope: VV PHTS and NBI PHTS on the north wall at L3M level

WP Expected starting date (T5.7): T0 + 21 Weeks

WP Time for Completion: T5.7+ 7 weeks

WP 5.7			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
5	5.7.1	WP 5.7 Design Input Record	T5.7+1
5	5.7.2	WP 5.7 Draft report support grouping	T5.7+2
5	5.7.3	WP 5.7 FEM model(s) (ANSYS)	T5.7+5
5	5.7.4	WP 5.7 Final analysis reports	T5.7+7

This WP includes the supports defined in ref. [240] and [283] (both for the supports located on the north wall of L3M).

8.6.8 WP 5.8: Piping supports thermal load cases: Port cells B1

Scope: IBED PHTS in Port Cells B1.

WP Expected starting date (T5.8): T0 + 26 Weeks

WP Time for Completion: T5.8+ 7 weeks

WP 5.8			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
5	5.8.1	WP 5.8 Design Input Record	T5.8+1

5	5.8.2	WP 5.8 Draft report support grouping	T5.8+2
5	5.8.3	WP 5.8 FEM model(s) (ANSYS)	T5.8+5
5	5.8.4	WP 5.8 Final analysis reports	T5.8+7

This WP includes the supports defined in ref. [247].

8.6.9 WP 5.9: Piping supports thermal load cases: B2M C10-C18

Scope: IBED PHTS divertor cooling, IBED PHTS Equatorial port cooling branch lines, drying system and VV PHTS branch lines in sectors C10 to C18.

WP Expected starting date (T5.9): T0 + 28 Weeks

WP Time for Completion: T5.9+ 7 weeks

WP 5.9			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
5	5.9.1	WP 5.9 Design Input Record	T5.9+1
5	5.9.2	WP 5.9 Draft report support grouping	T5.9+2
5	5.9.3	WP 5.9 FEM model(s) (ANSYS)	T5.9+5
5	5.9.4	WP 5.9 Final analysis reports	T5.9+7

This WP includes the supports defined in ref. [273] to [280] (for the ones related to divertor and equatorial port cooling branch lines), [239] (for the ones supporting the VV PHTS branch lines in sectors C10 to C18), and [287] (for the supports in B2M).

8.6.10 WP 5.10: Piping supports thermal load cases: L4 VV PHTS

Scope: VV PHTS in L4

WP Expected starting date (T5.10): T0 + 33 Weeks

WP Time for Completion: T5.10+ 7 weeks

WP 5.10			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
5	5.10.1	WP 5.10 Design Input Record	T5.10+1
5	5.10.2	WP 5.10 Draft report support grouping	T5.10+2
5	5.10.3	WP 5.10 FEM model(s) (ANSYS)	T5.10+5

5	5.10.4	WP 5.10 Final analysis reports	T5.10+7

This WP includes the supports defined in ref. [242].

8.6.11WP 5.11: Piping supports thermal load cases: L3-03 all other deliveries

Scope: Drying system at L3, IBED PHTS headers and piping modules, and VV PHTS headers and branch lines.

WP Expected starting date (T5.11): T0 + 35 Weeks

WP Time for Completion: T5.11+ 12 weeks

WP 5.11			
Task	**Deliverable**	**Document**	**Time for completion (Weeks)**
5	5.11.1	WP 5.11 Design Input Record	T5.11+1
5	5.11.2	WP 5.11 Draft report support grouping	T5.11+2
5	5.11.3	WP 5.11 FEM model(s) (ANSYS)	T5.11+10
5	5.11.4	WP 5.11 Final analysis reports	T5.11+12

This WP includes the supports defined in ref. [287], [240], [249] (for all sectors), [250].

9 Particular Requirements

9.1 Exchange and sharing of CAD files and calculation models

9.1.1 CAD files

For the TCWS components, the Configuration Management Models (CMMs – 3D models where the context of the plant is managed) are in ENOVIA\CATIA V5 software and the detailed design models (DMs) for TCWS components are created out of context using AVEVA E3D. The coherency between both models will be managed using exchanges of data between both software in neutral format (e.g. step files) as defined in section 6.

The Contractor shall provide a Design Plan to be approved by the IO. Such plan shall identify all CAD design activities and deliverables to be provided by the Contractor as part of the contract. In addition the Contractor and IO shall establish a DCIF to frame the CAD collaboration scheme and define all necessary CAD collaboration aspects (e.g. frequency of CAD context exchange, possible conversions into other CAD format …), as defined in ref. [38].

The Contractor shall ensure that all CAD Data (Schematics, Models and Drawings) delivered to the IO comply with the Procedures ref. [40] and ref. [41].

The TCWS design shall be exchanged based on 2D drawings and 3D models in the format of AVEVA E3D and release indicated within the latest version of the ITER CAD Manual ref. [44] and ref. [45]. In addition the Contractor has to use the AVEVA ITER Environment and to ensure that the CAD deliverable can be reintegrated into IO CAD databases. The AVEVA ITER Environment will be provided by the IO to the Contractor at KoM.

As indicated in ref. [40] and [41], CAD data associated only with production may be produced in other formats than the IO standard software, if compatible with the IO standard software and agreed by the IO Design Office. The Contractor shall ensure then that CAD data originated from the software of his choice is accurately converted to such version of AVEVA E3D. All consequences and defects resulting from an inadequate or inaccurate conversion from or to the ITER standard CAD software format is the sole responsibility of the Contractor.

The exchange of the CAD files shall follow the procedure ref.[38].

9.1.2 Calculation models

The calculation models (CAESAR II files, GT STRUDL files, or any other types specified in section 6) shall be submitted to the IO with the results of the calculations in the frame of the each task defined in section 6.
The analyses and calculation shall follow the requirements indicated in the procedure ref. [46]. 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 ref. [37].

9.2 Contractor's resources

The Awarded Contractor will establish a team fully and exclusively dedicated to perform the described services. The team involved in the Contract shall be located within the same building in order to have a good coordination between the different disciplines.

The Contractor will provide IO the CV of the assigned team during the tender phase. Once the Contractor is awarded, IO will only accept modifications in the team if the substituted profile has equal or better qualifications as the candidate proposed in the tender. After KoM, the Contract does not allow reassignment of the Contracted engineers and designers for the duration of the Contract without the prior approval of the ITER Organization (IO).

The Contractor shall include in his proposal a dedicated resource or frequent visit (monthly the first 6 months of the contract and then bi-monthly) on the IO site in order to ensure a permanent communication with the IO. This resource will mainly ensure that the work performed in the Contractor's premises is perfectly integrated in the IO plant environment.

The Contractor will include in his proposal a Design Plan where he describes:

- How the Contractor will organize the team to meet the technical requirements and the schedule, including organizational chart.
- Its understanding of the tasks proposed and how the Contractor will perform each of the tasks proposed.
- Technical proposal on the approach to follow for each of the tasks included in the contract.
- Procedure for the final validation of pipes and supports.
- Proposed procedure for the exchange of AVEVA E3D files and CATIA files in order to work in context, if different to that proposed by IO.
- Technical contact point for each tasks, in addition of the project manager.
- List of documents to be produced.

9.3 Contractor's reporting

The Contractor will provide a Monthly Report one working week before the end of each month on the progress of the different tasks, subtasks and the related Deliverables at the cut-off date of the middle of the month. This report shall contain a summary of the activities performed and items accomplished in the 30 last days and 30 days look ahead, percentage of accomplishment per activity and per Deliverable, update of risks issues and concerns, as well as required IO input data that may have impact in current or following activities.

The Contractor will provide as well as Schedule at the start of the Services and an update with each Monthly Report. Each version will be submitted for the IO approval. This schedule will list and define the organization and status of all the technical and non-technical documents to be provided by the Contractor during the development of the Services.

This schedule, organized in accordance with Works Package breakdown, will include, among others, details of when documents are to be published, when they are actually published and when they received their validation visa.

The Contractor has to issue Documents that constitute the Contractor Documentation Package and to update its schedule accordingly throughout the duration of the Contract as each part of the works is completed rather than wait until the end of the works.

The schedule includes, as a minimum, the following information:

- The document identification reference.
- The document title.
- The version of the document and indication if it is the latest version.
- The expected and current date of issue.
- The status of the document (for approval, for information …).
- The acceptance visa of the document and related status (in-work, released, commented\revised, approved, NA).
- The file format of the native documents (.doc, .xls, .dwg…).
- The folder and sub-folder of the Documentation Package in which the document is stored.

This list can be completed with extra information on the IO's request or if found necessary by the Contractor. However, the first mandatory columns cannot be changed by the Contractor, only extra columns can be added by the Contractor on the right of the table.

9.4 Hold-Points

For each Work Package, a Kick-off Meeting (KoM) will be held to formalize the start of the Services related to the concerned WP. Within this meeting IO will provide the Contractor with the necessary input data and required references to proceed with the activity. Contractor shall produce a Design Input Record of all the design information received from IO and update periodically (in case of changes).

The Contractor shall provide to IO the Deliverables corresponding to the WP assigned by IO in due time. The content of such Deliverables is summarized in chapter 6.

For each WP to be studied through Tasks 0 to 4, IO will ensure the progress and the quality of the Services by establishing a Hold Point after the completion of each step as presented here-after. For one WP, the Contactor will not be authorized to start to work on the next WP as long as the Hold-Point is not released by the IO by approving the Deliverables and intermediate steps related the Hold-Point as defined here-after.

For Task 0: Water Hammer analyses

- First hold point: Screening of the water hammer and hydraulic loads cases. Description of the geometry for the selected cases. Methodology, assumptions and input data.
- Second hold point: Output of the analysis with the water hammer time history (draft final report) and explanation of the obtained results.

For Task 1: Piping Stress Analysis:

- First hold point: Caesar model before running the analysis.
- Second hold point: Caesar model after line qualification.

For Task 2: Piping Support Design

- First hold point: AVEVA E3D models updated with the proposed support configuration.
- Second hold point: Structural calculation software models after supports qualification.
- Third hold point: AVEVA E3D models updated with the qualified supports.

For Task 3: Optional task for the construction drawings

No hold point

For Task 4: Task for local thermos-hydraulic phenomena

Hold point: Short report on the mitigation measures able to solve the local thermo-hydraulic issues without performing detailed analysis (First issue of final report).

9.5 Validation Circuit for Contractor's Documents

The Contractor shall provide a Quality Plan to be approved by the IO. Such plan shall identify all activities and deliverables, including the Contractor's internal validation circuit which shall comply with ref. [46]. The Independent Peer reviewer and the Technical Checker as defined in ref. [46] have to be identified in the Contractor's validation circuit and on each deliverable.

The Contractor shall be responsible for Submitting all the required documentation for the IO's approval, through IO's Document Management System (hereafter called IDM for documents and SMDD for drawings) in accordance with the validation circuit defined hereinafter. The upload of document in SMDD shall be performed following the references [39] and [330].

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

The Contractor shall submit its documents in version 01.0 into IDM and SMDD. The documents will be identified "For approval" or "For information".

In parallel, the Contractor shall send a message (e-mail or IDM message) to the IO representatives involved in the validation circuit in accordance with the distribution list provided by the IO. This message will inform relevant recipients that documents have been uploaded.

The IO review of the document shall begin after the notification done by the Contractor. Hereinafter, D defines the date of the document uploaded into IDM, and from which begins the evaluation of the document.

During the duration given in the tables below, the IO shall submit its comments and propose a consolidated and final version status.

Type of document	Deadline for comments submission
WH screening	D + 10 working days
WH analysis output	D + 10 working days
WH analysis report	D + 15 working days
Caesar II model	D + 10 working days
Piping Stress analysis report	D + 15 working days
Structural models of supports	D + 10 working days
Structural support analysis report	D + 15 working days
BoMs and list	D + 10 working days
Drawings and Isometrics	D + 15 working days
Thermo-hydraulic issues mitigation draft report	D + 10 working days
Thermo-hydraulic issues mitigation final report	D + 15 working days
CFD and fatigue analysis models	D + 15 working days
3D model with support design	D + 15 working days
3D model for other tasks	D + 10 working days

Table 3: Document review duration

At the end of the analysis, the document can be finally approved without comments, approved with comments or refused (revision requested). If the document is approved with comment or refused, the Contractor shall have 10 (ten) working days to update the document according to these comments and to re-submit it in a new version for approval following the circuit described above.

If the document is approved with comments, it means that the comments are minor and have no impact on the next activities, nevertheless the comments have to be answered by Contractor and a new version addressing them shall be submitted to the IO.

In any case, when a document is commented by the IO, the Contractor shall incorporate changes as required by comments on the document. The Contractor shall provide a resolution sheet including brief descriptions in line item letter form on how each IO comment was resolved. Corrected documents shall be resubmitted to IO for review as specified on the document transmittal form. All revisions shall be clearly indicated on the document and the document number and control log shall be updated.

Note: Changes in documents between each version provided by the Contractor shall be identified with a summary of the changes performed in the beginning of the document and in the core of the documents (for text using highlight for example, and clouds on drawings).

10 Input data from the IO

Depending on the Work Packages, the IO shall make available to the Contractor at the KoM of the WP some of the following documents:

- TCWS Load Specification [53]
- Water and steam hammer loads in case task 0 is not performed by Contractor for the related sub-system.

- Lines list.
- Design Guidelines [57] and [58]
- P&IDs
- Pipe class data sheets
- Valve specification and other in line elements specifications.
- TCWS current configuration of editable 3D model in AVEVA E3D CAD Platform.
- TCWS current configuration integrated with other systems and buildings in CATIA non editable format (3DXML or exe in this case for information).
- Floor response spectra and major components spectra (e.g. Cryostat).
- Thermal Insulation (or fire protection and any other types of protection) specification.
- Allowable loads on static and rotating equipment. If the equipment is not yet selected by the time the Contractor needs this definition, IO will provide limiting criteria for the loads transmitted to equipment and penetrations.
- Data sheets and GA drawings of connecting equipment at pipe boundaries.
- Allowable loads for any other types of interfaces such as building and major components penetrations (Cryostat), or supporting interfaces (EPs).
- Analysis models and relate report(s) of the previous analyses done so far by IO or his Contractors (if existing).
- List of embedded plates included in CATIA 3D models.
- Screening of Local Thermo-Hydraulic phenomena applicable for TCWS performed by IO.

11 Non – disclosure Conditions

The Awarded Contractor assigned to perform the services described under this specification must agree to abide by the following nondisclosure conditions:

- Not to disclose, deliver, or use for the benefit of any person other than the IO, or its authorized agents, any restricted or confidential information or material he or she receives from the IO, other than material or information previously in the records of the Contractor or obtainable prior to such disclosure, delivery, or use, from third parties or from the public domain, or required to be disclosed by law or court order.
- To adhere to any reasonable policies or instructions provided by the IO as to the classification, use or disposition of any restricted or confidential information or materials.
- Not to use any restricted or confidential information or material for personal gain.
- Because of Export License conditions the Contractor shall not share the documentation related to this task outside the assigned team. At the end of the contact the Contractor will return the documentation to the ITER Organization or destroy the documentation as might be mutually agreed.

All the documentation provided as reference for this Technical Specification is subjected to the above conditions. During the Contract deployment, unless clearly stated by IO, all documentation provided by IO will be subjected to the above conditions.

The Contractor further agrees to take such reasonable steps as may be needed to ensure that the terms of the nondisclosure statements are observed during and after the termination of the Services.

12 Travel Expenses

See Contract conditions for details concerning traveling conditions and meetings location.

13 Nuclear Safety Assurance

13.1 Propagation of Safety Requirements

ITER is a nuclear facility identified in France by the number INB-174. The external Contractor must respect the Authorization Basis.

The IO informs the Contractor that the present technical specification includes design of protection important components (PIC), to which the French Order dated 7th February 2012 ref. [1] applies and are subject to IO and regulatory body inspections.

The documents important for nuclear safety are presented in the chapter 4.3.

Under Order 7 February 2012 ref. [1], 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 ref. [21] 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) have to be monitored by the IO.

The subcontractor must possess a quality system in agreement with the importance of the activities being performed and in particular for the follow-up of the PIA corresponding to the PIC to be designed under the contract. This system shall be included in the Quality Plan. In addition, the external Contractor must guaranty that the defined requirements identified for Protection Important components and activities are properly cascaded down in its chain of external Contractors through their own technical specification. When necessary for the Protection Important Activities related to the nuclear safety demonstration and in particular for assessing the results of the studies, the requirements of the Title III of the INB Order ref. [1], Article 3.9 must be taken into account.

The external Contractor shall grant access rights to the IO and Host regulatory body representatives to its facilities and records and those of its suppliers and sub-Contractors for the purposes of surveillance of defined requirements during the design of a PIC as required by the French Order dated 7th February 2012 [1]. This surveillance shall also include the examination of all protection-important activities and the follow-up and verification of all corrective actions which are to be implemented.

The document Provisions for Implementation of the Generic Safety Requirements by the External Actors/Interveners ref. [31] is just a declination of the French order. The goal of this document is to describe more practically the requirements defined in the French order. For the contract which is a study, the supplier shall comply with the following points:
- To get validated input data
- To use a validated and qualified code in the range of use
- To ask to a 3rd person to check the analyses
This corresponds to comply with R13 and R28, and R29.

13.2 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 traced 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.

14 Quality Assurance

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, on the basis of activities defined and executed by the Contractor and its Sub-contractor. This system shall 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 at the start of this contract.

14.1 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 Contractor shall ensure that their subcontractors carrying out the activities in the scope of this contract are in compliance with the QA requirements under the relevant QA classifications as defined in section 2.3. Consequently and among others, all levels of Suppliers and Sub-Contractors shall submit their own Quality plan for IO approval before the start of their own activities.

A project Specific Quality Plan that meets the requirements of the IO procedure for a project specific Quality Plan Ref. [35] shall be submitted for IO review and approval before the start of the Services. Similar control of quality activities for all levels of subcontractors supplying services is requested when inspection or certification is required.

The ITER QA Program is based on IAEA Safety Standard GS-R-3 and on conventional QA principles, and integrates the requirements of the French Order dated, 7th February 2012 ref. [1] on the quality of design, construction and operation in a Basic Nuclear Installation. 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.

14.2 Responsibilities

The Contractor shall be fully responsible for quality with respect to all services. 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. 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 contractual documents.

14.3 Third Party

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

The third party may be involved in checking:

- Design checks (e.g. calculation notes, plans)
- Review of procedures and qualifications of workers

The Contractor shall provide access and information required by the third party to perform the necessary evaluations and tests to fulfil its responsibilities.

14.4 Access to Contractor's Premises

The Contractor shall take all necessary measures to allow IO unrestricted access to all of the Contractor's documentation, premises and personnel (including that of its Sub-Contractors) during all stages of the Contract for the purpose of such audit, review, surveillance and inspection as IO may consider necessary.

IO reserves the right to make unscheduled visits to the Site or the Contractor or Sub-Contractors' work premises, and free access must be provided at all reasonable times.

IO shall have the right to have permanent inspectors working inside the Contractor's premises. Should this be required, the Contractor shall reserve an office inside its workshops for the inspectors, equipped with a telephone and facsimile with international access, and computers with internet access.

IO or its representatives shall be permitted to take photographs and / or video recordings of any activity relating to the Contract. The material so obtained will remain confidential.

The IO procedure for Quality Management System Audit, ref. [34] is applicable.

14.5 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 activities included in the present technical specification is described in the document ref. [23]. The Contractor shall ensure that they implement a system 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 requests 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. [36].

If the conformity assessment could not be completed because of NCR from the Contractor and/or its subcontractor(s), the Contractor shall have the related activities or parts redone at its own costs.

14.6 Verification and Validation of software(s)

Contractor must perform the Verification and Validation of all the softwares used within the framework of this contract according to ASME NQA-1 ref. [16] and depending on the Quality Classes to Software Qualification Policy ref. [50].

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

The software V&V plan including V&V reports for each computer has to be delivered to IO before the starting of any activity including calculations. The Dossier must include the reports of the validation for each machine used by Contractor and its sub-Contractors, if any.

APPENDIX A – DRAWING QUANTITIES FOR TASK 3

EWP	Number of Sheets Required									Piping length
	P&ID	Isometric	Secondary Support Drawing	Primary Supports Drawings	Specialty Item Drawing	Bills of Material (Pipe and fitting, insturumentation, valve, primary supports, secondary supports)	General Arrangement Drawing	Standard Detail Drawing	Lists (Line , Valve, Support)	
WP 3.1 Construction documentation for EWP L3-03 first delivery	20	135	100	15	0	15	15	12	15	2,691
WP 3.2 Construction documentation for EWP TCWS at NB Cell in B11	2	19	14	0	0	3	2	0	3	197
WP 3.3 Construction documentation for EWP L3-03 second delivery	20	74	34	15	0	15	11	6	15	1,551
WP 3.4 Construction documentation for EWP B2M in B11 C10-C18	11	236	326	80	0	15	54	1	15	1,972
WP 3.5 Construction documentation for EWP 55 Install Upper VV PHTS Pipework	3	50	108	0	9	1	9	2	1	1,275
WP 3.6 Construction documentation for EWP 54 Install Upper IBED PHTS Pipework	18	828	54	0	18	1	18	2	1	6,380
WP 3.7 Construction documentation for EWP 53 Lower & EQ PHTS	5	83	108	0	9	1	9	2	1	1,846
WP 3.8 Construction documentation for EWP B1 in B11	20	654	216	0	0	2	72	0	2	4,176
WP 3.9 Construction documentation for EWP L4 in B14	3	30	30	0	0	3	2	0	3	189
WP 3.10 Construction documentation for EWP L3-03 -Third delivery	20	295	136	15	0	15	41	6	15	6,204
WP 3.11 Construction documentation for EWP L4 VV PHTS	6	105	50	0	0	3	6	0	3	664
WP 3.12 Construction documentation for EWP DTR in B11	11	278	199	40	0	3	4	1	3	1,291

APPENDIX B – DRAFT SCHEDULE

Task	WP #	WP description	Duration (weeks)	T0	T0 + 1W	T0 + 2W	T0 + 3W	T0 + 4W	T0 + 5W	T0 + 6W	T0 + 7W	T0 + 8W	T0 + 9W	T0 + 10W	T0 + 11W	T0 + 12W	T0 + 13W	T0 + 14W	T0 + 15W	T0 + 16W	T0 + 17W	T0 + 18W	T0 + 19W	T0 + 20W	T0 + 21W	T0 + 22W	T0 + 23W	T0 + 24W	T0 + 25W	T0 + 26W	T0 + 27W	T0 + 28W	T0 + 29W	T0 + 30W	T0 + 31W	T0 + 32W
0	WP 0.1	Water Hammer analysis of NBI PHTS	11																																	
0	WP 0.2	Water Hammer analysis of IBED PHTS second plasma portions	11																																	
0	WP 0.3	Water Hammer analysis of CVCS for IBED PHTS	11																																	
0	WP 0.4	Water Hammer analysis of CVCS for NBI PHTS	11																																	
1	WP 1.1	Piping stress analysis of NBI PHTS	8																																	
1	WP 1.2	Piping stress analysis of IBED PHTS second plasma portions	14																																	
1	WP 1.3	Piping stress analysis of CVCS for IBED PHTS	8																																	
1	WP 1.4	Piping stress analysis of CVCS for NBI PHTS	8																																	
1	WP 1.5	Piping stress analysis of Sampling system	8																																	
1	WP 1.6	optional piping stress analysis of IBED PHTS in L3 headers up to piping modules	11																																	
1	WP 1.7	optional piping stress analysis of IBED PHTS piping modules at L3	11																																	
1	WP 1.8	optional piping stress analysis of IBED PHTS piping in-cryostat upper part	11																																	
1	WP 1.9	optional piping stress analysis of VV PHTS in VS, NB Cell, L3 and In-cryostat upper parts	15																																	
2	WP 2.1	Support design of NBI PHTS	10																																	
2	WP 2.2	Support design of IBED PHTS second plasma portions	14																																	
2	WP 2.3	Support design of CVCS for IBED PHTS	10																																	
2	WP 2.4	Support design of CVCS for NBI PHTS	10																																	
2	WP 2.5	Support design of sampling system	8																																	
2	WP 2.6	optional support design of IBED PHTS in L3 headers up to piping modules	10																																	
2	WP 2.7	optional support design of IBED PHTS piping modules at L3	10																																	
2	WP 2.8	optional support design of IBED PHTS piping in-cryostat upper part	10																																	
2	WP 2.9	optional support design of VV PHTS in VS, L3 and In-cryostat upper parts	10																																	
3	WP 3.1	Construction documentation for EWP L3-03 first delivery	4																																	
3	WP 3.2	Construction documentation for EWP TCWS at NB Cell in B11	4																																	
3	WP 3.3	Construction documentation for EWP L3-03 second delivery	4																																	
3	WP 3.4	Construction documentation for EWP B2M in B11 C10-C18	4																																	
3	WP 3.5	Construction documentation for EWP 55 Install Upper VV PHTS Pipework	4																																	
3	WP 3.6	Construction documentation for EWP 54 Install Upper IBED PHTS Pipework	4																																	
3	WP 3.7	Construction documentation for EWP 53 Lower & EQ PHTS	4																																	
3	WP 3.8	Construction documentation for EWP B1 in B11	4																																	
3	WP 3.9	Construction documentation for EWP L4 in B14	4																																	
3	WP 3.10	Construction documentation for EWP L3-03 -Third delivery	4																																	
3	WP 3.11	Construction documentation for EWP L4 VV PHTS	4																																	
3	WP 3.12	Construction documentation for EWP DTR in B11	4																																	
4	WP 4.1:	Local Thermo-hydraulic phenomena for VV PHTS	16																																	
4	WP 4.2:	Local Thermo-hydraulic phenomena for IBED PHTS	21																																	
4	WP 4.3:	Local Thermo-hydraulic phenomena for DYS	12																																	
4	WP 4.4:	Local Thermo-hydraulic phenomena for CVBD	17																																	
5	WP 5.1	Piping supports thermal load cases: B2M area 1.1	7																																	
5	WP 5.2	Piping supports thermal load cases: B2M VS to L3	7																																	
5	WP 5.3	Piping supports thermal load cases: Drain Tank Room (DTR)	12																																	
5	WP 5.4	Piping supports thermal load cases: Safety drainage Ring Header	7																																	
5	WP 5.5	Piping supports thermal load cases: B2M C01-C09	7																																	
5	WP 5.6	Piping supports thermal load cases: Drying System at L4	7																																	
5	WP 5.7	Piping supports thermal load cases: L3-03 First delivery	7																																	
5	WP 5.8	Piping supports thermal load cases: Port cells B1	7																																	
5	WP 5.9	Piping supports thermal load cases: B2M C10-C18	7																																	
5	WP 5.10	Piping supports thermal load cases: L4 VV PHTS	7																																	
5	WP 5.11	Piping supports thermal load cases: L3-03 all other deliveries	12																																	

Task	WP #	WP description	Duration (weeks)	Date																																				
				T0 + 33W	T0 + 34W	T0 + 35W	T0 + 36W	T0 + 37W	T0 + 38W	T0 + 39W	T0 + 40W	T0 + 41W	T0 + 42W	T0 + 43W	T0 + 44W	T0 + 45W	T0 + 46W	T0 + 47W	T0 + 48W	T0 + 49W	T0 + 50W	T0 + 51W	T0 + 52W	T0 + 53W	T0 + 54W	T0 + 55W	T0 + 56W	T0 + 57W	T0 + 58W	T0 + 59W	T0 + 60W	T0 + 61W	T0 + 62W	T0 + 63W	T0 + 64W	T0 + 65W	T0 + 66W	T0 + 67W	T0 + 68W	T0 + 69W
0	WP 0.1	Water Hammer analysis of NBI PHTS	11																																					
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Notes:

1- If optional WPs of task 1 and optional task 0 are not activated, the firm WPs for task 1 and task 3 will be anticipated starting at T0 following the same sequence as defined here).

2 - In task 3 production of EWP documentation, the sequence of WP can be re-organize but the same overall duration will be kept having not more than one WP at the same time.

3- The schedule here above is a tentative schedule, final schedule will be developed with the Contractor at KoM in order to meet IO milestone and harmonize as much as possible the workload during the overall contract duration.