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Technical Specifications (In-Cash Procurement)

Nuclear Integrated Engineering contract

The aims of the contract are:To support an ALARA approach with iterative steps considering an integrated maintenance (areas approach)To support PBS team in their design justification to meet their requirements following a coherent and integrated approach (ALARA, Maintenance, Human & Organizational Factor, Hazard analysis)

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1 Purpose

The aims of the contract are:

- To support an ALARA approach with iterative steps considering an integrated maintenance (areas approach)
- To support PBS teams in their design justification to meet their requirements following a coherent and integrated approach (ALARA, Maintenance, Human & Organizational Factor, Hazard analysis)

The purpose of this contract is to support NIU, SCOD/OPDA, and H&S who are in charge of transversal activities related to nuclear integration, maintenance, health and safety and PBSs to provide coherent and integrated design justification at Tokamak level on the following topics:

- Characterization of the Maintenance scenario per area to be defined, assimilating input from existing ITER documentation and related WPs within this contract. Then production of area maintenance plans;
- Development of the specification and implementation of a secure (multi-user + data under configuration control) ALARA-Maintenance Database;
- Implementation of an ALARA approach (iterative with several ORE assessments which include Shutdown Dose-rate (SDDR) assessment, formal justification);
- Coherent Contamination maps development;
- Maintenance considerations as input to the PBS design and standardization and Integrated Contamination controls design following a Tradeoff approach will be used to justify the best solutions among concepts. Propose System Requirements documents at concept level for the solutions that have been identified,
- Human & Organizational Factors (HOF) analysis based on ITER HOF program with two level approach: Macroscopic and microscopic analysis,
- Integrated Hazard analysis based ITER Occupational safety procedure.

These activities will be performed per area, in order to complete the PBS data with an integrated approach.

It should be noted the design is finished for some PBS, or quite advanced for other (FDR already passed). The contractor will have to take in considerations in its proposals/recommendations the level of maturity of the systems.

Definition and acronyms are given in Annex 1.

2 Context of ITER Project

The ITER project aims to demonstrate the scientific and technological feasibility of fusion power for peaceful purposes and to gain the knowledge necessary for the design of the next stage device.

The ITER project is organized as an international research and development project jointly funded by its seven Members; the European Union (represented by EURATOM), Japan, the People's Republic of China, India, the Republic of Korea, the Russian Federation and the USA.

ITER is being constructed in Europe, at St. Paul-lez-Durance in southern France, which is also the location of the headquarters of the ITER Organization (IO).

During ITER construction, most of its components will be supplied "in-kind" by the ITER Members. These in-kind contributions are being managed through a Domestic Agency (one per ITER Member) located within the Member's own territory.

The working language of the ITER Project is English.

More details about the Project Organization, The Domestic Agencies, the IO location and other different aspects of the Organization are available on the website: www.iter.org.

The ITER Organization (IO) is the nuclear operator, complying with the relevant French Laws and regulations, authorization, codes and standards applied to Basic Nuclear Installation (INB). IO is responsible for integrating the activities from the early stage of design, to the procurement, the assembly, commissioning and operation.

The Nuclear Integration Unit – NIU is a joint IO-CT/DA ITER team for all nuclear integration activities. It was created to ensure a consistent and fully integrated nuclear engineering approach throughout the whole ITER project compliant with project and regulatory requirements.

When ITER succeeds in producing 500MW of fusion power the total neutron production will be 1.8×10^{20} neutrons/s giving a flux on the first wall of the order of 10^{14}n/cm^2/s. This large specific source gives rise to several nuclear issues related to unusual radiation conditions for equipment and potential occupational radiation exposure to workers. In addition, internal exposure hazards are associated with potential contamination spreading of tritium and activated dust and Beryllium if appropriate prevention measures are not duly implemented to face any event. The proper management of these complex issues has an obvious impact on the design, construction, operation, maintenance and safety of the ITER facility.

The radiological protection objectives, which determine, together with system technical requirements, the nuclear shielding and radiation/contamination protection requirements which depend on the project lifecycle and on the particular location within the ITER facility. Nuclear integration is therefore a complex transverse function which involves multiple systems and interfaces. A close interaction with the involved systems, structures and components design activities is required to ensure that respective requirements for shielding, radiation exposure for plant and personnel, material and equipment design and selection, and minimization of radioactive contamination can be met in the integrated system. As regards limitation of exposure to ionizing radiation the processes have to provide demonstration of compliance with the ALARA principle.

IO Safety department has defined safety (including radiation) requirements; the RPrS [1] has been transmitted to ASN. The main goals of NIU include coordinating and leading the design efforts to solve all problems related to radiation exposure, confinement and contamination control, particularly in areas where there may be conflicting requirements and constraints.

In application of the ITER agreement, article 14, ITER follows the French Regulation for nuclear safety. Because of its inventory in nuclear materials, ITER has been classified in France as a nuclear facility “Installation Nucléaire de Base” and in particular numbered as INB no.174 per the French decree No 2012-2148 and the associated decision from the ASN (French Safety Authority. ITER Organization (IO) is the nuclear operator of this INB and understood like that in the framework of this contract.

As required by the INB Order, and notably its article 2.2.1, the nuclear operator (IO) must notify the external interveners of the necessary provisions for application of the INB order.

The supplier must comply with the all requirements expressed in “Provisions for implementation of the generic safety requirements by the external interveners” [5]**Error! Reference source not found.**. The contractor shall comply with requirements described in chapter 15 of this document.

3 Areas of work

3.1 Integrated approach

The ITER project requirements are identified in [2], including safety requirements coming from RPrS [1] and Safety Roombook [3].

The ITER system organization is on a PBS breakdown base (see figure 2 below).

In order to provide a coherent and integrated design justification the scope of work shall be organized on an Area basis. Each Area is basically a geometrical space (i.e. room) where a number of systems, based on the ITER PBS breakdown, operate.

The Tokamak complex consists of three building B11 (tokamak building), B14 (Tritium Building) and B74 (Diagnostics Building). This contract will be focused on Tokamak building B11 (firm part, then options could include other buildings). The drawings in ref.[4] give an overview of the Tokamak building.

Figure 1 - ITER site

Within the Tokamak Building (B11) several areas have been identified as follows:

- The galleries at each level,
- The Cryo-pump port cells at B1,
- The Remote handling port cell at B1,
- The IVVS ports cells at B1,
- The TBM ports,
- The Port area at equatorial level (L1) with vacuum extensions,
- The Port area at equatorial level (L1) without vacuum extensions,
- The Port area at upper level (L2) (ECH port),
- The Port area at upper level (L2) (Diagnostics port),
- The lower pipe chase at B2M,
- The upper pipe chase at L3,
- The NB Cell,
- The HV Deck,
- The drain tank room.

However, the scope of this technical specification is limited to:

- **Firm part: areas defined as PRIORITY 1** in annex 2 (a table with different areas, identifying representative areas, priority and the PBS concerned (see fig. 2 for the PBS level 1).
- Option part: **areas defined as PRIORITY 2 and 3** in annex 2

A prioritization of the areas has been identified and the work schedule has been defined accordingly. The priorities are defined as a function of the following factors:

- ORE Main Contributors as defined per the ITER RPrS [1], in particular: PBS55 Diagnostics, PBS26 Cooling Water systems, PBS23 Remote Handling systems, PBS 52 ECH, PBS 51 ICH and PBS 53 NBI.
- ITER PBS Design Schedule, (i.e. PBS to be installed for First Plasma, captive components …).
- Maturity of Design
- Criticality for the machine and scientific programme
- Value as generic examples

The scope of work is divided in two principal levels:

- GLOBAL ANALYSIS (Overview on all Areas – here is priority 1):

  ALARA approach implementation, all the areas will be analysed in order to identify the Tokamak Building 11 Global "ORE status N". This ORE status N, will then constitute the baseline radiological assessment from which improvements can be benchmarked. An optimization process (see detailed analysis below) will be implemented according to the priority list defined by IO (see annex 2 as well as the schedule presented in chapter 11.2) and highlighted by the "ORE status N". Once the optimization process has been implemented the "ORE status N+1" can be identified and the ALARA approach implementation can be demonstrated.
- DETAILED ANALYSIS (per Area):

  Detailed analysis will be performed according to the priority list defined by IO (see annex 2 as well as the schedule presented in chapter 11.2) and identified by the optimization process addressed in the Global Analysis. All the different topics to demonstrate the ALARA approach implementation will be analysed and detailed. Even if this activity is on Area base a global overview will be anyway promoted to enhance standardization (i.e. strategy, process, equipment…) with a coherent and integrated approach.

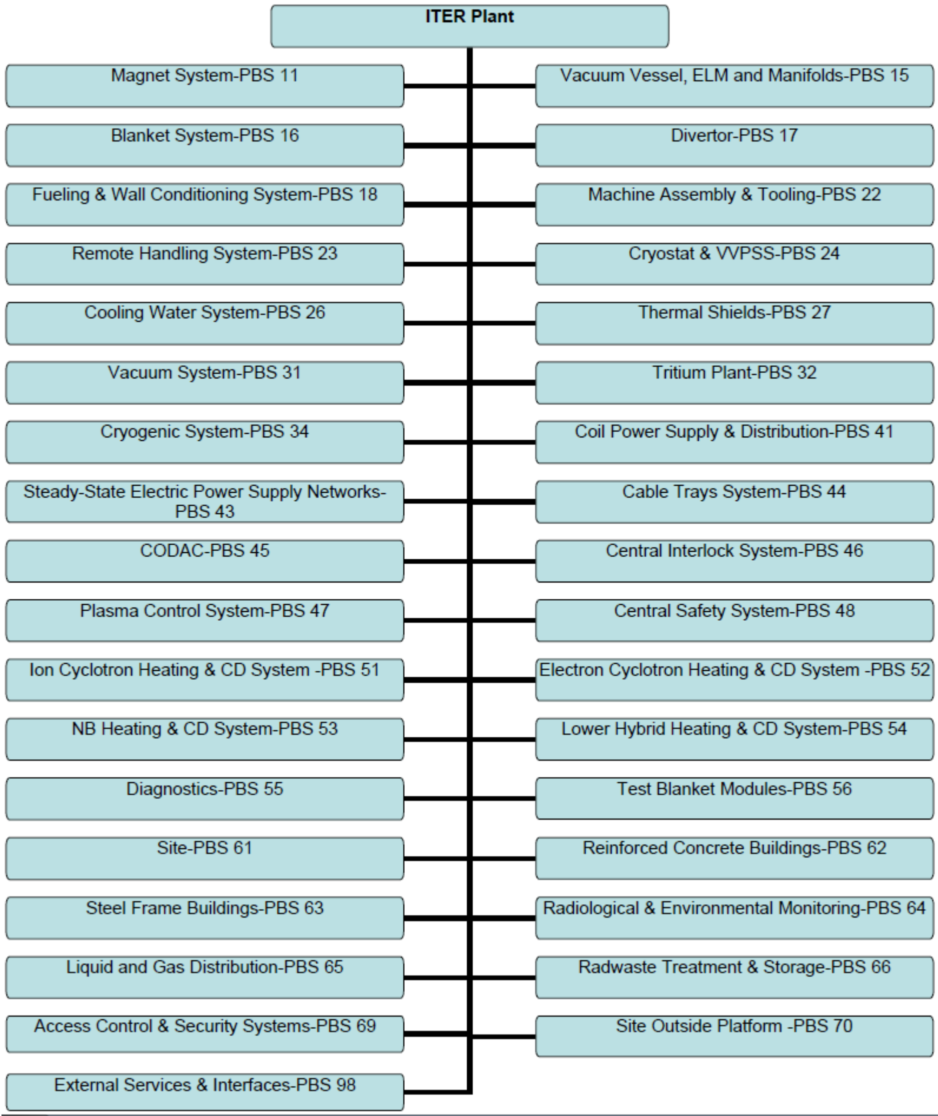


Figure 2 - Top level and Plant Breakdown Structure level 1

3.2 Description of the Tokamak

The Tokamak Building 11 is basically composed of:

- Tokamak Pit, located in the centre of the building, houses the VV, the superconducting magnets, the Thermal Shield and the cryostat. This cylindrical structure contributes to radiological shielding, and it is closed by a thick concrete slab,
- Port cells and peripheral galleries, located outside the Bioshield around the pit, through which the machine is accessed at the Divertor (B1), Equatorial (L1) and Upper (L2) levels. During certain operating phases, personnel and equipment transit via these port cells and galleries,
- The lower and upper pipe chases at levels B2M and L3 respectively,
- The Neutral beam cell and the HV deck room immediately above it. These are located on the north side of B11 and extend from L1 to L3,
- The building consists of 5 levels above 0 m and 2 below 0 m.

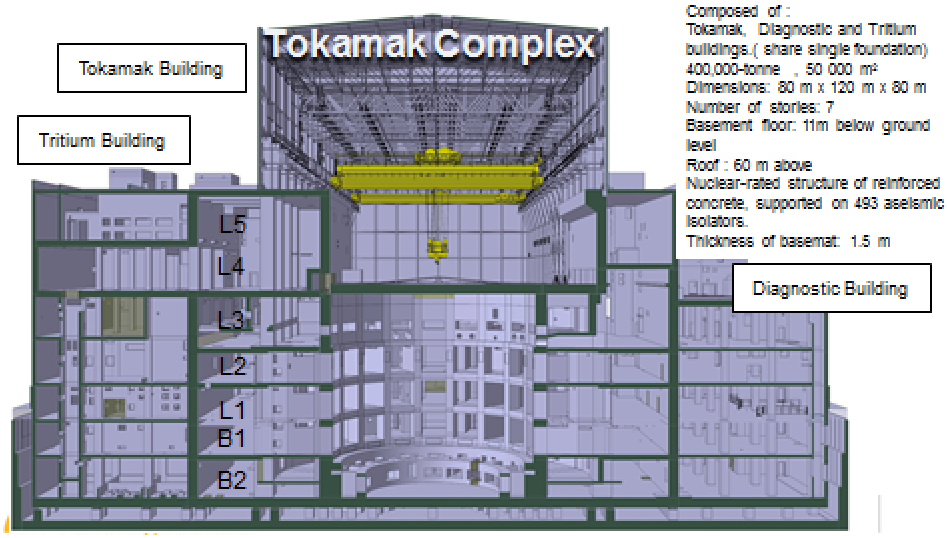


Figure 3 - Tokamak complex

The floor levels are aligned to suit the access requirements to the ports of the Tokamak machine at the Divertor (B1), Equatorial (L1) and Upper (L2) levels. The floors are split for the purpose of space allocation into galleries by compass direction. Galleries are largely uninterrupted by structures so that access for the remote handling equipment is possible.

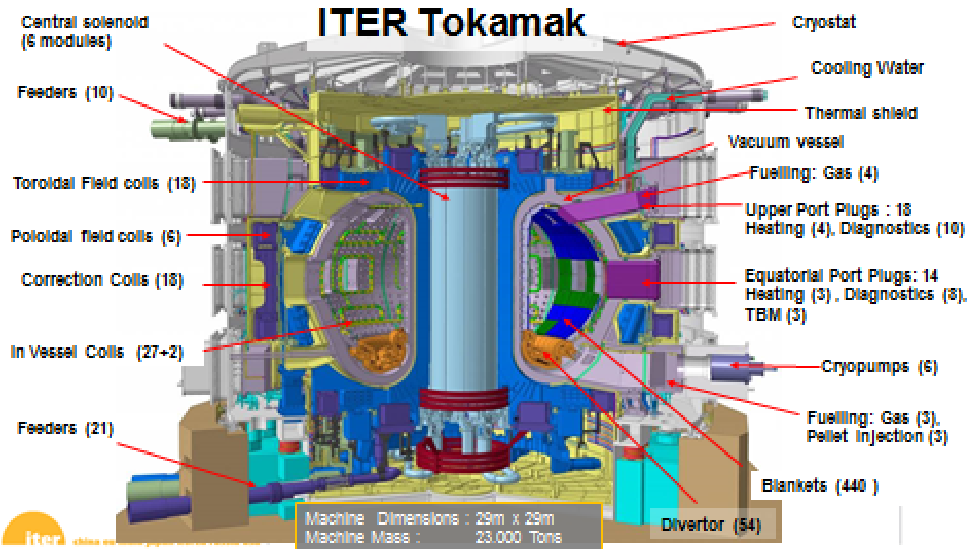


Figure 4 - ITER Tokamak Machine

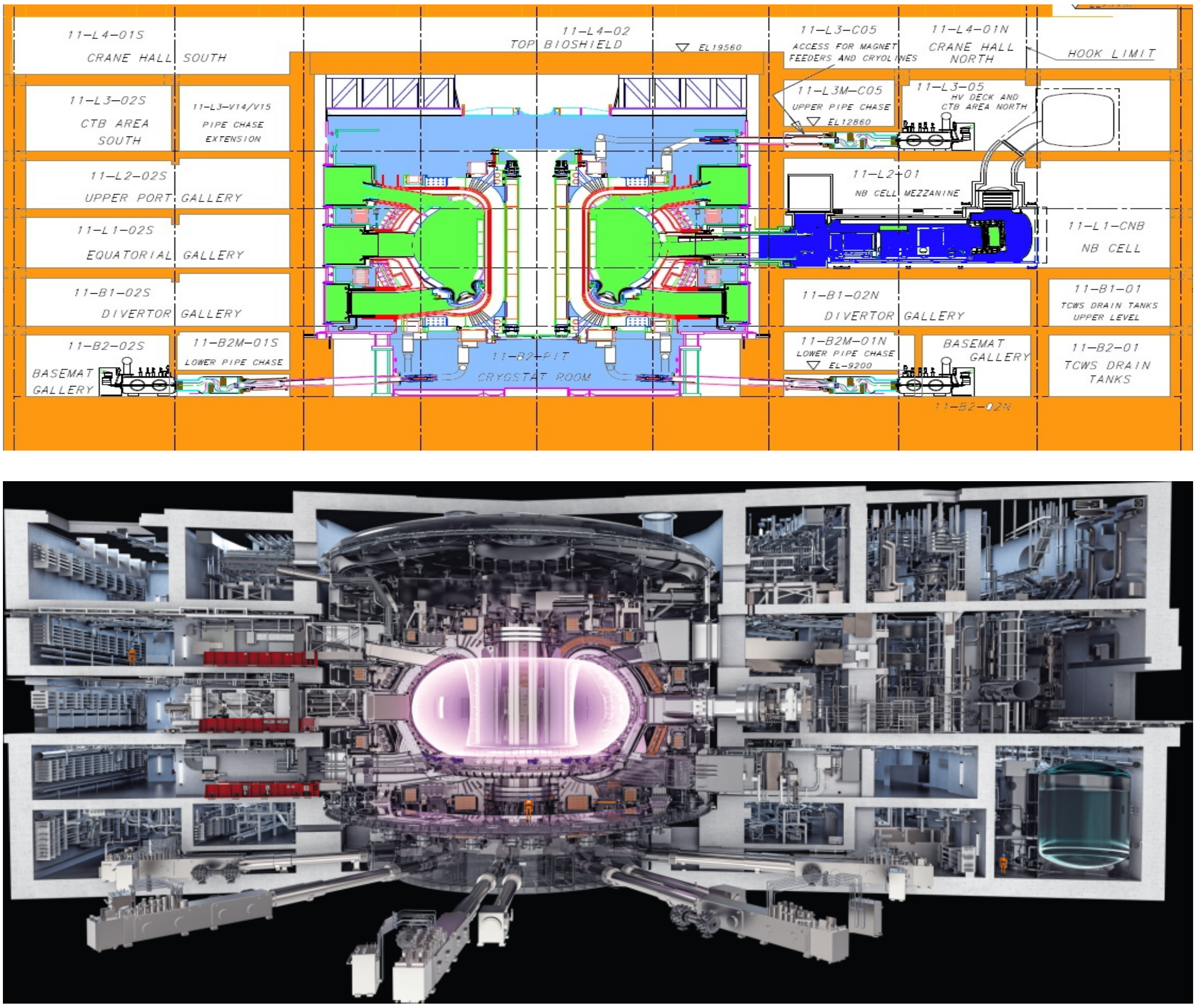


Figure 5 - ITER TOKAMAK Building 11

In the following paragraphs all the identified areas are further detailed and additional pictures are available in Annex 3.

3.2.1 Vacuum vessel

Concerned areas			
Galleries	NO	Port interspace at upper level	NO
Cryo-pump port cells at B1	NO	Lower pipe chase at B2M	NO
Remote handling port cell at B1	NO	Upper pipe chase at L3	NO
IVVS port cell at B1	NO	NB Cell	NO
Port cell at L1	NO	HV Deck	NO
Port interspace at equatorial level	NO	Drain tank room	NO
Port cell at L2	NO		

The vacuum vessel is a hermetically-sealed steel container inside the cryostat that houses the fusion reaction and acts as a first safety containment barrier. In its doughnut-shaped chamber, or torus, the plasma particles spiral around continuously without touching the walls. Forty-four ports will provide access to the vacuum vessel for remote handling operations, diagnostic systems, heating systems, and vacuum systems:

- The 18 ports in the upper part of the VV (upper ports) are tilted upwards; VV cooling system piping and in-vessel component pipes are welded to the outer surface of the ports and the port plugs are bolted on and welded by lip joints or metallic gasket bolted sealing flange,
- The 17 ports in the intermediate level of the VV (equatorial ports) include:
    - 3 ports for neutral beam injection (NBI) designed for tangential access for neutral beams used to heat the plasma, including a diagnostic neutral beam,
    - 14 radial ports designed for access to high frequency wave heating and current drive, the diagnostic equipment, limiters and test blanket modules as well as remote handling maintenance equipment for blanket modules,
- the 9 ports in the lower level of the VV and the 18 local penetrations (lower, divertor ports) are tilted downwards; the closure plates are fastened to the ports in the same way as in the upper closures while for the vacuum pumping ports, the pumping ducts extend to the cryopumps attached to the cryostat wall.

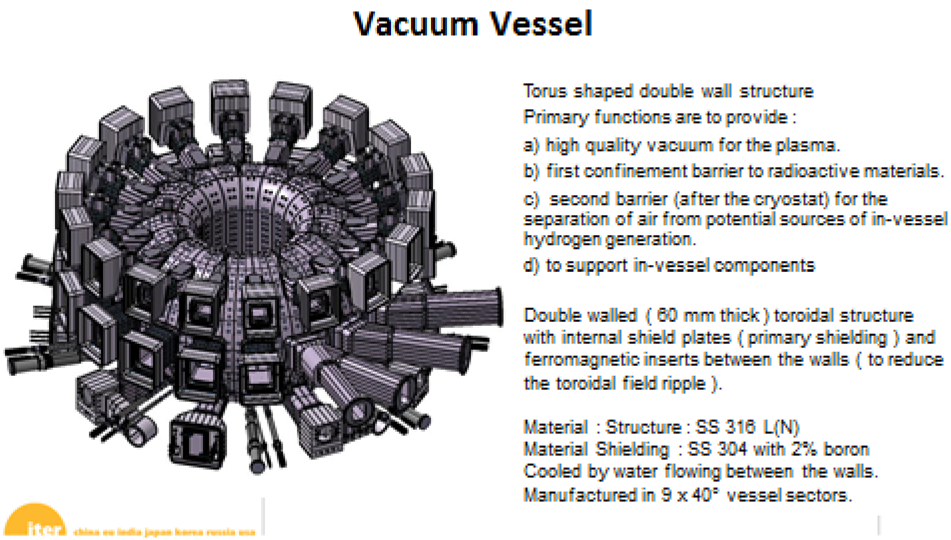


Figure 6 - ITER Vacuum Vessel

3.2.2 *Port cell area*

Concerned areas			
Galleries	NO	Port interspace at upper level	YES
Cryo-pump port cells at B1	YES	Lower pipe chase at B2M	NO
Remote handling port cell at B1	YES	Upper pipe chase at L3	NO
IVVS port cell at B1	YES	NB Cell	NO
Port cell at L1	YES	HV Deck	NO
Port interspace at equatorial level	YES	Drain tank room	NO
Port cell at L2	YES		

The Port Cell Area is located between the Port Cell Door and the Port Plug. The Interspace area is therefore part of the port cell area. The Port Cell Area is a classified nuclear area (yellow zone - 25µSv/h-2mSv/h). The main risks (radiological or similar) associated with this area are:

- Radiation (material activation);
- Contamination (tritium, Activated corrosion Product);
- Contamination (Beryllium dust).

Human workers can access the room in order to execute all the maintenance tasks as required (i.e. inspections, disconnections, installations …). All along the Port Cell Area the Port Rails are permanently and radially installed. The Port Plug is installed on the VV port extension and a sealing flange provides the 1st static confinement barrier. The Port Cell Door separates the gallery and the port cell itself providing the 2nd static confinement barrier together with the Port Cell itself.

The whole Port Cell Area is divided and contains two main zones: the Interspace and the Port Cell. The separation is provided by means of the Bioshield Plug.

The Bioshield plug provides only a shielding function since it is the extension of the building Bioshield.

3.2.2.1 Port cell area for diagnostics

These ports are equipped with different kind of diagnostics. The diagnostics are installed in a number of equatorial ports, upper ports and lower ports; some ports are dedicated to diagnostics, while others are equipped with diagnostic devices during machine operation which can be removed during maintenance campaign (scheduled or not) in order to perform in-vessel maintenance tasks.

For example, four of the Equatorial Ports (#3, #8, #12 and #17) and three of the Lower Ports (#2, #8 and #14) can be cleared for installing RH equipment to carry out In-Vessel tasks (e.g., cleaning/decontamination, Blanket/ First wall Panels replacement, diagnostic calibration, Divertor replacement…).

Some diagnostics extend the torus vacuum into the port cell.

The diagnostic devices are installed and supported by dedicated structures, Interspace Support Structure (ISS) inside the interspace between the VV port duct and the bioshield, and a Port Cell Support Structure (PCSS) outside the bioshield located in the port cell. A dedicated port plug is then installed on the VV port extension.

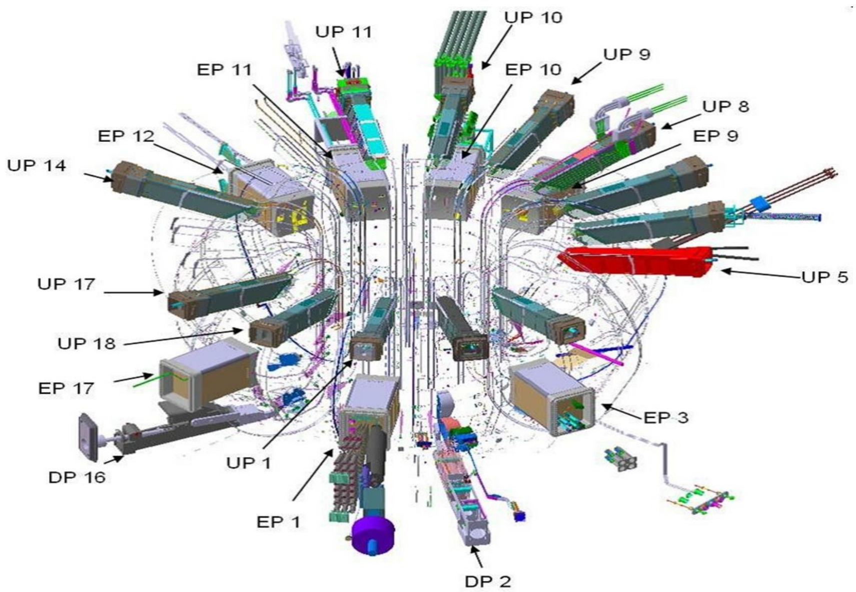


Figure 7 - Tokamak Diagnostics

Each port cell, among others, hosts typically one of the main systems. Each system is typically divided into the Interspace Support Structure (ISS), installed in the interspace zone, and the Port Cell Support Structure (PCSS), installed in the port cell zone. Generally, ISS and port plug hosts several and different kind of diagnostics, the PCSS hosts the main diagnostics services.

The Bioshield plug is divided in several parts: a permanent part (installed on the building and not removable), a main plug part (so-called Diagnostic Shielding installed on the ISS) and the two side Bioshield Door Modules (installed between the main plug part and the permanent part). These latter are removable and are foreseen to allow human access in the interspace zone.

Figure 8 - Equatorial Port Cell Area – Top View and Figure 9 - Equatorial Port Cell Area - Side View show the main systems and extension of the Port Cell Area with dimensions.

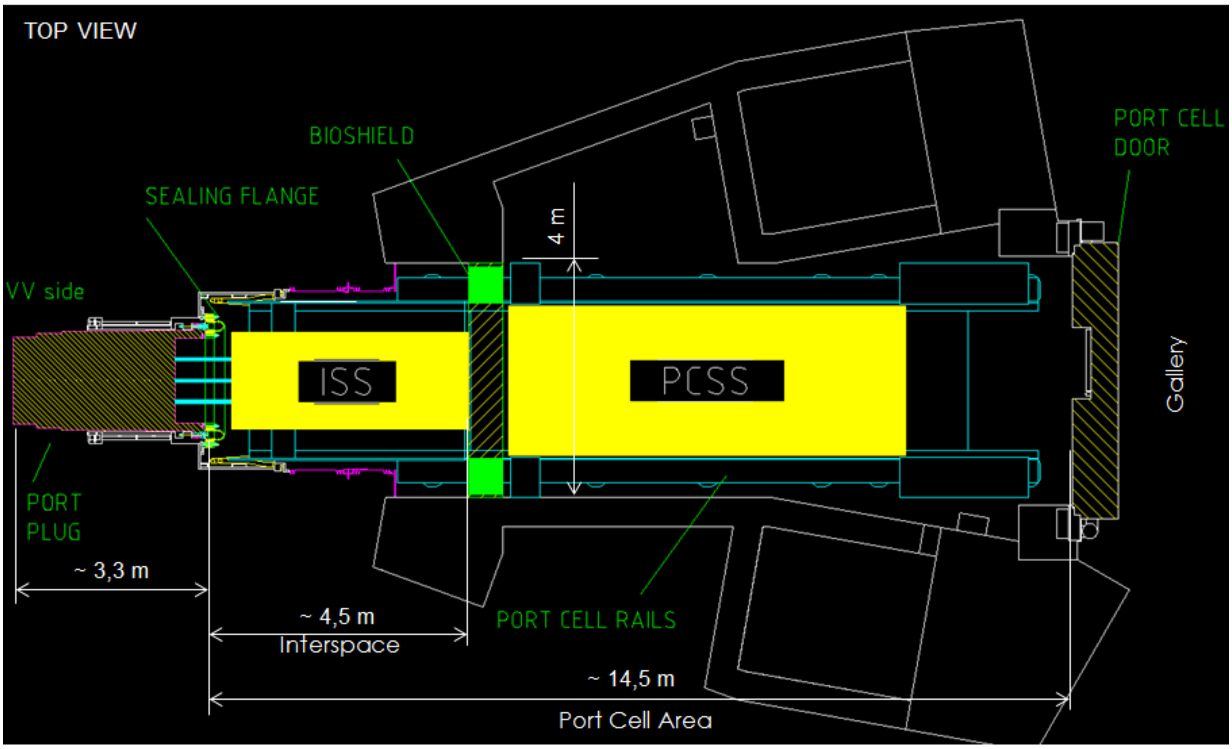


Figure 8 - Equatorial Port Cell Area – Top View

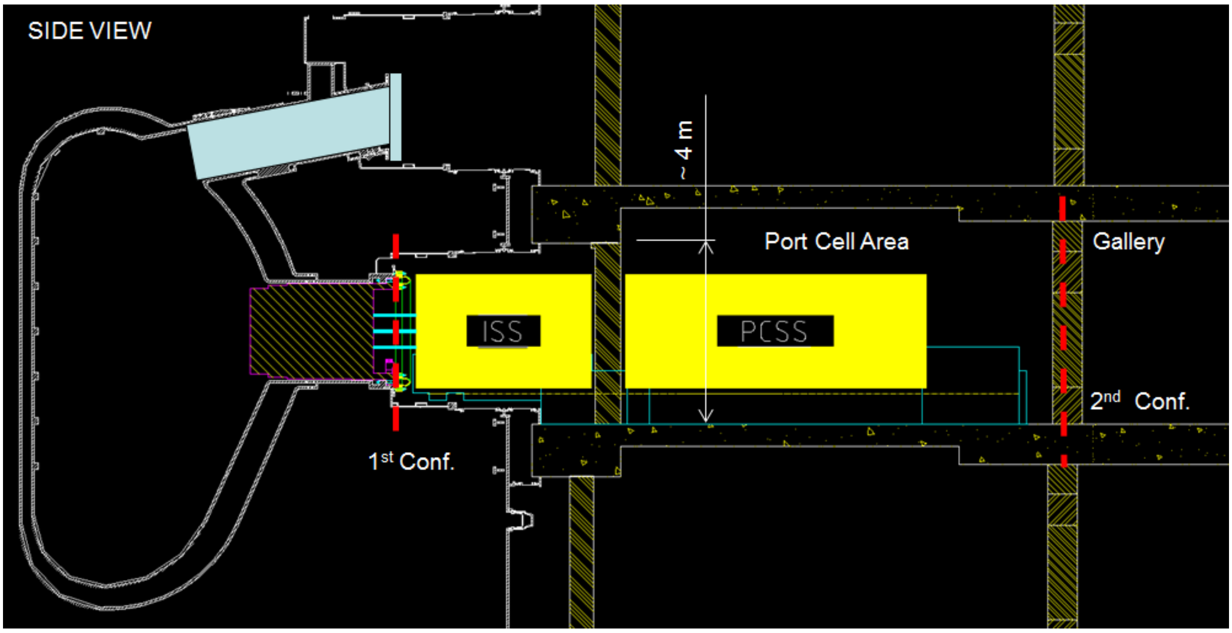


Figure 9 - Equatorial Port Cell Area - Side View

3.2.2.2 Port cell area for ECH

The electron cyclotron (EC) system is one of the four auxiliary plasma heating systems to be installed on the ITER tokamak. The ITER EC system consists of 24 gyrotrons with associated 12 high voltage power supplies, a set of evacuated transmission lines and two types of launchers. The whole system is designed to inject 20 MW of microwave power at 170 GHz into the plasma. The primary functions of the system include plasma start-up, central heating and current drive, and magneto-hydrodynamic instabilities control.

The EC system consists of various subsystems that run from Building 15, through building 13, towards the Tokamak Building 11. At Building 11, various transmission lines run the galleries and port cells up to the different launchers:

- Equatorial Launcher: installed in one equatorial port (EP#14) and can be used for plasma initiation,
- Upper Launcher: installed in four upper ports (UP#12, 13, 15, 16) is optimized for plasma control.

Only upper launcher in port 16 will be used for first plasma. The rest of the launchers will be installed in a next phase called PFPO-1.

Each launcher has associated ex-vessel waveguides (EW) in the Port Cell (8 waveguides in each upper port cell and 24 waveguides in the equatorial port cell). It is important to mention that each EW carries the main torus vacuum until a SIC-1 diamond window located at the ceiling support structure in the port cell. As redundant SIC-1 barrier, each EW has an isolation valve located at the torus side of each window. Both components are maintainable. In addition, an additional isolation shutter valve is installed in each transmission line at the level of the port cell lintel. Below, Figure 10 shows the different port cells. Figure 11 shows the EW system upper port cell 16 (the ECH system in each upper port cell is identical).

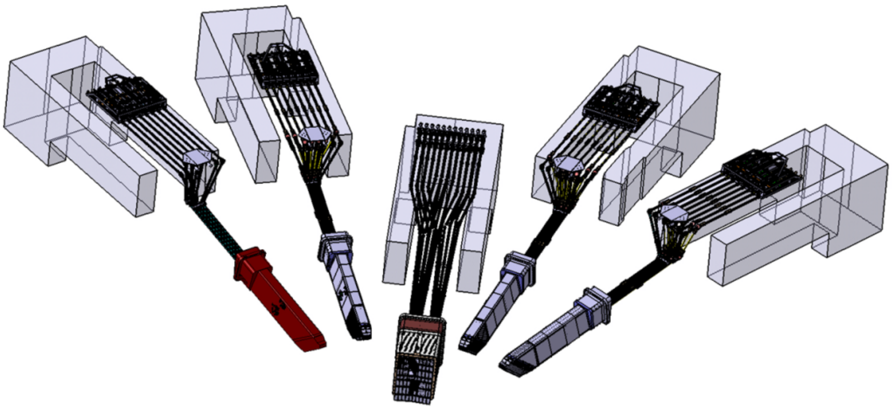


Figure 10 - EW system in upper and equatorial port (to be updated)

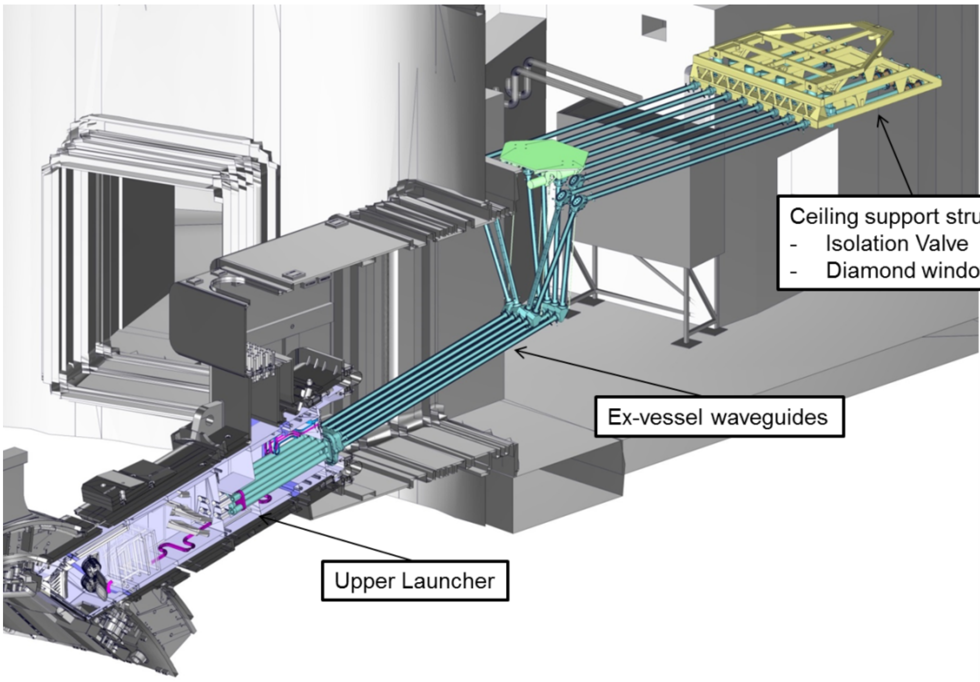


Figure 11 - EW system in upper port 16

One important point to remark is that the ECH launchers are non-remote handing ports. Their removal is therefore considered intervention or, in other words, it is only required in case of failure (non-scheduled maintenance).

The EW system needs auxiliaries (cooling water from CCWS-1 loop in the port cell, compressed air for isolation valves, service vacuum and cabling for instrumentation). In addition, in each port cell, there will be a helium loop needed for each launcher to actuate the front steering mirrors. This loop mainly consists in a helium supply and associated instruments and valves (servo valve for pressure control and isolation valves). These services are mainly located in the walls of the port cell (permanently). See Figure 12 below for additional details (upper port cell 16).

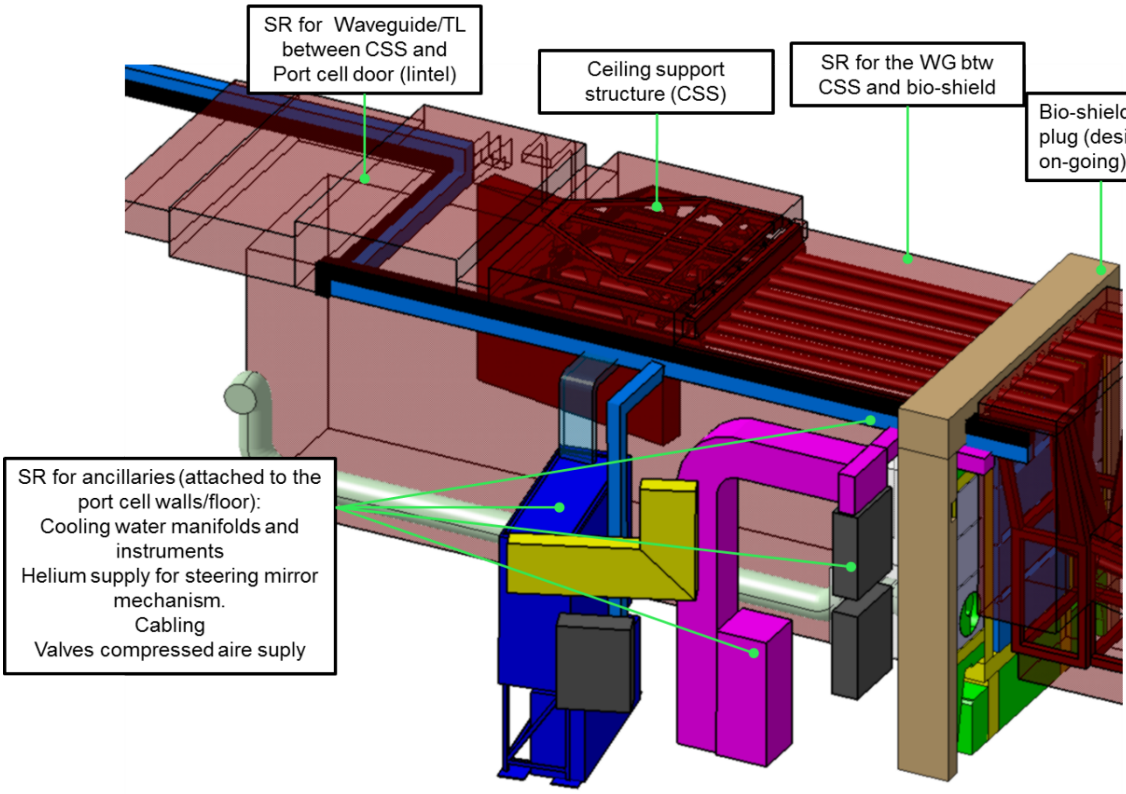


Figure 12 - Space reservations for EW services in upper port 16

3.2.2.3 Port cell area for ICH

The Ion Cyclotron Heating and Current Drive (ICH&CD) system provides radio-frequency (RF) heating and current drive to the ITER plasmas by means of phased ion cyclotron (IC) antenna arrays incorporated in dedicated equatorial port plugs. The ICH&CD system consists of three main subsystems: the RF sources and power supplies, supplied by the IN DA; the transmission line (TL) and matching system, supplied by US DA and the two antennas and Interspace equipment supplied by F4E

Major components of the ICH&CD system are located in three buildings: the RF building (sources and power supplies), the assembly building (transmission lines and matching equipment), and the tokamak building (transmission lines and prematching equipment, and the antennas). In particular pre-matching systems and antennas are installed in equatorial ports 13 and 15 (see figure 13).

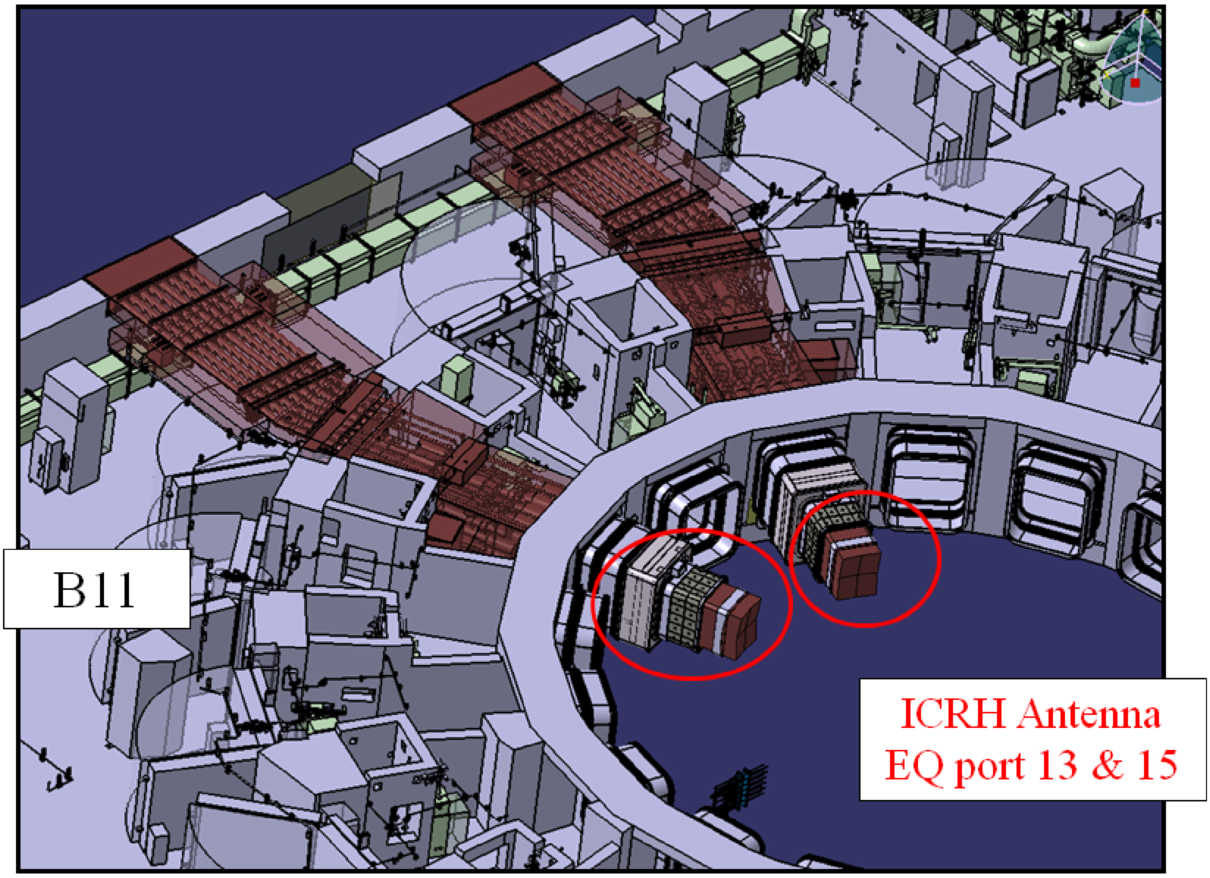


Figure 13 - overview of the ICRH Antennas and Port cell 13 & 15

The port cells 13 & 15 (contoured in red) are occupied by the Pre-matching systems, and the interspaces (contoured in blue) are filled with the antenna ex-vessel equipment. Note that because of the optimized pre-matching configuration, there is a significant number of pre-matching elements which are installed in the interspace area (overview is given in Figure 13 - overview of the ICRH Antennas and Port cell 13 & 15).

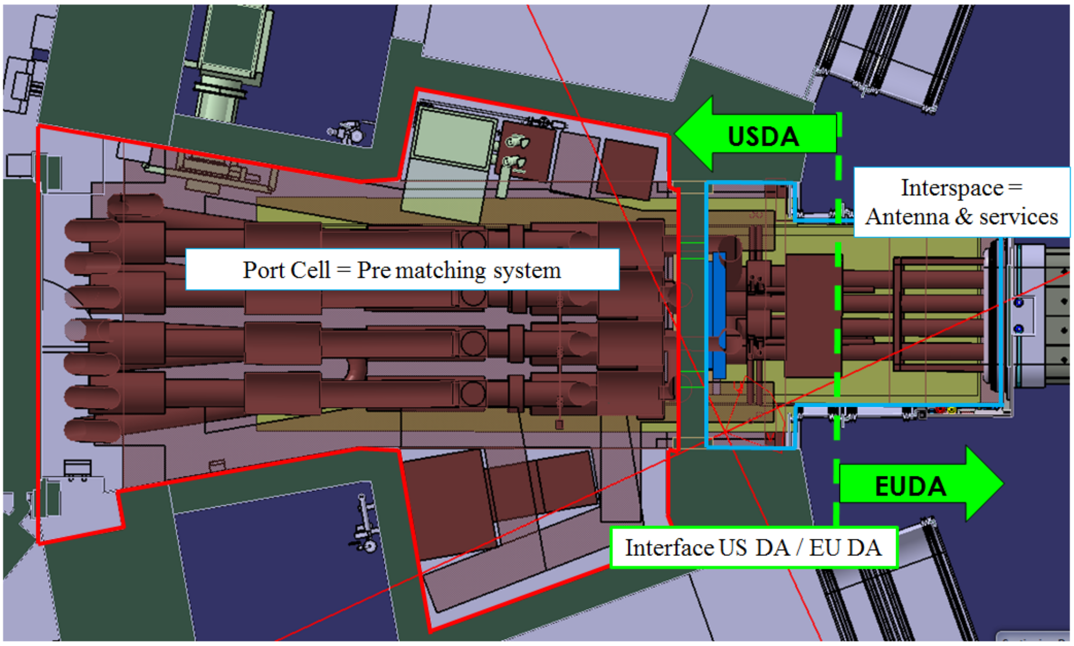


Figure 14 - overview of the ICRH port cell & interspace physical boundaries

The maintenance and other human activities are challenging because of the size of the equipment and their complex integration within the Port cell and interspace areas. Human access in the interspace is required without removal of the pre matching system.

3.2.2.4 Port cell for TBM

Test Blanket Modules (TBMs), will be inserted and tested in ITER in three dedicated equatorial ports and will face directly the plasma. They are the principal means by which ITER will provide the first experimental data on the performance of the breeding blankets.
In each port, several pipes and various I&C cables cross the VV boundary and the biological shield plug to reach the area of the port cell where the Ancillary Equipment Unit (AEU) is located.
The corresponding bundle of pipes between the back of the TBM PP and the biological shield (corresponding to the port interspace) is called the Pipe Forest (PF). It is envisaged that the TBM port plugs will be changed during the ITER operational life.

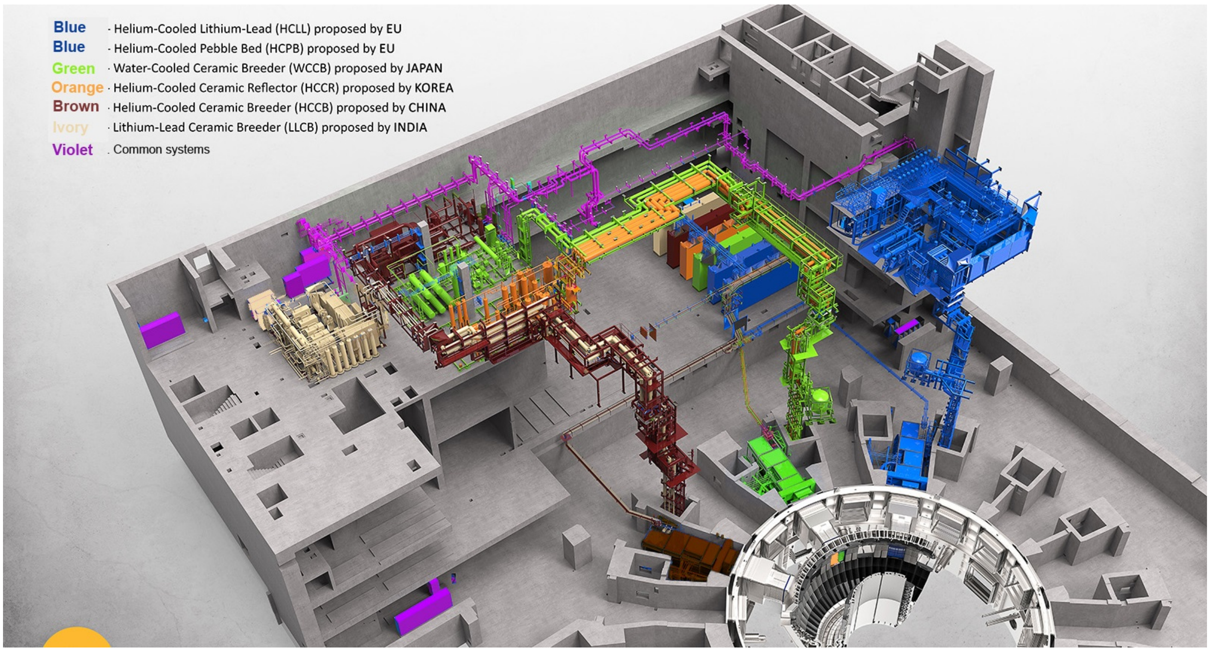


Figure 15 - Test Blanket Modules

3.2.2.5 Vacuum Pumping Ports

There are 2 different types of vacuum pumping ports depending on the hosted systems: the torus vacuum pumping system (6 ports) and the cryostat vacuum pumping system (2 ports).

The function of the pumps is to perform and maintain the vacuum inside the machine. In particular the torus cryo-pumps are used to perform and maintain the 1st vacuum inside the vacuum vessel while the cryostat cryo-pumps are used to perform and maintain the 2nd vacuum inside the cryostat volume.

Each cryo-pump is connected to a Cold Valve Box (CVB). The connection between the CVB and the cryopump is performed by cryo-jumpers. Permanent RH rail are located in the port cells to allow maintenance of the cryo-pumps, when needed.

In 3 of the 6 torus cryo-pump port cells, a pellet injection system cask is installed on the RH rails of the port cell during operation. The goal of this system is to fuel the plasma thanks to pellets of hydrogen isotopes. A gas valve box is installed in the each one of these port cells, as a service for the PIS cask (cf. 3.2.4).

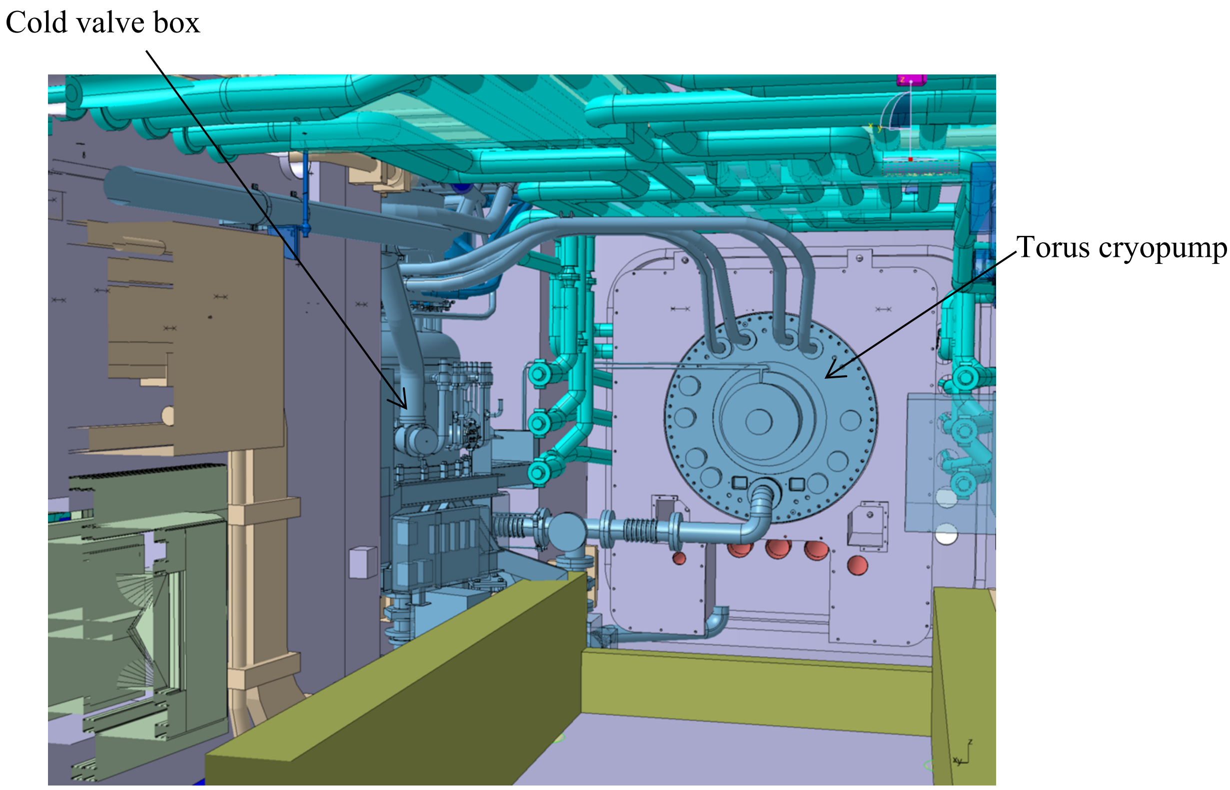


Figure 16 - Vacuum pumping ports

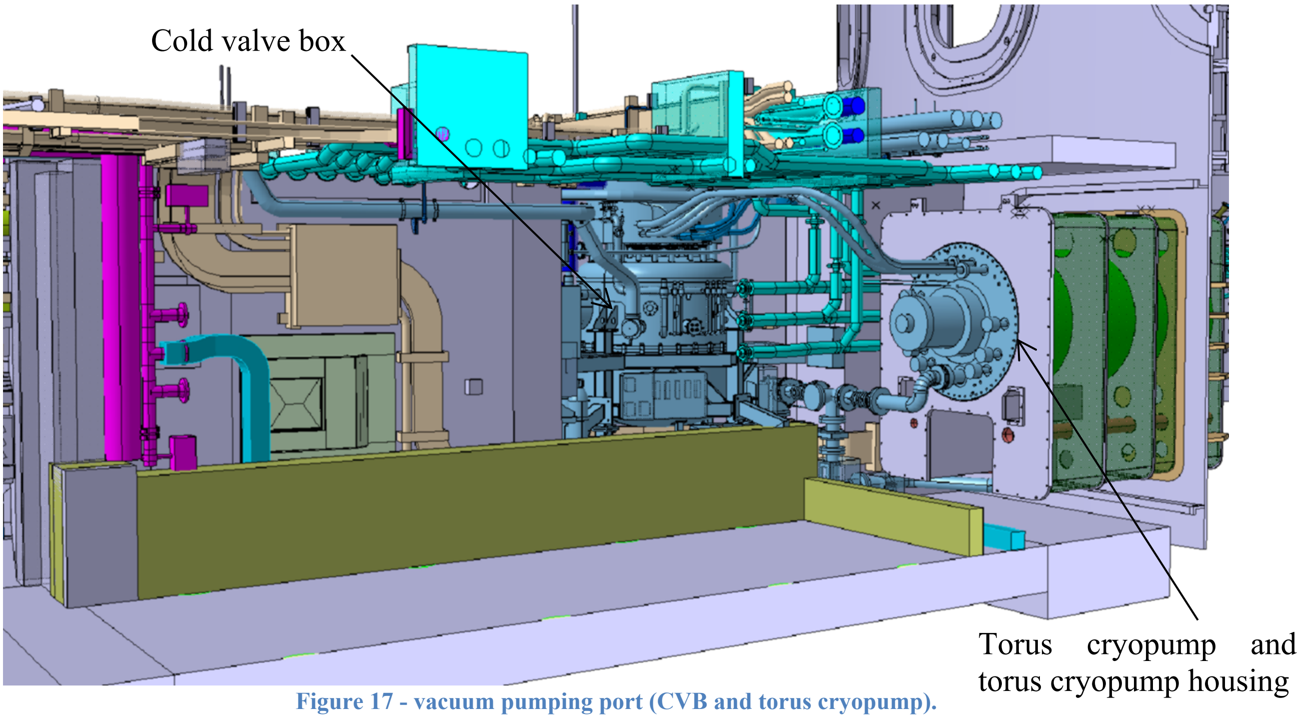


Figure 17 - vacuum pumping port (CVB and torus cryopump).

3.2.2.6 In-Vessel Viewing Ports

Six of the lower port cells are used for the in-vessel viewing system (IVVS). The IVVS is mainly composed of a duct connected directly to the vacuum vessel facing the port cell area. This duct is name IVVS port. This port contains the in-vessel viewing system, which is used to control the erosion of the first wall and the position of the blanket. These ducts in the port cell are a 1st vacuum barrier extension. RH rail is permanently installed in front the of VV duct in order to remove the IVVS from the port if maintenance is needed.

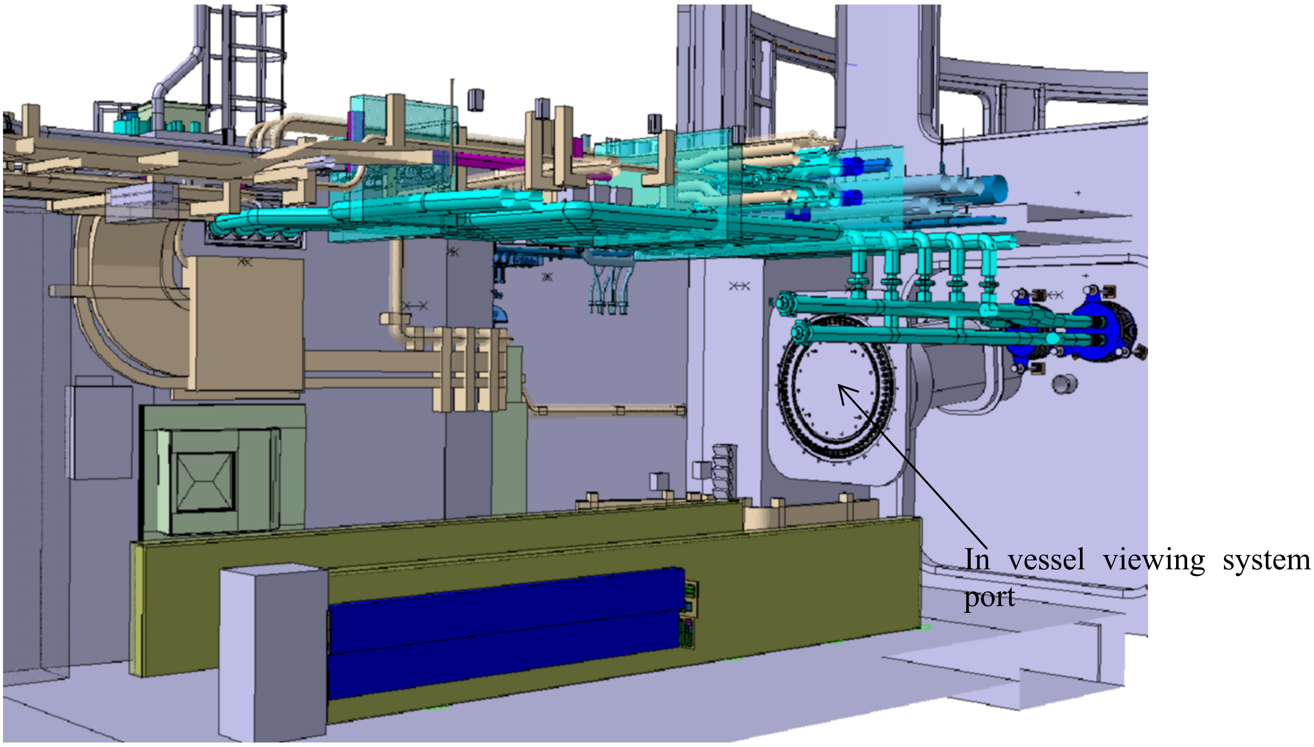


Figure 18 - In vessel viewing port

3.2.3 *Neutral Beam cell*

Concerned areas			
Galleries	NO	Port interspace at upper level	NO
Cryo-pump port cells at B1	NO	Lower pipe chase at B2M	NO
Remote handling port cell at B1	NO	Upper pipe chase at L3	NO
IVVS port cell at B1	NO	NB Cell	YES
Port cell at L1	NO	HV Deck	NO
Port interspace at equatorial level	NO	Drain tank room	NO
Port cell at L2	NO		

The neutral beam heating and current drive system is comprised of two injectors and one diagnostic neutral beam injector installed in 2 equatorial ports. A third port is reserved for the installation of a further injector.

Each neutral beam injector has the following components:

- The ion source and accelerator,
- The High voltage bushing,
- The neutralizer,
- The residual ion beam dump,
- The calorimeter,
- The fast shutter,
- A magnetic compensation,
- High vacuum isolation valve,
- Instruments.

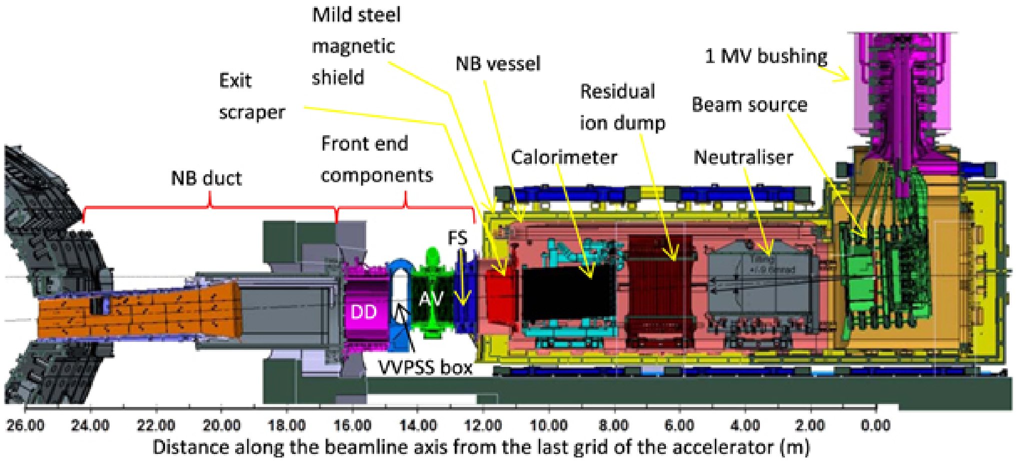


Figure 19 - Heating neutral beam

3.2.4 ITER fuelling and wall conditioning systems

Concerned areas			
Galleries	NO	Port interspace at upper level	YES
Cryo-pump port cells at B1	YES	Lower pipe chase at B2M	NO
Remote handling port cell at B1	NO	Upper pipe chase at L3	YES
IVVS port cell at B1	NO	NB Cell	NO
Port cell at L1	YES	HV Deck	YES
Port interspace at equatorial level	YES	Drain tank room	NO
Port cell at L2	YES		

The primary functions of the ITER fuelling and wall conditioning systems are:

- to inject DT fuel and other impurity gases into the vacuum vessel at the required fuelling rate and response time to maintain fusion power at the required level;
- to inject tritium rich or other hydrogenic pellets into the vacuum vessel at the required fuelling rate and response time using a centrifuge type pellet injector;
- to inject impurity gas(es) using puffing valves into the vacuum vessel for machine protection;
- to inject impurity gas(es) using the dedicated system into the vacuum vessel for disruption mitigation (TBD);
- to inject impurity ice pellet(s) using a centrifuge type pellet injector into the plasma for physics study;
- to supply hydrogen or deuterium gases to the NB and DNB injectors;
- to implement wall conditioning by baking, glow discharge cleaning (GDC), electron cyclotron resonance discharge cleaning (ECR-DC), ion cyclotron resonance discharge cleaning (ICR-DC), and other techniques in order to provide clean and stable plasma operation by reduction and control of impurities and hydrogenic fuel outgassing from plasma facing components.

The fuelling system configuration is therefore the following (see figures 20 & 21):

- Gas Injection System (GIS)
    - Upper port level GIS : 4 ports
    - Divertor port level GIS : 6 ports
    - NB/DNB injector GIS

- Fusion Power Shutdown System (FPSS)
  - Two locations at upper port level (100% redundant)
- Pellet Injection System (PIS)
  - Three divertor ports (Two injectors at each port)
    - Two injectors at machine start-up
    - Six injectors after up-grade
- Disruption Mitigation System (DMS)
  - Three upper ports and 1 equatorial port for thermal mitigation
  - One equatorial port for runaway electron suppression

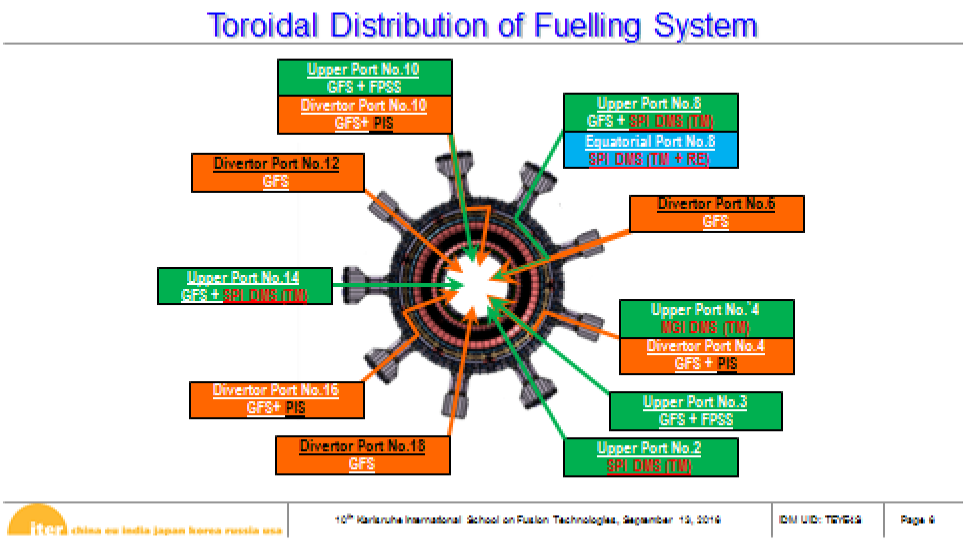


Figure 20 - Toroidal Distribution of Fuelling System

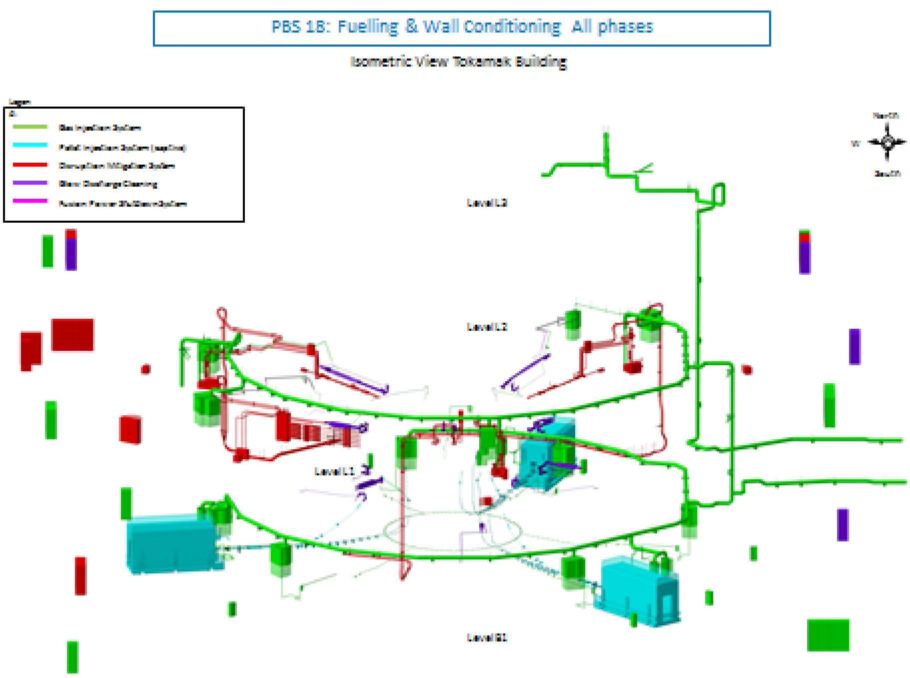


Figure 21 - Fuelling & Wall Conditioning All phases

3.2.5 Detritiation systems

Concerned areas			
Galleries	YES	Port interspace at upper level	YES
Cryo-pump port cells at B1	YES	Lower pipe chase at B2M	YES
Remote handling port cell at B1	YES	Upper pipe chase at L3	YES
IVVS port cell at B1	YES	NB Cell	YES
Port cell at L1	YES	HV Deck	YES
Port interspace at equatorial level	YES	Drain tank room	YES
Port cell at L2	YES		

This first part describes the overall Detritiation system (DS) and partially the HVAC to get an overview of the confinement system arrangement. DS is then described by area to further define DS service for maintenance operations.

3.2.5.1 System Rationale

ITER will operate with tritium, a radioactive gas. The two ITER nuclear safety principles can be summarized as:

- Confine radioactive material
- Limit radioactive doses to workers and the public

The Tokamak Complex Detritiation System (TC-DS) contributes to both of these principles as follows:

<u>Confine radioactive material:</u> Tritium is confined within physical structures which may not have perfect leak tightness. By providing a lower pressure inside a confinement structure, leakage will be from outside the structure to within the structure, thus maintaining confinement. TC-DS provides the reduced pressure within confinement structures.

<u>Limit radioactive doses:</u> It is unavoidable in a facility such as ITER that gases are released to the environment. The TC-DS detritiates these gases before they are released to reduce the Public's exposure to radioactivity.

It is also unavoidable in a facility such as ITER that some tritium will migrate through confinement systems to come in contact with workers. By reducing the amount of tritium within these structures (e.g. gloveboxes), the amount of tritium migration is reduced which in turns reduces worker radioactive doses. DS reduces the amount of tritium within confinement structures by detritiating the gas.

In off-normal conditions such as failure of primary tritium confinement resulting in a room tritium release, TC-DS detritiates the room atmosphere to avoid both worker and public exposure.

Finally, TC-DS filters gases prior to discharge to prevent environmental release of activated dust and corrosion products.

3.2.5.2 System Functions

The primary functions of TC-DS are:

- Detritiate gases in a once-through fashion prior to release to the environment from the following sources:
  - Room atmospheres
  - Enclosure atmospheres
  - Elephant trunks

  - Process gases
  - Torus (off-normal through VVPSS)

- Provide a source of reduced pressure

  DS provides a source of reduced pressure which is necessary to provide dynamic confinement of tritium to minimize worker and public radiation doses. This is provided to a variety of clients in normal and off-normal conditions:
  - Rooms with tritium levels which are not normally elevated (C2 rooms)
  - Rooms which normally have elevated tritium levels (C3 rooms)
  - Enclosures (e.g. gloveboxes and Port Cells) which normally have elevated tritium levels (C3 enclosures)
  - Processes which normally have elevated tritium levels (safety function)
  - Other processes (non-safety function)

- Connect DS Core equipment to client systems and control flow through these connections
  - Rooms with tritium levels which are not normally elevated (C2 rooms)
  - Rooms which normally have elevated tritium levels (C3 rooms)
  - Enclosures (e.g. gloveboxes and Port Cells) which normally have elevated tritium levels (C3 enclosures)
  - Processes which normally have elevated tritium levels (safety function)
  - Other processes (non-safety functions)

- Filter aerosol ACPs from detritiation system clients

The secondary functions of TC-DS are:

- Detritiate gases using a recycling approach, whereby the gas is recycled to the client.

3.2.5.3 System Description

The Detritiation System (DS) at ITER consists of many subsystems and components. DS performs atmosphere detritiation.

The TC-DS serves the Tokamak Building and the Tritium Plant Building. In addition, there is a Glovebox Detritiation System comprising dedicated mobile modules, which can be deployed to complement TC-DS to increase the rate of detritiation as required. This system is non-SIC, and is outside of the scope of TC-DS. An overview of TC-DS and HVAC is given in Figure 22 - Top-level view ITER of HVAC / TC-DS systems. The overall confinement system is composed of HVAC and DS with the following subsystems:

DS-Core: This refers collectively to the gas processing equipment which performs the detritiation. DS-Core is divided into:

N-DS: This system is normally operating and performing detritiation, servicing the tokamak, fuel cycle processes, enclosures and gloveboxes. This system is PIC2.

SB-DS: This system is in standby during normal operations, and is available to detritiate room atmosphere gases in the event of a tritium release. This system is also available to take over the N-DS loads should N-DS become unavailable. This system is PIC1.

DS-Dist: DS-Distributed is a distributed piping network connecting all users. Network is segregated in different manifold such as

- **M0** : for inerted feed for process (in purple color in Figure 22 - Top-level view ITER of HVAC / TC-DS systems)
- **M1** : for large flow serving C3 rooms (in amber)
- **M2** : open in accident situation in C2 rooms or N-DS failure (in green)

HVAC: Ductwork is segregated by building and ventilation zoning with 3 Air Handling Units and 3 Extraction Units.

- **TP- Facilities**
- **TP- Process Room**
- **TK- Galleries**
- **TK- Process Room** (Vault, Drain tank and Neutral Beam)
- **TK- Facilities**

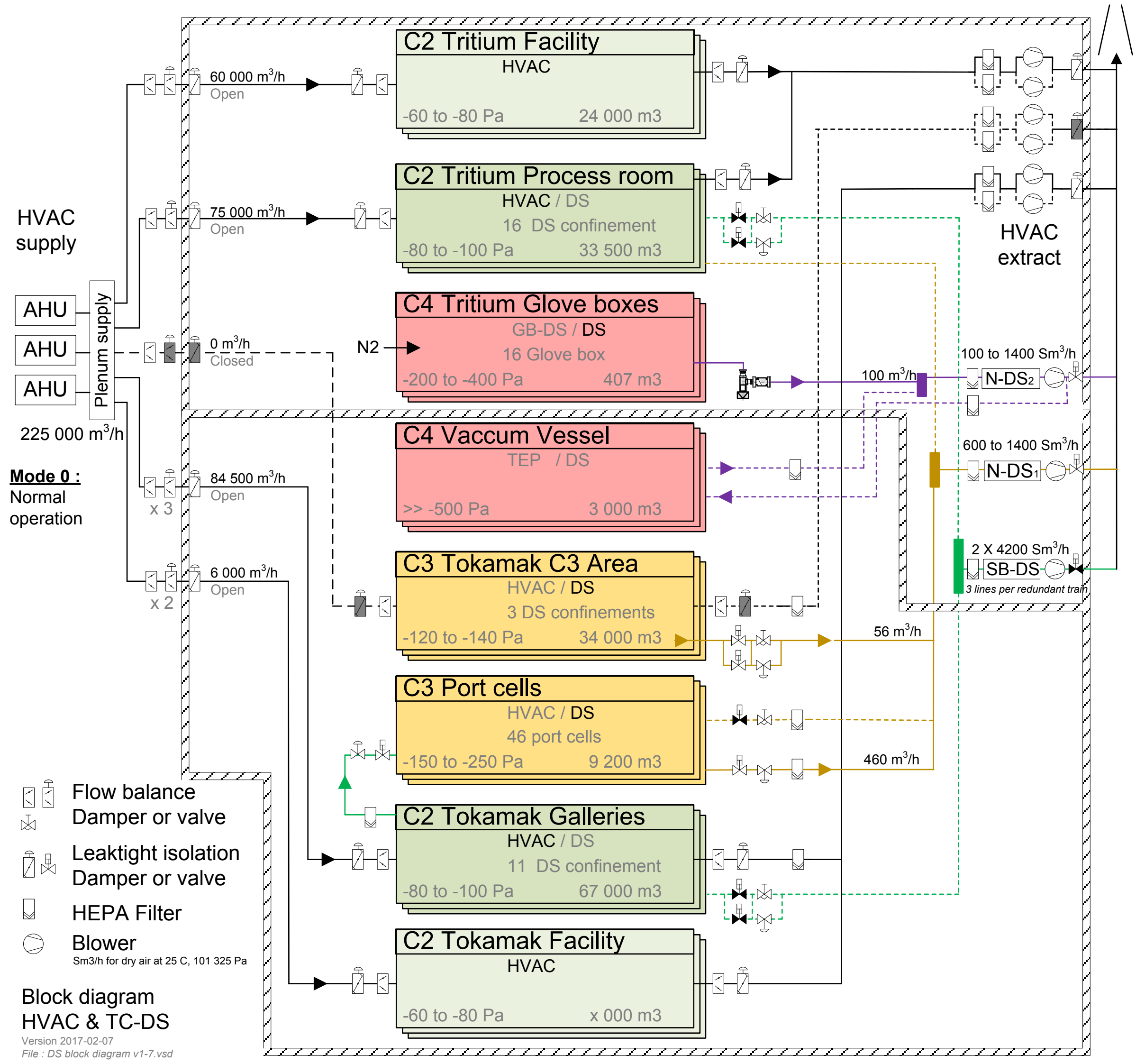


Figure 22 - Top-level view ITER of HVAC / TC-DS systems

In next sections, DS is described by area to further define the utility interface that DS is providing for maintenance in the following 3 typical area:

1. Galleries areas (include HV DECK)
2. Port cell areas (all others)
3. Vault area (include Lower and upper pipe chase)
4. NB cell area
5. Drain tank room area

3.2.5.4 Detritiation System in Port cell areas

Concerned areas			
Galleries	NO	Port interspace at upper level	YES
Cryo-pump port cells at B1	YES	Lower pipe chase at B2M	NO
Remote handling port cell at B1	YES	Upper pipe chase at L3	NO

IVVS port cell at B1	YES	NB Cell	NO
Port cell at L1	YES	HV Deck	NO
Port interspace at equatorial level	YES	Drain tank room	NO
Port cell at L2	YES		

Detritiation system provides support for maintenance activity with Interface Point for each port cell.
DS capacity: Detritiation System (DS) capacity is limited to 500 m3/h per port cell with the current design basis to perform maintenance. Design margins are given to get estimation on DS flexibility. Each maintenance activity involving the use of DS should estimate the flowrate with the available connection to:

a. Process exhaust (fixed for PBS 23): 0 to 100 m3/h (dedicated for Remote handling. Consist of a quick connector which is available for a connection to DS by remote handling).
b. Process exhaust (fixed for other PBS): 0 to 100 m3/h (Fixed as pipe already installed to have direct connection to process pipe with a remote actuation to purge process pipe). This one can be duplicated based on IS between process and PBS 32.
c. Process exhaust (temporary for maintenance): 0 to 100 m3/h (pipe between DS and Process install by operator hand could be activated remotely. Include connection to temporary enclosure). This one can be duplicated based on maintenance study
d. Local Ventilation connector in PC : 0 to 200 m3/h (local ventilation without additional enclosure or/and airlock installed and flow control valve actuated by operator)
e. Local Ventilation connector near PC in gallery : same as point d but outside PC

Connection a and b are designed by client PBS to be remote compatible while c and d with associated control pressure valve are installed during maintenance by operation. Sum of a to d is limited to 500 m3/h in the current design basis per port cell, and 1000 m3/h for all port cells. For each type of connection, flow range is given for a pressure at interface of -5000 Pa @ 0 m3/h and -1000 Pa @ max flow range. The range is given as information as each connection can be 0-500 m3/h.

Design network and control valves are sized to ensure a minimum of 500 m3/h for 2 port cells under maintenance (1000 m3/h). For scenarios with more than 2 port cells under maintenance the design margin allows for higher flowrate given below.

	Design value (m3/h)	Design margin (m3/h)
1 Port cell	500	950
2 Port cells	500	700
4 Port cells	500 <	450
6 Port cells	500 <	350

*all flowrates are given for dry air at 25 C, 101325 Pa

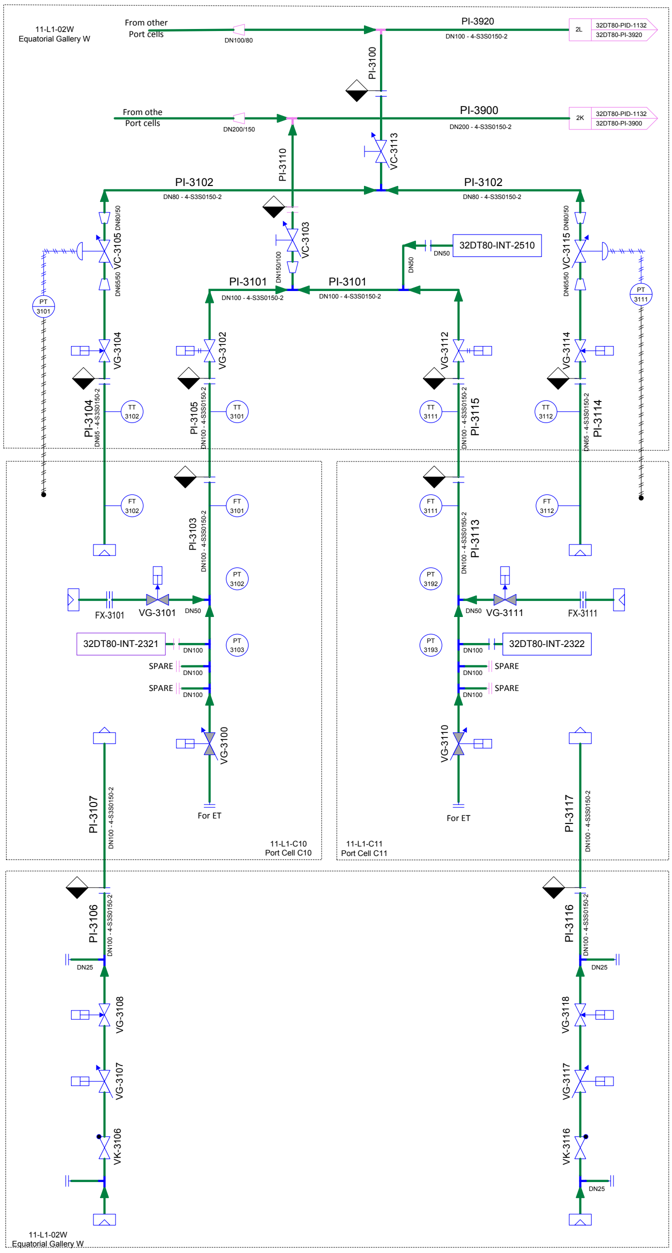


Figure 23 - Extract of P&ID

3.2.5.5 Detritiation System in Gallery areas

Concerned areas			
Galleries	YES	Port interspace at upper level	NO
Cryo-pump port cells at B1	NO	Lower pipe chase at B2M	NO
Remote handling port cell at B1	NO	Upper pipe chase at L3	NO
IVVS port cell at B1	NO	NB Cell	NO
Port cell at L1	NO	HV Deck	NO
Port interspace at equatorial level	NO	Drain tank room	NO
Port cell at L2	NO		

3.2.5.6 Detritiation System in Vault areas

Concerned areas			
Galleries	NO	Port interspace at upper level	NO
Cryo-pump port cells at B1	NO	Lower pipe chase at B2M	YES
Remote handling port cell at B1	NO	Upper pipe chase at L3	YES
IVVS port cell at B1	NO	NB Cell	NO
Port cell at L1	NO	HV Deck	NO
Port interspace at equatorial level	NO	Drain tank room	NO
Port cell at L2	NO		

3.2.5.7 Detritiation System in NB Cell and drain tank room areas

Concerned areas			
Galleries	NO	Port interspace at upper level	NO
Cryo-pump port cells at B1	NO	Lower pipe chase at B2M	NO
Remote handling port cell at B1	NO	Upper pipe chase at L3	NO
IVVS port cell at B1	NO	NB Cell	YES
Port cell at L1	NO	HV Deck	YES
Port interspace at equatorial level	NO	Drain tank room	YES
Port cell at L2	NO		

3.2.6 TCWS areas

Concerned areas			
Galleries	YES	Port interspace at upper level	NO
Cryo-pump port cells at B1	YES	Lower pipe chase at B2M	YES
Remote handling port cell at B1	NO	Upper pipe chase at L3	YES
IVVS port cell at B1	NO	NB Cell	NO
Port cell at L1	NO	HV Deck	NO
Port interspace at equatorial level	NO	Drain tank room	YES
Port cell at L2	NO		

The Tokamak Cooling Water System (TCWS) is the primary coolant system of ITER machine having the main aim to remove the power generated by the plasma and transferred to dedicated components of the machine and to release it to the secondary coolant system.
The TCWS is based on three Primary Heat Transfer Systems (PHTS):

- VV PHTS for cooling the Vacuum Vessel,
- IBED PHTS for cooling the in-vessel components
- NBI PHTS for cooling the Neutral Beam Injectors.

The TCWS includes auxiliary systems as:

- Chemical and Volume Control System (CVCS),
- Draining and Refilling System (DRS)

- Drying System (DYS).

TCWS is widely distributed all around the Tokamak Complex.

3.2.6.1 IBED PHTS

The following major IBED PHTS components are located in the TCWS Equipment Vault in room 11-L3-02E:

- 8 Cooling Trains
  - Pump
  - Heat Exchangers

The following major IBED PHTS components are located in the TCWS Equipment Vault in room 11-L4-04:

- Baking Train
  - Baking Pump
- Baking Heater
- Pressurizer
- Pressure Relief Tank

A general arrangement of the IBED PHTS is shown in figure 24. The main heat exchanged and main pumps on the cooling train are shown in figure 25.

The main supply and return headers are routed through the floor of the L3 to the Upper Pipe Chase and through vertical shafts to the Lower Pipe Chase. The supply and return piping to the FW/BLK components is routed through ring headers in the upper pipe chase. Pneumatically operated globe valves for flow balancing for each FW/BLK module are installed in the upper pipe chase. Typical supply and return piping for FW/BLK sector is shown in figure 26.

Supply and return piping for the divertor cassettes continues from the upper pipe chase through vertical shafts 17 and 18 to the lower pipe chase. Supply and return piping for each divertor cassette branches off the lower pipe chase ring headers. Typical divertor cassette supply and return piping is shown in figure 27.

Supply and return piping for the ELM coils and Upper Port Diagnostics is routed through the ring headers in the Upper Pipe Chase.

Supply and return headers for the Equatorial Ports continues from the Upper Pipe Chase through vertical shafts 16 and 17 to the lower pipe chase. Supply and return piping for each Equatorial Port branches off the Lower Pipe Chase ring header, penetrates the Bioshield wall and is routed to the Equatorial port inside the Vacuum Vessel.

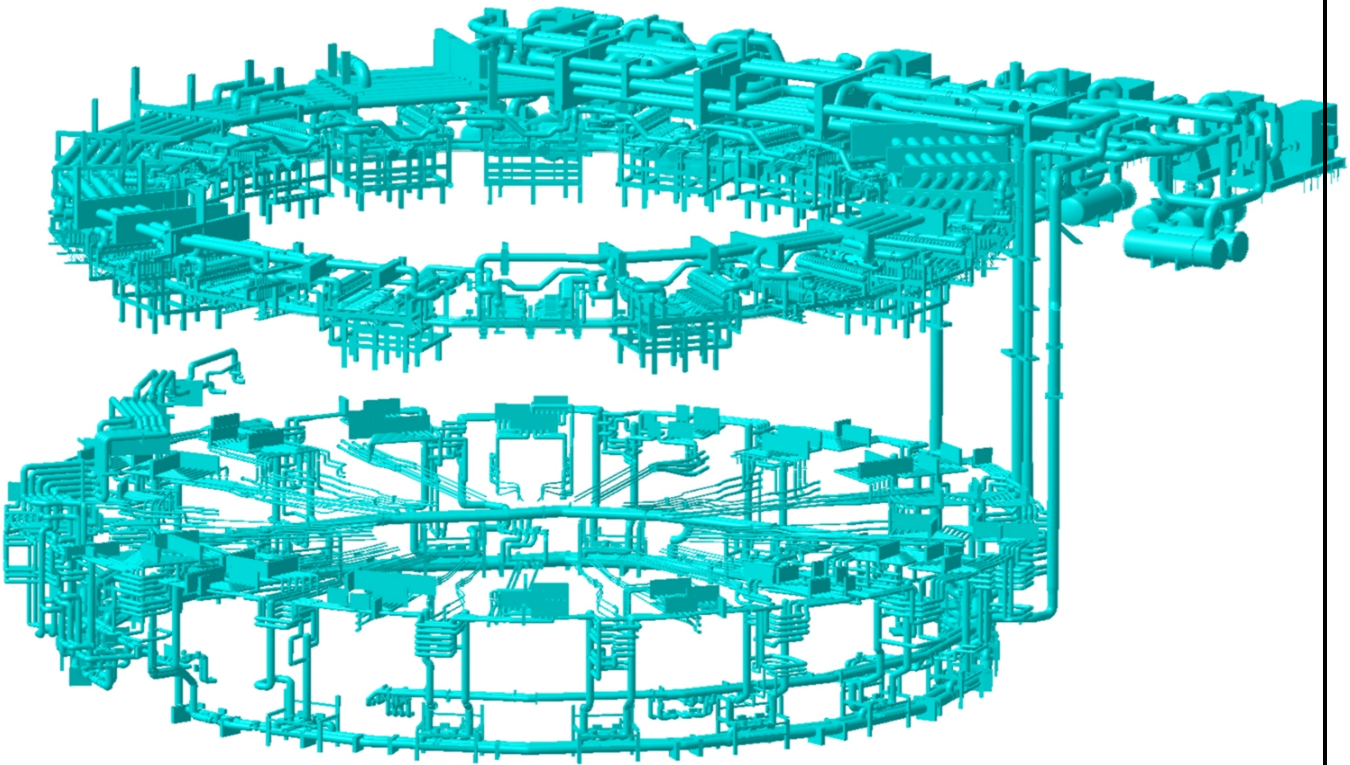


Figure 24 - 3D Model view of IBED PHTS

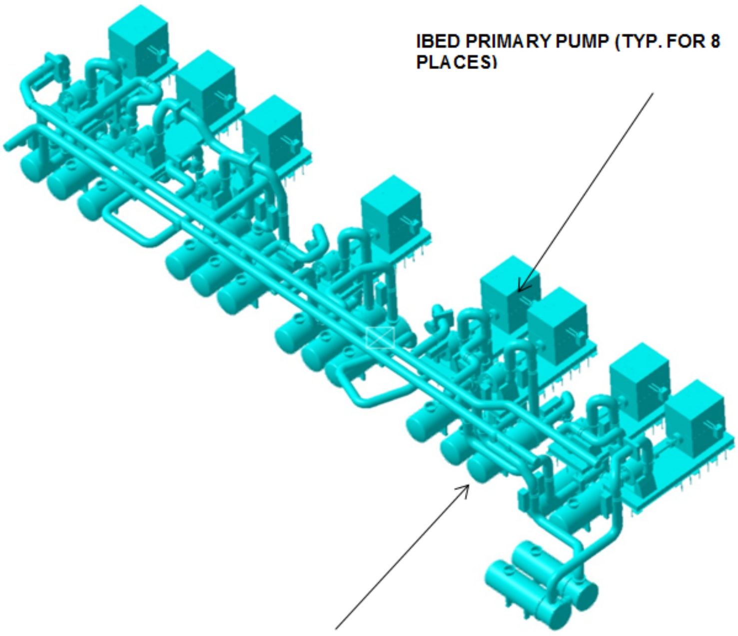


Figure 25 - PHTS Major Equipment – TCWS equipment vault

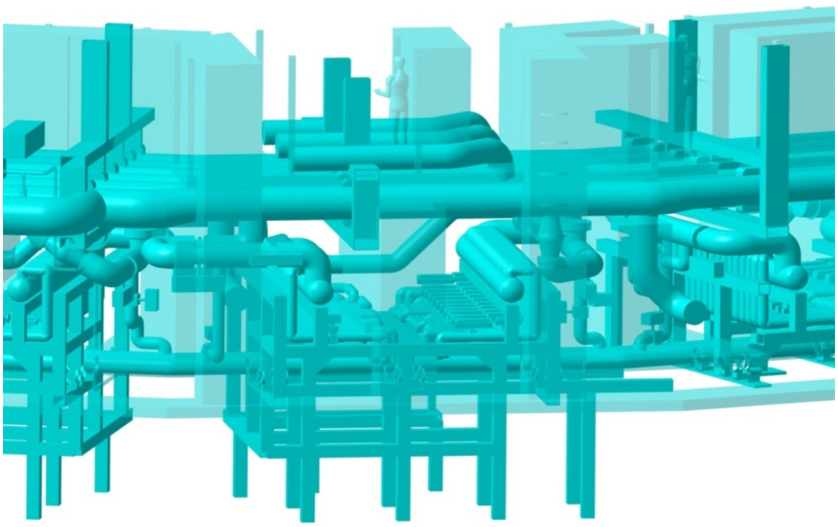


Figure 26 - Typical FW/BLK Piping Module

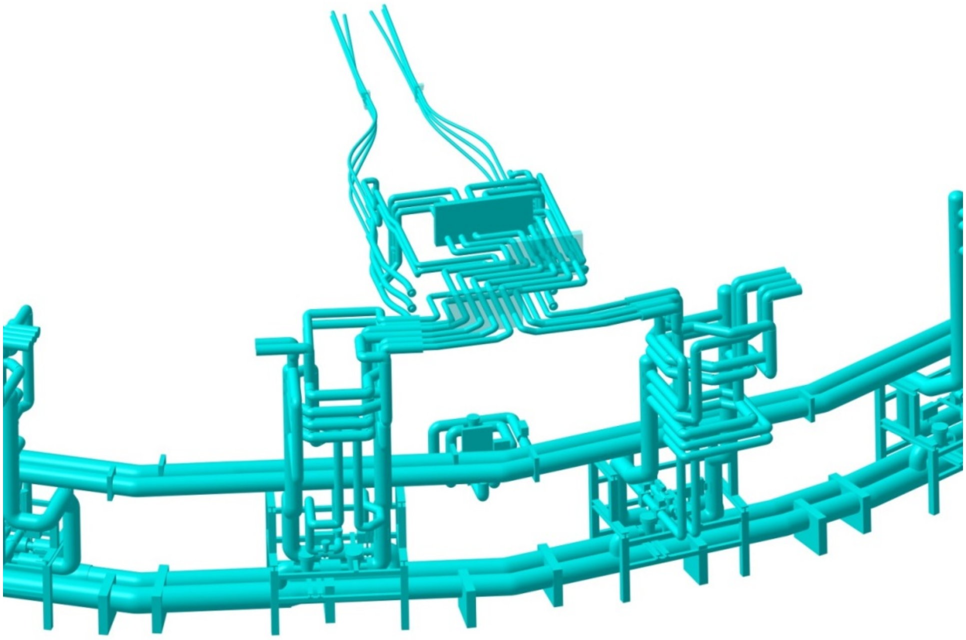


Figure 27 - Typical Divertor Cassette Piping

3.2.6.1.1 VV PHTS

A general arrangement of the VV PHTS is shown in figure 28. A detail view of the VV PHTS major components in the drain tank room is shown figure 29.

The following major VV PHTS components are located in the Drain Tank room, 11-B1-01.

- Primary pump
- Primary heat exchanger
- Pressurizer
- Pressure relief tank
- Decay heat pump
- Decay heat exchanger
- Baking heater

The supply piping to the Vacuum Vessel connections is routed through the lower pipe chase ring header with individual branch connections. Return piping from the Vacuum Vessel is routed through a ring header in the upper pipe chase which then routes through the vertical pipe shafts to return to the major components located in the drain tank room. The components in the VV PHTS volume control loop are located at L3 and L4.

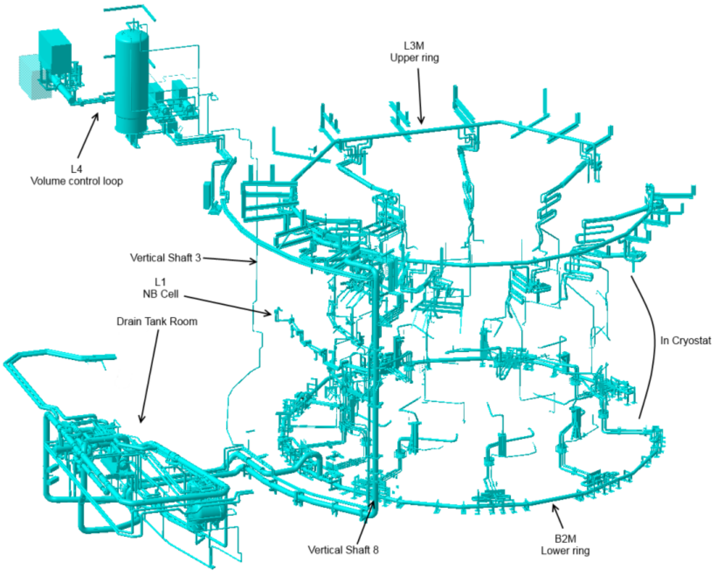


Figure 28 - 3D model view of VV PHTS

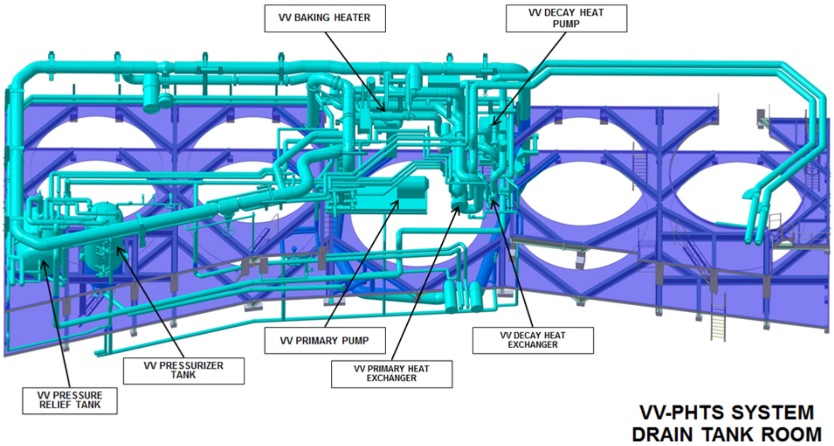


Figure 29 - VV PHTS detail view – drain tank room

3.2.6.1.2 NBI PHTS

The following major NBI PHTS components are located in the TCWS Equipment Vault in room 11-L4-04.

- Primary Train
  - Pump
  - Heat Exchangers
- Freeze Protection Pump
- Pressurizer

The main supply and return headers are routed through the floor of the L4 equipment vault into the CVCS area East at L3 and the Upper Pipe Chase (11-L3-03). The system boundary between the NBI PHTS and the NBI system is in the Upper Pipe Chase North (11-L3-02N). A general arrangement of the NBI PHTS is shown in figure 30.

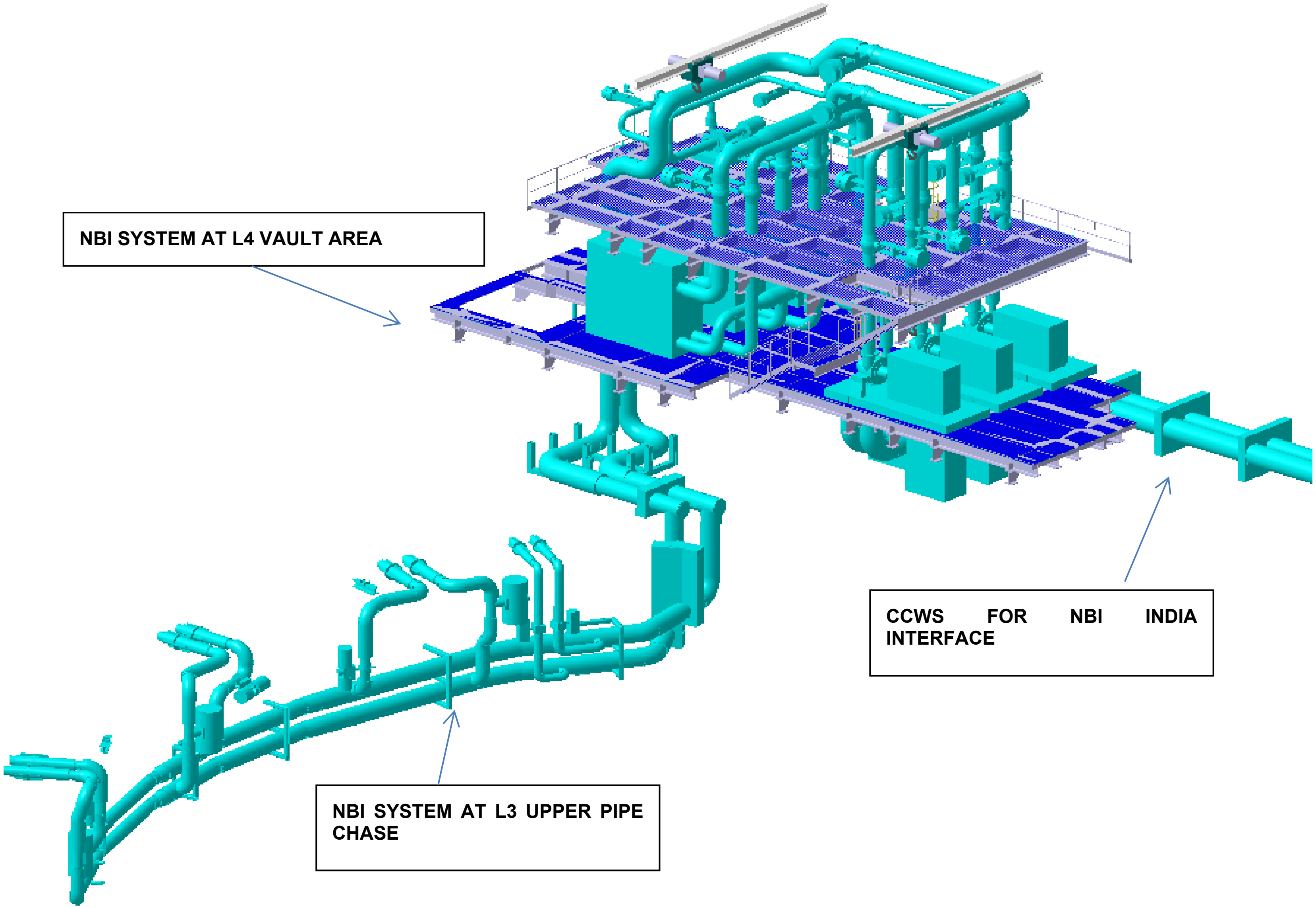


Figure 30 - 3D model view of NBI PHTS

3.2.6.1.3 CVCS (IBED and NBI)

The CVBD and CVNB are arranged together in the CVCS Area East in room 11-L3-02E. CVBD and CVNB filters; demineralizers; VV filters; a space reservation for future VV CVCS equipment; and all valves and piing are located inside a shielded room. The CVBD and CVNB degasifiers, CVBD and CVNB pumps, CVBD heat exchangers and NBI and IBED VCTs are located out of the shielded rom.

A general arrangement of the CVCS (IBED and NBI) is shown in figure 31. A detail view of the CVCS shielded room is shown in figure 32.

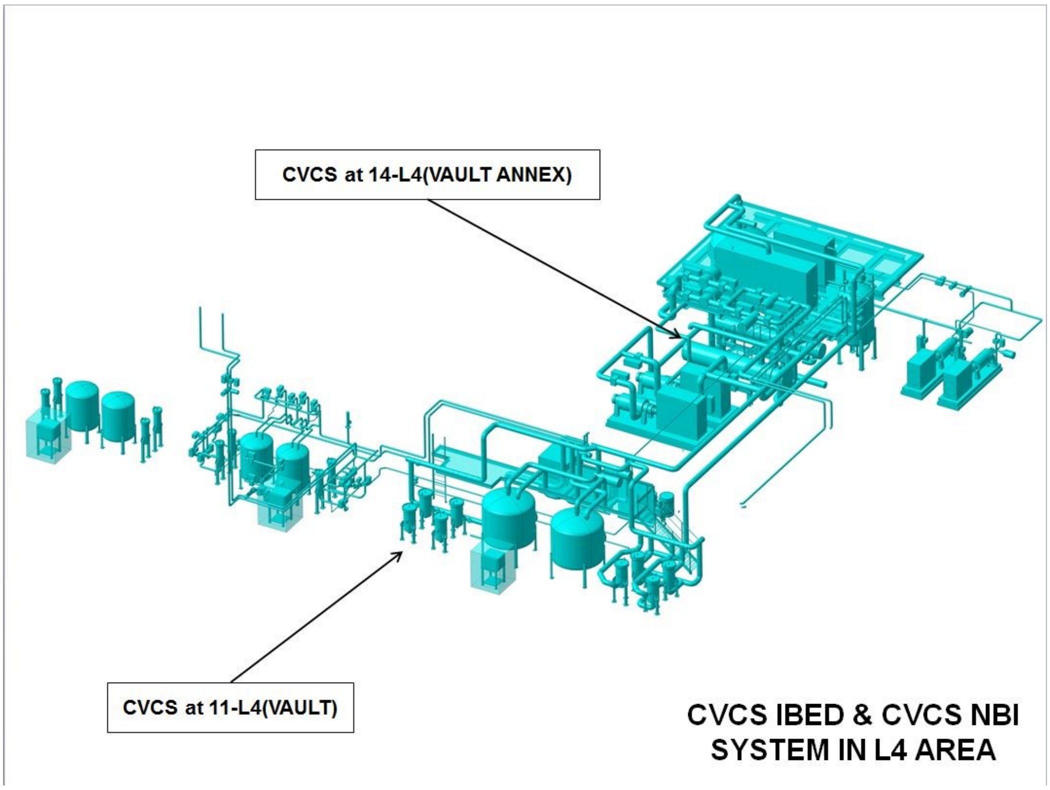


Figure 31 - 3D Model View of CVCS

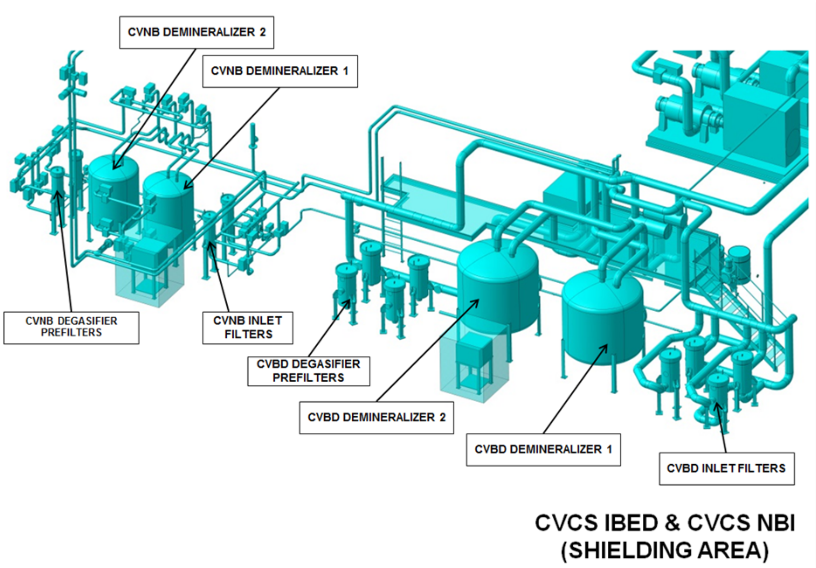


Figure 32 - CVCS Shielded Room Detail View

3.2.6.1.4 DYS

Major DYS components (except for the cyclone separator) are located in the TCWS vault annex in room 14-L4-22. Cyclone Separator (26DY00-DS-1002) is located in the upper pipe chase. All client system isolation valves are located in either upper or lower pipe chases. Refer to the following two figures for DYS equipment arrangement.

The DYS has connections with the VV PHTS, IBED PHTS and NBI PHTS in the upper and lower pipe chases.

A general arrangement of the DYS is shown in figure 33. A detail view of the DYS major components in TCWS vault annex is shown in figure 34.

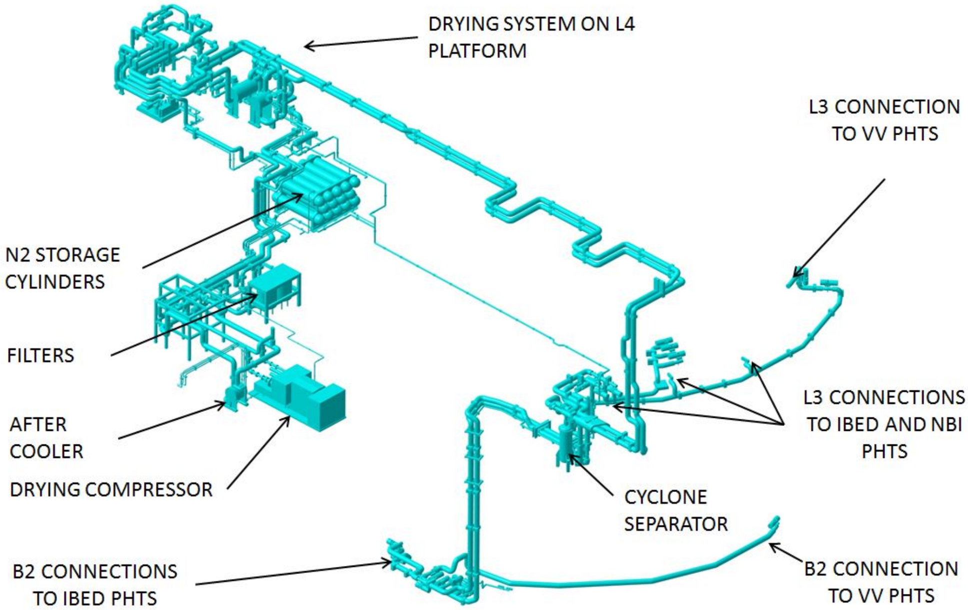


Figure 33 - 3D Model View of Drying System

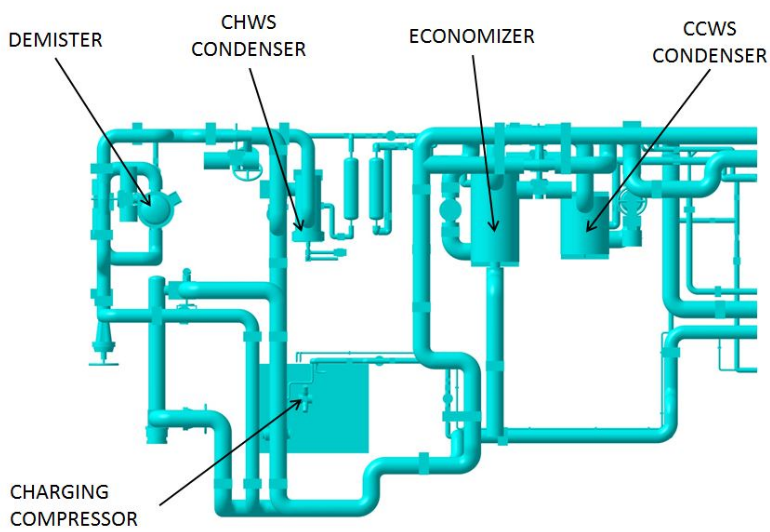


Figure 34 - DYS Major Components- TCWS Vault Annex

3.2.6.1.5 DRS

The following major DRS components are located in the Drain tank room, 11-B2-01.

- One Safety Drain Tank (TA-001). The other one is in the Hot Cell Bldg.
- One Normal Drain Tank (TA-003). The other one is in the Hot Cell Bldg.

- NBI PHTS Drain Tank
- Auxiliary Drain Tank
- Refilling/Transfer Pumps

The DRS has connections with all subsystems of the TCWS throughout the Tokamak Building. A general arrangement of the DRS is shown in **Error! Reference source not found.**[71].

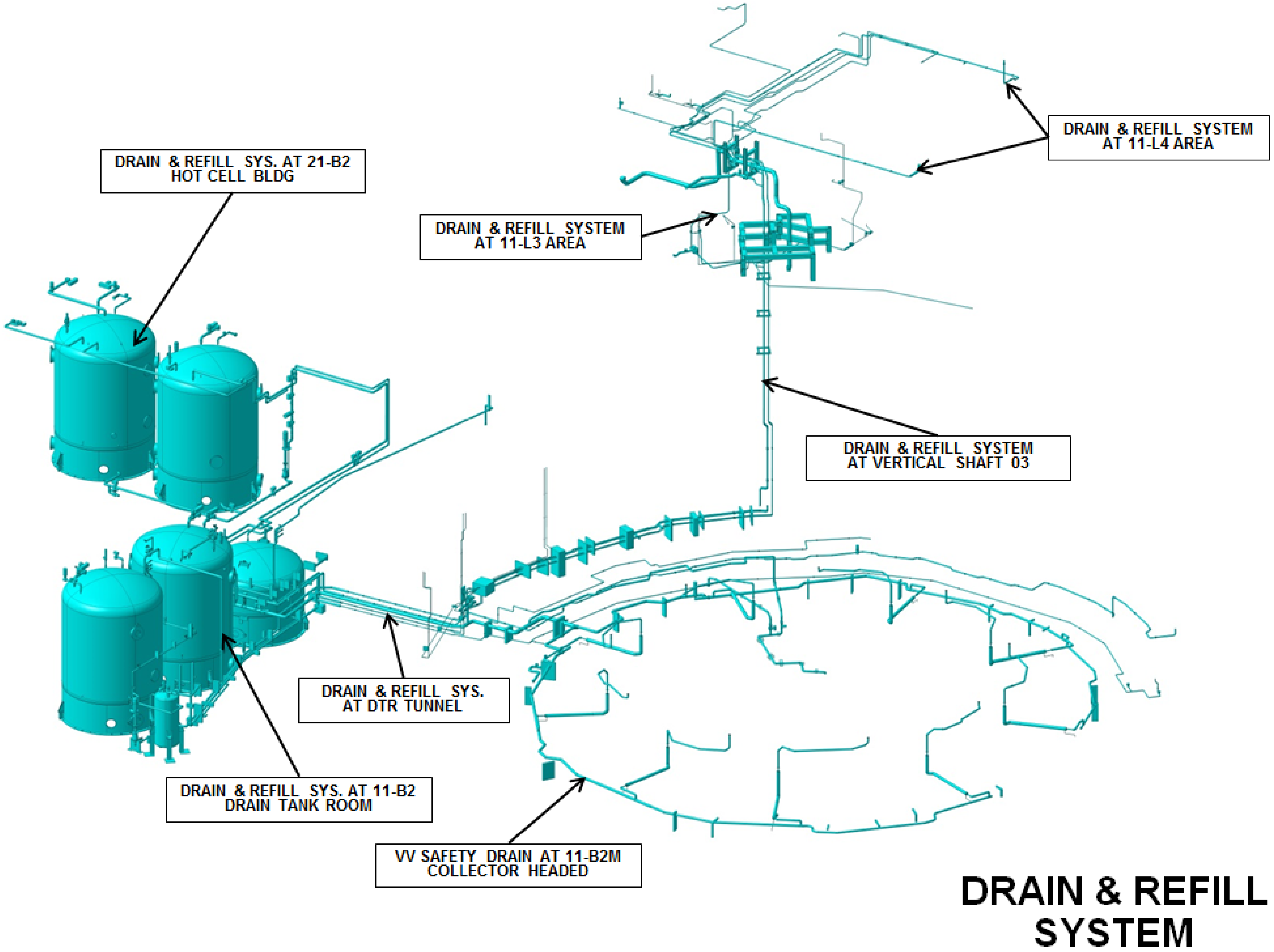


Figure 35 - 3D model view of DRS

3.2.6.1.6 VCS

The VCS is a subsystem of the DRS. The major VCS components listed below are located on the B2 level of the Tokamak Complex.

- Waste Collection Tank
- Vacuum Pump

The VCS has connections with all subsystems of the TCWS throughout the Tokamak Building. A general arrangement of the VCS is shown in figure 36.

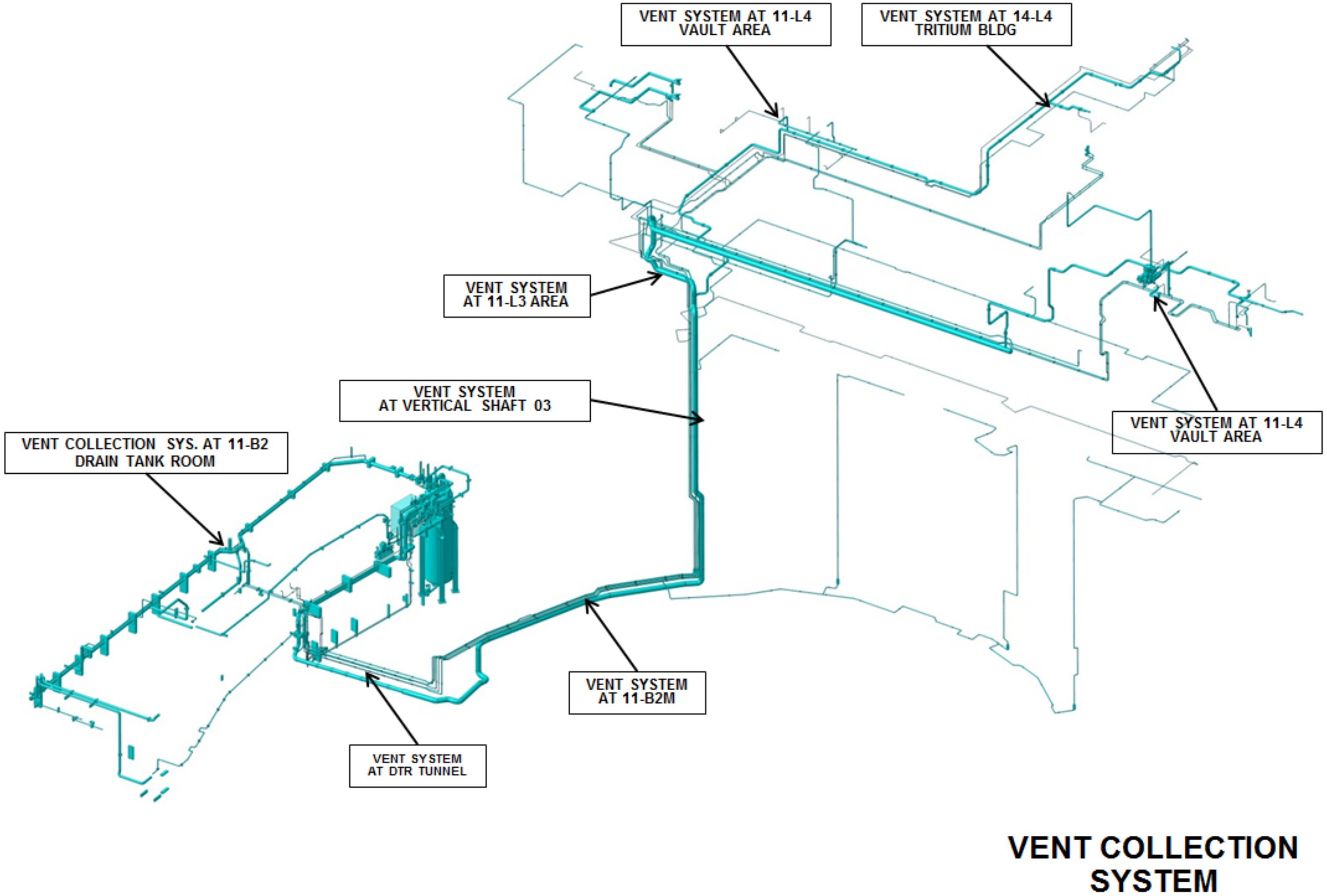


Figure 36 - 3D Model View of VCS

3.2.6.1.7 TCWS Sampling System

The Major Components of the Sampling System will be located in room 14-L2-23, TCWS Secondary side Valve room as shown in figure 37. A skid with HXs and re-injection pumps is located in 14-L2-21.

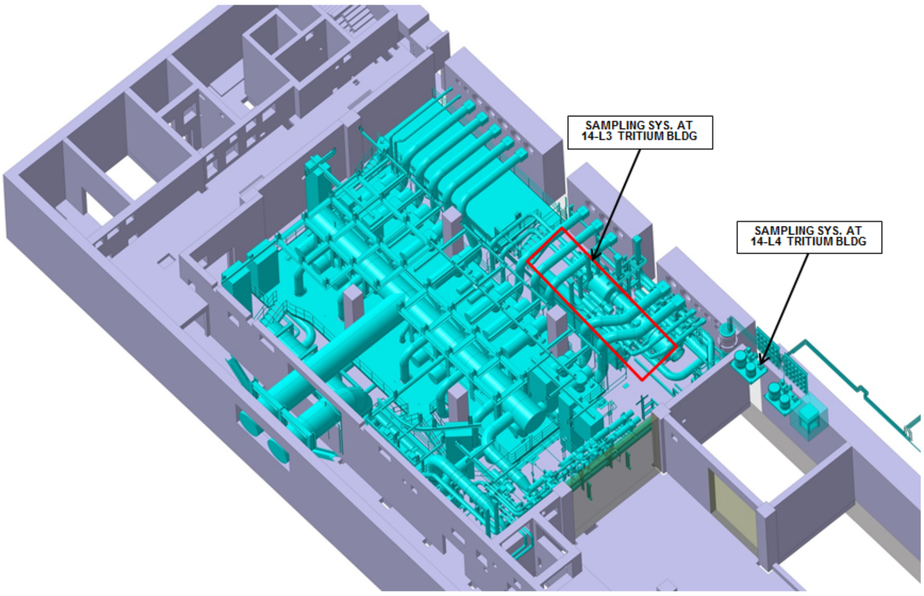


Figure 37 - View of the Sampling Room

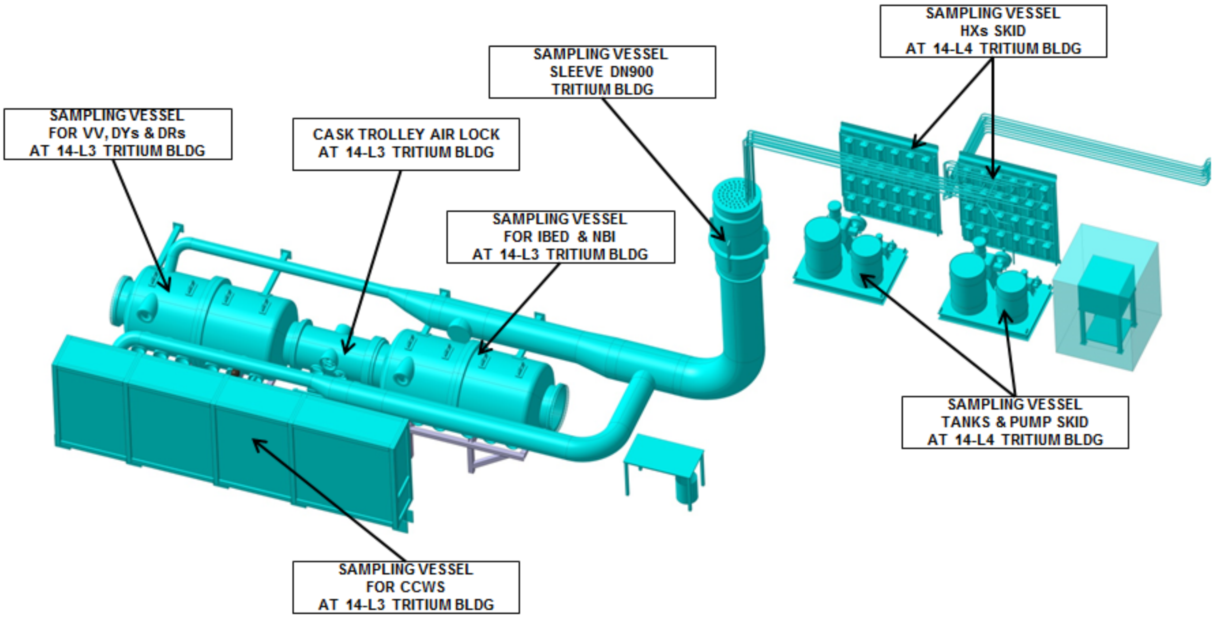


Figure 38 - sampling system

3.3 Plant configuration

This contract will be performed for the following phase, according to [4]:

- Pre Fusion Power Operation I (Be confinement issues);
- Fusion Power Operation (Radiological (notably Tritium) and Be confinement issues + irradiation issues).

All the deliverables to be provided will have to consider these two phases.

4 Input Data

A set of input data is provided here. However some of documents are not approved, however they have been assessed as the best picture available. This set of input data will be updated during Work Package 1, and potentially at the beginning of the work on the area according to the priority in order to give up to date information for the next tasks to be performed.

4.1 Generic References

Generic reference applicable documents are listed here below.

[1]	Preliminary Safety Report (RPrS) (3ZR2NC v3.0)
[2]	Project Requirements (PR) (27ZRW8 v5.3)
[3]	Safety requirement Roombook (KF63PB v2.11)
[4]	Tokamak Complex General Arrangement Drawings (P74U5J v1.0)
[5]	ITER_D_SBSTBM - Provisions for Implementation of the Generic Safety Requirements by the External Interveners
[6]	Staged Approach Configuration - PBS Level 3 (SNE6G8 v3.1)
[7]	ITER_D_2V3V8G - Recommendation on Plasma scenarios
[8]	ITER_D_W6655F - Guidelines for ALARA Implementation

4.2 Fueling & Wall condition systems – PBS18

[9]	SRD-18-GI_(Gas_Injection)_from_DOORS_2AC9FQ_v3
[10]	PBS_18_Maintenance_Activities_-_ASN_Requ_U4FZJW_v1_1
[11]	GIS_maintenance_activities_and_dose_rate_TXBRJL_v1_1
[12]	Current_status_of_Gas_Injection_Sys_2EZY53_v1_0

4.3 Remote Handling Systems – PBS23

[13]	System Design Description (DD 23.03) - Cask & Plug Remote Handling System (CPRHS) (JE6YHS v1.1)
[14]	IS-62.11-62.74-23.03-DRW_B1_GENERAL_ARRANGEMENT (L23PT9 v2.3)
[15]	IS-62.11-62.74-23.03-DRW_L2_GENERAL_ARRANGEMENT (L4Z7RV v2.2)
[16]	IS-62.11-62.74-23.03-DRW_L1_GENERAL_ARRANGEMENT (KLK5S8 v2.2)
[17]	PFD_23.03_CPRHS (RMNWTT v2.0)
[18]	Assembly Drawings of System 23.03 for TAC tender (TLCCBM v1.3)
[19]	Assembly Drawings of System 23.03 for TAC tender (TLCCBM v1.3)
[20]	Port Plug Removal Strategy (ITER_D_VESKZM v2.0)
[21]	Port Cell Door Airlock_Pre-Concept (ITER_D_V5CKAW v2.2)
[22]	Bioshield-Side-Opening&Handling_Pre-Concept (ITER_D_W459DS v1.0)
[23]	Equatorial Ports Breach evolution_Sealign Flange to Cask Docking Flange (ITER_D_VVU6QF v1.0)
[24]	VVPSS ORE Assessment Report (TL6YHE v1.2)
[25]	Occupational radiation exposure (ORE) estimation for the Neutral Beam RH System (TMW2ED v1.0)

[26]	PFD - PBS 23.05 Neutral Beam Cell Components Maintenance (F4E_D_2ACCZY v1.0) (QCKB5Z v2.0)

4.4 TCWS – PBS26

[66]	ITER_D_94WLDK - TCWS System Description Document (SDD) - EXPORT CONTROL
[67]	ITER_D_VMJTXG - GA DWG TCWS in 11-B2M
[68]	ITER_D_VMKKCM - GA DWG TCWS in 11-L3
[69]	ITER_D_VMJRPT - GA DWG TCWS in 11-L4
[70]	ITER_D_VJKQRL - GA DWG TCWS in 14-L4
[71]	ITER_D_VMKKRF - GA DWG TCWS in Drain Tank Room.
[72]	ITER_D_VJKUGF - GA DWG TCWS in Vertical Shafts
[73]	ITER_D_VHFZEB - GA_DWG TCWS inside Bioshield
[74]	ITER_D_SGE7Z5 - Inservice Inspection and Maintenance Plan for VV PHTS
[75]	ITER_D_SPS4KS - Inservice Inspection and Maintenance Plan for Draining System
[76]	ITER_D_SZWWMC - Inservice Inspection and Maintenance Plan for IBED PHTS (FP portions)
[77]	ITER_D_UFY8XN - Inservice Inspection and Maintenance Plan for Drying System
[78]	ITER_D_UNR8M7 - WP8.1 Final Report of RAMI analyses for TCWS (1st plasma subsystems)
[79]	ITER_D_UF8GQ2 - TCWS Human and Organisational Factors (HOF)

4.5 Vacuum system – PBS31

[27]	ITER_D_28B2Y8 - SRD-31 (Vacuum System) from DOORS
[28]	ITER_D_3DBZED - DESIGN DESCRIPTION DOCUMENT PBS31
[29]	ITER_D_Q9MV9V - TCP and CCP design outline and requirements to the cryogenic supply for the operation
[30]	ITER_D_US8GYH - Maintenance Plan for the Torus and Cryostat Cryopumps
[31]	ITER_D_VGCAQ9 - Periodic tests and inspections of the Torus and Cryostat Cryopumps pressure assemblies

4.6 Tritium plant – PBS32

[32]	s-SRD-32-DT (Tokamak complex Detritiation System) from DOORS (35YGFT v1.2)
[33]	Diagrams DS pipework : PFD DS pipework T3BTRD v2.0 P&ID DS pipework T6ZMQT v1.1 PFD and ESD for the PC depression control RZM8SV v1.5
[34]	Drawings DS pipework B1 (SQC4Q9 v1.3), L1(SQKVCA v1.3), L2(STLDR2 v1.3) , L3 (V3Q8RB v1.0)

4.7 ICH – PBS51

[35]	Ion Cyclotron Heating and Current Drive (ICH & CD) Subsystem Design Description Document (sDDD) - USDA Scope (CVZYVA v4.0)

[36]	ITER_D_UKNTPZ - PC&HC_maintenance_IC
[37]	ITER_D_VFYZG4 - New prematching configuration overview - Tilted version T1 VS T2

4.8 ECH – PBS52

[38]	Analysis of UL and EL Port Cell maintenance procedure (QXQGFL v1.1)
[39]	SRD-52 (ECH&CD) from DOORS (28B365 v4.2/C) [to be revised]
[40]	DDD_5.2 (2UY43G v2.4)
[41]	RN-52EW-001: PC maintenance (VVUZ9D)
[42]	ORE-52 (U5LN2M)

4.9 NB Heating – PBS53

[43]	DDD for PRIMA (ITER_D_3E6QV3 v1.0
[44]	PBS53 System Description (TE9FRF v1.1)
[45]	NBI assembly drawings https://user.iter.org/?uid=QEZBR2
[46]	NB cell nuclear analysis ITER_D_Q73NR8 - Deliverable 5 - Final report

4.10 Diagnostics – PBS55

[47]	Generic Diagnostic Port Plug Requirements (33LH72 v5.4)
[48]	Access space available inside the port cells when using the Personnel Access Door (SKJNGV v1.1)
[49]	Access strategy to Port cells (SQ2KFH v1.0)
[50]	Port Plug Maintenance_List of Processes and Steps_12-02-2014 (BEUTMF v1.0)
[51]	Port Plug Maintenance Process Context_DLV 05-02-2014 (M38MRG v1.0)
[52]	Port Plug Maintenance_Processes 09 and 10 (BFER9E v1.0)
[53]	Action A37_Update list of operations for port plug removal and installation_v1-0 (C9Y7AL v1.0)
[54]	Action A37_Update list of operations for EQ PP 11_v1-1 (C9YN3C v1.0)
[55]	Maintenance of Port Plug_Summary Report (N3UWNJ v1.1)
[56]	List of maintenance operations for EQ PP 11: Updated for Meeting 15 (HR29K3 v1.0)
[57]	Hands-on maintenance scheme proposal - presentation to PTF (Q4V8Q9 v1.0)
[58]	Port Cell Maintenance Standardization Preliminary Assessment (Q4SV8E v1.1)
[59]	Port Cell Maintenance - Port Plug Removal Process & VV Inner Environment Evolution (UPU6WP v1.0)
[60]	Time to Be Spent in EQP11 Corridors (URBF2V v1.0)
[61]	Maintenance Isolators for flange Breaching (ITER_D_UPU9HN v1.0)
[62]	Technical note on internal interfaces of EP#11 (98CY56 v1.7)
[63]	Maintenance procedures at EP#11 Closure Plate (TL7D6J v1.0)
[64]	Detailed_Study_of_Installation_and_Replacement_Procedure (SZRNM7 v1.1)
[65]	11. Port Integration - Standardisation - ISS, Bioshield, PCSS Status_T.Giacomin (UHU9QX v1.2)

4.11 Maintenance

[80]	Policy for the ITER Plant Maintenance (FFTH8A v2.1)
[81]	ITER Maintenance Program (MPR) (S7THN6 v1.0)
[82]	Policy for the identification and approval of ITER Maintenance Tasks (45UWCF v1.5)

4.12 Human & Organizational Factor

[83]	ITER_D_QUK6LF - ITER Human & Organizational Factors Policy
[84]	ITER_D_2WBVKU - ITER Human Factor Integration Plan
[85]	ITER_D_SAKT22 - ITER Procedure for HOF Issues Management

4.13 Hazard analysis

	PBS	HIRA Link
[86]		Safe Access for maintainability (ITER_D_RUGWUK v1.3)
[87]		Protective equipment and hostile environment layout (ITER_D_RBYZ42 v1.1)
[88]	PBS15	ITER_D_RH7LN5 - HIRA Report - HNB Duct Liner
[89]	PBS16	ITER_D_T6V5LH - HIRA - Risk assessment report for PBS16 ITER_D_UD7395 - HIRA PBS 16 FP Final Report
[90]	PBS17	ITER_D_TVF89T - PBS 17 - HIRA report
[91]	PBS18	ITER_D_QFFK98 - PBS 18 - Risk assessment (HIRA) report
[92]	PBS23	ITER_D_SNBSUZ - HIRA Report for PBS 23.06.RM ITER_D_V3H7Y4 - PBS 23.06.CM HIRA - Risk Assessment
[93]	PBS24	ITER_D_R7J9FJ - PBS 24 - VVPSS Occupational Health and Safety hazard table
[94]	PBS26	ITER_D_S3GEWG - HIRA PBS 26 Risk Assessment Table ITER_D_T6X8RE - HIRA analysis for TCWS
[95]	PBS32	ITER_D_PNJQN3 - PBS 32 DS HIRA Final Report ITER_D_VMYMYN - PBS 32 - DS Captive Piping Occupational Safety Demonstration ITER_D_URFQ37 - PBS 32 TEP HIRA Final Report ITER_D_RW6QZN - PBS 32 WDS HIRA Final Report
[96]	PBS34	ITER_D_S7Q3YH - 34.4H.00 - IORA - 001 : HIRA
[97]	PBS41	ITER_D_MTUCHG - CPSS - risk assessment table
[98]	PBS43	ITER_D_Q8NXQE - PBS-43 HIRA Final report
[99]	PBS46	ITER_D_SL7C6T - Hazard Identification and Risk Assessment for PBS46
[100]	PBS48	ITER_D_QRUUXU - PBS 48 HIRA
[101]	PBS51	ITER_D_Q5HT9J - PBS51 HIRA Final Report
[102]	PBS52	ITER_D_PB4U8U - PBS 52 - HIRA report
[103]	PBS53	ITER_D_RD5HXA - PBS53 HIRA Final Report
[104]	PBS55	ITER_D_JNPJ7T - Laser hazards table ITER_D_T8DGN3 - Hazard Identification and Risk Assessment for 55.C1 and 55.C2

		ITER_D_UPQHMB - 55.C4 - Hazard Identification and Risk Assessment (HIRA) Report ITER_D_RBL3BM - HIRA_Report_VUV_Alignement (55.E) ITER_D_RXKR96 - HIRA report for NAS Diagnostic (55.B8) ITER_D_UNGLX2 - 55.ED - HIRA Final Report_PBS55.ED XRCS
[105]	PBS58	ITER_D_PNZVQQ - PBS58 PPTF HIRA Report
[106]	PBS64	ITER_D_S23LBW - PBS64-HIRA Report
[107]	PBS66	ITER_D_Q9CF2U - PBS66 - HIRA Final Report
[108]	PBS69	ITER_D_QSQCKR - PBS 69 HIRA Final Report

4.14 ALARA

	PBS	ALARA Link
[109]		ITER_D_2543FJ - Occupational Safety, ORE and ALARA
[110]		ITER_D_PNJUPL - Last achievements in the ITER Occupational Radiation Exposure (ORE) assessment
[111]		ITER_D_Q3R9H6 - UPDATE AND PERFORMANCES OF ORE STUDIES IN NUCLEAR BUILDINGS FOR D–T PHASE
[112]	PBS11	ITER_D_UHCNFY - Description of the maintenance activities for PBS-11(Magnets)
[113]	PBS15	ITER_D_TX5M34 - VV ISI_Request on the study of work places – ASN request
[114]	PBS16	ITER_D_TK5LHP - Occupational Radiation Exposure for the Blanket System (PBS 16)
[115]	PBS17	ITER_D_TYGQCF - Occupational Radiation Exposure for the Divertor (PBS 17)
[116]	PBS18	ITER_D_TXN443 - DMS maintenance activities and dose rate ITER_D_TXBRJL - GIS maintenance activities and dose rate ITER_D_TXMY5C - GDC maintenance activities and dose rate ITER_D_TXQHQA - PIS maintenance activities and dose rate
[117]	PBS23	ITER_D_TEAN69 - Cumulative Dose in BRHS Related Workstations in Tokamak Building ITER_D_U24PX3 - ORE Report (PBS-23) ITER_D_TMW2ED - Occupational radiation exposure (ORE) estimation for the Neutral Beam RH System
[118]	PBS24	ITER_D_UHC9H5 - Maintenance activity description - PBS-24 Cryostat
[119]	PBS26	ITER_D_V5ZCJS - TCWS ORE calculation
[120]	PBS31	ITER_D_UJ8P6E - Maintenance Activity Description for ORE evaluation of PBS-31
[121]	PBS32	UL99GX
[122]	PBS34	UD9H9S
[123]	PBS41	ITER_D_UMSL3U - Maintenance study - Work effort inputs for ORE estimation of PBS-41
[124]	PBS43	UR8RUX
[125]	PBS46	UMTYRQ
[126]	PBS48	UMU3NN

[127]	PBS51	ITER_D_UFFCG2 - ICH&CD part of ORE_assessment
[128]	PBS52	ITER_D_U5LN2M - ORE-52
[129]	PBS53	ITER_D_44W6EL - 10- Status of ORE studies in the NB cell
[130]	PBS55	ITER_D_V3A7TF - PBS 55 ORE Estimation
[131]	PBS58	PQTSAX
[132]	PBS64	ITER_D_N3TW76 - Periodic Testing and Inspection Plan - PA 6.4.P1.EU.01
[133]	PBS66	TBD

5 Scope of work – Firm part

One of the main objectives of the contract is to perform these activities following an integrated approach applying existing System Engineering concepts, with coherent approach, data, and common tools.

Therefore, it is fundamental that the contractor's team and IO team work jointly, sharing information, participating in integrated meetings in order to benefit of each activities progress.

The activities to be performed are divided into Work Packages (WP).

In order to illustrate the approach and the logic between WPs, the scheme in *annex 4* is proposed.

Three different groups of areas are identified according to the IO priorities (see *annex 2*), as follows:

- Priority 1 Areas (scope of the firm part)
- Priority 2 Areas (scope of the option)
- Priority 3 Areas (scope of the option)

Each area identified, and included in the scope of work, has been selected as representative for a certain number of other areas which shall be, therefore, well represented by the analysis, conclusions and results for the areas in the scope of work.

The division of scope is to be done according to the IO design schedule as shown in paragraph 11.2.

Each group of areas shall be dealt in an analysis loop as shown in *annex 4*. One of the purposes of WP2 will be for the contractor to develop/detail this approach based on its method, engineering approach, lesson learned.

The typical analysis loop is basically composed of the following main steps:

a. Input data collection and review (relevant for the areas of concern);
b. WPs (see below) activities and ALARA implementation (design optimization loop);
c. Definition of the new ORE status.

NOTE:

The ORE Status, at each loop, shall include the status of the complete scope of work. The data to be used are therefore:

- Data resulting the analysis of the Areas in the scope of the priority package under study;
- Data of the areas represented by the area in the scope of work (therefore using the same conclusions and data);
- Data available from previous ORE status for all the other areas.

At the end of the analysis loop the supplier shall issue the following main documents:

- Areas integrated maintenance assessment reports (composing the "ALARA Status N report" – ORE status N)

- Area Maintenance Plan

Further details are in *Annex 6: Area Integrated Maintenance Assessment Report* and *Annex 7: Area Maintenance Plan – Contents*.

In the following paragraphs the work packages are described.

5.1 WP 1 – Familiarization of the context and team building spirit

The purpose of this WP1 will be for the contractor to gather and become familiar with the input provided by IO. In order to well understand the environment and the constraints, IO proposes to have:

- 2 Introduction meetings at Tokamak level (4 hours each) using CAD data (CATIA files), in the Virtual Reality Room in order to have an overview of the ITER project focusing on the Tokamak, as well as presentations on transverse activities (ALARA, contamination, RAMI/maintenance, HoF, Hazard analysis, safety requirements). The IO and contractor organizations for this contract will be presented and define during this phase.
- 4 Introduction meetings for key PBS (26, 52, 53, 55) – (2 hours each) using CAD data (CATIA files), Virtual Room in order to have an overview of the system, a presentation of the current design, the main functions and the key associated documents. That will be an opportunity for an exchange between the contractors and the main PBS Technical Officers.

This set of meeting will complete the documents provided in order to freeze the input to be considered for the others Work Packages. Similar approach will be done for the options according to priority list.

In order to have a common approach, the contractor will present its nuclear engineering processes (ALARA, confinement and contamination controls, HoF, Hazard analysis and integrated approach), discussions will be organized between IO and contractors in order to customize such processes according to ITER context, to finally present the processes that will be implemented for the contract including relationship between both teams. In addition, technical visit of a Nuclear site will be organized with objectives to highlight some analogies.

5.1.1 Input

- This technical specification
- All the references identified in the input package regarding the PBS and the transverse activities
- Additional document provided by IO during the contract updating initial input

5.1.2 Activities

- Appropriation of the initial set of inputs including Technical exchange with IO team in preparation of deliverables WP1 and WP2.
- Review of initial input data PBS (requirements, CDR/PDR/FDR package) and transverse activities
- Technical assumptions approval for data not provided,
- Input package review and validation per area (multi PBS and integrated approach)
- Co-organize, and co-prepare with IO the meetings
- Provide minutes of these meetings

- Organize Team building spirit workshop, provide nuclear engineering processes based on contractor's training and guidelines, then propose customization of such processes for the contract and nuclear facilities visit

5.1.3 Output

- Memos, mails based on Question & Answer approach
- Input data review & completion report
- Workshop PPT + workshop report

5.2 WP 2 – Management, implementation plan, status report

The purpose of this WP2 is dedicated to the management of the contract (Technical, budget, schedule) and the reporting.

5.2.1 Input

- This technical specification
- All the references identified in the input package regarding the PBS and the transverse activities
- Additional document provided by IO during the contract updating initial input
- Project schedule

5.2.2 Activities

- Define and update the contract management plan (including deliverables list, provide a compliance matrix with regards of the application of The Order 7th February 2012 applies to all the components important for the protection (PIC) and the activities important for the protection (PIA) – see chapter 14). This step is fundamental. The contractor, based on his experience implementing engineering processes in parallel, at the end of the appropriation phase, will define the integrated plan including all the WP processes based on the logic presented in Annex 4. The purpose will be to define the most efficient way to work between contractor and IO (core team, PBS) as an integrated team. The contract management plan will be presented and improved in the workshop (see WP1).
- Organize, follow up, report on all the contract activities (Planning, prioritization and detailed scope of work)
  NOTA: A follow up and monitoring including notably: List of Deliverables, schedule, progress report needs to be done for each WP.
- Advise IO on optimization of the current contract and recommendations to improve ITER project
- Organize and prepare the contract management meeting (quarterly progress)
- Coordination of the contractors activities and participation to key technical meeting
- Provide minutes of these meetings

5.2.3 Output

- Contract management plan versions (including integrated processes).
- Quarterly Status report (including planning and detailed scope of work schedule)
- Minutes of the Contract management meeting
- Minutes of Technical meeting involving several transverse activities
- Memos to advice, to warn, to make recommendations to IO

5.3 WP 3 – Integrated Maintenance activities

The purpose of this Work Package is to prepare and conduct integrated maintenance assessments for specified areas, producing Area Maintenance Plans (Sequence of coordinated tasks based on PBS needs) as an output. It should assimilate the input from related WPs, namely WP4, WP5, WP6, WP7, WP8 and WP9. This Work Package also includes the outlining of a working process for producing Area Maintenance Plans, and the specification and development of an 'ALARA Maintenance Database' to be used to support ALARA implementation.

The objectives are as follows:

- Development of the specification and creation of a secure (inputs data under configuration control as well as the DB itself) ALARA Maintenance Database.
- Outline of the working process for producing Area Maintenance Plans, including a standard approach for assessment of maintenance tasks in this context.
- Characterisation of the areas in which maintenance assessments are to be undertaken, assimilating input from existing ITER documentation (PBS maintenance plans notably) and outputs generated from related WPs within this contract.
- Consolidation of the PBS input data, and identification of missing information. This consolidation will be undertaken by the contractors (Process to be set up to collect, check, consolidate and validate) with IO support. Where necessary, assumptions will be proposed by the contractor based on experience and lesson learned and reviewed by IO (PBS TRO keeping the responsibility of the PBS maintenance plan).
- Generation of maintenance solutions, for preventative and corrective maintenance, that are demonstrated to be practically implementable, and adhere to the principle of ALARA (discussed in more detail in §5.3.1).
- Productions of Area Maintenance Plans (develop the maintenance sequence in the area considering all the maintenance needs of the different PBS, then check the co-activity). Engineering process loop will be required to modify PBS maintenance plans and Plant level approach if required. The contractor will make recommendations to IO, with the IO retaining the responsibility to implement the recommendations.
- Population of ALARA Maintenance Database with data generated.

Note: Inspection tasks are included in the maintenance tasks

5.3.1 Input

- This technical specification
- Contract Input package up to date
- Reference international standards for maintenance and asset management applicable to nuclear facilities.
- Existing PBS M&I documentation.
- ITER project integrated schedule (staged approach)
- ITER building and system layouts and drawings.
- ITER numbering system.
- Output generated in other WPs of this contract (namely WP4, WP5, WP6, WP7, WP8 and WP9)

5.3.2 Activities

<u>Database and Process Development</u>

- Development of the requirements for a secure ALARA Maintenance Database through solicitation of stakeholder requirements. Development of a specification for the database, and selection of a suitable method for database implementation. The database should encompass all maintenance activities to be undertaken of the life-cycle of the ITER plant, and should enable to completion of the ALARA analysis to be undertaken in WP9 (see Annex 5 for a preliminary list of database fields).
- Procurement of the database software, and implementation of the database.
- Review of the existing ITER Maintenance Management Procedure(s) in order to propose and gain stakeholder approval of the approach for developing Area Maintenance Plans.

<u>Assimilation of Maintenance Requirements and Characterisation of Maintenance Areas</u>

- Review and familiarisation of the maintenance areas to be assessed, including review of equipment inventories, CAD models, P&ID diagrams etc., and assimilation of output from related WPs (namely WP4, WP5, WP6 and WP8) in order to fully characterise the area to be assessed. Collate the data gathered in the database.
- Review existing PBS M&I plans, RAMI reports, conduct interviews with TROs and review of other documents as required establishing the maintenance needs per PBS element in the area(s) to be assessed. Ensure that any constraints to maintenance activities are identified so that they can be taken into account. Propose the collated data as a summary of maintenance requirements per area, for approval of stakeholders and collate the data gathered in the database as required.

<u>Maintenance Solution Generation</u>

- The contractor shall, based on their previous experience in nuclear design and maintenance, provide maintenance recommendations and solutions, and demonstrate the feasibility of their implementation (reparability: preventive, corrective maintenance), their ability to satisfy all relevant requirements and their adherence to the principle of ALARA. For example, with reference to the ITER port area context, the following topics shall be covered:
    - Design principles of the equipment in order to implement the maintenance in nuclear environment (tooling, handling, preparation, radioprotection, and interfaces with plant systems…)
    - Recommendations regarding the confinement approach:
        - Airlock concept
        - Double groove concept (glove box concept) for the use of plastic bag
        - DPTE concept
        - …
    - Recommendations to perform eventually real mock-up and trials
    - Principles of waste management
    - Human factor considerations
        - Accessibility taking in account environment,
        - Movement around working spaces
        - Physical atmosphere in the working spaces,
        - Equipment – Technical devices,
        - General layout of the operations rooms,
    - Mitigation and management of hazardous substances (Beryllium?) in a maintenance context.

<u>Area Maintenance Plan Development</u>

- On the basis of the above, the contractor shall develop the first iteration of the Area Maintenance Plans for the areas specified, adhering to any applicable guidance and requirements from existing ITER MQP or safety guideline documents. The contractor shall organise meeting with Stakeholders to present integrated Area Maintenance Plan(s) (IO proposes Half day/area). Contractor will make proposals and IO will be responsible of their implementation or not.

- The contractor shall identifying all the work stations within a maintenance area and assessment of SDDR contributions to each work station, provide ORE status N (main contributors). The contractor shall assess the collected dose rate for the area, based on the maintenance plans defined and review this collective dose rate shall against the collective dose rate assigned to the area. Following the process described in WP9, the contractor shall implement the principles of ALARA (check list to analyze all the reduction factors that could be used) to identify actions that may reduce the ORE – and repeat the steps described through WP3 to investigate how the ORE could be reduced.
- Based on lesson learnt from nuclear industry and maintenance tasks assessed, the contractor will identify the required maintenance equipment. Key functions of these systems will be defined, an effort of rationalization and standardization is requested in order to optimize the systems needed to be studied in WP6.Indeed, after rationalization effort, the needed maintenance equipment identified will be those who have to be studied in WP6 (However a preliminary list of these equipments is proposed).
- The Area Maintenance Plans shall then be updated and presented to stakeholders, based on actions identified through execution of the ALARA process. A minimum of 2 iterations are expected.

5.3.3 Output

- Working Procedure for Area Maintenance Analysis
- Summary reports on existing RAMI and M&I plan reports for each PBS including consolidation.
- Minutes of Technical meeting and final to present integrated maintenance per areas on this activity
- Integrated Area Maintenance Assessment Report(s) for the areas specified (see Annex 6) + this report could be merged with ALARA report)
- Area maintenance plans (with updated version according to ALARA steps, see Annex 7)
- ALARA Maintenance Database completed, coherent with Area maintenance plans and Shutdown Dose rate maps.

5.4 WP 4 – Shutdown Dose Rate (SDDR) maps

The purpose of this work package is to update the radiation source descriptions, then produce radiation maps (biological shutdown dose rate) per areas for the main workstations in order with WP3 to perform the ORE assessment WP9. In order to support ALARA process, the different systems/sub-systems/element contributing to the SDDR shall be identified, then after an optimization process re-compute new Radiation Maps.

5.4.1 Input

- This technical specification
- Contract Inputs package up to date
- Outputs of others activities performed in the frame of this contract
- Radiation transport models of all components in the areas of interest and those other components which determine the radiation levels in the areas of interest or CAD models

providing sufficient description of all relevant components to prepare radiation transport models. This shall include geometry and material descriptions and source terms when appropriate.

5.4.2 Activities

- Create radiation transport models of Areas including all equipment relevant to SDDR.
- Provide radiation source descriptions for radiation transport simulations (neutrons and gamma-rays)
- Produce radiation maps for all the Areas and provide SDDR in useful workstations (in the different Area maintenance configurations, i.e. if a component has been removed the SDDR map shall be updated, where meaningful, to provide the applicable dose rate values):
  - ➔ Compute the neutron flux s in B11. The calculations will be run until the statistical error on the flux <10% at the boundaries of B11.
  - ➔ Determine the activation of equipment at the end of life (SA2 scenario) and after eight years of operation according to the scenario [7]. This shall include the identification of dominant nuclides covering at least 99% of the contribution to the dose. This is to be done for 10^5, 10^6 and 10^7 seconds cooling time.
  - ➔ Compute the SDDR field. The calculations will be run until the statistical error on the flux and dose rate is <10% when the dose rate is <10% of the requirement.
  - ➔ Compute maps of the isotopic distribution of those isotopes contributing (together) at least 99% of the dose.
  - ➔ Provide a report describing the main contributors to the SDDR at the work stations for each of the maintenance configurations.
  - ➔ Compute the gamma flux (γ-ray energy >100keV) in B11. The calculations will be run until the statistical error on the flux and dose rate is <10% at the boundaries of B11.
  - ➔ Compare the results with previous radiation maps and provide a report on the differences between the two with particular attention to any locations where the fluxes have increased.
  - ➔ Provide radiation source model explanations and a chapter of technical report describing it including calculation methodology, approximations, nuclear data used and a description of the range of validity of the sources
- Following ALARA optimization, update radiation maps for all the areas and provide SDDR, isotope maps, and main contributors at workstations.

5.4.3 Output

- SDDR Maps report per area status N identifying the key contributors for each maintenance configuration
- Isotope Maps report per area status N for each maintenance configuration
- All models and radiation maps.

5.5 WP 5 – Contamination maps and integrated contamination controls design

Based on plasma physics, initial radioactive or beryllium inventory, conditions of operations of 1st barrier system including vacuum, detritiation system, HVAC the goal is to propose or substantiate the controls solutions (technical or operational) with regards to the need for preventing potential contamination for all the work station where contamination spread could all along the different maintenance activities identified.

5.5.1 Input

- This technical specification
- Contract Input package up to date
- Output of others activities performed in the frame of this contract

5.5.2 Activities

- The contractor will have to apply the work instruction for the methodology to perform contamination analysis and workers dose assessment (To be determined). The contractor will review/comment this work instruction, including other inputs for contamination assessment, and use or propose an alternative based on their own lesson learned agreed with IO.
- Based on WP3, WP6 to 9, identify the areas, then the workstation where contamination hazard may appear in normal and incidental conditions during maintenance.
- Assess and/or substantiate (including if necessary by calculations) the controls solutions against potential airborne & surface contamination levels associated with each situation where hazard contamination can occur (breach of 1st barrier, primary process interventions – activated cooling system), then estimate the potential internal doses (& toxins – Be - uptake) to workers during PBS maintenance activities.
- Perform macro aerolic simulation (0D or 1D) using code such SYLVIA for the DS/HVAC (pressure cascade, air velocity breach...) inside the areas concerned in order to support a confinement expertise.
- Contribute to Integrated Maintenance procedure, participating to integrated technical meeting.
- Based on contamination hazard assessment performed by the contractor and trade off on existing concept, considering lesson learned from existing devices used in nuclear industry, the objective is to justify the best concept to be used for all the systems to be disconnected with contamination hazard. The Contractor will propose
    - ➔ a global concept of maintenance and design improvement in order to manage properly the confinement (airlock, temporary enclosure, vinyl bag, maintenance cabin, local extract ventilation, HEPA filters need, airborne and surface contamination monitoring…),
    - ➔ the type of suits to be used based on best practice in nuclear industry,
    - ➔ The technical features (leaktighness, pressure cascade, pressure integrity, confinement velocity, safety protection factors) for confinement systems will be proposed.
    - ➔ The decontamination techniques useful and applicable

  This activity will be conducted in strong interaction with WP6.
- Tabulate all Machine Maintenance Activities, that require specific Confinement measures, Static (Permanent or temporary) with Dynamic (PBS32-DS, PBS31-SVS, PBS62-VA especially local air cooler), ensuring capacity of service providers, maintenance scheduling and in-particular identification of high-risk & hazard activities to be analyzed in priority.

5.5.3 Output

- A synthesis report at Tokamak level providing a contamination Hazard mapping, including an xls sheet / extraction of the ALARA Maintenance database or all activities requiring confinement measures are identified.
- Contamination Hazard analysis report per areas according to priority list.

5.6 WP 6 – Maintenance process & Equipment standardization

Main input to this work-package is based on WP3 and PBS Input data.

This work-package is applicable to all the maintenance related issues in the Tokamak Building 11 and the Areas identified in the scope of work focusing on promoting Standardization in terms of technical solutions, processes, and equipment between all the stakeholders involved in the several topics sharing similar needs and functions.

Design and value analysis to identify, justify and promote the best solutions among concepts is part of this work-package scope.

<u>The list of Priority 1 items relevant the Port Cell Maintenance to be developed within the Firm Contract execution follows:</u>

ID	ITEMS	INPUT	ACTIVITY	OUTPUT
1	**Cask docking flange and maintenance door Installation/Removal and relevant equipment**	- System Design Description (DD 23.03) - Cask & Plug Remote Handling System (CPRHS) (JE6YHS v1.1) - IS-15-23-002_VV Equatorial port to Docking Flange and CPRHS interface (2EQVCT v3.1) - IS-23-15-002-ANNEXE_IP1_IP2 (V9ZAMK v1.0)	Functional analysis, value analysis and identification of the concept. Key interfaces identification, safety compliance demonstration and concept development	- Technical requirement document - Conceptual design report
2	**In port cell temporary enclosures for port components removal**	- Port Cell # 11 Maintenance Feasibility study report - FINAL - (WF8Y6D v1.0)	Functional analysis, value analysis and identification of the concept. Key interfaces identification, safety compliance demonstration and concept development	- Technical requirement document - Conceptual design report
3	**VV Sealing Flanges Removal/Installation and relevant equipment**	- VV Port and Port Plug Flange Sealing Design Finalisation (QFED86 v1.1) - Large Seal Test Rig Technical Specification (R7WQNK v1.3) - Vacuum Equatorial Flange Mock-up - Conceptual_Design - Drawings (WPQMRC v1.1)	Functional analysis, value analysis and identification of the concept. Key interfaces identification, safety compliance demonstration and concept development	- Technical requirement document - Conceptual design report

ID	ITEMS	INPUT	ACTIVITY	OUTPUT
		- Port Sealing Flange Drawings - June 2018 - Lipseal at all levels (WPQUWP v1.0)		
4	**Cleaning methods for Port Cell and Port Cell Components/ Equipment and needed packing/ protection equip.**	/	Functional analysis, value analysis and identification of the concepts. Key interfaces identification, safety compliance demonstration and concept development	- Technical requirement document - Conceptual design report
5	**Port Plug Bolting/Unbolting and relevant equipment**	- Development of the Bolt Tensioners for the Upper and Equatorial Ports (HPYKYW v1.0) - Final Report (Q9XSJ3 v1.0)	Functional analysis, value analysis and identification of the concept. Key interfaces identification, safety compliance demonstration and concept development	- Technical requirement document - Conceptual design report
6	**Port Cell Door Airlock**	- Port Cell Door Airlock_Pre-Concept (V5CKAW v2.2)	Critical assessment	- Chapter in WP6 Assessment Report
7	**Port Plug Cooling Water Pipes equipment and solution for removal/installation**	- TS for IBED pipes Mock-*up with RACE --- on-going		
8	**Port plug tilting**	- 4.1. Port Plug Handling Mock-up - Test synthesis Report (U7Y65V v2.0)		

<u>The proposal list of Priority 2 and Priority 3 topics relevant the Port Cell Maintenance to be developed within the Contract Option Part execution follows (further details will be provided):</u>

- Improvements on Priority 1 topics where needed
- Priority 2 topics:
    - Accessibility:
        - Personnel access platforms (Technical requirement document, Conceptual design report)
    - Port components removal equipment: (critical assessment)
        - Port Cell Components common transport system
        - Pipe Welding Equipment and NDE Tools
        - Pipe Cutting and Bevelling Tools
        - Sealing Flange Milling/Welding Equipment
- Priority 3 topics:

- Ancillary related maintenance topic: (critical assessment)
  - Gallery Temporary Parking Areas
  - In-Port Cell Services
  - Ancillary Maintenance Equipment
- Additional Shielding:
  - Temporary Shielding Port Plug and relevant Handling Equipment
  - Additional in port cell shielding (Technical requirement document, Conceptual design report)
  - In service inspection tools ((Technical requirement document, Conceptual design report)
  - Human assisted RH equipment (Technical requirement document, Conceptual design report)

Development of output documentation (see paragraph below) for each of the identified topics according to the contract schedule is included in the scope of work.

Further topics can be identified during the contract development. The potential new topics identified shall be included in the scope of work in agreement with IO representatives.

5.6.1 Input

- This technical specification
- Contract Input package up to date
- Output of others activities performed in the frame of this contract, notably Process and Maintenance Strategy description (WP3)

5.6.2 Activities

- Based on WP3 notably and in coherence with others WP, perform Trade off approach to justify the best solutions among concept (based on current ITER development, lesson learned from existing systems…):
  - Challenge input data, cross check and consolidation,
  - Trade studies and benchmarking,
  - Review and consolidation,
  - Integration of lessons learned from existing nuclear facility,
  - Promoting Standardization in terms of technical solutions, processes, and equipment between all the stakeholders involved in the several topics,
  - Recommendations and supports of decision
- Following trade off studies deliver Design concept report (including drawings, CAD data files)
- Following the trade-off approach on the concept, the contractor will propose the System Requirements documents at concept level for the solution that have been identified.

5.6.3 Output

- Concept design report (Functional analysis, value analysis, design concept with CAD data, key features, area integration and safety demonstration…) for enabling systems identifying in table above or following contractor analysis performed in WP3
- System Requirements documents of developed equipment concepts, including Interface of developed equipment concepts – Concept level

  See table in chap. 5.6 for more details.

5.7 WP 7 – Human & Organizational Factor analysis

Human & Organizational Factors (HOF) analysis based on ITER HOF program [2WBVKU]. The HOF program will follow the two levels approach:

- **Macroscopic analysis**: the objective of this analysis will be to have an overview of the needs for maintenance operations, the constraints generated by the working environment (hazards management and individual protections needed, accessibility issues – in line with WP8, technical environment, performance requirements, etc.). The Return of Experience (REX) from other facilities with similar working situations shall be included (the contractor with the design/operation experience on the installations representing similar characteristics, especially in terms of hazards management, is preferred).
- **Microscopic analysis** will consist in elaborating and analysing the maintenance/inspection scenarios (representative for the future probable activity in the port cell areas–necessary to ensure facility's safety objectives. The Task Analysis method will be based on operation scenarios analysis covering all normal operation conditions that may occur, in particular for the analysis of the working situations (work stations) which are the most penalized in terms of environmental and physical constrains, especially for the radiological/beryllium zones, and that cover protection important activities [PIA] to address the human and organizational reliability issues.

The Macroscopic and Microscopic studies will be preceded by the review of existing ITER guidelines for the design of local workplaces (on site) and the complementary standards review.

The HOF analyses will be performed in line with the priority topics listed in the WP6 (section 5.6) and in particular the Safety Sensitive Activities (SSA), which are any human intervention on PIC components and/or human work performed in irradiated/contaminated areas, necessary to ensure facility's safety objectives. The analyses will identify the most representative working situations in ITER with the goal to cover all normal operation conditions, and the most penalized cases in terms of risk severity and operational complexity is implemented. These analyses might be done on selected port cell areas, so as the results could be propagated to the design of other (similar) port cell areas.

The results of the HOF analyses will provide the requirements and design solutions for workplace layout, accessibility, maintenance/inspection feasibility (e.g. equipment and procedures design), and work organization in line with ALARA and ORE approaches, including Health and Safety requirements.

5.7.1 Input

- This technical specification
- Contract Input package up to date (notably ITER HOF program, PBS maintenance plan)
- Output of other activities performed in the frame of this contract

5.7.2 Activities

- Perform the review of ITER guidelines for the design of local workplaces (on site) and the international standards and guidelines that might bring additional design requirements adapted to ITER specificities.

- Select (in collaboration with ITER staff) the port cell areas that would be the most appropriate for the thorough HOF investigations and design studies, in line with the priority topics presented in WP6 (section 5.6).
- Perform macroscopic study of the selected port cell areas in order to have the overview of maintenance operations in terms of accessibility, physical working conditions, radiation/contamination zoning, etc.
  - ➔ Input data analysis (design specification/description, hazard identification, ALARA Maintenance Database with available information such as maintenance/inspection tasks description, existing operating modes, etc.)
  - ➔ Preliminary analysis of the maintenance tasks (based on WP3: analysis of workstations, environmental constraints, PIC/SIC equipment, maintenance and inspection phases and tasks, tools needed for the tasks performance, performance objectives and criteria)
  - ➔ Return of Experience [REX] (data collection/formalization on the operations in similar hazardous working environments, lessons learned for the ITER port cell areas design)
  - ➔ Working groups / discussions with IO staff (needs analysis, preliminary statements, HOF issues identified, etc.)
- Perform microscopic study in order to identify and analyze the unsafe operations for human and machine safety, and offer suggestions for possible improvements (design of working situation)
  - ➔ Preparation of the maintenance/inspection scenarios (work situations based analysis) to build up safety cases for safety demonstration
  - ➔ Perform the task/activity analysis based on the chosen inspection/maintenance scenarios following appropriate HOF techniques, e.g.:
    - Scenarios unfolding based on design documentation support within working groups
    - Scenarios unfolding based on 3D mock-ups provided by IO (Virtual Reality Room)
    - Scenarios unfolding based on physical mock-ups provided by IO
  - ➔ HOF Data traceability (HOF issues log and HOF design requirements data base update, ALARA Maintenance Database update with HOF results)
  - ➔ Working groups / discussions with IO staff (needs analysis, preliminary statements, HOF issues identified, etc.)
- Contribute to Integrated Maintenance procedure development, participating to integrated technical meeting
- Organize technical meetings (working groups) on HOF with IO team
- Review the Area integrated maintenance assessment Report and the Area maintenance report

5.7.3 Output

1. HOF design requirements from reviewed guidelines and standards;
2. HOF program and method proposed in line with ITER project needs with selected port cell area to be studied, the topics to be addressed, and the maintenance / inspection scenarios to be analyzed;
3. Lessons Learned from the Return of Experience in similar facilities to feed the design of ITER port cell areas and to incorporate identified good practices in ITER maintenance strategy;

4. HOF report (progressive) with the results of Task Analyses based on maintenance / inspection scenarios (taking into account the batch topics from the WP6 and the SSA analysis).

All the HOF deliverables shall be reviewed and approved by IO HOF RO.

5.8 WP 8 – Area Hazard Analysis

The objective will be to perform an integrated hazard analysis per area based on ITER Occupational safety procedure, gathering information coming from different PBS (Hazard Identification and Risk Assessment – HIRA per PBS available at each Design review) – see input package, considering their interaction. The outcome of the risk assessment process shall include all risk mitigation measures that remove or reduce the risk through design solutions.

5.8.1 Input

- French Legal Requirements concerning OHS
- This technical specification
- Contract Input package up to date (notably ITER Occupational safety procedure, PBS HIRA)
- Output of others activities performed in the frame of this contract

5.8.2 Activities

- Perform an integrated hazard analysis per area according to IO procedure and following sequencing process defined in annex 8.
  - ➔ Identify the PBSs present each area;
  - ➔ Identify the hazards present;
  - ➔ Classify the room according to IO criteria (Oxygen deficiency, Confined space, Noise, Electricity, Pathogenic agents, ATEX, Laser, Electromagnetism, contamination, irradiation,…) → Interaction with Work Package 7
  - ➔ Identify hazardous interactions between PBSs
  - ➔ Identify transverse issues (lighting, accessibility...)
  - ➔ Identify workplaces → Interaction with Work Package 3
  - ➔ Identify frequency of exposure to hazards or any other safety issues
  - ➔ Identify the safety precautions / constraints / limitations applicable to the workplace / room / area → Interaction with Work Package 3
  - ➔ Propose improvement and corrective action → Interaction with Work Package 7
  - ➔ Follow-up the improvement and corrective actions implementation
- Contribute to Integrated Maintenance procedure, participating to integrated technical meeting
  - ➔ Provide guidance on OHS aspect within the maintenance and ALARA considerations
  - ➔ Identify improvement opportunity
- Review the Area integrated maintenance assessment Report and the Area maintenance report
- Organize technical meeting on Hazard Analysis with IO team

5.8.3 Output

- Hazard Analysis report per area.
  These reports will be delivered with intermediate version with following steps:

- ➔ Step #1: Compilation of hazards present in the room
- ➔ Step #2: Compilation of integration issues regarding hazards
- ➔ Step #3: Room safety improvement and corrective actions

These reports will be updated according to the implementation of corrective actions and changes done within the framework of this Engineering contract (mainly ALARA iterations).

- Maintenance-ALARA Data base filled in with Hazard Analysis parameters

5.9 WP 9 – ALARA

This Work Package is the backbone of the contract as it is shown in annex 4. Indeed, according to current ORE assessment in ITER, it is necessary to put in place a strong iterative and formalized optimization process to reduce as low as achievable the ORE, notably the ITER collective dose which have to be in average less than 500 men.mSv/year.

In order to assess the ORE, it is necessary to perform WP 3 in order to have integrated, coherent and consolidated maintenance scenarios with main workstations, all the information being gathered in a unique ALARA Maintenance Database, completed by output from WP 4 and 5 to assess the radiological environment for each of the different workstation for the different configuration representative to the maintenance scenario.

2 iterations are expected with 2 ORE status.

5.9.1 Input

- This technical specification
- Contract Input package up to date (notably ITER ALARA procedure, PBS design, ITER Radiological data and models)
- Output of others activities performed in the frame of this contract

5.9.2 Activities

- In close cooperation with WP 3, production of ALARA Maintenance Database (define requirements, select architecture, collect, complete information coming from PBS and support WP3 to define integrated maintenance scenario)
- Implementation of the ITER ALARA procedure, notably assess global ORE for the Tokamak (all areas) status N
  - ➔ For 1st ORE assessment: An effort will be provided to identify all the optimization axis (reduction factors) already put in place in previous design phase. The objectives are to evaluate ORE for each areas and PBS then qualitatively: to identify, collect and try to quantify the dose reduction factors for the previous design phase.
  - ➔ According to areas priorities, a formalized and strong optimization process will be put in place between ORE N and N+1. The objectives will be:
    - ▪ Evaluation of exposure scenario,
      - Definition of work areas
      - Definitions of work stations in work area
      - Specification of maintenance tasks
      - Definition of maintenance task parameters (frequency, resources, duration…)
      - Determination of SDDR
      - Definition of contamination mobilization and internal hazard

        - Calculation of ORE
    - Identification and quantification of dose reduction factors
        - Propose mitigation strategies through application of ERIC-PD Approach
        - Eliminate source if possible
        - Reduce source
        - Isolate through segregation of higher and lower dose areas
        - Control contamination levels
        - Use personal protective equipment
        - Define disciplines to be employed during maintenance
    - Analysis of the performance of options
        - Verify feasibility of each mitigation strategy (integration)
        - Cost/benefit analysis of each mitigation strategy

5.9.3 Output

- Maintenance-ALARA Data base filled in following ALARA process
- ALARA Status N report (see content in Annex of ALARA procedure number [8])
    - ➔ Evaluation of exposure situation to identify the need for an optimization study
    - ➔ Identification and quantification of dose reduction factors
    - ➔ Analysis of the performance of mitigation options
    - ➔ Recommend options for protection

  This report will give information at Tokamak level, per areas and per PBS in order to justify the optimization process implemented at each level.
- ALARA Status N+1 report and assessment and decision of ALARA N+1 status report

Note: It has been considered the Area Integrated Maintenance Assessment Report will support the ALARA process per area – see Annex 6 for content expected.

6 Scope of work – Option part

The option part is the extension of the contract by 12 months.

The objective will be to work on the area priorities 2 and 3 to complete the ALARA program and the ORE at plant level.

7 Estimated Duration

The estimated starting date of the contract shall be after contract signature. Implementation of the activities shall only start after the Kick off Meeting (T0). The expected duration of contract is for the firm part **T0 + 12 months**, and then there is an option to work in addition 12 months more. It means the maximum estimated duration of the contract with all options should be around **24 months**.

8 Specific requirements and conditions

The official language of the ITER project is English. Therefore all input and output documentation relevant for this Contract shall be in English. The Contractor shall ensure that all the professionals in charge of the Contract have an adequate knowledge of English, to allow easy communication and adequate drafting of technical documentation.

The key personnel forming the core of the contractor's team will be continuously located at ITER in order to enhance integration approach, to collect data, to better integrate the design constraints with IO stakeholders and ensure an efficient engineering process which meets requirements, in particular safety and trade studies. **This shall include the WP2, WP3, WP6, WP7, WP8, WP9 main contributors.**

The contractor's core team will be supported by a Back office for all the activities that could be performed in the contractor's premises (WP4, WP5) and all the experts (engineering, operation, dismantling…).

The Kick off, technical and final meetings will be organized in IO premises in Cadarache.

The use of the IO Virtual Room will be possible under request from the contractor with a delay of 1 week. IO will assist the contractor for using the virtual Room.

Some visits or meetings could be organized by the contractor in its premises or a specific site for specific needs.

The following skills are mandatory to perform the contract:

- Demonstrated and practical experience for participants in maintenance in nuclear facility (confinement management, ALARA) on piping, mechanical equipments, plant services
- Experience in nuclear engineering design (equipment to be maintained, maintenance tools, handling) and mechanical design engineering in general.
- Experience in use of CATIA V5 cad and relevant Enovia PLM system both for design purposed and integration control of huge cad models.
- Experience in Remote Handling design for nuclear facilities
- Expertise in Health and Physics, notably demonstration of the implementation of the "As Low As Reasonably Achievable" approach into design activities of complex nuclear project.
- Human and Organizational Factors integration, definition and tracking of HOF requirements, task analysis, activity simulation and analysis on mockups (3D, physical), knowledge of IEC and ISO standards, HOF integration into the safety demonstration, work in multidisciplinary environment (including final user representatives), experience in workplaces design in radiological/toxic/chemical environments. The contractor shall involve (in the offer preparation, the design studies, and the deliverables production) the SQEP[1] personnel:
  - With the degree in Human & Organization Factors / Ergonomics,
  - Having at least 5 years of working experience in the hazard industry and being familiar with the safety demonstration / safety cases.
- Experience in radiation calculation using MCNP codes in order to assess quickly design evolution on TOKAMAK
- Expertise in Nuclear confinement with a capability to perform this transverse simulation using DS SYLVIA Experience in contamination hazard assessment using codes such as RESRAD. Experience in Tritium and Beryllium (or toxic) Management
- Experience in hazard analysis and safety integration into the design. Example hazards which may be faced in the future ITER facilities are: oxygen deficiency, moving part, electricity, surface at extreme temperature, laser, and fluid under pressure, noise,

[1] SQEP: Suitably Qualified and Experienced Person

electromagnetic field, extreme ambient temperature, hazardous chemical products, and explosive atmosphere.
- Experience in Database development, notably in maintenance database (notably to support Maintenance activities), ideally used for ALARA purpose.

8.1 Place of performance for core team

Due to the nature of the work the activities shall be performed at the IO for core team member site since that activity requires frequent and continuous communication with the IO team, procedure users within IO, process owners/process managers, process representatives and other staff in various technical or management units to collect inputs.

8.2 Logistics support

The IO will provide the following support for the core team (free of charges):

- A working place, Supply (electrics, water, IT…),
- Connections/ capacity/ bandwidths,
- Office furniture,
- Computer/work-station,
- IO-configured hardware,
- IO-configured software & licenses,
- Phone line, e-mails,
- Meeting rooms with visio-conference capabilities.

The Back office (premises (WP4, WP5, and all the experts) supporting the core team will perform the activities in the contractor's premises. The contracting organization shall have fully licensed versions of all relevant codes and the computer resources to carry out the required analyses and activities. In the case of off-site work, the Contractor shall be required to propose and implement a suitable connection scheme.

9 Responsibilities

9.1 IO Responsibilities

IO shall assign one IO representative, to work as sole Contractor interface.

The IO representative will assess the performance and quality of the work. The main criteria will be:

- Mobilization of a team based on skills as expected and described in chapter 8 (including proper back office for expertise), as well as capacity to be integrated with IO and to enhance engineering approach between contractor/IO team.
- Technical content, quality, of the deliverables based on contractor's skills as expected and described in chapter 8 and capability to enhance integration approach (coherency between documents, in the approach…)
- Milestones and deliverables provided according to schedule

The IO representative shall be responsible for checking the deliverables against requirements, schedule the processes (including CAD).

IO shall make available to the Contractor all technical data and documents which the Contractor requires to carry out its obligations pursuant to this specification in a timely manner. For delays of more than two weeks in making them available, the Contractor shall advise IO representative of the potential impact on the delivery of the Work Packages, to agree and define all the correction actions to take in place.

9.2 Contractor's responsibilities

The Contractor shall ensure that he complies with the following:

- The Contractor shall guarantee that all input information provided to perform the task remain property of IO and shall not be used for any other activity than the one specified in this specification;
- The Contractor shall have access to a fully documented set of processes and procedures in its own Quality Management System to execute the service tasks in case the process in not yet available in IO;
- The Contractor shall be in charge to provide evidence of the competence of its personnel and provide its personnel with the training & coaching to the level of competence required;
- The Contractor shall provide an organization suitable to perform the work as described in this specification;
- The Contractor shall work in accordance with the QA plan approved by IO;
- The Contractor shall perform the activities accordingly to this specification taking into account all relevant additional documents and IO processes into account (hand books, export control, intellectual properties, …);
- The Contractor shall be responsible to produce and manage, using the ITER software platform, all the documents listed in chapter 11.
- The Contractor shall provide to the IO representative full access to its work premises and related documentation, to permit to follow up the progress of the work
- The Contractor shall guarantee that all input information provided to perform the task remain property of IO and shall not be used for any other activity than the one specified in this specification.
- The Contractor shall be in charge of the training & coaching of all its resources. Identification and change of contractor's core team on IO approval.
- The contractor shall provide an organization suitable to perform the work as describe in this specification;

Prior to the start of work on each activity, the Contractor shall review the input technical information provided to it by IO for completeness and consistency, and shall advise the IO representative of any deficiencies it may find. The contractor shall not be responsible for errors in the input technical information which could not be reasonably detected during such review; duration of this review will be agreed between Contractor and IO representative and will have no impact on the delivery schedule.

During the execution of its contract the Contractor shall be responsible to:

- Before starting the task propose and agree with the IO-representative the solutions intends to put in place or develop to respond to the IO problem,
- During the task, alert and come to the IO-representative to find out any missing information, late input delivery, difficulty in controlling its work, and more generally be pro-active in providing solutions and resolving issue.

10 Work Monitoring

The WP shall be launched after the Kick off Meeting where the contractor will present the work plan, including the main milestones (meeting, deliverables…).

The parties will interact as much as possible regarding technical matters using telephone, emails. In all the exchange, the IO RO and the contractor RO will be in copy of all the exchanges.

Quarterly contract management meetings shall be conducted between the Contractor and the IO RO, if needed other meeting may be needed after mutual agreement. This progress meeting could be organized the same days of preparation and technical meetings.

Section 11 below sets out the proposed IO delivery schedule for the Work Package. The contractor shall review and provide to IO for approval, within two weeks following contract entry into force a detailed schedule to meet the delivery requirements.

The contractor has to deliver the documents/database at the due date as summarized in the table here after. The required input data is given to the contractor at least 2 weeks in advance of the delivery date.

11 Work schedule / List of Deliverables

11.1 List of Deliverables

The contract will start at T0 (kick-off meeting date).

IO proposes following milestones as shown in the following tables:

#	MILESTONES	BY
	INTRODUCTIONARY PHASE	
1	**WP 2 - Contract Management and Implementation Plan Report**	1.5 months
2	**WP 3 - Database structure and description**	2 months
3	**WP 3 – Procedure and PBS maintenance consolidation**	3 months

#	MILESTONES	BY
	PRIORITY 1 AREAS	
	STEP 1:	
4	**WP 1 - P1 - Input data review & completion report**	2 months
5	**P1 – STEP 1 - Analysis Process**	6 months
	WP 3 - P1 - Database filled [intermediate version]	“
	WP 4 - P1 - SDDR Maps report [intermediate version]	“
	WP 5 - P1 - Contamination Hazard mapping [intermediate version]	“
	WP 6 - P1 – Assessment report [Intermediate version]	
	WP 6 - P1 - Equipment concepts documentation [items 1 to 3]	“
	WP 7 - P1 - Human & Organization Factor report [intermediate version]	“
	WP 8 - P1 - Hazard analysis report [intermediate version]	“
6	**WP 9 - ORE N status report & further activities plan** **Priority 1 Preliminary Version**	6 months
	STEP 2:	
7	**P1 – STEP 2 - Analysis Process**	12 months
	WP 3 - P1 - Database filled [final version]	“
	WP 3 - P1 - Areas Maintenance Plans	“
	WP 3 - P1 - Areas Integrated Maintenance Assessment Report	“
	WP 4 - P1 - SDDR Maps report [final version]	“
	WP 5 - P1 - Contamination Hazard mapping [final version]	“
	WP 6 - P1 – Assessment report [final version]	“
	WP 6 - P1 - Equipment concepts documentation [items 4 to 5]	“
	WP 7 - P1 - Human & Organization Factor report [final version]	“
	WP 8 - P1 - Hazard analysis report [final version]	“
	WP 9 - ORE N status report & further activities plan **Priority 1 Final Version**	12 months
8	**FINAL REPORT – firm part**	12 months

If the option is launched, the milestones should be the following (the duration is based the milestone: T0 of the option):

#	MILESTONES	BY
	PRIORITY 2 AREAS	
	STEP 1:	
	WP 1 - P1 - Input data review & completion report	**2 months**
	WP 3 – Procedure and PBS maintenance consolidation	**3 months**
9opt	**P2 – STEP 1 - Analysis Process**	6 months
	WP 3 - P2 - Database filled [intermediate version]	"
	WP 4 - P2 - SDDR Maps report [intermediate version]	"
	WP 5 - P2 - Contamination Hazard mapping [intermediate version]	"
	WP 6 - P2 – Assessment report [Intermediate version]	
	WP 6 - P2 - Equipment concepts documentation [items 1 to 3]	"
	WP 7 - P2 - Human & Organization Factor report [intermediate version]	"
	WP 8 - P2 - Hazard analysis report [intermediate version]	"
10opt	**WP 9 - ORE N+1 status report & further activities plan** **Priority 2 Preliminary Version**	6 months
	STEP 2:	
11opt	**P2 – STEP 2 - Analysis Process**	12 months
	WP 3 - P2 - Database filled [final version]	"
	WP 3 - P2 - Areas Maintenance Plans	"
	WP 3 - P2 - Areas Integrated Maintenance Assessment Report	"
	WP 4 - P2 - SDDR Maps report [final version]	"
	WP 5 - P2 - Contamination Hazard mapping [final version]	"
	WP 6 - P2 – Assessment report [final version]	"
	WP 6 - P2 - Equipment concepts documentation [items 4 to 5]	"
	WP 7 - P2 - Human & Organization Factor report [final version]	"
	WP 8 - P2 - Hazard analysis report [final version]	"
	WP 9 - ORE N status report & further activities plan **Priority 2 Final Version**	12 months

#	MILESTONES	BY
	PRIORITY 3 AREAS	
	STEP 1:	
12opt	**P3 – Analysis Process**	12 months
	WP 3 - P3 - Database filled [final version]	"
	WP 3 - P3 - Areas Maintenance Plans	"
	WP 3 - P3 - Areas Integrated Maintenance Assessment Report	"
	WP 4 - P3 - SDDR Maps report [final version]	"
	WP 5 - P3 - Contamination Hazard mapping [final version]	"
	WP 6 - P3 – Assessment report [final version]	"
	WP 6 - P3 - Equipment concepts documentation [items 4 to 5]	"
	WP 7 - P3 - Human & Organization Factor report [final version]	"
	WP 8 - P3 - Hazard analysis report [final version]	"

	WP 9 - ORE N+1 status report & further activities plan **Priority 3 Final Version**	"
13opt	**CONTRACT OPTION FINAL REPORT**	12 months

IO defined a master schedule, in coherence with the table of deliverables below and the priorities defined in Annex 2. The contractor based on his organization and experience will make his proposal in the offer. The schedule / table of deliverables will be tracked and updated (if approved by IO) during the contract.

The Contractor shall issue the document type with due date indicated in the following table*:

Deliverables are identified for the firm part, the deliverables will be the same for the option.

It has to be mentioned for areas priority 3, there is no intermediate status and reports (no step 2).

*The following documents have not been quantified and are considered part of the daily work: minutes of the technical meeting, Memos to advice, to warn, to make recommendations to IO.

Deliverable description	Due date
WP1 – Appropriation of the context and team building spirit	
Minutes of Kick off meeting	T0 + 1 week
Minutes of Introduction meeting #1	T0 + 2 weeks
Minutes of Introduction meeting #2	T0 + 3 weeks
Minutes of Introduction meeting #3	T0 + 4 weeks
Minutes of Introduction meeting #4	T0 + 5 weeks
Minutes of Introduction meeting #5	T0 + 6 weeks
Minutes of Introduction meeting #6	T0 + 7 weeks
Minutes of the Workshop (Firm part)	T0 + 9 weeks
Set of Training PPT (firm part)	T0 + 8 weeks
Input data review & completion report	T0 + 2 months
WP 2 – Management, implementation plan, status report	
Contract Management Plan (firm part)	Version A: T0 + 3 weeks
	Version B: T0 + 6 weeks
Quarterly Status report	Every 3 months
Minutes of the Contract management meeting (firm part)	T0 + 3 weeks / T0 + 6 weeks
WP 3 - Integrated Maintenance activities	
Data base structure & description report (firm part)	T0+2 months
Integrated maintenance per area procedure (firm part)	T0+3 months

Analysis Reports on RAMI and maintenance reports for each PBS	T0+3 months
ALARA Maintenance Database completed and filled with maintenance data, coherent with Area maintenance plans and Shutdown Dose rate maps	Update T0+6, To+12 months
Minutes of Technical meeting and final to present integrated maintenance per areas on this activity	Any applicable occurrence
Areas integrated maintenance assessment reports	Version A: T0 + 6 months
	Version B: T0 + 12 months
Areas maintenance plans	Version A: T0 + 6 months
	Version B: T0 + 12 months
WP 4 - Shutdown Dose Rate (SDDR) maps	
SDDR Maps report per area status N identifying the key contributors	Update T0+6, To+12 months
All models and radiation maps	Update T0+6, To+12 months
WP 5 - Contamination maps and integrated contamination controls design	
A synthesis report at Tokamak level providing a contamination Hazard mapping, including an xls sheet / extraction of the ALARA Maintenance Database or all activities requiring confinement measures are identified	Update T0+6, To+12 months
WP6 - Assessment report	Version A: T0 + 6 months
	Version B: T0 + 12 months
Concept design report item 1	T0+4 months
System Requirements documents item 1	T0+4 months
Concept design report item 2	T0+3 months
System Requirements documents item 2	T0+3 months
Concept design report item 3	T0+6 months
System Requirements documents item 3	T0+6 months
Concept design report item 4	T0+8 months
System Requirements documents item 4	T0+8 months
Concept design report item 5	T0+10 months
System Requirements documents item 5	T0+10 months
WP7- Human & Organizational Factor analysis	
HOF report per area	Update T0+6, To+12 months

Maintenance-ALARA Data base progressively filled out with HOF parameters	Update T0+6, To+12 months
WP8 - Area Hazard Analysis	
Hazard Analysis report per area	Update T0+6, To+12 months
Maintenance-ALARA Data base filled out with Hazard Analysis parameters	Update T0+6, To+12 months
WP9 – ALARA	
ALARA ORE Status N report	T0+6 months
ALARA Status N+1 report	T0+12 months
FINAL REPORT	T0+12 months

The preliminary schedule consider the following assumptions: IO will have 1 week to review the minutes, 2 weeks to review the database and the reports.

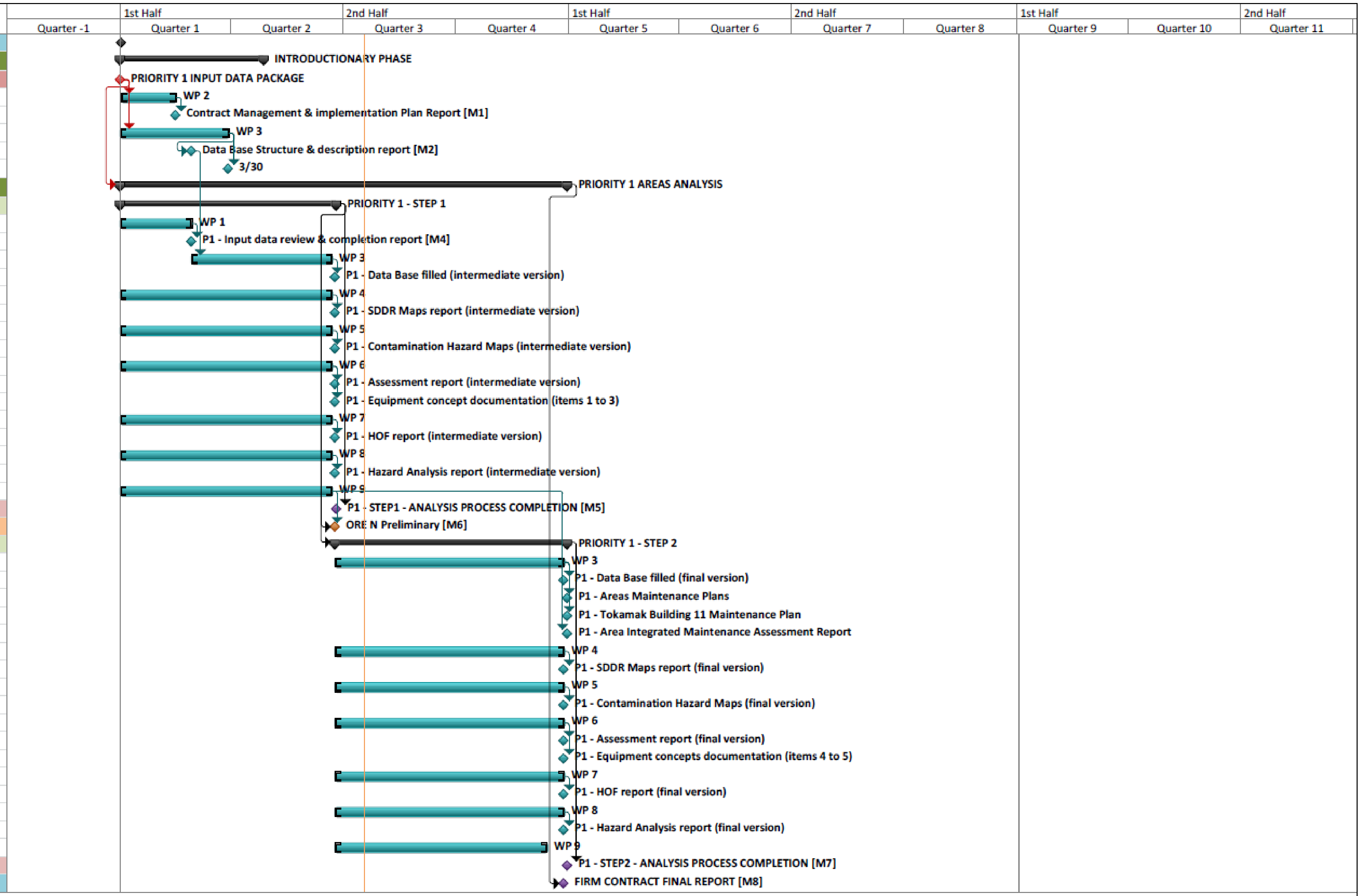
Should the Task quantities listed above and the associated deliverables be adjusted in content and priority, ITER and the Contractor shall arbitrate together in order to reach appropriate measures. The changes and decisions shall be recorded and formalized.

All documents shall be submitted in English.

11.2 Contract Schedule

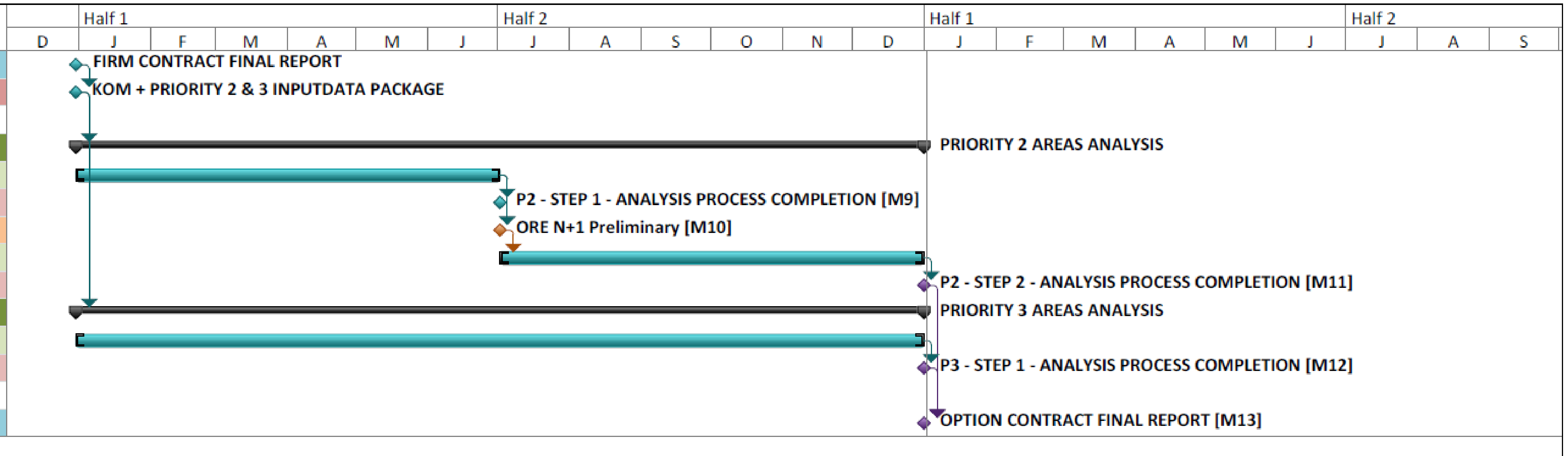
FIRM PART OF THE CONTRACT SCHEDULE

ID	Task Name
1	
2	INTRODUCTIONARY PHASE
3	PRIORITY 1 INPUT DATA PACKAGE
4	WP 2 - MANAGEMENT & IMPLENETATION PLAN
5	Contract Management & implementation Plan Report [M1]
6	WP 3 - INTEGRATED MAINTENANCE ACTIVITY
7	Data Base Structure & description report [M2]
8	Procedure and PBS Maintenance Consolidation [M3]
9	PRIORITY 1 AREAS ANALYSIS
10	PRIORITY 1 - STEP 1
11	WP 1 - P1 - APPROPRIATION OF THE CONTEXT
12	P1 - Input data review & completion report [M4]
13	WP 3 - P1 - INTEGRATED MAINTENANCE ACTIVITY
14	P1 - Data Base filled (intermediate version)
15	WP 4 - P1 - SDDR MAPS
16	P1 - SDDR Maps report (intermediate version)
17	WP 5 - P1 - CONTAMINATION MAPS & CONTAMINATION CONTROL DESIGN
18	P1 - Contamination Hazard Maps (intermediate version)
19	WP 6 - P1 - MAINTENANCE PROCESS & EQUIPMENT STANDARDIZATION
20	P1 - Assessment report (intermediate version)
21	P1 - Equipment concept documentation (items 1 to 3)
22	WP 7 - P1 - HUMAN & ORGANIZATION FACTOR
23	P1 - HOF report (intermediate version)
24	WP 8 - P1 - AREA HAZARD ANALYSIS
25	P1 - Hazard Analysis report (intermediate version)
26	WP 9 - P1 - ALARA IMPLEMENTATION
27	P1 - STEP1 - ANALYSIS PROCESS COMPLETION [M5]
28	ORE N Preliminary [M6]
29	PRIORITY 1 - STEP 2
30	WP 3 - P1 - INTEGRATED MAINTENANCE ACTIVITY
31	P1 - Data Base filled (final version)
32	P1 - Areas Maintenance Plans
33	P1 - Tokamak Building 11 Maintenance Plan
34	P1 - Area Integrated Maintenance Assessment Report
35	WP 4 - P1 - SDDR MAPS
36	P1 - SDDR Maps report (final version)
37	WP 5 - P1 - CONTAMINATION MAPS & CONTAMINATION CONTROL DESIGN
38	P1 - Contamination Hazard Maps (final version)
39	WP 6 - P1 - MAINTENANCE PROCESS & EQUIPMENT STANDARDIZATION
40	P1 - Assessment report (final version)
41	P1 - Equipment concepts documentation (items 4 to 5)
42	WP 7 - P1 - HUMAN & ORGANIZATION FACTOR
43	P1 - HOF report (final version)
44	WP 8 - P1 - AREA HAZARD ANALYSIS
45	P1 - Hazard Analysis report (final version)
46	WP 9 - P1 - ALARA IMPLEMENTATION
47	P1 - STEP2 - ANALYSIS PROCESS COMPLETION [M7]
48	FIRM CONTRACT FINAL REPORT [M8]



OPTION PART OF THE CONTRACT SCHEDULE:

ID	Task Name
1	FIRM CONTRACT FINAL REPORT
2	KOM + PRIORITY 2 & 3 INPUTDATA PACKAGE
3	
4	PRIORITY 2 AREAS ANALYSIS
5	PRIORITY 2 - STEP 1
6	P2 - STEP 1 - ANALYSIS PROCESS COMPLETION [M9]
7	ORE N+1 Preliminary [M10]
8	PRIORITY 2 - STEP 2
9	P2 - STEP 2 - ANALYSIS PROCESS COMPLETION [M11]
10	PRIORITY 3 AREAS ANALYSIS
11	PRIORITY 3 - STEP 1
12	P3 - STEP 1 - ANALYSIS PROCESS COMPLETION [M12]
13	
14	OPTION CONTRACT FINAL REPORT [M13]



12 Acceptance Criteria

All deliverable shall be reviewed in the IO system: IDM for relevant output, ENOVIA for relevant output.

An IDM/DWM folder to store the input and related output will be specified at the kick-off of each activity.

The process of acceptance is driven by IO internal process of approval, until this process is completed, modifications can be requested of the Contractor. The IO approval process involves all the interfacing system concerned.

The form of deliverable is according to the formalized in Section 11. Any deviations, if not previously agreed, may lead to the deliverable being refused.

The CAD data produced in the frame of this Task Order shall be delivered by the contractor through the submission of a DET containing the BOM identifying the delivered data as frozen in ENOVIA: to an EP (External Partner)-Draft status, accompanied by a possible transfer of ownership if the data is handed over back to IO.

The Acceptance of the CAD data will be performed by the IO-DO in accordance with the promotion process (Procedure for the Promotion of CAD Data from In-Work to Draft Status (28LVHH) and the criteria as defined in CAD Requirements & Deliverables Relative to Functional Design Milestone (P49NTN).

The maximum time for IO acceptance / comments is 10 working days after the storage (+IDM email) of the deliverables in IDM. After this period if no action has been performed by the IO, the deliverable shall considered as accepted.

Non-CAD deliverables (Graphics, Powerpoint Documents, etc) will be reviewed upon delivery by the IO RO/RE and will be accepted if compliant with the requirements advised by the RO at the start of the task, all these document shall follow a IDM workflow.

In case of non-compliance / conformity of a deliverable or a set of deliverables, the Contractor shall correct them and re-submit them for review and acceptance; resubmission shall be at contractor's cost.

In case of non-compliance / conformity of a deliverable or a set of deliverables, the Contractor shall correct them and re-submit them for review and acceptance; resubmission shall be at contractor's cost.

Once the deliverable is submitted by the Contractor in IDM, the deliverable may be considered as accepted if there is no comment from IO with 15 working days.

13 Quality Assurance (QA) requirement

13.1 IO CAD requirements

The Contractor shall ensure that all designs, CAD data and drawings delivered to IO comply with the Procedure for the Usage of the ITER CAD Manual (2F6FTX) and the Procedure for the CAD management plan (2DWU2M v2.0).

The contractor will work in synchronous collaboration scheme where contractor CAD team works in the IO Data Bases on ITER site. The following rules should be follow:

- IO will provide one workstation (and associated maintenance) per user to perform CAD activities for contractor with IO CAD setup.
- IO shall support contractor's designers, as described in the CAD World wide support concept and procedures (34VB64)
    - In obtaining the suitable CATIA/ENOVIA training and certifications on the ITER specific CAD design methodologies. More flexible training can be organized through an e-learning.
    - In following the proper design methodologies (for the support levels 1 and 2)
- IO will organize IDM accounts (if does not exist).
- For details about IO DO CAD systems, contractor to refer: ITER CAD Manual Section 1.3 - IO CAD System (249WLQ)
- The contractor should follow ITER standard and template. ISO drawing standards are given in the CAD Manual 10 - ISO Drawing Standards (24MZWV v3.0)

13.2 QA requirements overview

The Contractor should have ISO 9001 accredited quality system. Otherwise the Contractor shall have QA Program approved by the IO.

The general requirements are detailed in ITER_D_22K4QX - ITER Quality Assurance Program (QAP) and ITER Procurement Quality Requirements (ITER_D_22MFG4).

Prior to commencement of the work, a Quality Plan which complies with Procurement Requirements for Producing a Quality Plan (ITER_D_22MFMW) shall be submitted to IO for approval with evidence of the above. The Contractor's Quality Plan shall describe the organisation for tasks; roles and responsibilities of workers involved in; any anticipated sub-contractors; and giving details of who are the independent checkers of the activities.

Where any deviation is requested or non-conformity has happened from the Technical Specification, Contractors Deviations and Non Conformities the ITER Requirements Regarding Contractors Deviations and Non Conformities (ITER_D_22F53X) shall be followed.

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

IO will monitor implementation of the Contract's Quality Plan. Where necessary, IO will assess the adequacy and effectiveness of the quality system specified in the Quality Plan through surveillance or audit. Where condition adverse to quality is found during monitoring, IO may request to the Contractor to take corrective action.

The use of computer software to perform a safety basis task activity such as analysis and/or modelling, etc. shall be reviewed and approved by the IO prior to its use, in accordance with Quality Assurance for ITER Safety Codes (ITER_D_258LKL). Where applicable, Software Qualification Policy (KTU8HH v1.2) shall be taken into consideration to ensure quality and integrity of software prior to application.

Neutronic analyses have to be performed following the ITER QA requirements for analyses and calculations: ITER_D_22MAL7 - Analyses and Calculations and ITER_D_R7XRXB - Instructions for Nuclear Analyses.

14 Safety requirements

ITER is a Nuclear Facility identified in France by the number-INB-174 ("Installation Nucléaire de Base").

For Protection Important Components and in particular Safety Important Class components (SIC), the French Nuclear Regulation must be observed, in application of the Article 14 of the ITER Agreement.

In such case the Suppliers and Subcontractors must be informed that:

- The Order 7th February 2012 applies to all the components important for the protection (PIC) and the activities important for the protection (PIA).
- The compliance with the INB-order must be demonstrated in the chain of external contractors.
- In application of article II.2.5.4 of the Order 7th February 2012, contracted activities for supervision purposes are also subject to a supervision done by the Nuclear Operator.

For the Protection Important Components, structures and systems of the nuclear facility, and Protection Important Activities the contractor shall ensure that a specific management system is implemented for his own activities and for the activities done by any Supplier and Subcontractor following the requirements of the Order 7th February 2012 (Please refer to ITER_D_4EUQFL - Overall supervision plan of external interveners chain for Protection Important Components, Structures and Systems and Protection Important Activities).

In practice, and according to, the calculations to be carried out in the scope of this contract are a PIA. The defined requirements associated to this PIA are defined below:

Defined Requirement	Provisions to be implemented in this contract
The input data shall be: - Up to date - Validated - Consistent with safety demonstration For undefined input data: - Clearly identified and referenced assumptions - Sensitivity study to assess the impact of the range of assumptions or use of non-arguable conservative assumptions - Formally validated baseline or conservative input data in the document in support of the safety analysis	- Input data to be provided by IO to ensure that the input is formally validated baseline or conservative input data in the document in support of the safety analysis. - The contractor shall apply the instructions for verification of input for radiation transport calculations. - The contractor shall apply the instructions for nuclear analysis. - The contractor shall clearly define and identify the assumptions taken.
The calculation model used shall always be equally or more conservative than the Configuration Management Model (CMM).	Input data to be provided by IO to ensure that the input is formally validated baseline or conservative input data in the document in

	support of the safety analysis
The method and code shall be qualified	The contractor shall apply the instructions for nuclear analysis.
The method and code shall be used within its qualification domain.	The contractor shall apply the instructions for nuclear analysis and the requirements stated in this specification.
The uncertainties associated with the methods shall be estimated, or additional margins shall be added and substantiated, through sensitivity studies.	The contractor shall apply the instructions for nuclear analysis where the estimation of uncertainties is part of the output data and acceptance criteria.
The parameters (including input data) that have strong impact on the results shall be identified.	As part of this contract, the contractor shall identify the parameters (including input data) that have strong impact on the results and provide it in the final report.
All input data, methods codes and their validity domain and uncertainties shall be included in the report.	The contractor shall apply the instructions for nuclear analysis and the requirements stated in this specification.
Intermediate and final results shall be expressed in international units.	Intermediate and final results shall be expressed in international units.
A sensitivity studies shall be performed for covering uncertainties or additional safety factor in the results and the results shall be integrated in the report.	The contractor shall apply the instructions for nuclear analysis where the estimation of uncertainties is part of the output data and acceptance criteria.
The acceptance criteria shall be included in the report; all margins and safety factor shall be expressed in safety limits.	All margins and assumed safety factors shall be given in the final report.

Annex 1: Definition – Abbreviations - Acronyms

Definitions:

Ancillary Maintenance Equipment:

Any equipment might be required in the Port Cell Areas during the hands-on maintenance activities.

Typical equipment is:

- Human access equip. (scaffolding, stairs, …)
- Temporary lifting devices (floor based)
- Visual equip. (cameras, lights, …)
- Detectors
- Personnel protection equipment
- Temporary local shielding (lead bricks, ...)
- Decontamination equipment
- Radwaste handling/storage equipment

Bioshield Plug:

Removable plug in each Port Cell to provide shielding between the interspace side and the Port Cell side.

Bioshield Dismantling/Handling/Storage Equipment:

All the equipment needed to provide the Bioshield Plug installation/removal and storage (if needed) during all the phases of the plant lifetime.

Cask Docking Flange and Maintenance Door:

The Cask Docking Flange and Maintenance Door System will be installed on Port Cell rails and connected to the VV Port. Its aim is to allow the Cask docking to the VV and maintain the confinement between the VV inner environment and the Cask envelop during in-vessel components transfer.

Dust Cover/Cover Plate:

Light plate/s to be installed on the Port Plug Closure Plate external surface prior to its transfer to HCB, to avoid surface contamination of the Plug inside the Cask and inside the HC facility.

Gallery Temporary Parking Areas:

During Port Cell Maintenance activities some space could be needed in the gallery to provide the following main functions:

- store temporary maintenance equipment required during the activities;
- store temporary components removed from the Port Cell;
- perform cleaning/packing of components removed from the Port Cell before their transfer to the HCB.

Human Access Corridors on left and right sides and in front of the PP closure plate:

Space required in the Port Cell Areas (Interspace included) to allow personnel access to all the maintenance workplaces for inspections, disconnections, installations, etc.

Human Assisted RH Equipment (HAE):

Any system needed to provide disconnections/connection in the interspace area, or elsewhere, avoiding the prolonged presence of personnel in areas where the dose rate is higher than admissible. It can be: robot able to enter the area and provide the disconnection as required (locally remotely controlled), automatic flange system able to self-disconnect on demand or mixed approach between the two above (i.e. RH compatible flange system).

Human Factors and Ergonomics:

Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. Practitioners of ergonomics and ergonomists contribute to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people (*International Ergonomics Association*).

In-Port Cell Airlock:

Any system required in the Port Cell area to provide local confinement during installation/removal activities of components (i.e. accesso of human or transfer of tools).

In-Port Cell Services:

All the connections required in the Port Cells (power, signal, fluid, nitrogen, compressed air, etc.) to supply all the equipment that might be needed in this area during maintenance activities.

On-rail Platforms/Stairs and relevant equipment:

All the permanent or removable equipment to be installed above or directly interfacing the Port Cell Rails to allow human access and transit.

Packing/Protection Equipment for Port Cell Components (e.g. PCSS, ISS, AEU, PF…):

Any equipment needed to pack and protect the Port Cell Equipment during their transfer from the Port Cell to the Hot Cell Building to avoid potential spread of contamination into the galleries.

Pipe Cutting and Bevelling Tools:

All the standard cutting and bevelling equipment to provide pipe cutting or welding preparation in the Port Cell Areas.

Pipe Welding Equipment and NDE Tools:

All the standard welding and NDE equipment to provide pipe welding in the Port Cell Areas.

Port Cell Door Airlock:

Airlock to be installed onto the Port Cell Door, gallery side, to create a transition chamber between Port Cell and Gallery atmosphere and allow a controlled human access to the working area by using the personnel access door to the Port Cell

Port Cell Rails:

Rails permanently installed in the Port Cell floor.

Port Component Dismantling/Installation/Handling/Equipment:

Equipment required to provide the port components installation/removal and handling. The port components are all the items to be installed/removed, prior of the Port Plug transfer, to/from the VV Ports or Port Plugs. The port components are mainly: Temporary Closure Plate, Sealing Flange/s, Cask Docking Flange, Maintenance Door, Gripping Points, Cover Plates, Bolts or even tilting system.

Port Plug Bolting/Unbolting Tools:

All the equipment needed to provide the bolting/unbolting of the Port Plug mechanical junction.

Port Plug Cooling Water Standard Connection/Disconnection System:

Equipment required for the connection/disconnection of the Port Plug cooling lines and relevant handling; it may include the connecting system by itself (pipes, flange, etc.) between the cooling water line end and the Port Plug manifold.

Port Plug Tilting Tool:

Equipment needed during the installation/removal of the Port Plug to provide the tilting of the Port Plug from the sliding position to its final cantilever position (coupled to the VV port extension flange) and vice-versa.

Sealing Flange:

The Sealing Flange is the flange installed to provide the vacuum boundary between the Port Plug and the VV Port Extension. Two types of sealing flange are expected to be used:

- Lip Seal System;
- Double Flange (Gasket Seals) System.

Sealing Flange Milling/Welding Equipment:

All the equipment needed to mill the welded lip seal and then weld it again; weld testing equipment is included.

Shielded/Confinement Cabin/s:

The cabin/s needed to limit contamination in the Port Cell and the dose rate to personnel during maintenance activities in the Port Cell Areas.

Temporary Shielding Port Plug:

During the Port Plug removal and transfer to HCB, for its refurbishment/replacement, a temporary plug could be needed to provide shielding and avoid spread of radiation in the Tokamak Building due to the Port Plugs absence. This plug will provide only shielding function, it won't be used during plant operation.

Temporary Shielding Port Plug Handling Equipment:

Equipment needed to install/remove the Temporary Shielding Port Plug (in case the standard RH Cask is not considered available for this task).

Transfer System for the Port Cell Components (e.g. PCSS, ISS, AEU, PF…):

Transfer trolley which might be needed to transfer the Port Cell Components from/to the TB/HCB in case the use of the CTS [RH Call 1] is assessed not admitted to perform this activity.

VV Port Temporary Closure Plate:

The VV Port Temporary Closure Plates are those plates designed to be installed on the VV Port Extensions main opening in all the ports where no Port Plug is installed.

Acronyms:

AEU	Ancillary Equipment Unit
ALARA	As Low As Reasonably Achievable
ASN	« Autorité de Sûreté Nucléaire » - French Safety Authority
Be	Beryllium
CPRHS	Cask and Plug Remote Handling System
CSS	Ceiling Support Structure
CVB	Cold Valve Box
CWA	Ceiling Waveguide Assembly
DAC	Derived Atmospheric Contamination
DA	Domestic Agency
DB	Data Base
DS	Detritiation System
EQ	Equatorial Port
F4E	Fusion For Energy, European Domestic Agency
H&S	Health and Safety
HIRA	Hazard Identification and Risk Assessment
HOF	Human and Organizational Factors
INB	« Installation Nucléaire de Base » - Nuclear Facility
IRMS	ITER Remote Maintenance System
ISA	Interspace Assembly
IO	ITER ORGANIZATION
ISS	Interspace Support Structure
IVVS	In-vessel viewing system
IWA	Inclined Waveguide Assembly
KOM	Kick Off Meeting
LP	Lower Port
NB	Neutral Beam
NIU	Nuclear Integrated Unit
OMA	Operation Maintenance
ORE	Occupational Radiation Exposure
PCA	Port Cell Assembly
PC	Port Cell
PCSS	Port Cell Support Structure
PF	Pipe Forest
PIA	Protection Important Activity
PIC	Protection Important Component

PIS	Pellet Injection System
PF	Pipe Forest
PMWG	Port Maintenance Working Group
PP	Port Plug
QA	Quality Assurance
QVA	Quasi Vertical Assembly
RAMI	Reliability Availability Maintainability Inspectability
RH	Remote Handling
RHRM	Remote Handling and Radioactive Material
RPrS	« Rapport Préliminaire de Sûreté » - Preliminary Safety report
SDDR	Shutdown dose rate
SSC	System, Structure and Component
TKM	Tokamak
UPP	Upper Port Plug
VE	Value Engineering
VV	Vacuum Vessel
WG	Working Group

Terms:

- Shall: Mandatory requirement
- Should/May/Will: Recommendation or action which is advised but not required. "Will" is used for all actions to be performed by IO and/or the others.

For a complete list of ITER abbreviations see: ITER Abbreviations (ITER_D_2MU6W5).

Annex 2: Matrix PBS/ ALARA Areas – List of priorities

In the following table the different Areas and relevant group of priority are identified. Each area is represented by a defined one which is in the scope of work. Each area indicated in the scope of work is also to be used as representative of other areas (see GBS represented).

All the main PBSs involved and contained in the area scope are shown as well.

The current technical specification scope is limited to:

- **Firm part areas priority 1.**
- **Option part priority 2 and 3.**

Batch	ID	AREA	Scope	GBS Represented	Priority	DRIVING PBS
1	1	The Port area at upper level (L2) ECH port	UP_16	11-L2-C12/13/15/16	1	PBS-52 [ECH] - first plasma port
	2	Upper pipe chase at L3	L3	11-L3-03	1	PBS-26
	3	The RH Port area at equatorial level (L1) without vacuum extensions	EQ_8	11-L1-C01/03/08/09/12/ 14 (3, 8, 12, 17 - TBC) First plasma: partial config	1	PBS-55 [Diagn.] - DMS (PBS18) present but integration to be improved
	4	The Port area at equatorial level (L1) with vacuum extensions	EQ_17	11-L1-C10/11/17	1	PBS-55 [Diagn.] - DMS (PBS18) to be integrated
	5	NB Cells	L1 & L2	11-L1-CNB/L2-01	1	PBS-53 - Caesium oven
	6	The Remote handling port cell at B1	LP_02	11-B1-C02/08/14	1	PBS-55 [Diagn.] - Divertor (warning shielding design) - optimise diag removal
2	7	The Cryo-pump port cells at B1	LP_04	11-B1-C04/06/10/12/16/18	2	PBS-18 [PIS] & PBS-31 [Torus Cryo-pump] - (warning shielding design) - optimisati
	8	Lower pipe chase at B2M	B2M	11_B2M	2	PBS-26 & PBS-31 & PBS-34
	9	Equatorial Port Cell - Type 2	EQ_10	11-L1-C01/03/08/09/12/ 14	2	PBS-55 [Diagn.] (ORE reference)
	10	The Port area at Equatorial level (L1) ICH port	EQ_13	11-L1-C13/14	2	PBS-51 [ICH] (Maturity to be checked)
	11	The Port area at Lower - IVVS ports	LP_11	11-B1-C03/05/09/11/15/17	2	PBS-57 [IVVS] - diag SIC essential
3	12	Drain tank room	/	11-B2-01	3	PBS-26
	13	The Port area at upper level (L2) Diags port	UP_18	11-L2-C01/03/04/05/06/07/09/10/11/17/18	3	PBS-55 [Diagn.]
	14	The Port area at upper level (L2) Diags port	UP_02	11-L2-C02/08/14	3	PBS-55 [Diagn.]
	15	Galleries Levels B1, L1, L2	All levels		3	
	16	HV Deck	/	11-L3-01	3	PBS-53 & PBS-11
	17	The Port area at Equatorial - TBM ports	EQ_02	11-L1-02/16/18	3	PBS-56 [TBM] - SSA on going with CEA

ID	11	15	16	17	18	22	23	24.CR	24.VP	26	27	31	32	34	41	43	44	45	46	47	48	51	52	53	54	55	56	57	61	2.TBD	62.BP	63	64	65	66	69	70	98
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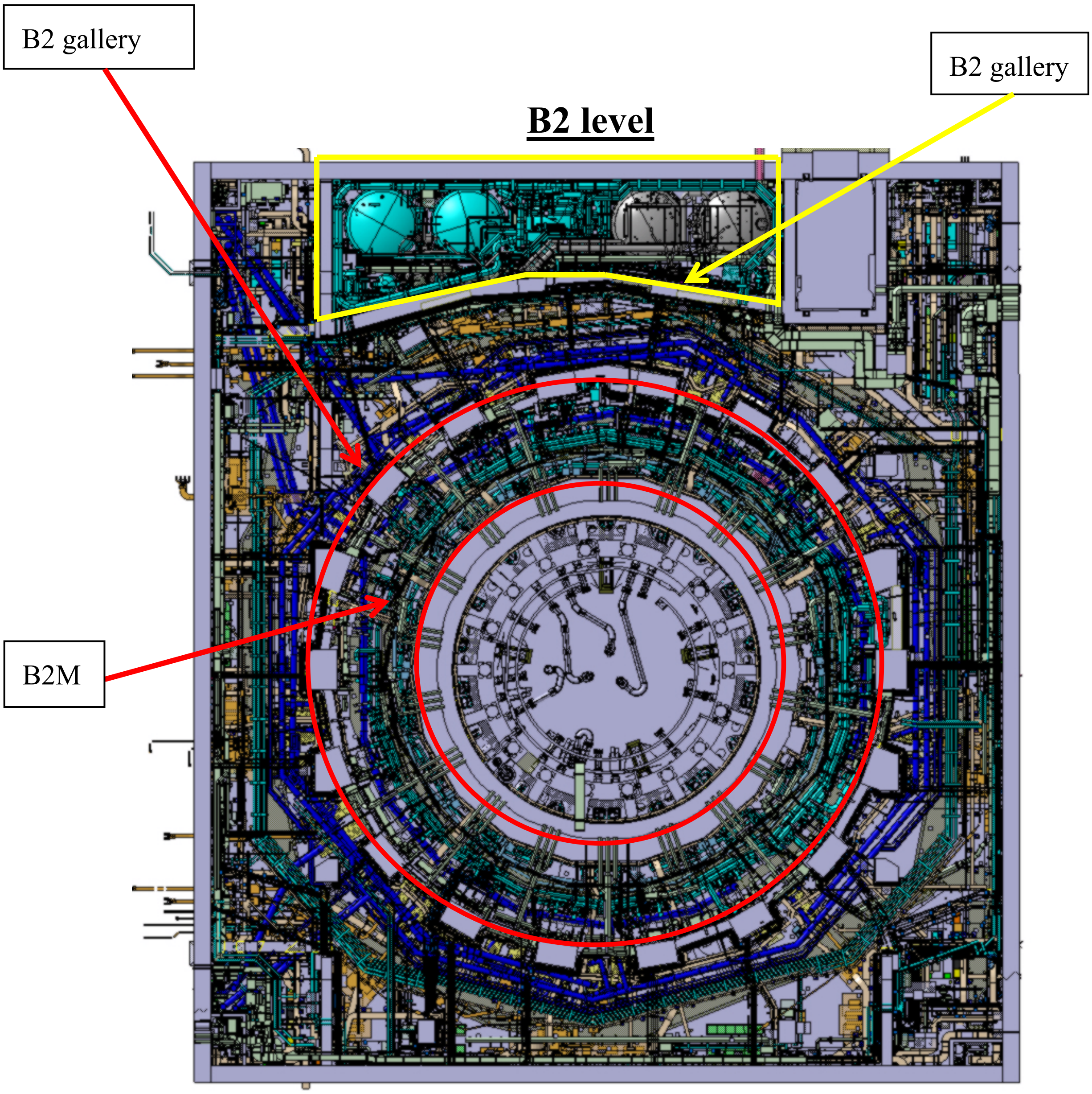
Annex 3: Description-General

Tokamak complex building

The Annex 3 is illustrating the rooms in the tokamak building and listing the main systems which are in these rooms.



B2M

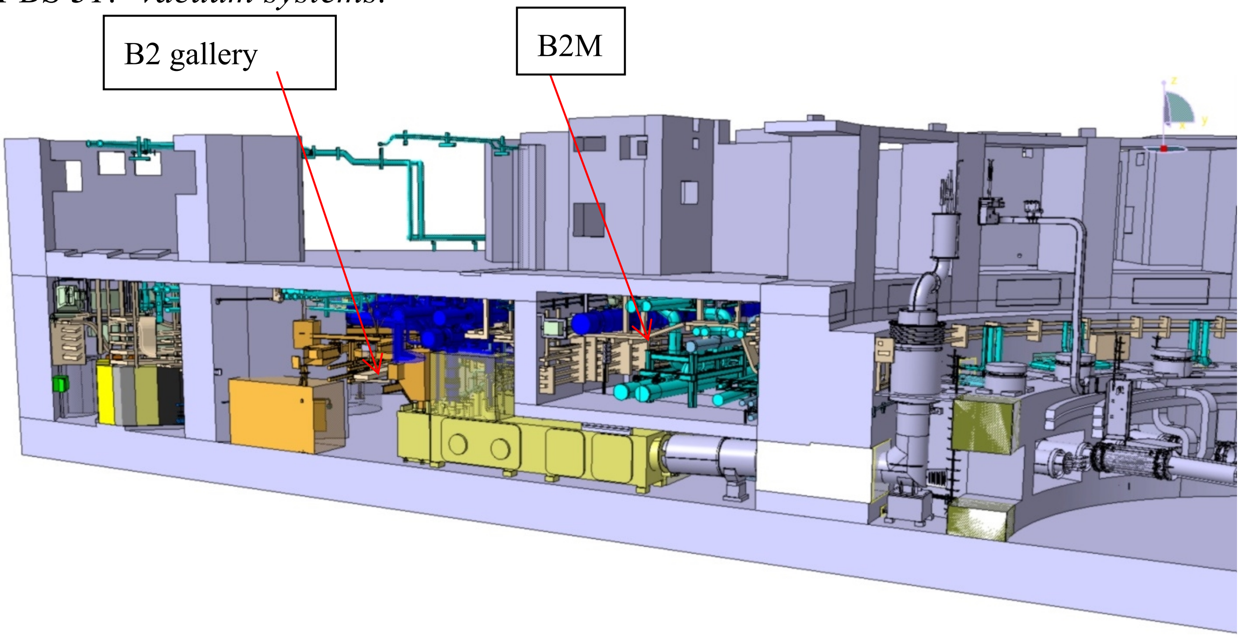
Main plant systems in the room:

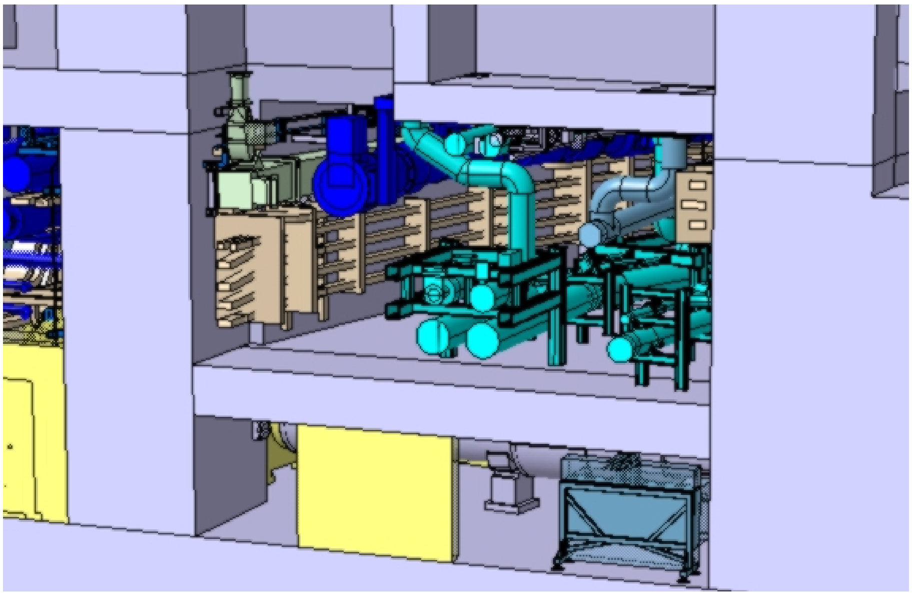
PBS 26: cooling water system.

PBS 34: cryogenic system.

PBS 44: cable trays.

PBS 31: vacuum systems.



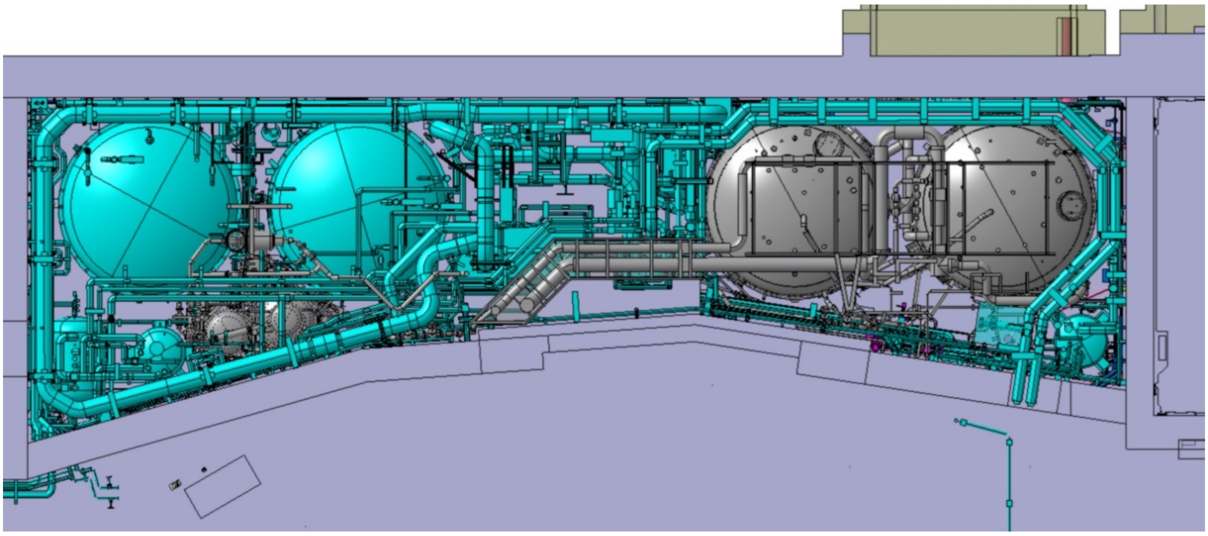


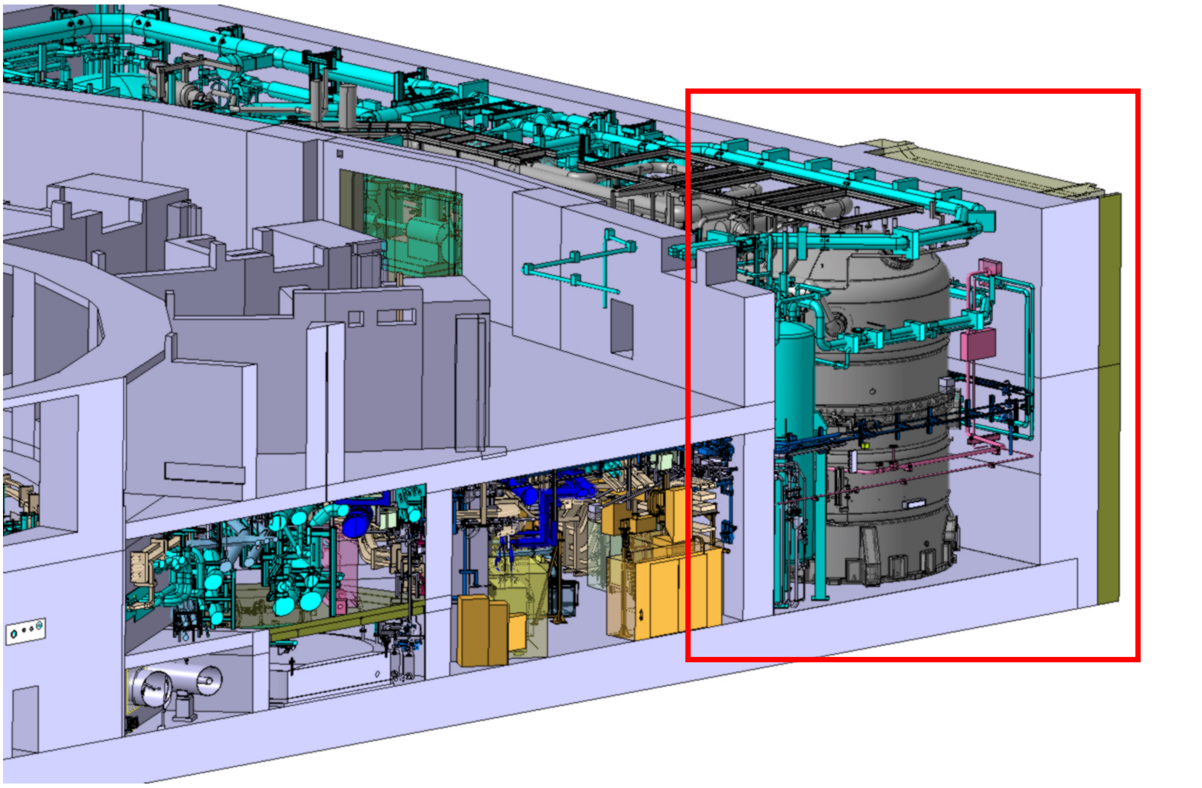
Drain tank room (room which covers B2 and B1 level)

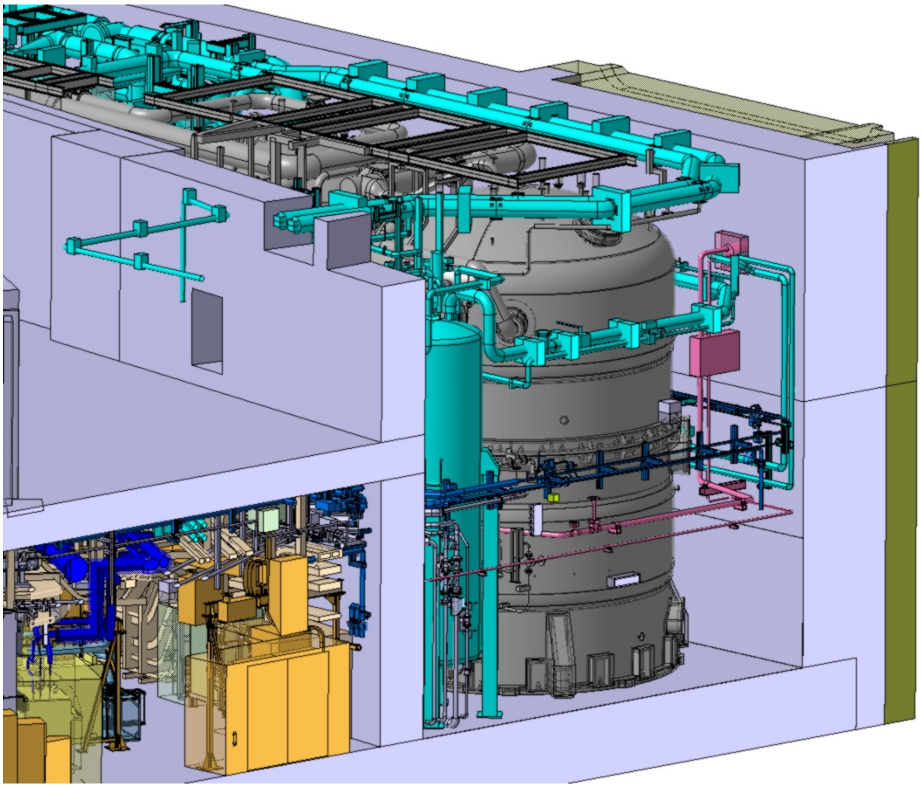
Main plant systems in the room:

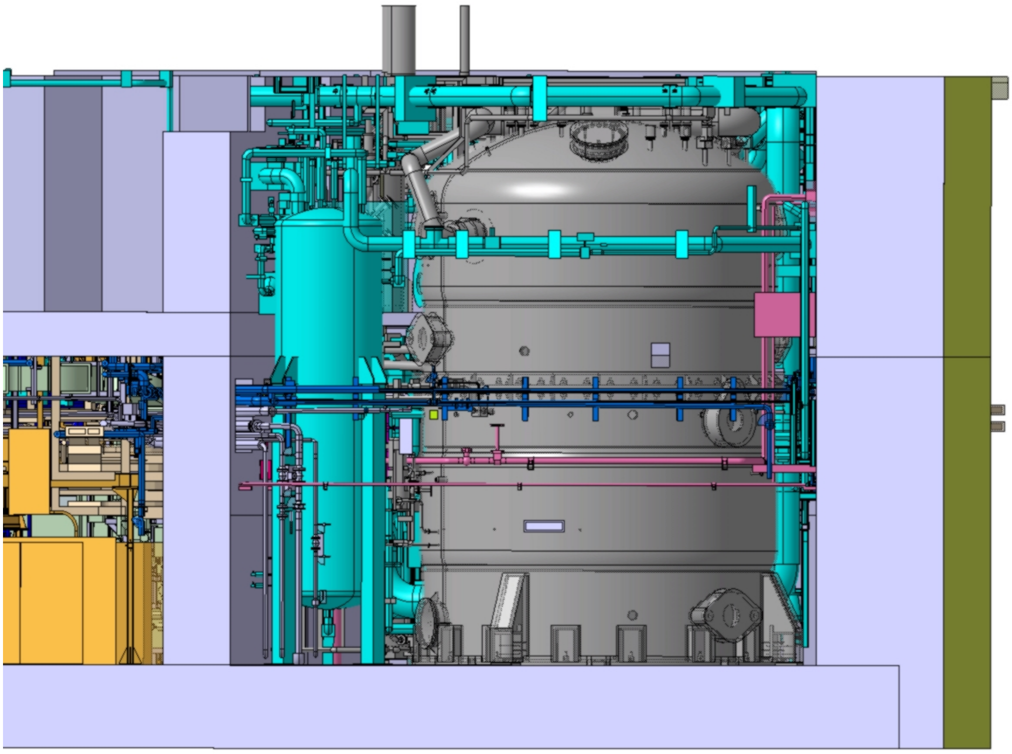
PBS 26: cooling water system.

PBS 24: VVPSS system









B2 galleries

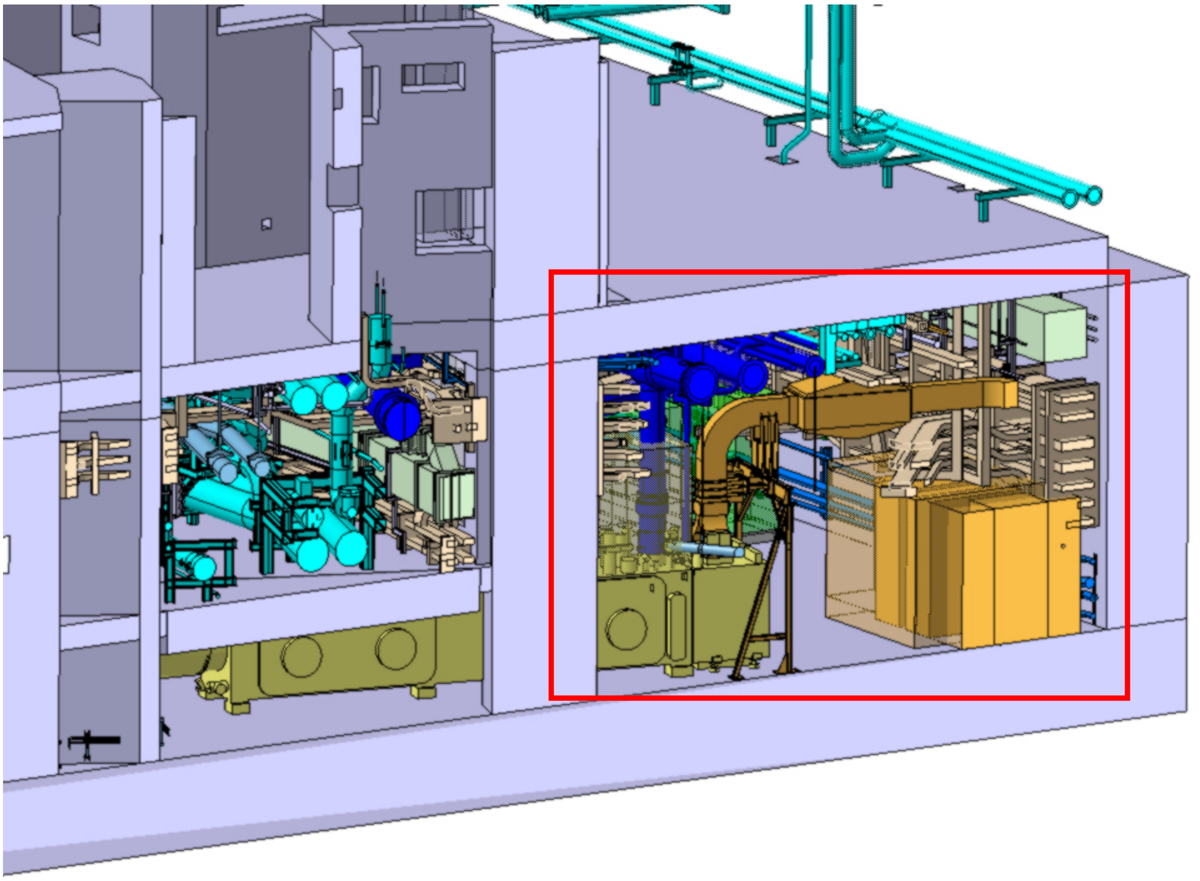
Main plant systems in the room:

PBS 41: power supply

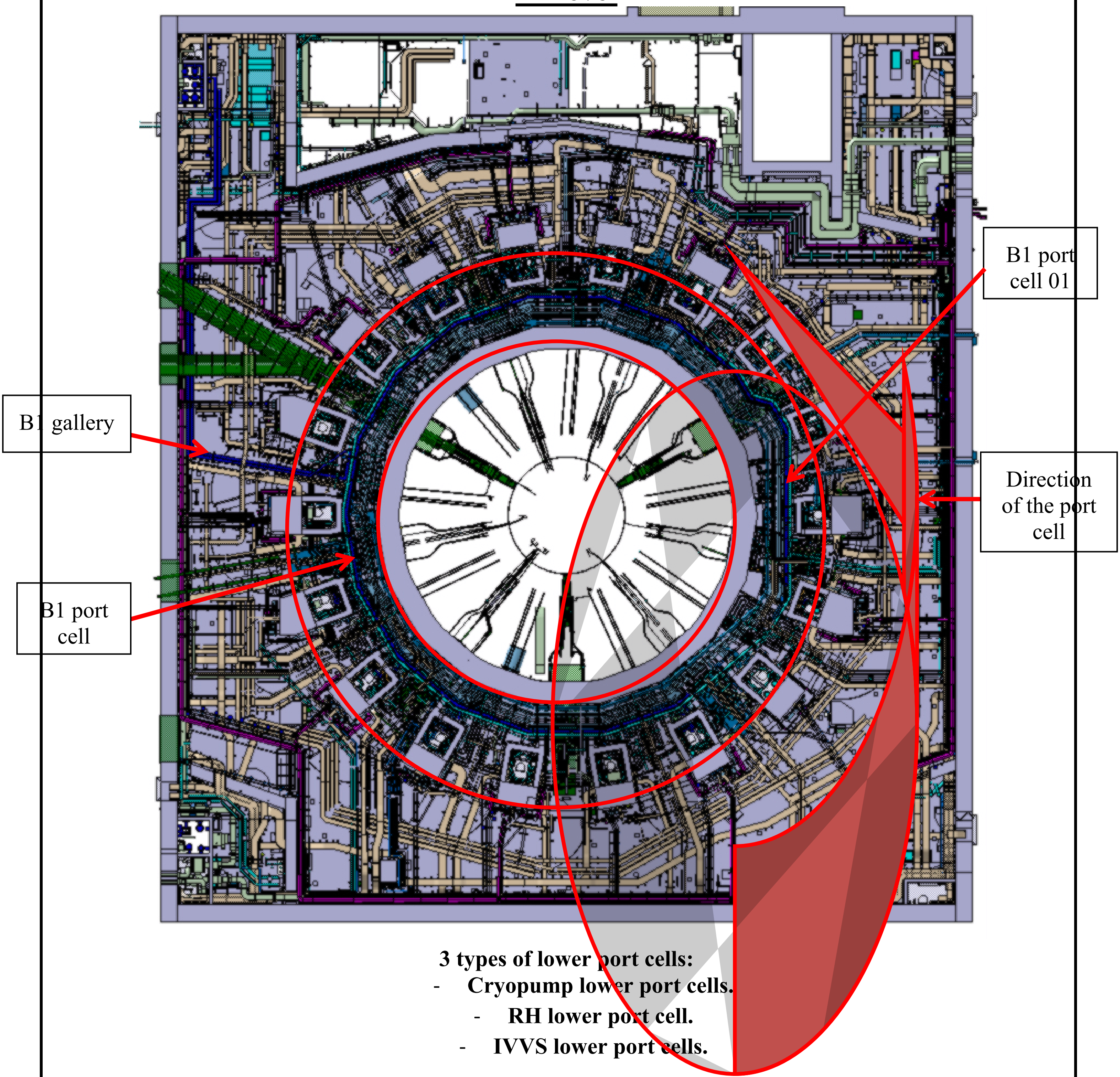
PBS 34: cryogenic system.

PBS 44: cable trays.

PBS 65: Liquid and gas system.



B1 level



3 types of lower port cells:

- **Cryopump lower port cells.**
- **RH lower port cell.**
- **IVVS lower port cells.**

B1 level – RH lower ports

Main plant systems in the room:

PBS 26: cooling water system.

PBS 34: cryogenic system.

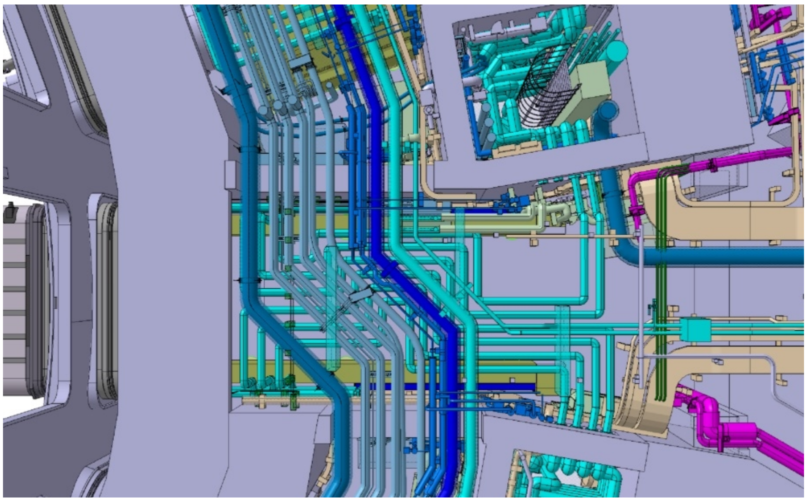
PBS 44: cable trays.

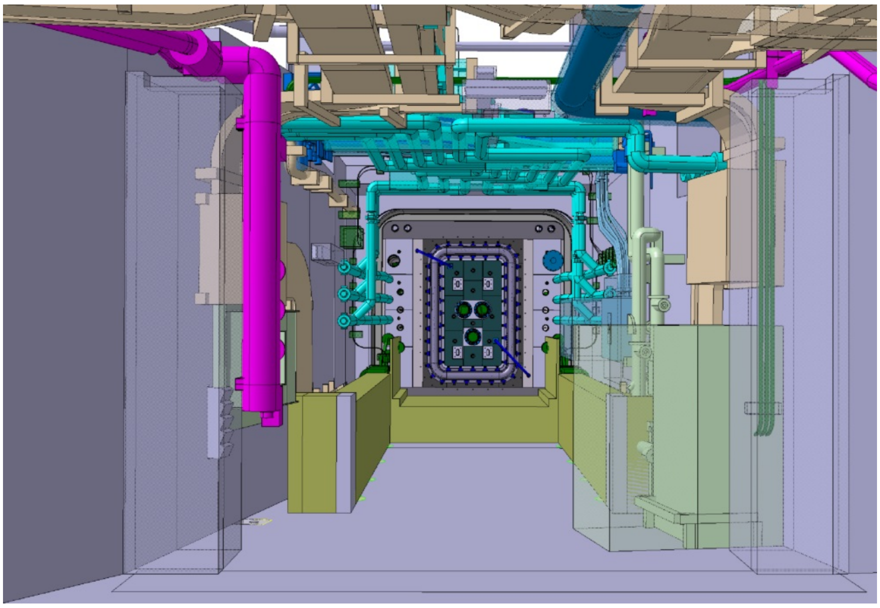
PBS 31: vacuum systems.

PBS 55: diagnostic system

PBS 62 and 65: building services and liquid and gas services.

PBS 32: detritiation system.





B1 level – cryopump lower ports

Main plant systems in the room:

PBS 18: Pellet injection and gas injection system.

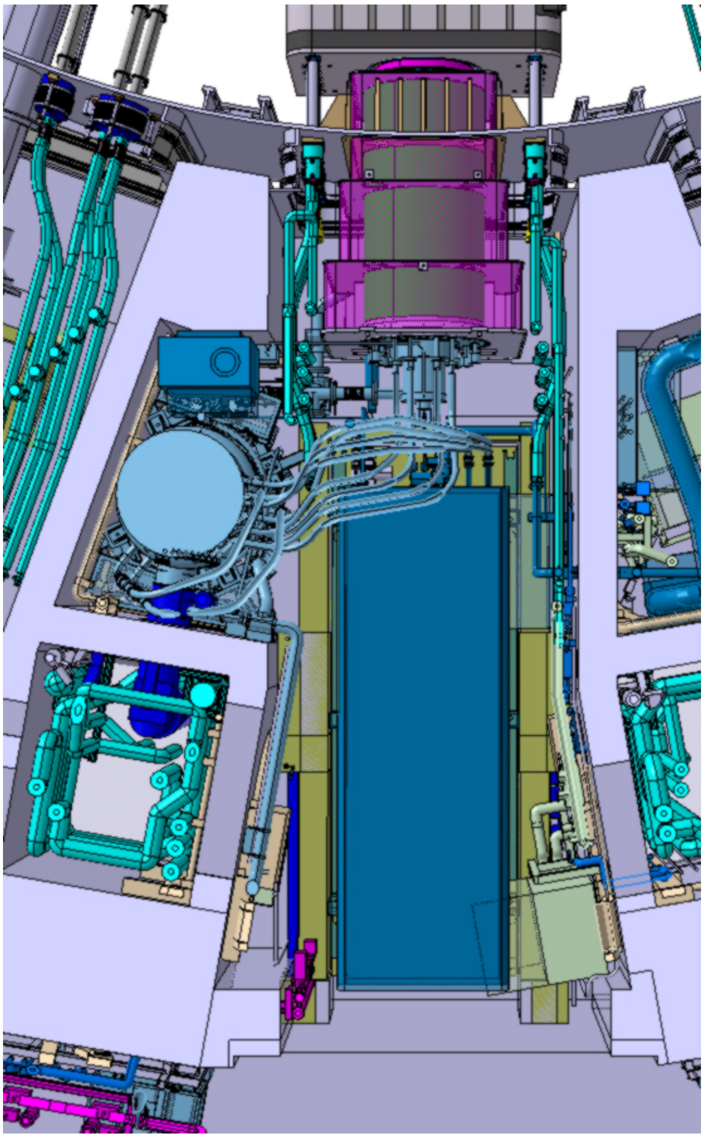
PBS 26: cooling water system.

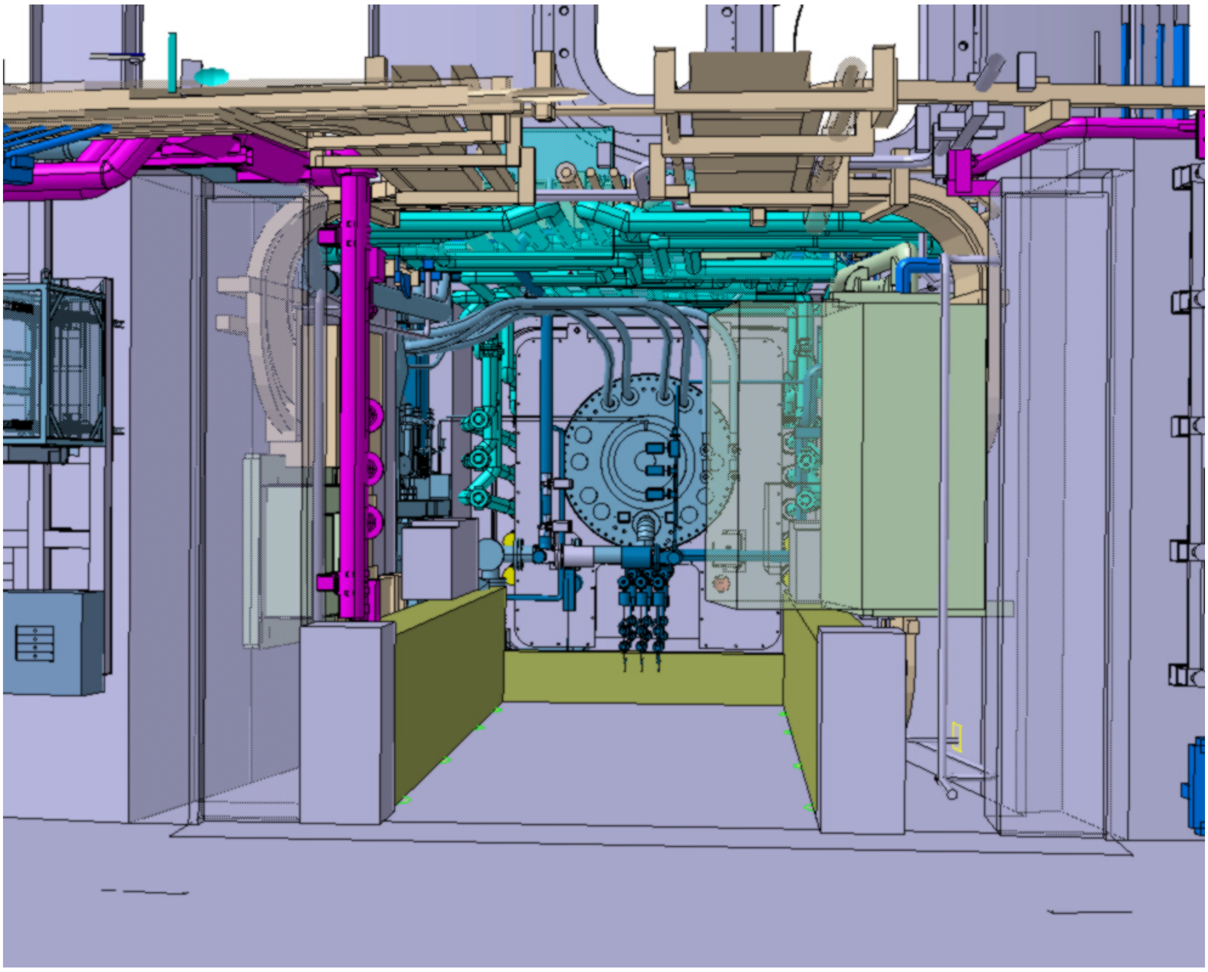
PBS 34: cryogenic system.

PBS 44: cable trays.

PBS 31: vacuum systems.

PBS 62 and 65: building services and liquid and gas services.





B1 level – IVVS lower ports

Main plant systems in the room:

PBS 26: cooling water system.

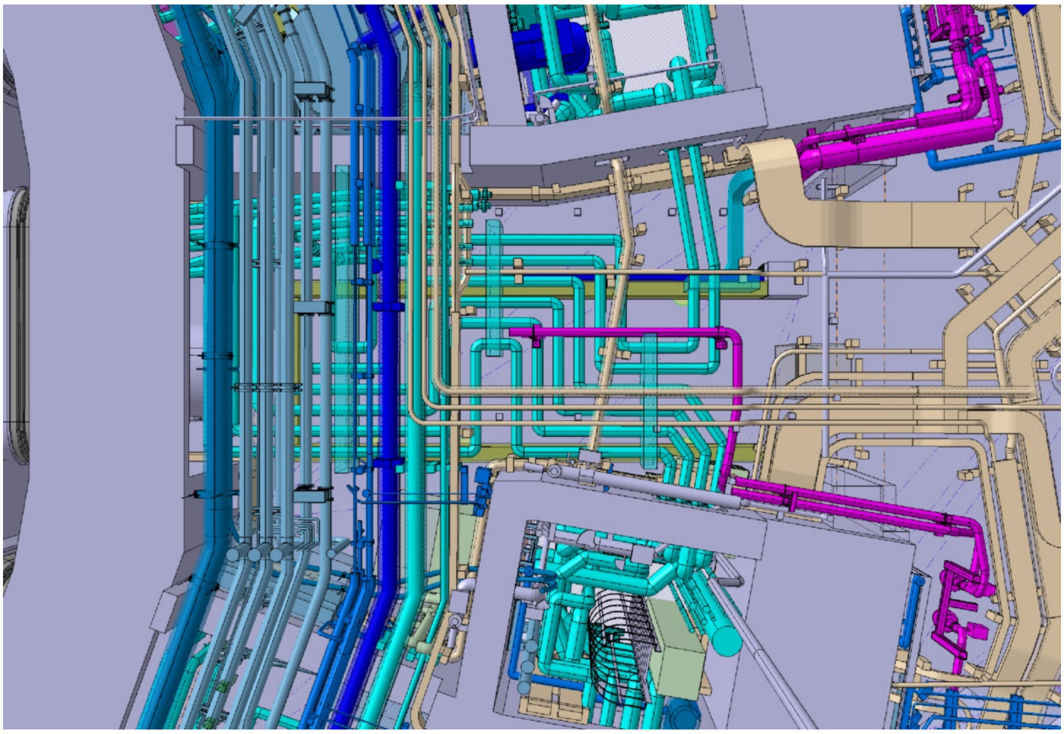
PBS 34: cryogenic system.

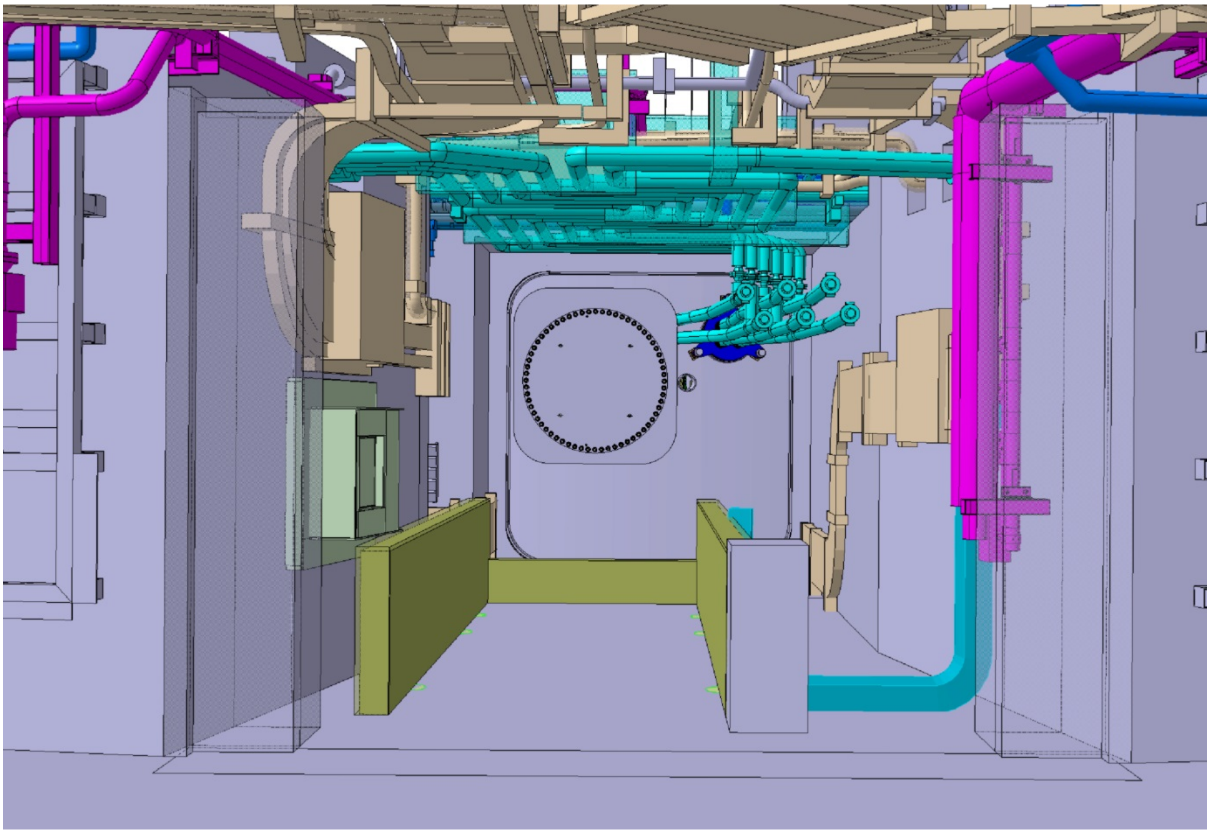
PBS 44: cable trays.

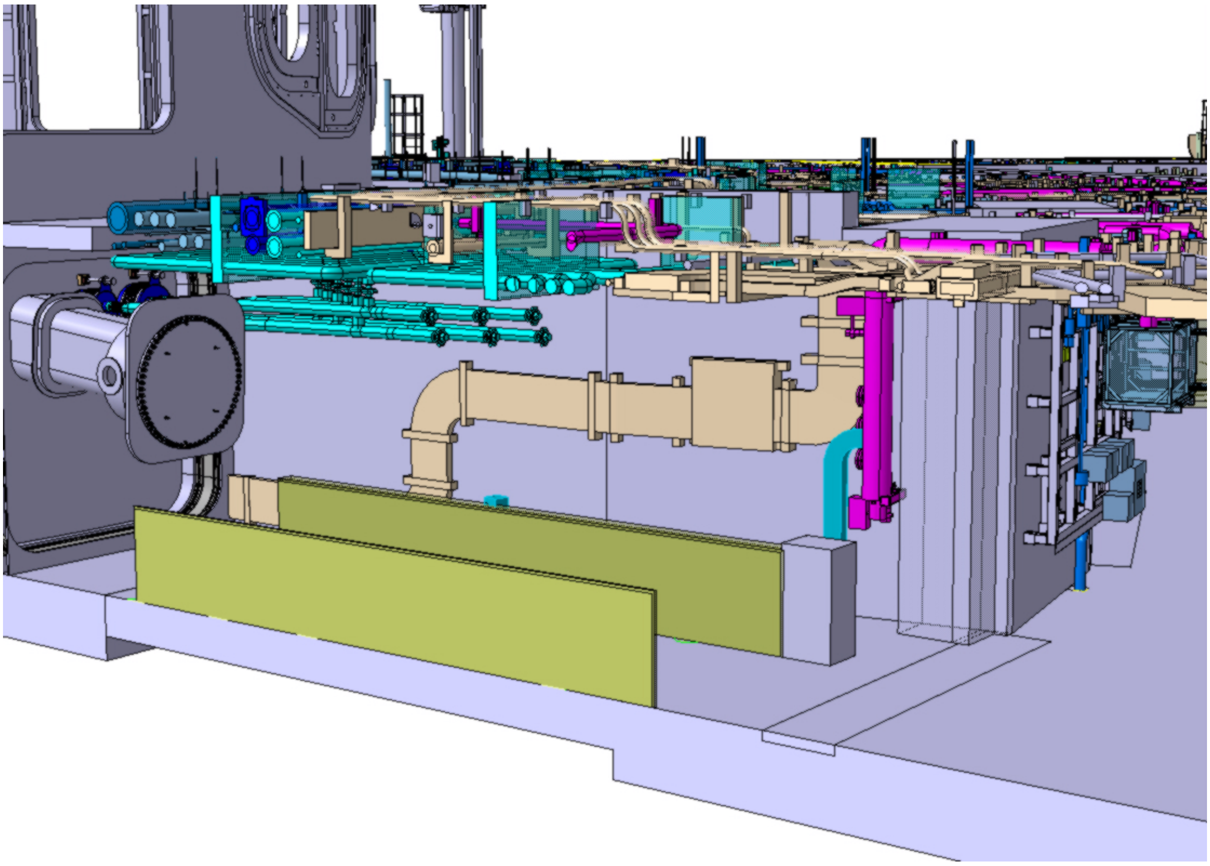
PBS 31: vacuum systems.

PBS 62 and 65: building services and liquid and gas services.

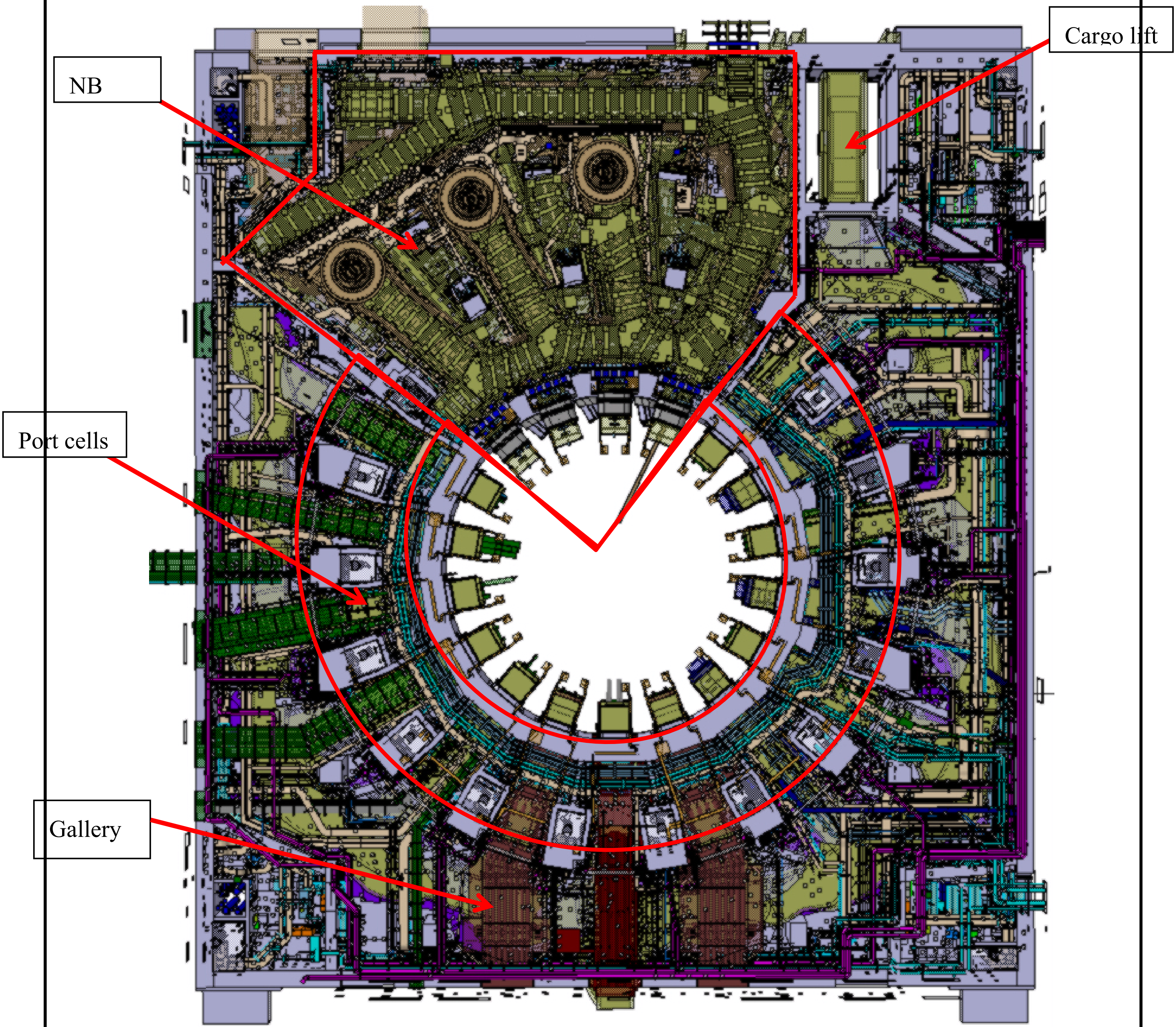
PBS 57: in vessel viewing system







L1 level



In the L1 level, 3 main users are using the ports:

- 3 equatorial ports are used by Test Blanket Module systems.
- 2 equatorial ports are used by ICH systems.
- 1 equatorial port is used by ECH systems.
- 8 equatorial ports are used by diagnostic systems.

L1 port cell and interspace

Main plant systems in the room:

PBS 55 or 51 or 52 or 56 systems.

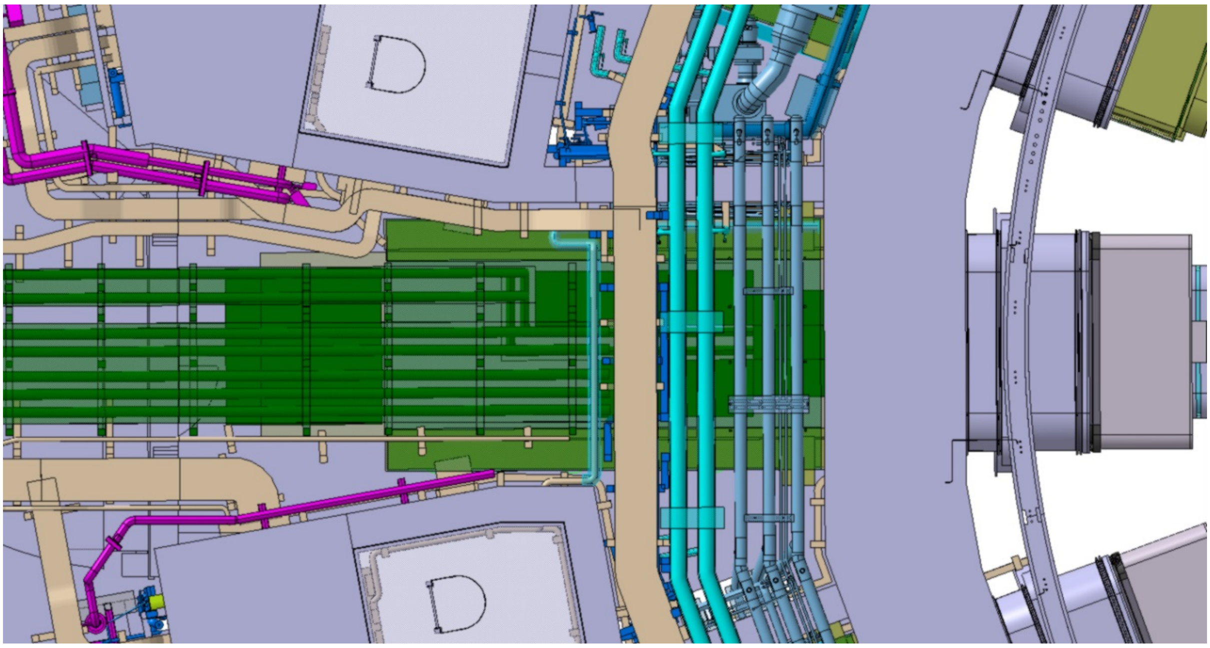
PBS 23: RH rails

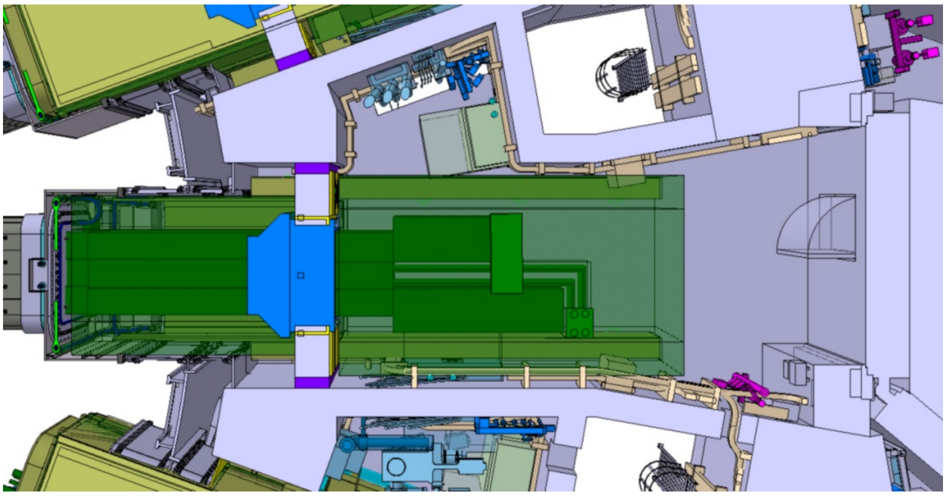
PBS 26: cooling water system.

PBS 44: cable trays.

PBS 31: vacuum systems.

PBS 62 and 65: building services and liquid and gas services.





Interspace

Main plant systems in the room:

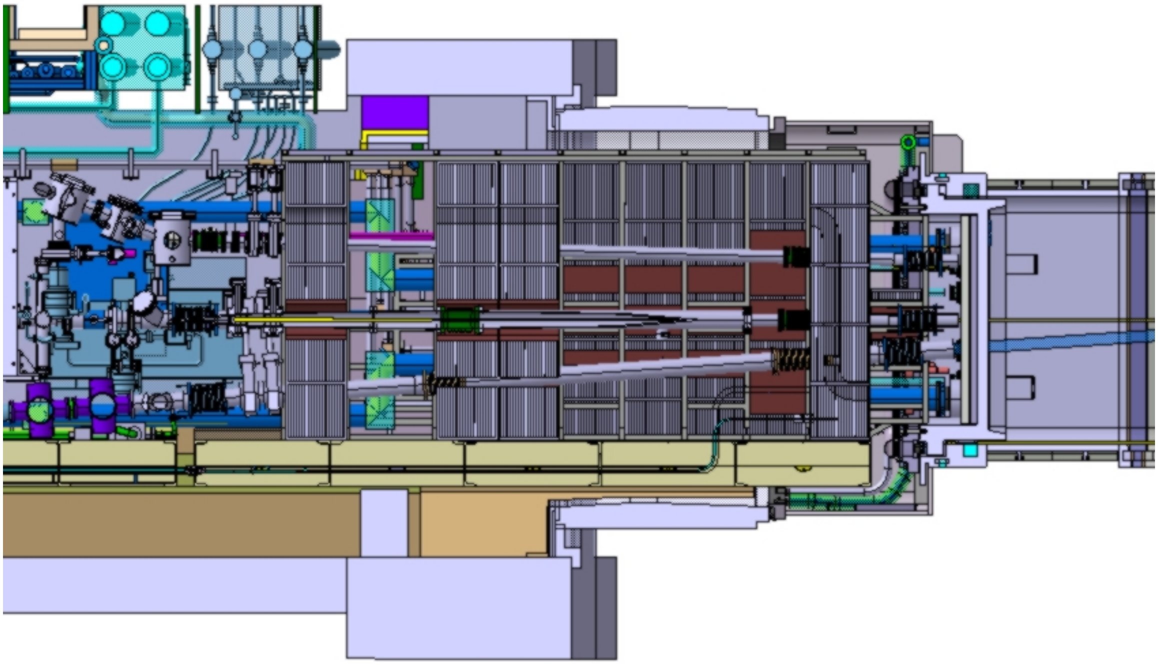
PBS 26: cooling water system.

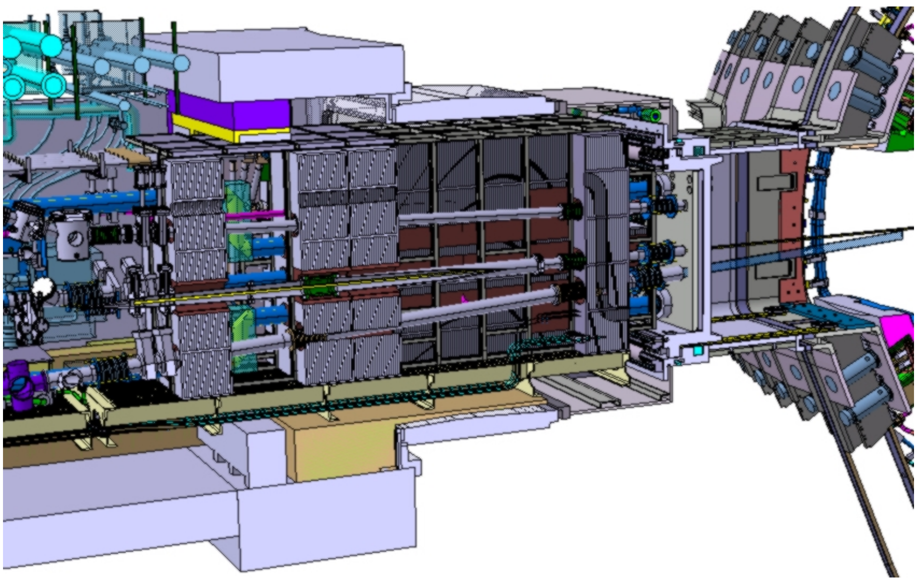
PBS 44: cable trays.

PBS 31: vacuum systems.

PBS 23: RH rails.

PBS 55: diagnostic system.





NB cell

Main plant systems in the room:

PBS 53: Neutral beam heating system.

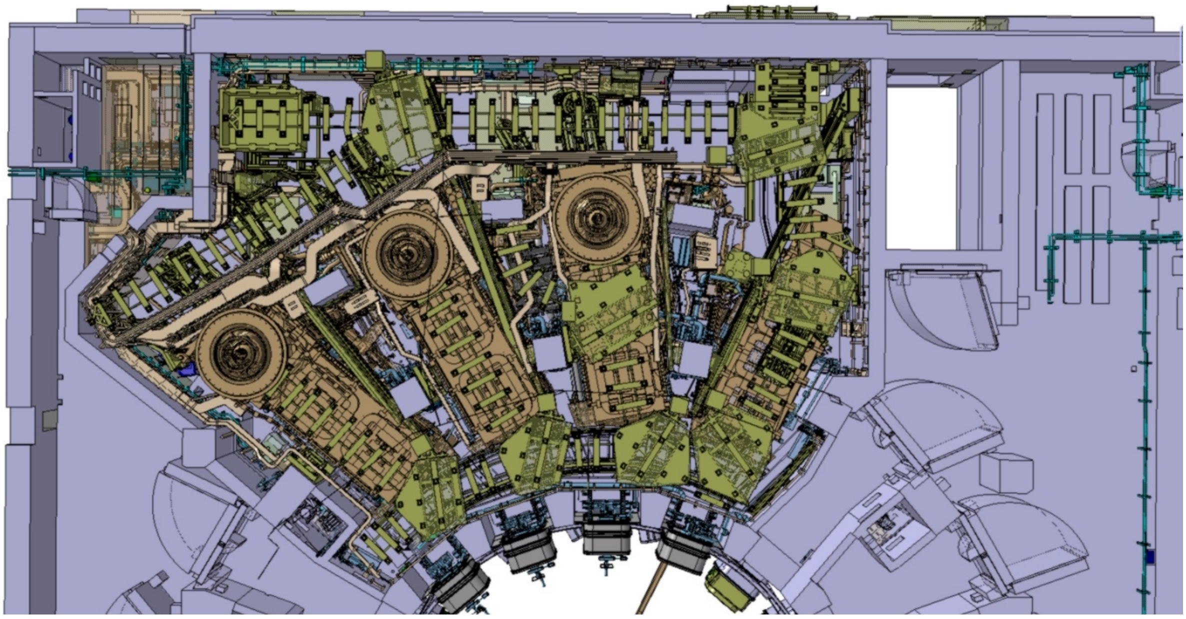
PBS 26: cooling water system.

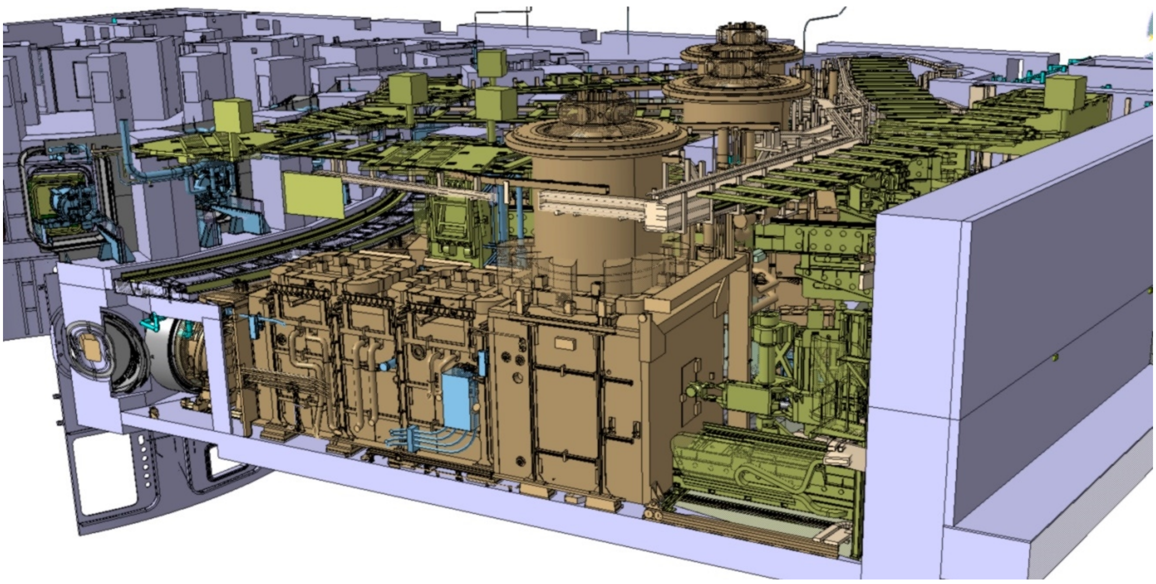
PBS 23: NB RH system.

PBS 44: cable trays.

PBS 31: vacuum systems.

PBS 62 and 65: building services and liquid and gas services.





L1 level gallery

Main plant systems in the room:

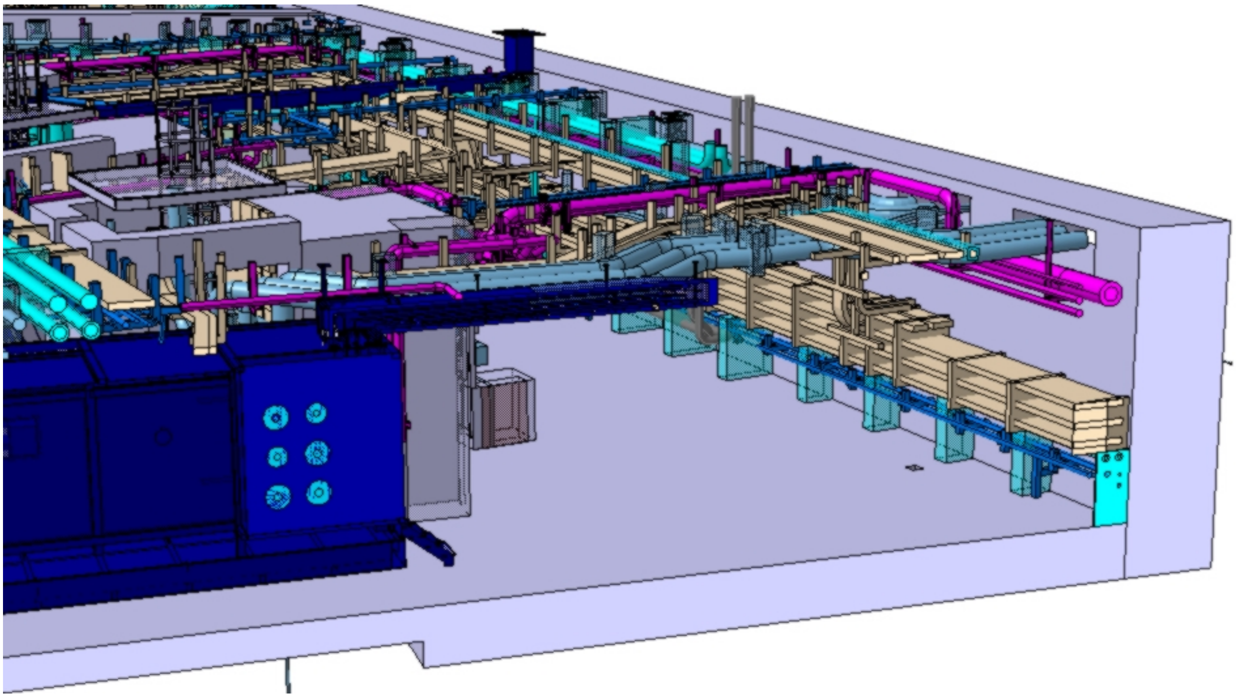
PBS 32: detritiation system.

PBS 26: cooling water system.

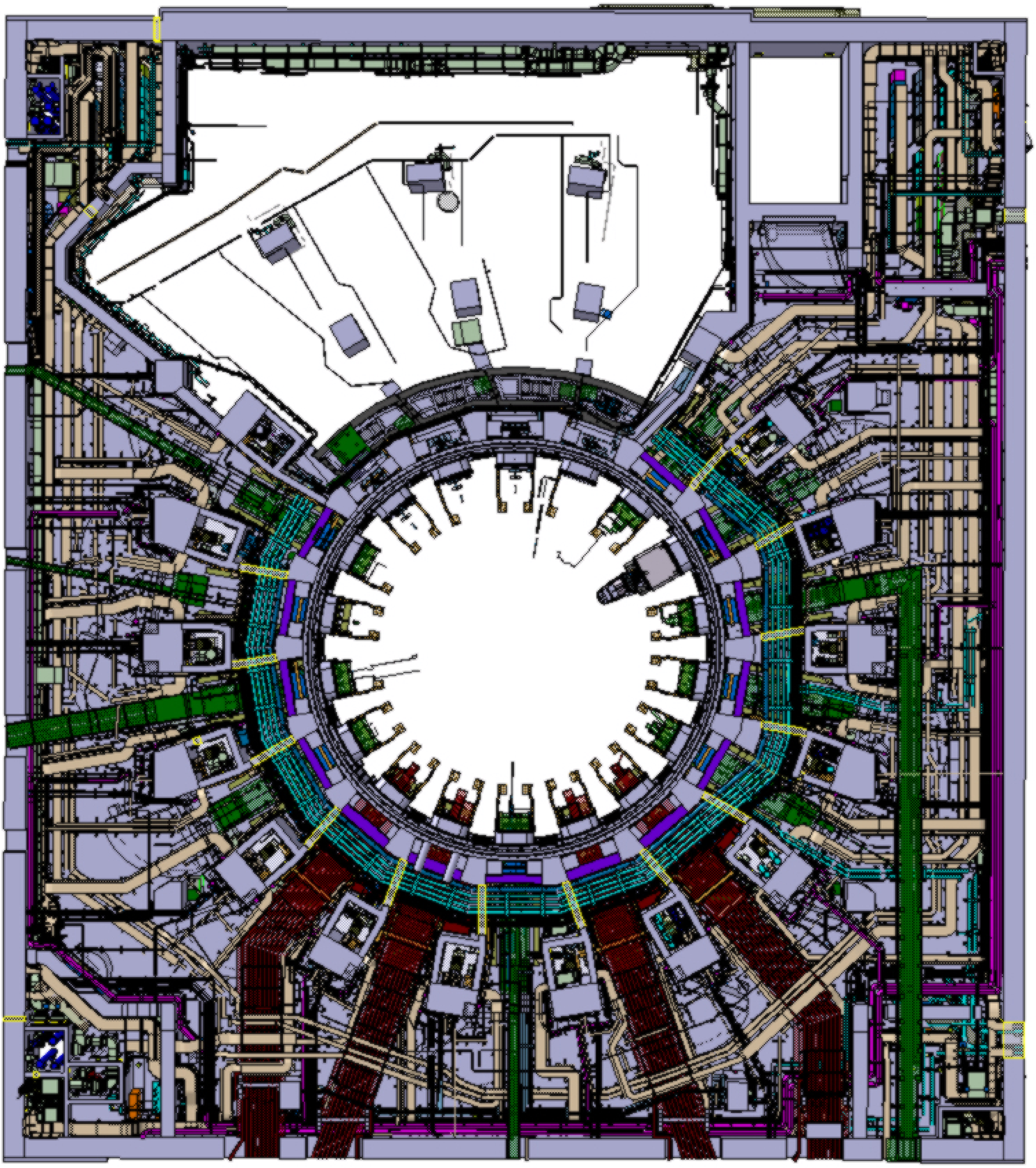
PBS 44: cable trays.

PBS 31: vacuum systems.

PBS 62 and 65: building services and liquid and gas services.



L2 level



In the L2 level, 2 main users are using the ports:

- **4 upper ports are used by ECH systems.**
- **10 upper ports are used by diagnostic systems.**

L2 port cells

Main plant systems in the room:

PBS 55 and 52 systems.

PBS 18: fueling system.

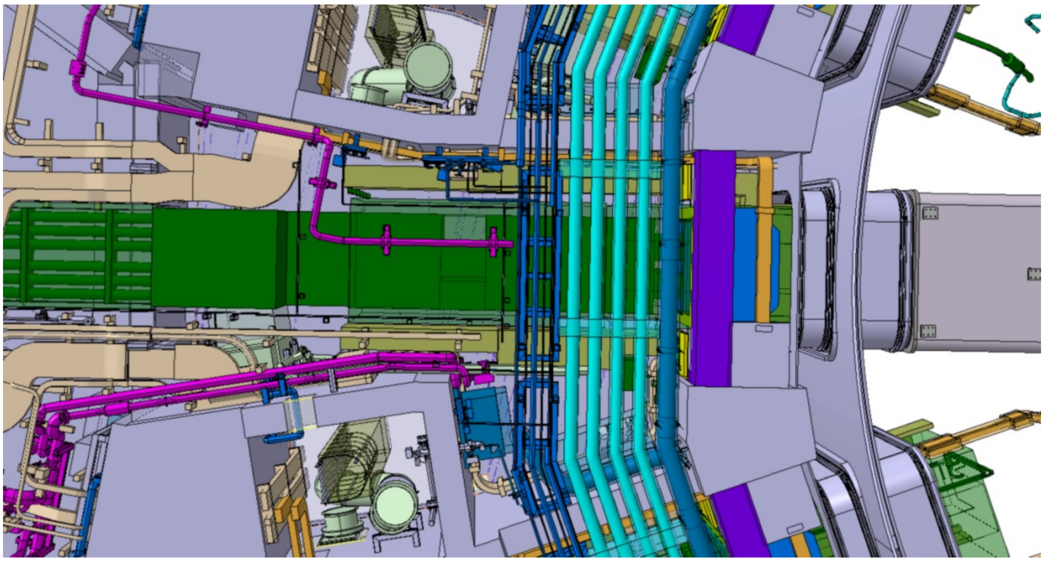
PBS 23: RH rails

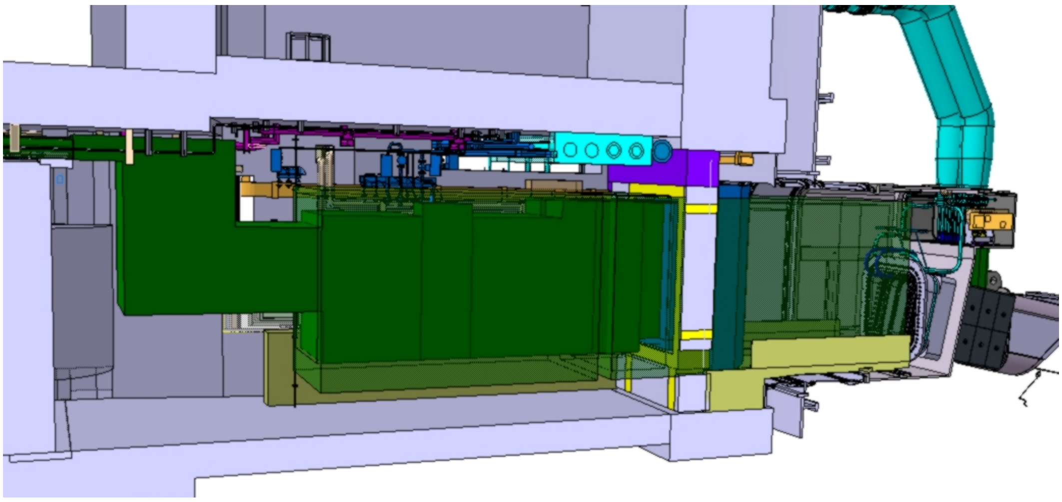
PBS 26: cooling water system.

PBS 44: cable trays.

PBS 31: vacuum systems.

PBS 62 and 65: building services and liquid and gas services.





Interspace

Main plant systems in the room:

PBS 26: cooling water system.

PBS 44: cable trays.

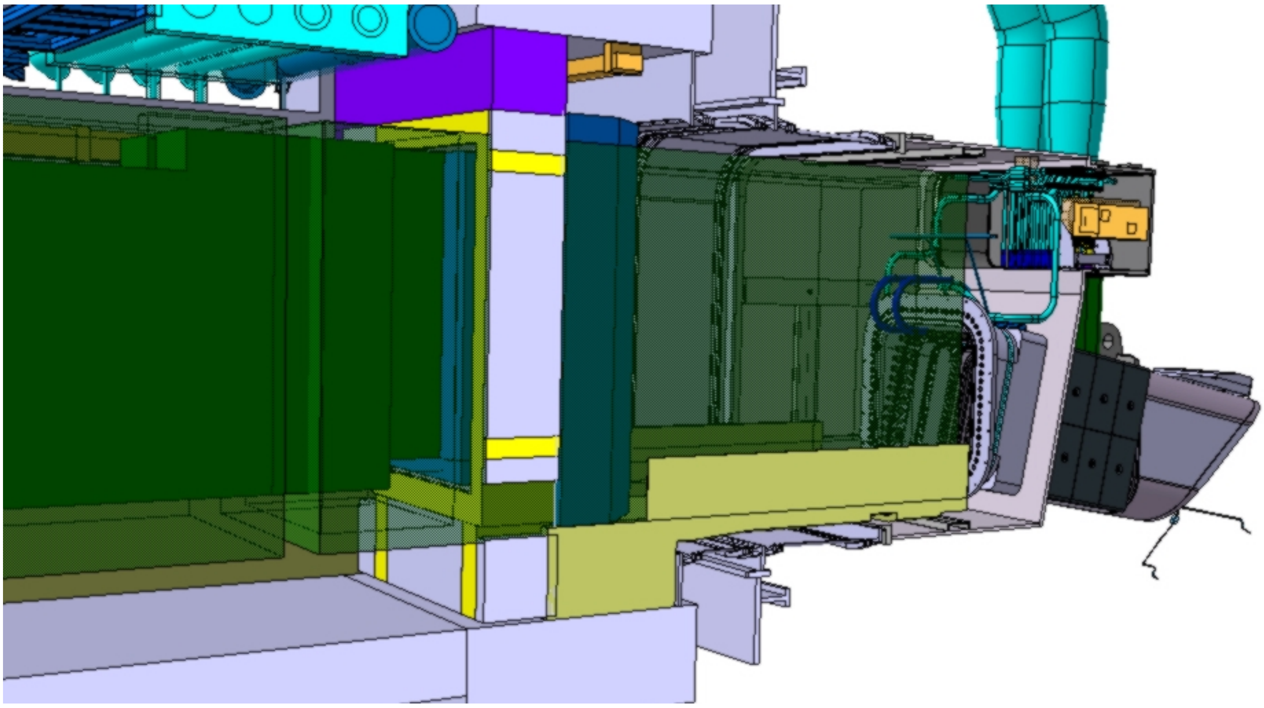
PBS 31: vacuum systems.

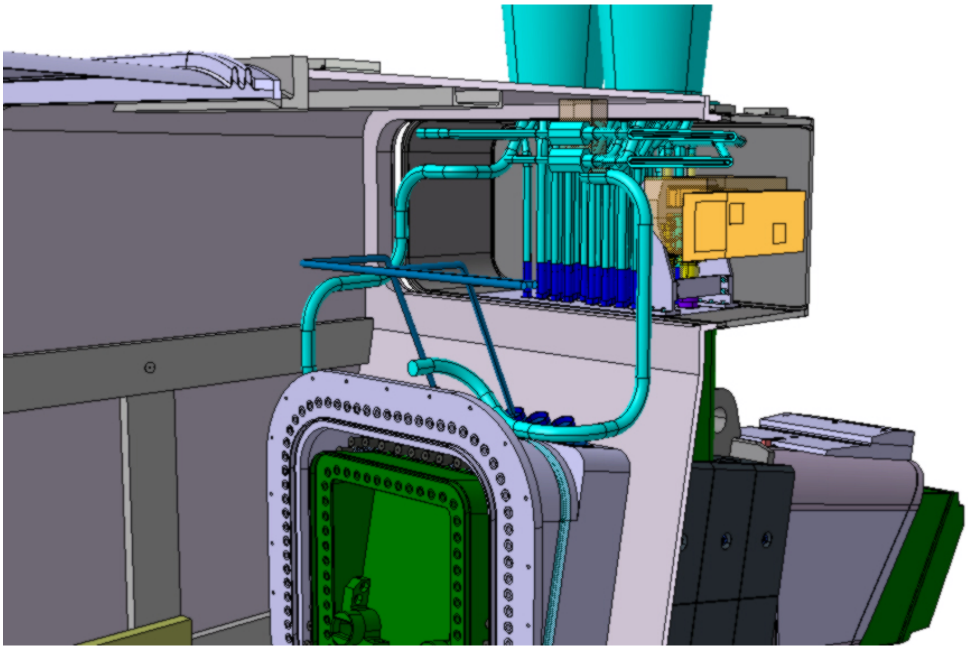
PBS 23: RH rails.

PBS 55NE presence and 52 systems.

PBS 41 : busbar for in vessel coil power supply.

PBS 15: In vessel coil feedthrough.





L2 level gallery

Main plant systems in the room:

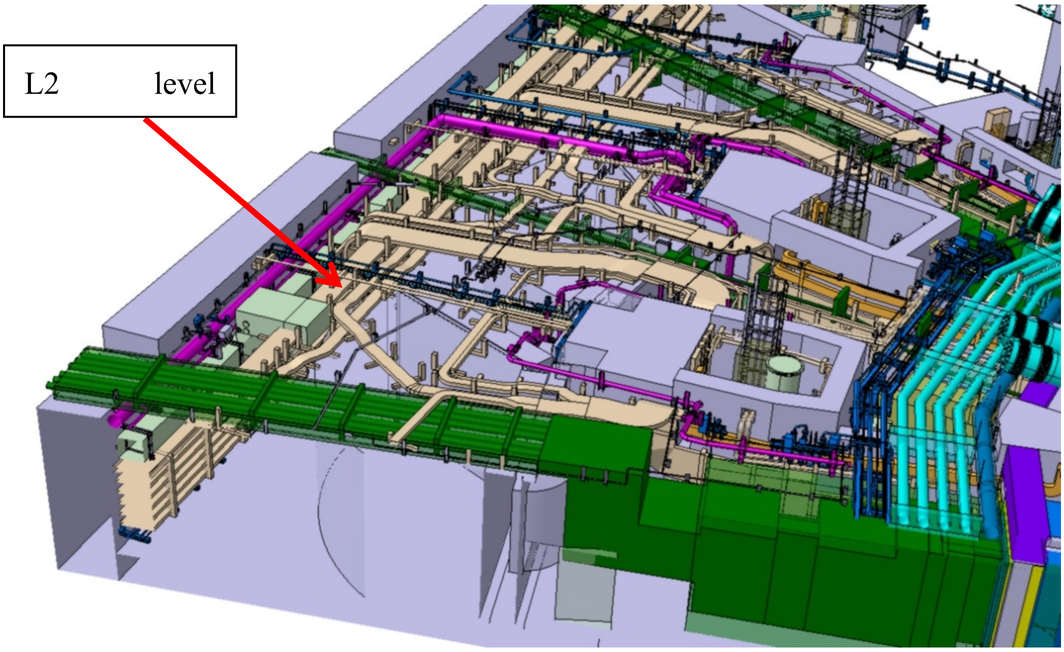
PBS 32: detritiation system.

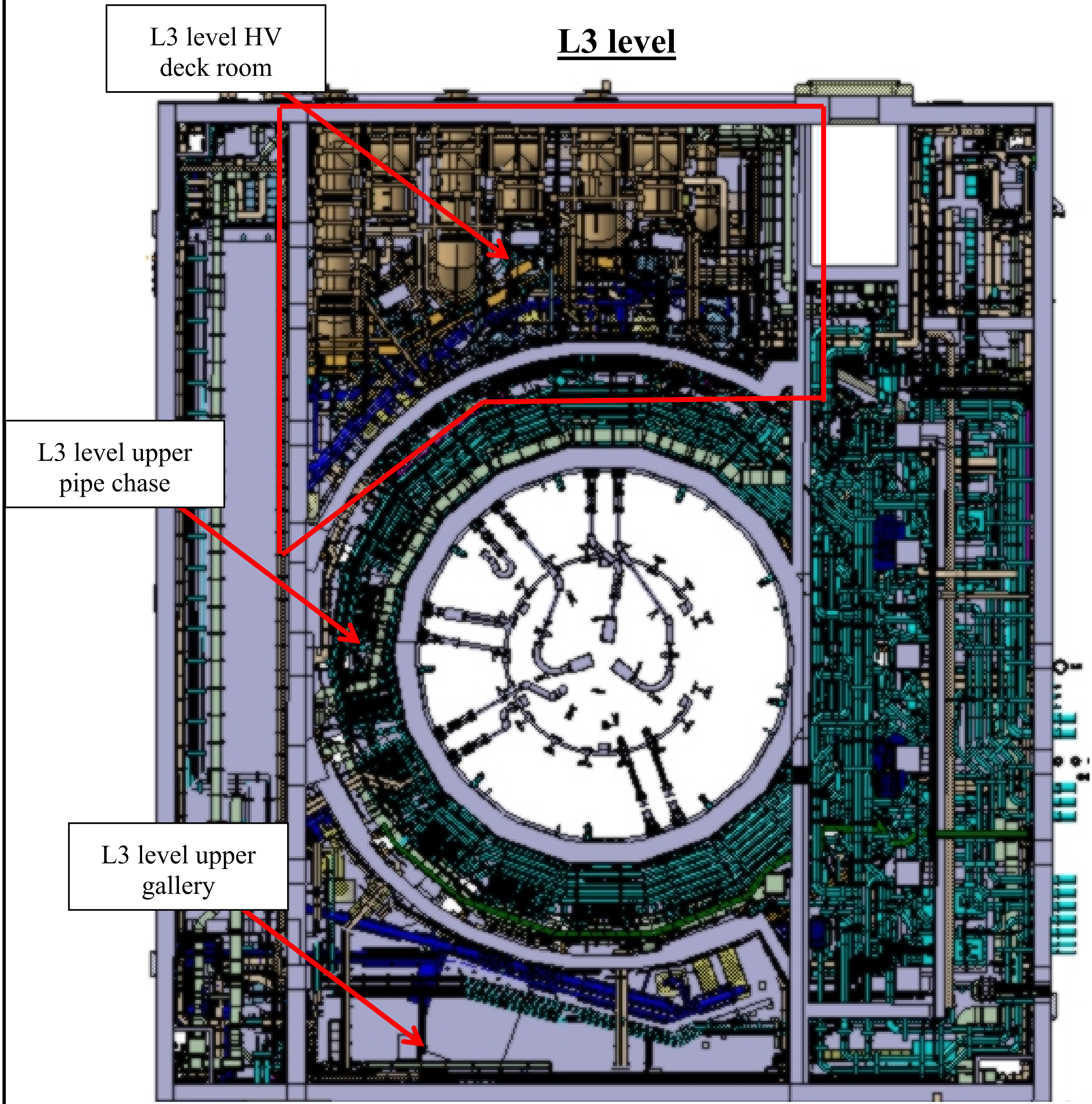
PBS 26: cooling water system.

PBS 44: cable trays.

PBS 31: vacuum systems.

PBS 62 and 65: building services and liquid and gas services.





Main plant systems in the HV deck room:

PBS 26: cooling water system.

PBS 44: cable trays.

PBS 53: NB transmission line systems

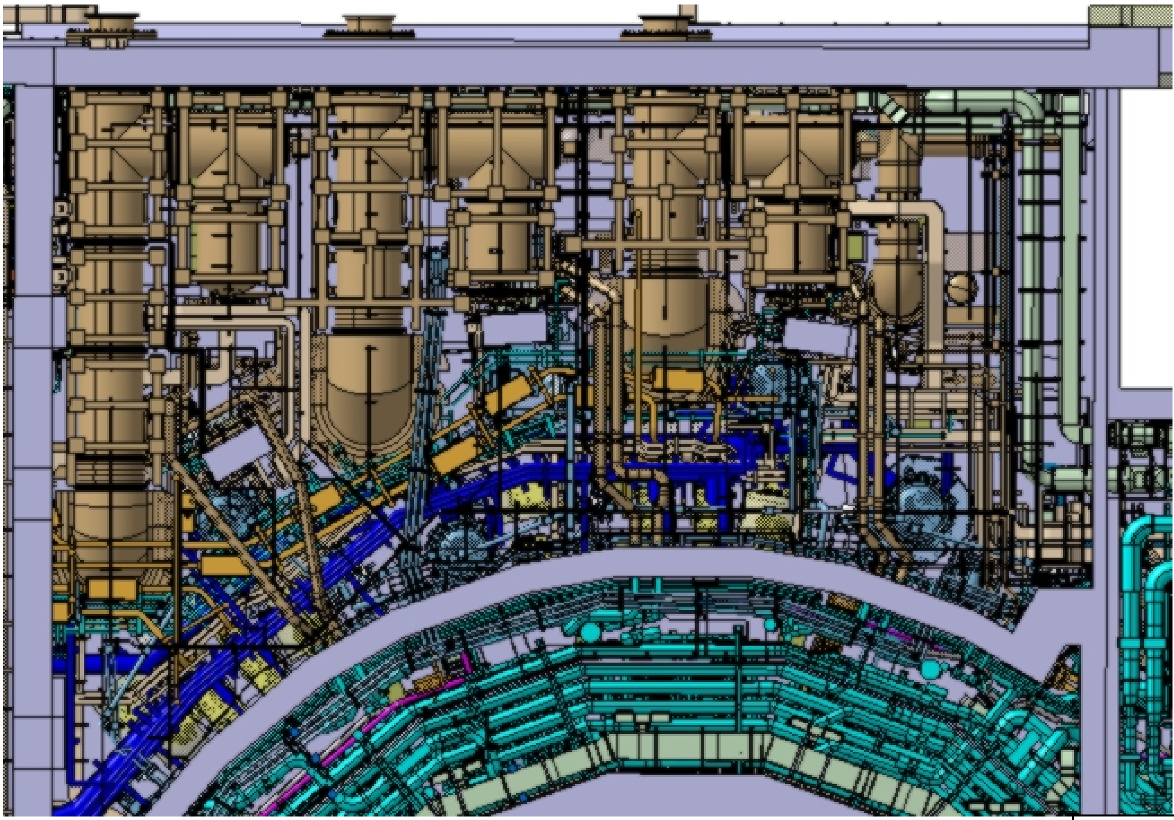
PBS 41: busbar

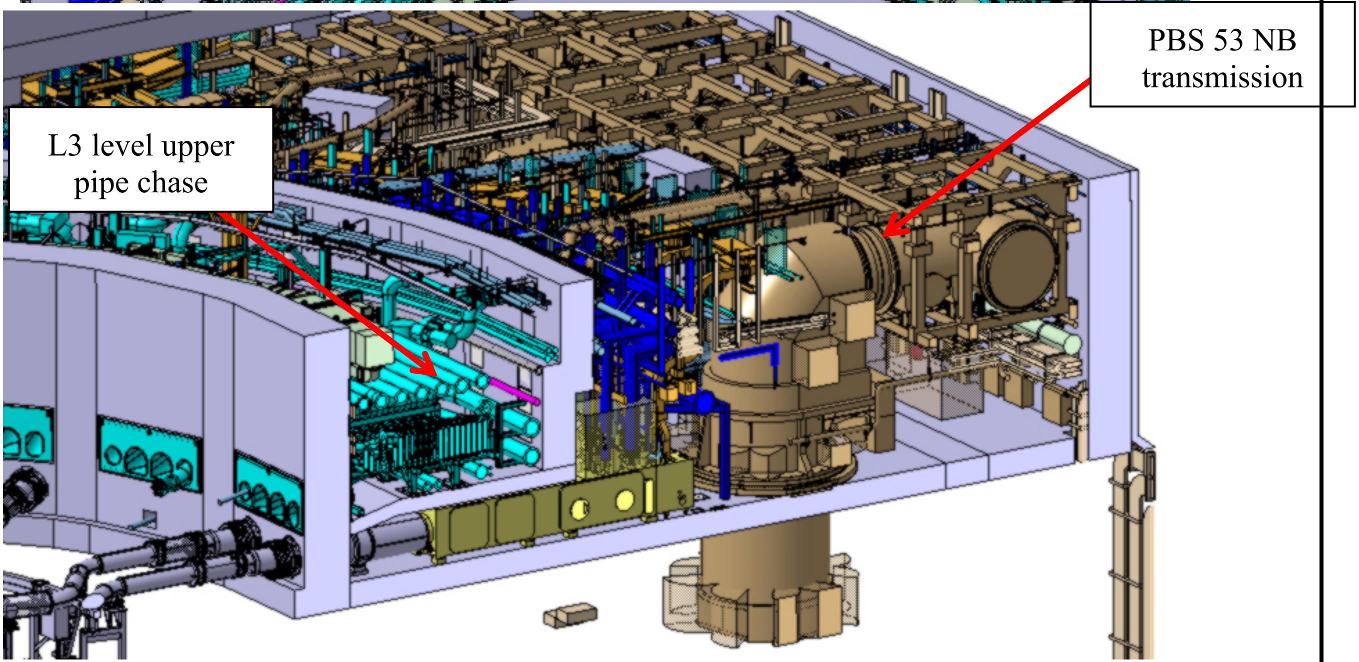
PBS 11: magnet feeder.

PBS 34: cryogenic lines.

PBS 62 and 65: building services and liquid and gas services.

L3 level HV deck room





L3 level upper pipe chase

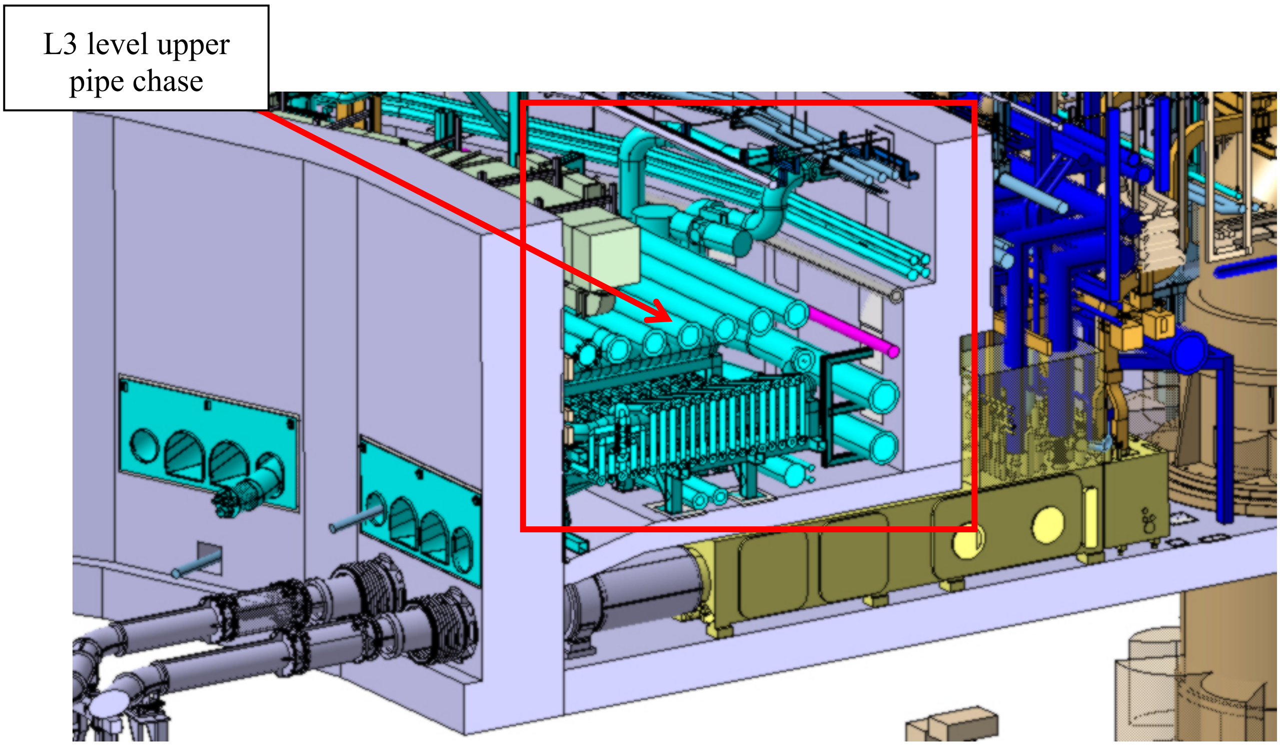
Main plant systems in the room:

PBS 32: detritiation system.

PBS 26: cooling water system.

PBS 44: cable trays.

PBS 62 and 65: building services and liquid and gas services.



L3 level gallery

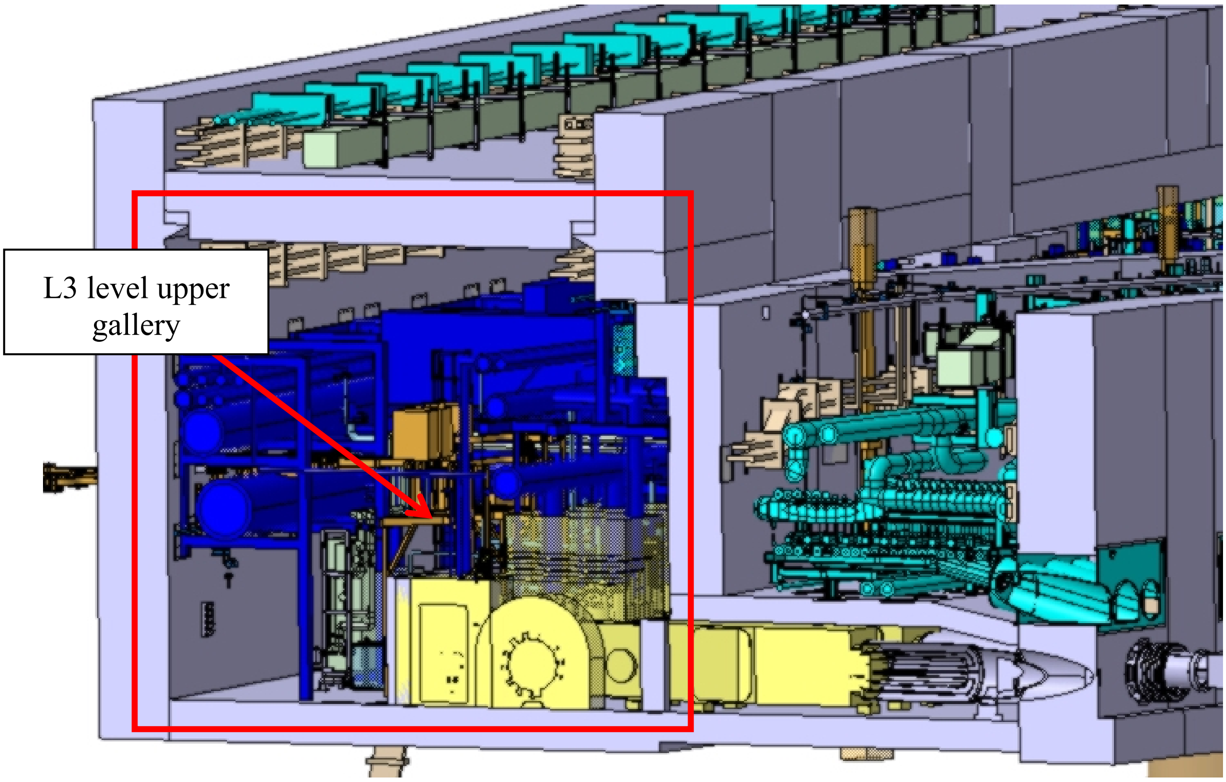
PBS 44: cable trays.

PBS 41: busbar

PBS 11: magnet feeder.

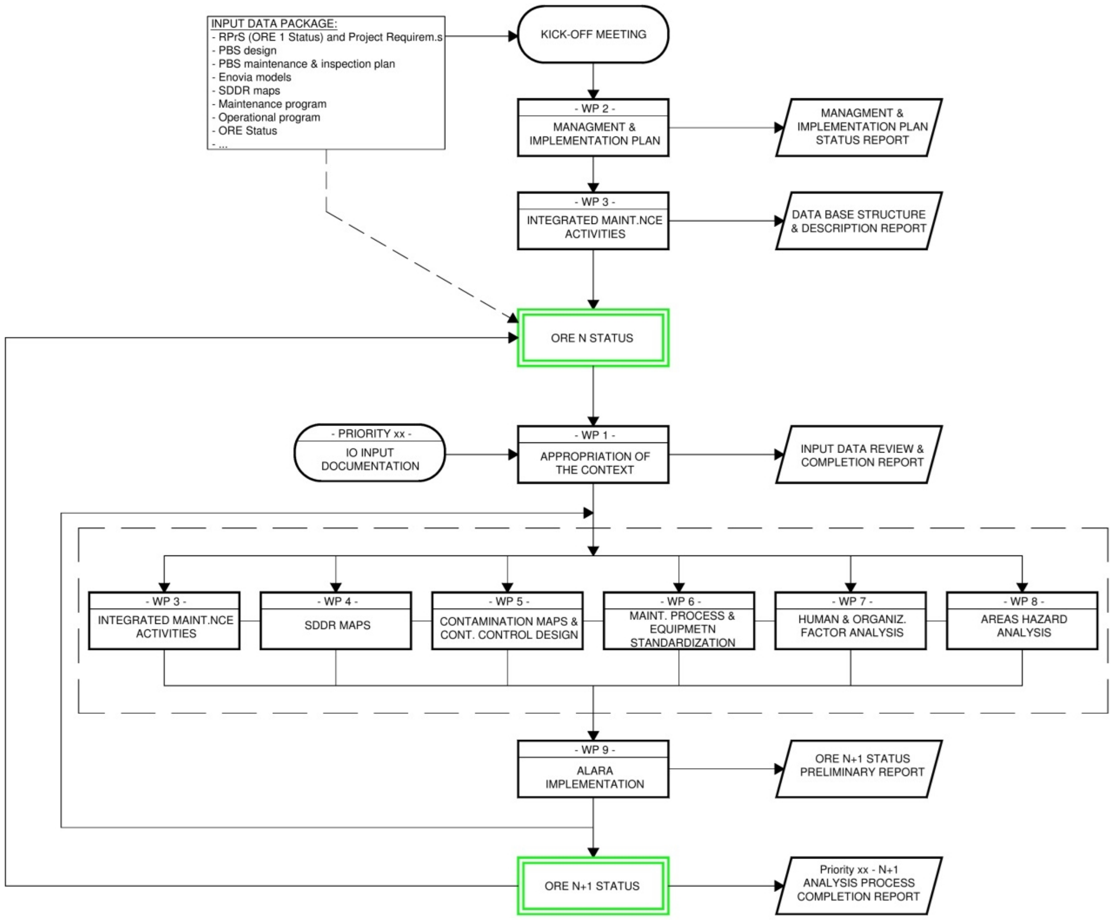
PBS 34: cryogenic lines.

PBS 62 and 65: building services and liquid and gas services.

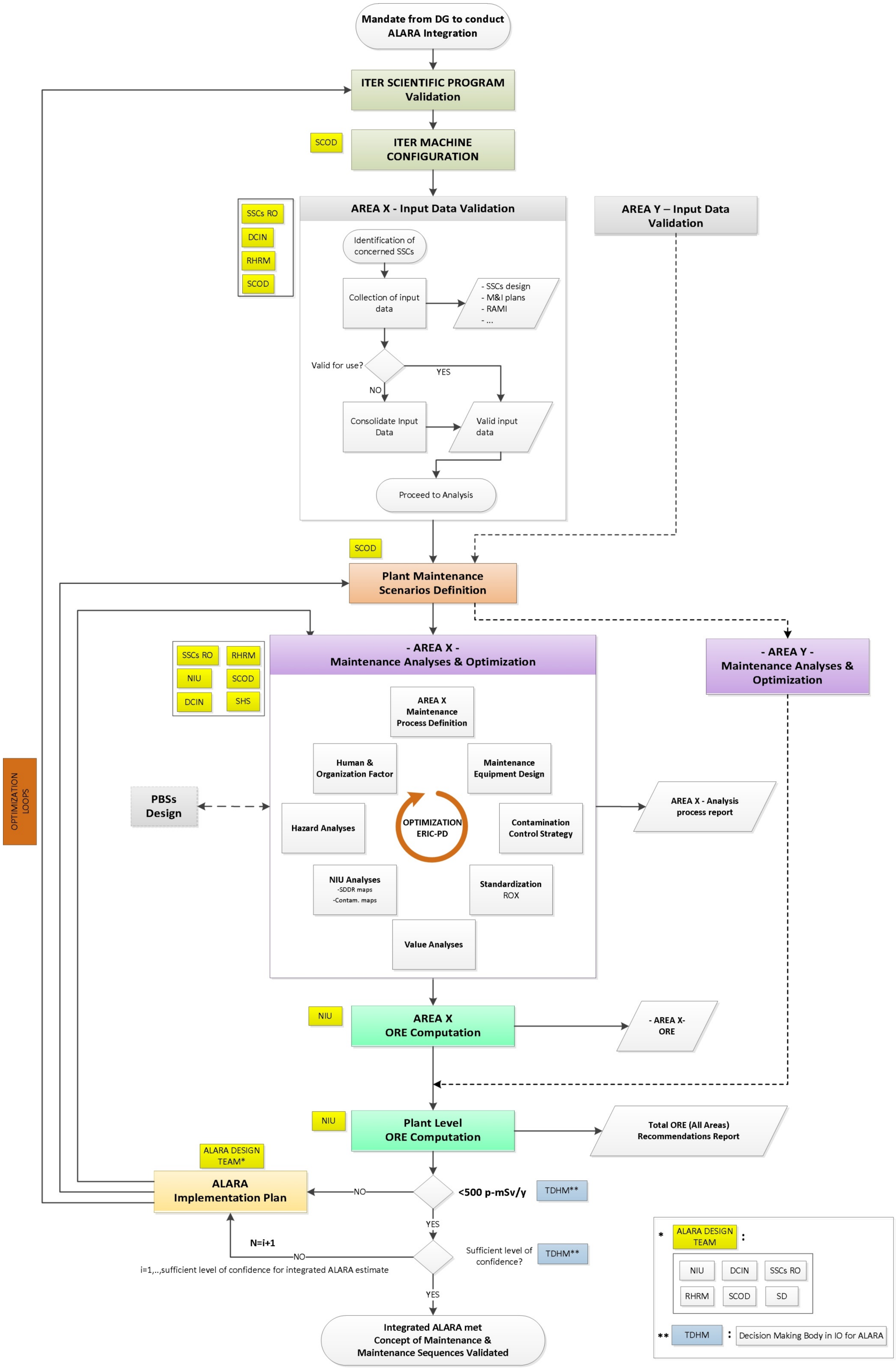


Annex 4: NIU engineering WP logic

**WP1: It has been considered the appropriation of the context will be done essentially at the beginning, but will be completed according to priority list schedule (that is why it is included in the iteration).*



In the following the IO ALARA implementation and working flow chart is presented as well (in yellow the IO working units are defined).


Mandate from DG to conduct ALARA Integration
ITER SCIENTIFIC PROGRAM Validation
SCOD
ITER MACHINE CONFIGURATION
SSCs RO
DCIN
RHRM
SCOD
AREA X - Input Data Validation
Identification of concerned SSCs
Collection of input data
- SSCs design
- M&I plans
- RAMI
- ...
Valid for use?
YES
NO
Consolidate Input Data
Valid input data
Proceed to Analysis
AREA Y – Input Data Validation
SCOD
Plant Maintenance Scenarios Definition
SSCs RO
RHRM
NIU
SCOD
DCIN
SHS
- AREA X -
Maintenance Analyses & Optimization
- AREA Y -
Maintenance Analyses & Optimization
AREA X Maintenance Process Definition
Human & Organization Factor
Maintenance Equipment Design
PBSs Design
Hazard Analyses
OPTIMIZATION ERIC-PD
Contamination Control Strategy
AREA X - Analysis process report
NIU Analyses
-SDDR maps
-Contam. maps
Standardization ROX
Value Analyses
OPTIMIZATION LOOPS
NIU
AREA X ORE Computation
- AREA X- ORE
NIU
Plant Level ORE Computation
Total ORE (All Areas) Recommendations Report
ALARA DESIGN TEAM*
ALARA Implementation Plan
NO
<500 p-mSv/y
TDHM**
YES
N=i+1
NO
Sufficient level of confidence?
TDHM**
i=1,..,sufficient level of confidence for integrated ALARA estimate
YES
Integrated ALARA met Concept of Maintenance & Maintenance Sequences Validated
* ALARA DESIGN TEAM :
NIU
DCIN
SSCs RO
RHRM
SCOD
SD
** TDHM : Decision Making Body in IO for ALARA

Annex 5: Preliminary lists of Maintenance DB parameters

ALARA Maintenance Database shall:

- Act as the central repository for all maintenance task information.
- Collect and gather, using similar format, all the information interesting maintenance to drive and assist the Systems design phase;
- Identify the equipment to be maintained for each PBS in the area (in correlation with PBS level 3 & 4) and their main features (size, weight, dose rate, contamination, etc.);
- Based on area maintenance plans and RAMI data, record the relevant maintenance task information such as:
    - Task identification (description, equipment maintained, duration, staff, tools required, etc.);
    - Work station (position, dose rate, contamination level);
    - Logistic needs (plant services, maintenance tools, radioprotection, area preparation...);
    - Staff qualification (mechanical, physicists, radioprotection…);
    - Waste assessment;
    - Flux of resources (staff, transfer of equipment, handling tools, specific tools or Equipment) ;
- Record the Occupational Radiation Exposure (ORE) for the area:
    - Shutdown dose rate for each workstation
    - Shutdown dose rate contributors for each workstation
    - Max and average collective dose;
    - Max and average individual dose;
    - Contribution of each sub-task to the collective dose.
- Assess the waste production per category (primary waste, technology waste, others…);
- Present results using pie chart or other appropriate views to highlight key information (duration and repartition of the maintenance tasks, equipment per PBS to be maintained, main dose task contributors, etc.).

The database shall be architecture with a set of tables, with capability to provide reports on key parameters. This database shall be used only by people involved in Integrated Maintenance and ALARA activities.

The ALARA Maintenance Database shall be task based. The general task definition shall be characterized, as a minimum, by the following data:

- Task identification/classification
- Location identification
- Time of occasion (+ frequency, just to have an indication, create a task ID for each event occasion even if recurrent.)
- Component identification
- Worker list needed (and relevant location? TBD)
- Equipment and tools needed
- SDDR maps
- Contamination hazard
- Note

In the following some details are reported as examples.

1) TASK IDENTIFICATION

The Task identification shall be in levels, each father level contains all the daughter tasks.

For example:

- LEVEL 0 → EQ11 Port Plug removal
  - LEVEL 1 → PCSS Removal preparation
    - LEVEL 2 → PCSS Disconnection
      - LEVEL 3 → Diagnostic NPA disconnection
        - LEVEL 4 → Confinement tent installation…

Note:

The DB shall allow the possibility to identify the cumulative data per each level (i.e. time needed to perform the Task Level 1 "PCSS removal preparation", including therefore all the daughter tasks), to be able then to perform specific reports and value analysis.

2) TASK CLASSIFICATION

Each task shall be classified according to a common practice.

For example:

- Type of task:
  - Periodic Maintenance
  - Predictive Maintenance
  - Planned Maintenance
  - Corrective Maintenance
  - Run-to failure Maintenance
- Priority → identify a priority scale
- Discipline → i.e. mechanical, HVAC, Electric…

Note:

The DB shall allow the possibility to identify the cumulative data per each characteristic (i.e. cumulative dose rate to perform all the Periodic Maintenance), to be able then to perform specific reports and value analysis.

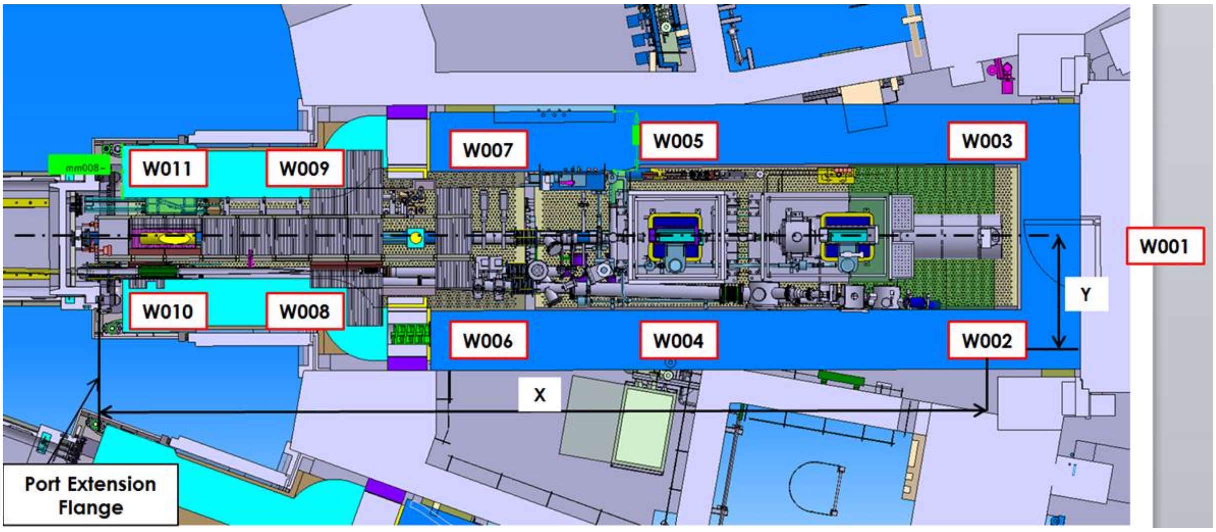
3) LOCATION IDENTIFICATION

The location identification shall be in levels, each father layer contains all the sons. For each working area the work stations shall be identified according to the actual geometrical position.

The identification of the areas, up to the room id, shall be done in accordance with the ITER reference GBS

For example:

- BUILDING → Tokamak Building
  - LEVEL → Level 1
    - ROOM ID → 11-L1-C11
      - WORK STATION → 11-L1-C11-W001



Each workstation shall be univocally identified and described in a dedicated workstation table, example follows.

ID	Description
11-L1-C11-W001	**In front of the Port Plug**
…	**…**

Note:

The DB shall allow the possibility to identify the cumulative data per each location layer (i.e. cumulative dose rate associated to all the maintenance tasks in a particular work station or in a tokamak building level…), to be able then to perform specific reports and value analysis.

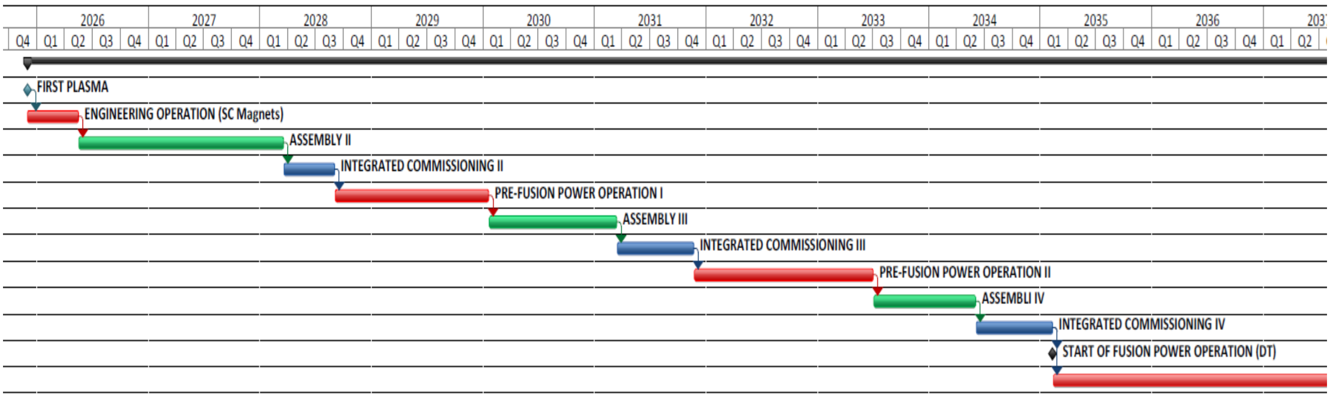
4) TIME TABLE

A Time Table shall be included to identify all the project steps according to the reference schedule to be able than to identify in which project phase the maintenance task will be performed.

For example:

- Assembly Phase I
- First Plasma
- Engineering Operation
- Assembly Phase II
- Integrated commissioning
- Pre-Fusion Operation I
- Assembly Phase III
- Integrated commissioning
- Pre-Fusion Operation II
- Assembly Phase VI
- Fusion Power Operation (DT)
    - Plasma operation 1
    - LTM 1
    - Plasma operation 2

- LTM 2
- …



Note:

The DB shall allow the possibility to identify the cumulative data per each project phase (i.e. cumulative dose rate for the execution of all the maintenance tasks in a particular long term shutdown), to be able then to perform specific reports and value analysis.

5) COMPONENT IDENTIFICATION

The Component to be maintained shall be identified in assemblies' levels; each father level contains all the sons.

The component identification shall be done in accordance with the PBS nomenclature up to the Level 3 as shown in the reference document (see Ref XXX).

For example:

- PBS → PBS 55 diagnostic (owner of the component)
  - ASSEMBLY ID → PCSS (ID/tag)
    - SUB ASSEMBLY ID → NPA Diagnostic (ID/tag)
      - COMPONENT ID → NPA transmission line (ID/tag)
        - SUB COMPONENT ID → … (depending on the sys complexity)

Note:

The DB shall allow the possibility to identify the cumulative data per each component and/or subcomponent (i.e. cumulative dose rate associated to the maintenance of the PCSS), to be able then to perform specific reports and value analysis.

6) WORKERS LIST

A workers list shall be identified including all the professions as needed to accomplish all the maintenance tasks.

The possibility to identify the number of professionals of the same type should be addressed to be able to estimate the overall need in terms of personnel to maintain the equipment.

Note:

The DB shall allow the possibility to identify the cumulative data per each professional gender (i.e. cumulative time needed to maintain a component), to be able then to perform specific reports and value analysis.

7) EQUIPMENT AND TOOLS NEEDED

An Equipment and Tools Table shall be included.

The needed information is at least:

- ID/Description
- PBS owner
- Quantity available
- Supply needed
- Spare parts
- …

8) SDDR MAPs

The identified SDDR maps shall be included into a table giving the actual dose rate applicable to each Work Station in function of the project phase/time and of the Area configuration (i.e. the dose rate in a work station inside the port cell is different if the Bioshield is present or not).

The dose rate table shall be created for example as follows:

Time	Work station	Area configuration	Dose Rate
Input from the Time Table (i.e. DT phase 01/01/2040)	**11-L1-C11-001**	**Configuration 1 (i.e. Port Cell empty)**	**xxx**
…	**…**		**…**

9) CONTAMINATION HAZARD

Hot to include it on the DB → Yannick + Srinivasan to be completed

Identify task with contamination hazard

Level of risk (Bq/m3 based on contamination map)

Therefore

Suits

Enclosure

Interface with DS

10) HUMAN FACTOR TABLE

Working conditions

LIGTHING

…

Annex 6: Area Integrated Maintenance Assessment Report

The Area Integrated Maintenance Assessment Reports are document to be issued at the end of the typical Area Design Optimization Process to summarize the activity performed and to highlight the main conclusions and achievements. The main input for this report creation is the data base which collects all the gathered information.

The collection of the all the Area Integrated Maintenance Assessment Reports is the typical "ORE Status Report".

This report shall include as a minimum:

- list of maintenance tasks and sub-tasks identified;
- tasks and sub-tasks features (**description,** life profile, constraints, preparation, maintenance activity, decontamination, dose rate, level of contamination, ALARA approach, duration...);
- staff required: number of people, skills required;
- maintenance and logistics tools required for the tasks (confinement management);
- specific suits, production of waste, evacuation of the equipment to be maintained);
- design options identified to optimize the design;
- value analysis illustrating the best option;
- implementation of the best options;
- remaining issues identification;
- identification of possible improvements and action plans to further optimize the design.

The Area integrated maintenance assessment report will be based according to the IO design.

The approach will be illustrated using 3D models (CATIA) with the main tasks. The maturity of this study will be between a concept design and preliminary design according to the data available. IO and contractor could propose assumptions if required to develop the maintenance study.
Here is a draft of the Area integrated maintenance assessment report content:

- Purpose
- Input documents
- 1st plasma configuration
  - Input (description, setting up, access, work station, workshop, hazard)
    - 1st plasma description and conditions
    - Port area configuration description
    - Accessibility and work station space
    - Life profile (maintenance needs)
    - Constraints
  - Operation & Preventive maintenance
    - Tasks description, life profile, constraints
    - Staff required

      Example: Staff required list

Localisation	Qualification	number

- Maintenance tools, spare
- Procedure
- Features (duration, health & safety, waste..)
- Hot topics

- Corrective maintenance (similar)

- DT plasma configuration
  - Input (description, setting up, access, work station, workshop, hazard)

    Example: Work station Shutdown dose rate

Localisation/work station ID	Description	SDDR (µSv/h)	Atmospheric contamination ($Bq.m^{-3}$ / Ci – ISO17873)	Level of contamination ($Bq.cm^{2}$)	Hazard

  - Operation & Preventive maintenance
    - Tasks description, life profile, constraints

    Example: Tasks list

Localisation	Sub-task description	Equipment to be maintained (size, weight)	Duration	Staff number	Working conditions

    - staff required
    - Maintenance tools required, handling, spare
    - Procedure
    - Features (duration, health & safety, waste..)

    Example: Staff required list

Waste category	Quantity	
	Unit mass	Total mass

Example: Dosimetry

Localisation	Sub-task description	Duration (h)	SDDR (µSv/h)	Individual dose (µSv)	% individual total dose

  - Corrective maintenance (similar)
- Recommendation synthesis
  - Design feedback
  - Human factor

- Contamination management
- ALARA options
- Issues

Annex 7: Area Maintenance Plan – Contents

The Area Maintenance Plan is a key document to be issued once the ALARA implementation process has been addressed to the Area of concern and the optimized maintenance profile has been defined. This document shall be issued together with the Area Integrated Maintenance Assessment Report (see Annex 6) to summarize and collect the main data, the improvements performed

The Area Maintenance Plan shall include all the maintenance and inspections activities/tasks foreseen in the Area of concern.

All the system populating the Area shall be well identified and all the maintenance needs as well (all the relevant reference can be used where possible, i.e. maintenance plans, RAMI analysis…).

The overall maintenance strategy for the Area shall be identified considering all the included system's needs, constraints and interfaces as needed.

A flow diagram including the Area Maintenance & Inspection (M&I) process, interfaces and needs shall be included as well.

All the applicable SSDR maps considered, in the different working configurations (according to the M&I process different configurations of the area are expected), shall be included (applicable reference can be used where possible).

Pressurized equipment in the PCs is present and is one of the greatest hazards, together with fire or LOCA. Regular inspection may be needed.

The following main information shall be, therefore, included (or reference provided) as a minimum:

1. Area Description
    a. Location identification
    b. Applicable Classification
    c. Systems and Equipment included
    d. Layout sketches
    e. Constraints & Interfaces
    f. Life profile
2. Systems Maintenance & Inspection
    a. RAMI
    b. M&I needs
    c. M&I plan
        i. Schedule of M&I
        ii. Maintenance Equipment description
        iii. Constraints & Interfaces
        iv. Maintenance tasks description (strategy, execution time, needed personnel, workstations…)
3. Area Maintenance & Inspection Plan
    a. Area M&I overall strategy
    b. Area M&I flow diagram (process, interfaces, equipment, timing…)
    c. List of Maintenance & Inspection tasks
    d. Area configurations description
4. Applicable SDDR
    a. SDDR for each Area working configuration
    b. Workstations VS Area configuration SDDR summary table

Annex 8: Integrated Hazard Analysis Sequencing Process