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Technical Specification

TCC2 Technical Summary for CFN

This document gives an high level overview of the scope of TCC2 contract for CFN purpose.

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	Name	*Action*	*Affiliation*
Author	**Yan Q.**	**27 Apr 2018:signed**	**IO/DG/COO/CST/TCS**
Co-Authors			
Reviewers	**De Cat W.** **Olcese M.**	**27 Apr 2018:recommended**	**IO/DG/RCO/FPD/PCD/CAL** **IO/DG/COO/PED**
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Approver	**Murphy S.**	**27 Apr 2018:approved**	**IO/DG/COO/CST/TCS**
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Technical Summary

Tokamak Complex Installation Works
TCC2 Contract

1 Purpose

The purpose of this document is to provide a high level summary of the scope of works, strategy, and required Contractor competences for the Tokamak Complex Contract (TCC2), covering the pre manufacturing, assembly and installation works inside the Tokamak Complex Area (WS2) and outside the Tokamak machine boundary (WSI) of the ITER project based in Saint Paul Lez Durance, France.

2 Abbreviations

The following table lists and defines the abbreviations used in this document.

Abbreviation	Definition
ASN	Autorité de Sûreté Nucléaire
CMA	Construction Management as Agent
CWP	Construction Work Package
DA	Domestic Agency
E&IC	Electrical, Instrumentation and Control
ESPN	Equipements Sous Pression Nucléaire (Nuclear Pressure Equipment)
INB	Installation Nucléaire de Base (Basic Nuclear Installation)
IO	ITER Organization
IWP	Installation Work Package
M&P	Mechanical & Piping
NDT	Non Destructive Testing
PIA	Protection Important Activities
TAC	Tokamak Assembly Contract
TCC	Tokamak Complex Contract
WS	Worksite

Table 2.1 *- Abbreviations and Acronyms*

3 General Statement

3.1 Staged approach

Assembly of the ITER Tokamak is separated into four distinct phases; and the timeline for the first two Tokamak Assembly Phases is shown in Figure 3.1.1.

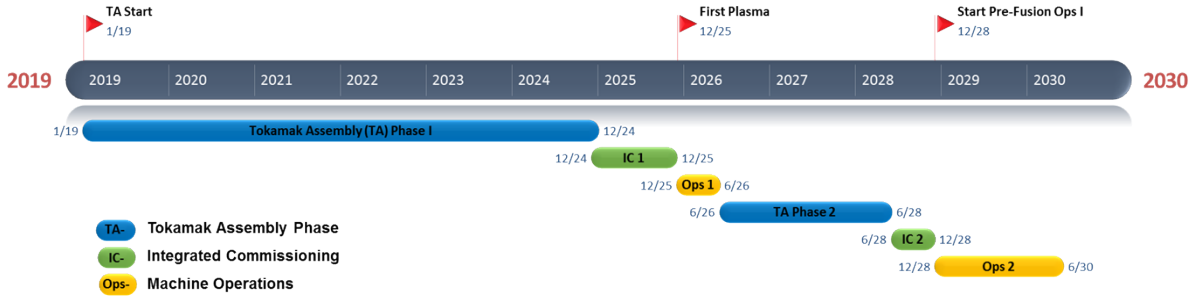


Figure 3.1.1 *- Assembly Phases*

- **Assembly Phase 1** includes the basic Tokamak machine with systems essential for First Plasma operation; the installations comprise permanent hardware, temporary equipment replacing permanent hardware, such as the main in-vessel components, and captive components that cannot be installed in later assembly phases.

- **Assembly Phase 2** includes the installation of the main in-vessel components, including the Blanket, the Divertor and coils. Heating systems will be installed and diagnostics systems will be added to support the research program. Preparatory activities for Assembly Phase 2 will occur during Assembly Phase 1. The contract strategy for this phase will be defined later.

The ITER Organization (IO) is already in the process of tendering for the Assembly Phase 1.

For Worksite 2, the IO plans to award three contracts TCC0, TCC1 and TCC2, to cover the whole scope of the Assembly Phase 1; the scope of these Contracts will cover all the Mechanical & Piping (M&P) and Electrical, Instrumentation and Control (E&IC) installation works of this area. This technical summary covers the TCC2 contract only.

3.2 Construction Areas

The works in the scope of the Contract are located on the ITER Platform currently under construction in Cadarache, Southern France. Central to the facility is the Tokamak Complex, a nuclear rated structure in reinforced concrete that comprises three integrated buildings, Figure 3.2.1. The Complex has a footprint of 118 x 81 m, extends vertically from -15 m to +40 m relative to ground level, and contains the plant systems that service (power, heat, cool, condition, fuel, monitor and control) the Tokamak machine.

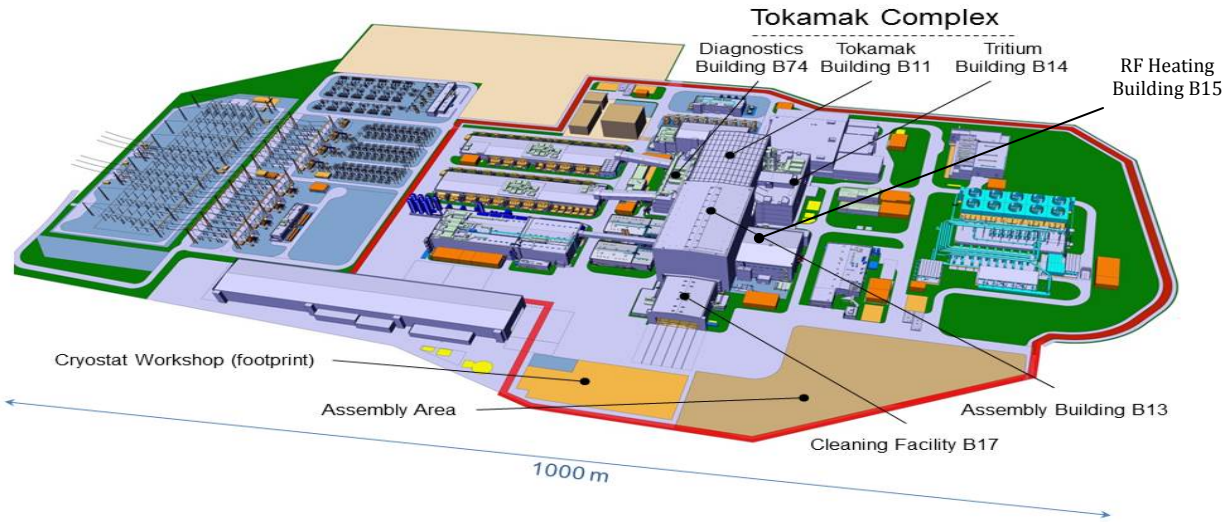


Figure 3.2.1 *Site Overview – Future Final Configuration*

The ITER site has been divided into 5 independent main worksites (WS). The worksites are defined to collect together groups of buildings and areas by major discipline, in order to better allocate works Contractors and suitably qualified persons. As presented in the Figure 3.2.2 below, the breakdown of the site and works is the following:

WS1 - Tokamak Basic Machine (including Assembly and Cleaning Facility buildings)

WS2 - Tokamak Complex buildings (excluding Tokamak Pit)

WS3 - Other nuclear buildings and Control building

WS4 - Cryogenic plant and Site Services buildings

WS5 - Electrical Areas and Power Supplies Buildings

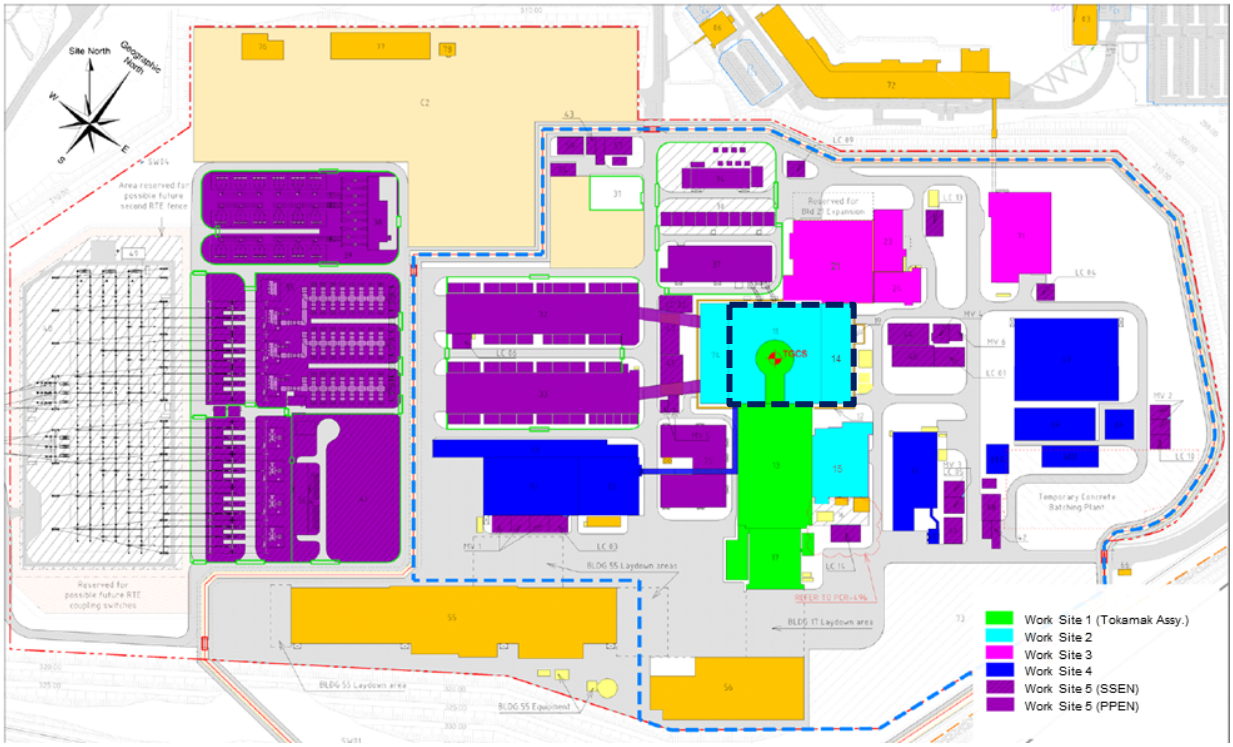


Figure 3.2.2 *- Breakdown of the ITER Site and buildings to independent Construction Worksites.*

The works in the scope of the Contract will take place in the WS2 in the buildings indicated with dashed black line in the Figure 3.2.2. These are:

- Building 11 – Tokamak Building
- Building 14 – Tritium Building

3.3 Structure

The IO, assisted by the Construction Manager as-Agent (CMA), will define the assembly process through Construction Work Packages (CWPs). Each CWP will define a package of works prepared and instructed to the Contractor by the CMA and performed by the Contractor as a unit, with a defined start and completion point and a required cost based upon the tendered unit rates for each type of work.

3.4 Scope of Activities

The contract will include but not limited to ESPN systems, TCWS, VVPSS, TBM, Fuelling, Vacuum and associated electrical devices which are in IO scope for phase I configuration, or which IO executes on behalf of Domestic Agencies (DA). Refer to Annex for further details.

The scope of this contract includes various activities such as:

- Construction execution documentation to properly perform the construction works,
- The contractor shall issue all the necessary documentation required to undertake and to follow-up installation activities and to record all activities
- Pre-manufacturing and Installation of pipework spools including relative supports,
- Installation of pre-manufactured pipework spools including procured items from other DAs in the scope of IO,
- Installation of large/heavy equipment like pumps, compressors, heat exchangers, pressure vessels and valves,
- Preservation works,
- Installation of special components like cryopumps, cold boxes, gas valves boxes, pipe lines for cryo fluid, vacuum lines,
- Installation of specific systems requiring special cleanliness, techniques or accuracy (e.g. fuelling lines, transmission lines, waveguides, vacuum lines),
- Procurement, pre-manufacturing and installation of steel platforms and structures fixed to the buildings for man access or for supporting components or pipes when procurement or installation is in the scope of IO,
- Procurement and installation of low voltage panels and junction boxes,
- Installation of the instrumentation and control cabinets which will constitute the process boundary (e.g. thermowells, in line instrumentation like flowmeters or others),
- Installation Tests (e.g. NDT, pressure test, leak tests and vacuum tests, calibration, electrical tests),
- Finishing works (e.g. internal cleaning, touch-up paint, thermal insulation, cladding, labelling and tagging),
- Assistance during Start-Up and Pre-commissioning Activities,
- Assistance during commissioning activities performed by the IO or DA Operator of systems,

The Contractor shall also be responsible for the following activities:

- Provide any required temporary works including, but not only, the means of protection and the tools needed to properly manage and perform the different stages of work in the buildings and on site,
- IO will provide the needed scaffolding through a service contractor while the CMA will coordinate the services. The Contractor will be responsible for defining the scaffolding needs.
- Minor lifting and handling equipment required for the installation of the described items in Annex.
- Issue all necessary documentation for the works, such as Quality Plan. Health and Safety plan, Workforce planning (Installation sequence and Level 4 Schedule) and the List of documents to be issued for the execution of the works.
- Provide the records of NDE's and all the information required to comply with ESP and ESPN regulations,
- Issue the As-Built dossier,
- Provide support during commissioning phase with a minimum number of resources (the duration and specific resources will be specified at the call for tender stage)
- Perform final installation tests (mechanical & electrical completion) and verifications, as described below:

1. Mechanical completion of the Structural, Mechanical & Piping includes, but is not limited to:
   - Verification that the piping systems, mechanical equipment and their supporting structure are correctly installed
   - Non-destructive examination
   - Hydrostatic tests
   - Technical cleaning (foreign material exclusion, dust control, flushing or others)

2. Completion for instrumentation systems includes verification and validation of the instruments and valves and its comparison with the original design data to assure their process flow condition will be met. This verification and validation include:
   - All wiring checked & verified
   - Inspection for continuity & insulation
   - Control system loop checking for confirmation (with specific mock-up)
   - Checking of boards, modules and cubicles.
   - Hydraulic & pneumatic tubing cleaning, flushing and pressure testing to assure that there are no leaks and that the cleanliness meets required quality.

NOTE: For some horizontal activities (e.g. handling, lifting, scaffolding, transport) the IO Works Contractor (TCC2) will have to interface with the companies awarded for these specific activities. The interfaces will be managed by the Construction Manager as Agent (CMA) under the surveillance of the IO.

The contractor shall execute works according to instructions, with pricing based upon tendered unit rates for each type of work.

All above mentioned works (except some pre-fabrication activities) shall be performed by the Contractor within ITER premises at Saint Paul-lez-Durance in France.

4 Interfaces and Resources

4.1 Boundary between Worksite 1 and Worksite 2

As described in section 3.2 and in figure 3.2.2 the works in the scope of the Contract take place in Worksite 2 (WS2) which includes Tokamak building 11. The physical boundary of the Tokamak Machine inside building 11 is, for the purpose of assembly and installation works, defined by the outer surface of the bio-shield. In general terms, this surface demarcates the Tokamak machine assembly works to be executed by the TAC Contractors (WS1) from the Tokamak Complex plant installation works to be executed by the TCC Contractors and others (WS2).

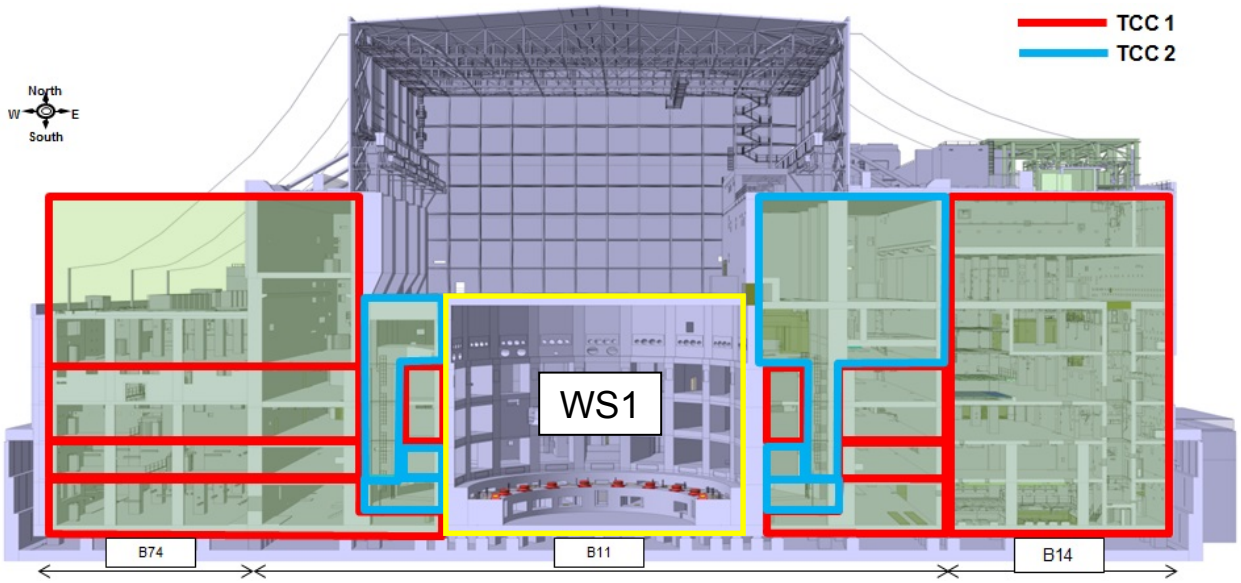


Figure 4.1.1. *Physical boundary principle between WS1 and WS2 in the Building 11*

It is expected some coactivity with other Contractors working on the ITER site around the Buildings and also inside the Buildings involved in these installation activities.

To manage the coactivity on site and the installation schedule, the IO is currently working with a Construction Management-as Agent (CMA). The CMA shall oversee these tasks on behalf of the IO:

- Project management,
- Works preparation,
- Site coordination (including permit to work),
- Material management,
- Work supervision, quality control, record keeping,
- Management of completion activities.

4.2 Workshops

The IO will provide an area dedicated to the Contractor for the installation of his site facilities, possibly covering a workshop, local storage, and some pre-assembly activities on smaller components. These areas will be located on the ITER Worksite platform. The areas will be connected to the potable water, IT and electrical networks as well as to the industrial drainage network.
To support the pre assembly activities, the Contractor shall provide a general workshop facility within the area described above and as appropriate to volume and schedule an off-site locally workshop to enable the pre fabrication and modification of pipe spools, steel structure, supports, insulation, temporary meanings, etc. These workshops shall be staffed by competent technicians, and have an acceptable selection of hand tools, machine tools, control instrumentation and welding equipment. Part of these workshops shall be segregated for carbon and stainless steel fabrication.
The contractor will be fully responsible for transport between the ITER site and these workshops, and for any ITER components while off-site.
On the site, ITER has available a number of buildings for component storage. In general IO special tools will be collected by the Contractor from these storage locations, and returned to them on completion of the corresponding CWP.
Due to the limited area available for the onsite workshop, not suitable for complete scope prefabrication, the contractor is responsible to provide his own workshop for main pipes, steel structures and supports prefabrication activities outside of IO site.

4.3 Interfaces to Other Contracts

4.3.1 Interfaces to IO WS2 Contractors

The Contractor may:

- Execute a CWP where the preceding CWP was performed by another contractor;
- Complete a CWP where the following CWP is performed by another contractor;

At the start of a CWP the Contractor will have an opportunity to examine and accept the components/environmental conditions, and at the end of the works, the completion will be certified by the IO with the support of the CMA.

4.3.2 Scaffolding

The IO will put in place a framework contract for the lease of scaffolding (scaffolding contractor). This contract will be for the provision of scaffolding to the Contractor and other IO works contractors.
Due to the high level of interaction between different contractors, the use of this scaffolding contract will be obligatory for all work being carried out in WS2 as several works contractors may use the same scaffolding. IO will pay the scaffolding contractor directly.

4.3.3 Lifting

In order to avoid that each Works Contractor places a separate subcontract for the hire of lifting equipment (mainly mobile cranes), IO had envisaged the obligatory use of a single contractor throughout the ITER Site (excluded Contractors areas and workshops).
The use of this framework contract shall be obligatory for the IO Contractors working in WS2. The IO will pay the lifting contractor directly but the responsibility for the lifting operation shall remain with the Contractor.

5 Required Competences

The competence and experience of the Contractor, and the ability, experience, and training of his engineering and construction team will have a direct influence on quality, re-work, and schedule, and ultimately on the performance of the Tokamak during operation; the Contractor will be required to demonstrate competence and experience in a number of key areas as listed in Table 5.1.

Area of Competence
Codes and Standards
Occupational Safety
Process Development and Qualification
Quality Assurance / Quality Control
Regulated construction
Process piping and equipment installation
Nuclear Pressure Equipment regulation
Vacuum pipes installation
Multi core pipes installation
Carbon and stainless steel welding process
Inspection and Non-Destructive Examination
Instrumentation Installation
Lifting and Handling
Tooling Maintenance, Storage and Preservation
Clean condition working
Cubicles installation
Cable pulling
Assembly of complex specialist equipment (wave guides, etc.)
Handling, placement and interconnection of specialist mechanical, electrical and electromechanical equipment to a high degree of accuracy (e.g. vacuum pumps; HV/MV equipment, cabling and Busbars; transmission lines).
Managment and execution of site works in highly regualted, complex, industrial/nuclear projects
Ability to comply with, the French Order of 7 February 2012, establishing the general rules for Basic Nuclear Installations
Experience in overall scope as described in section 3.4
Installation and installation testing of complex bespoke equipment including vacuum equipment
Execution of trials on mock-ups and development of detailed installation procedures

Table 5.1 *Required Competences*

Tokamak Complex Installation Works
TCC2 Contract

Overview of Scope of Work

Mechanical and Electrical Installation Works

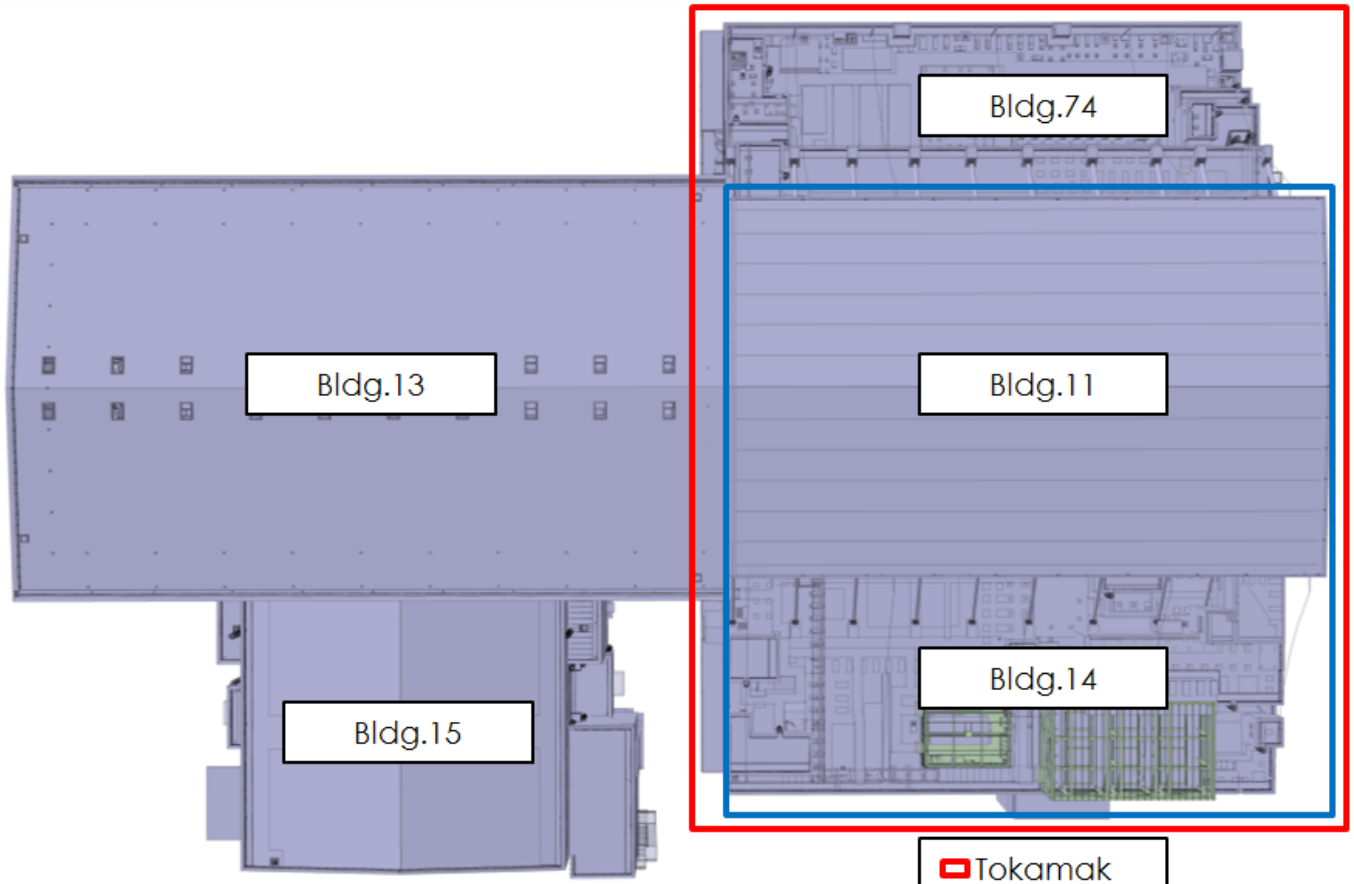
TCC2: ESPN Systems, CCWS and a part of Vacuum, CHWS and Fuelling

Overview of Scope of Work

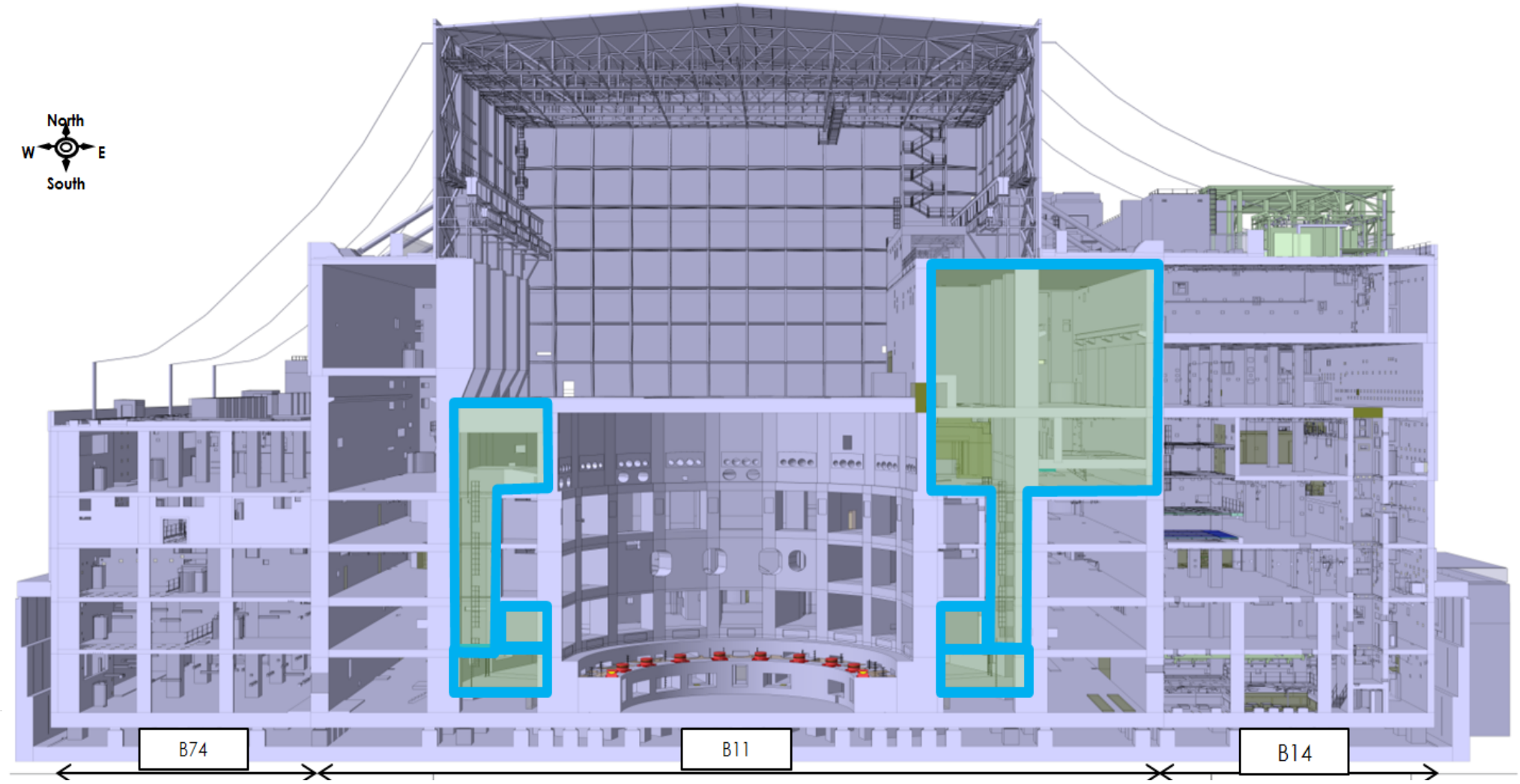
List of Main Systems in the Scope of Work

- *Fuelling and wall conditioning system*
- *Cooling Water system*
- *Vacuum system*
- *Diagnostics system*
- *Steel structure platforms for man access & support of equipment*
- *Test Blanket Modules (piping only)*
- *Cubicles and E&I for systems in the areas*
- *Busbars*

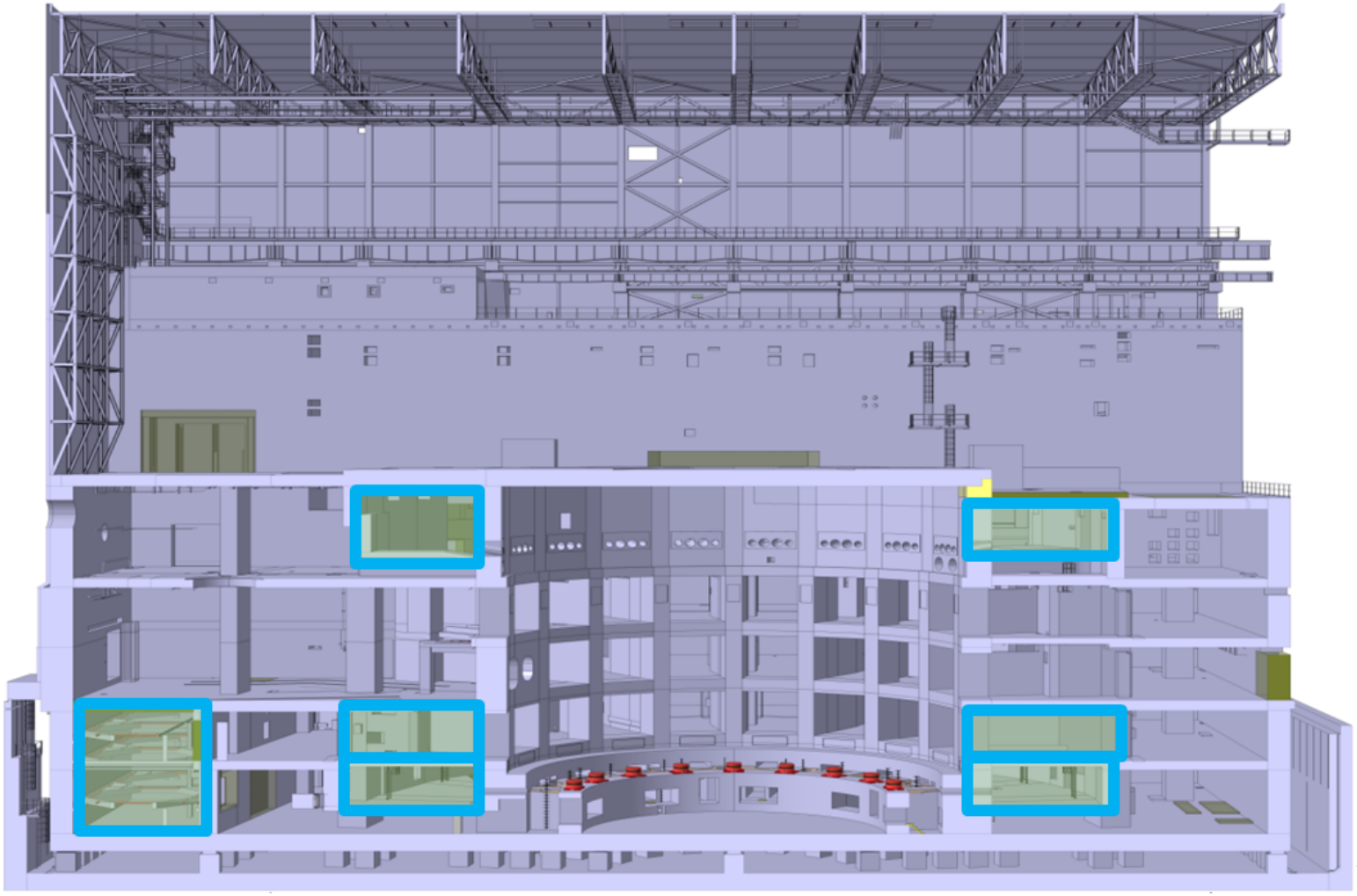
Work Site 2 and buildings relevant for contractor's scope



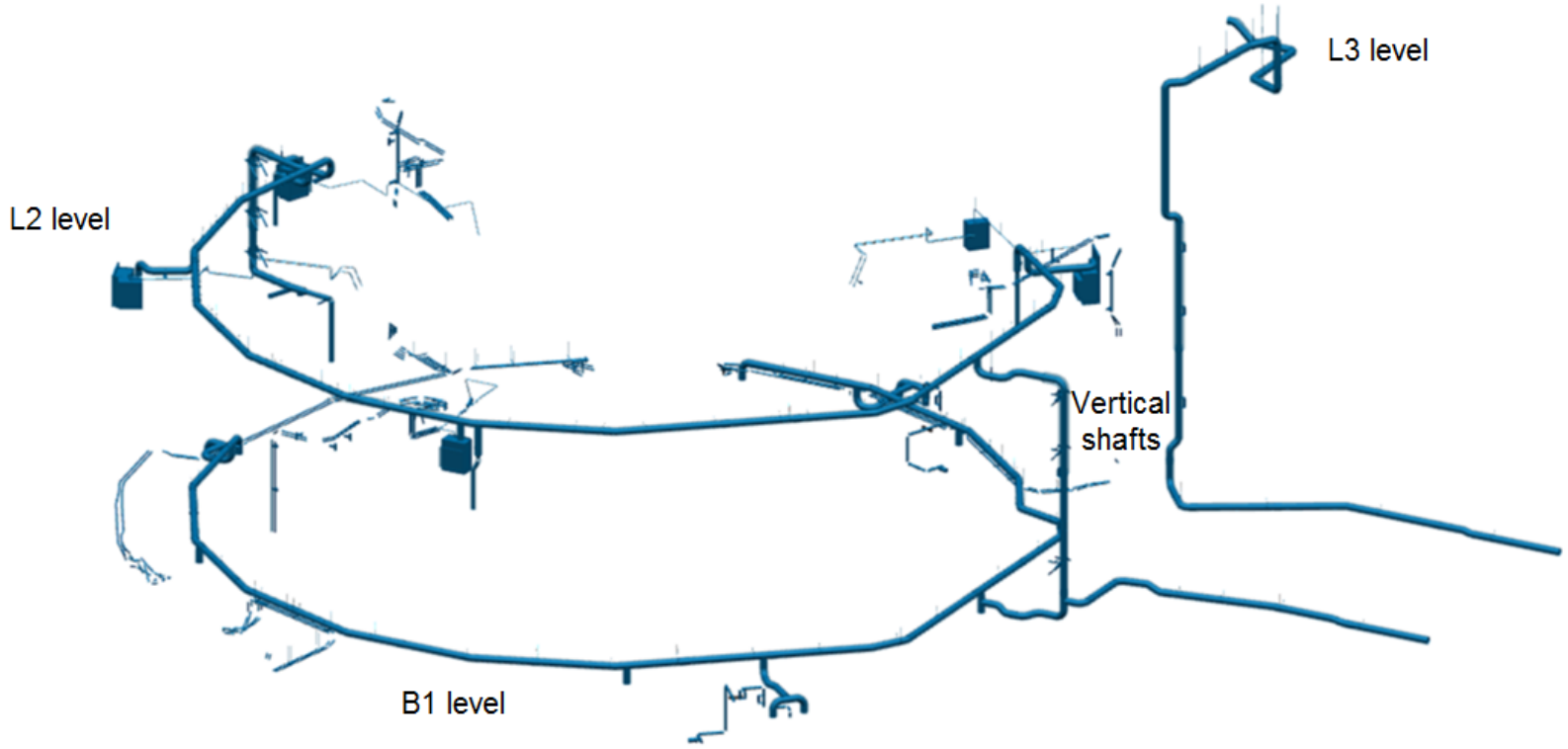
Tokamak Complex – Section view - Work Areas



Tokamak Complex – Section view – Work Areas



Fuelling network



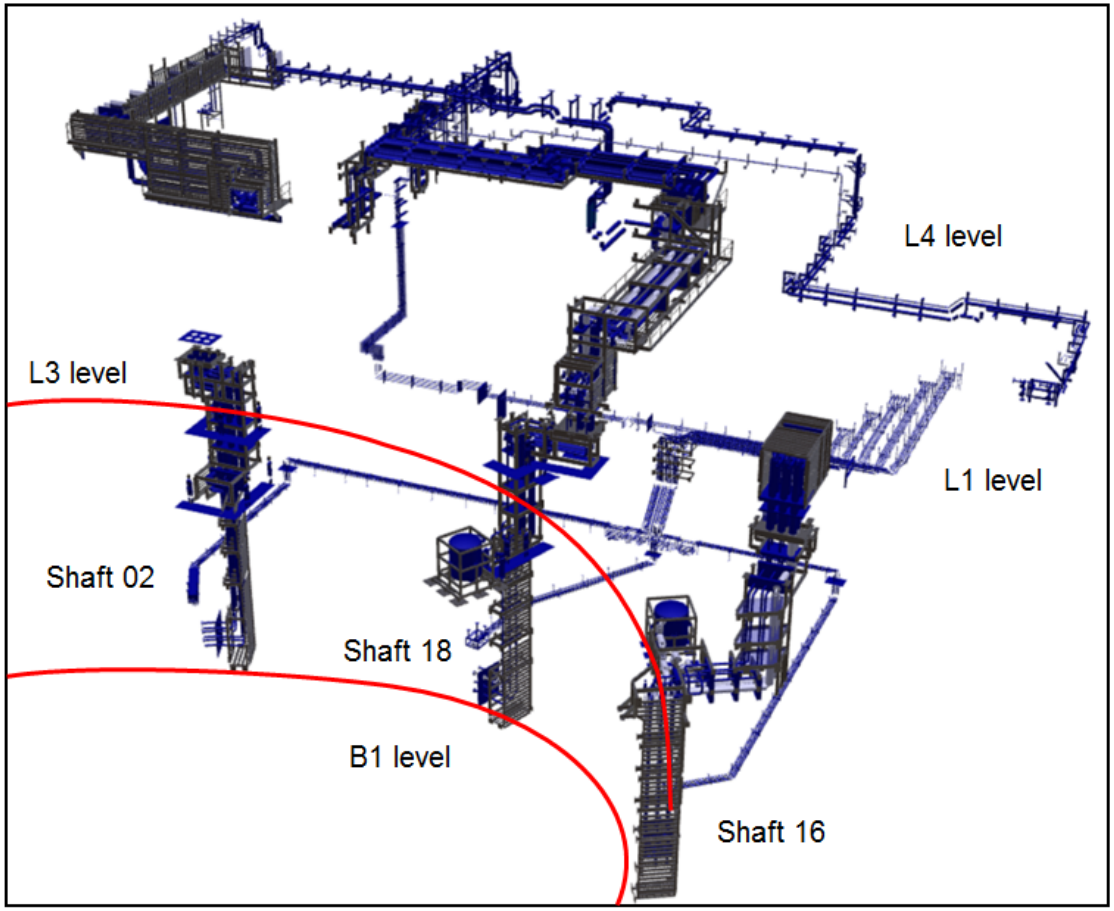
The scope is split between TCC0/1/2 contracts depending the area, mainly multi core pipe in scope of this contract (GFS and NB manifold in vertical shaft)

TBS Connection Pipes

TBS Connection Pipes system is composed of following items (stainless steel):

- Pipes ~4 km
- Fittings ~1500 items
- Valves ~200 items
- Flanges ~250 items
- Decay Tanks 2 items
- Piping Mechanical Supports ~2000 items
- Metallic Supports ~30t of various steel profiles Insulation Material ~37t of insulation material (1,7 km of pipes to be covered)
- Protective Grids ~70t of various steel profiles

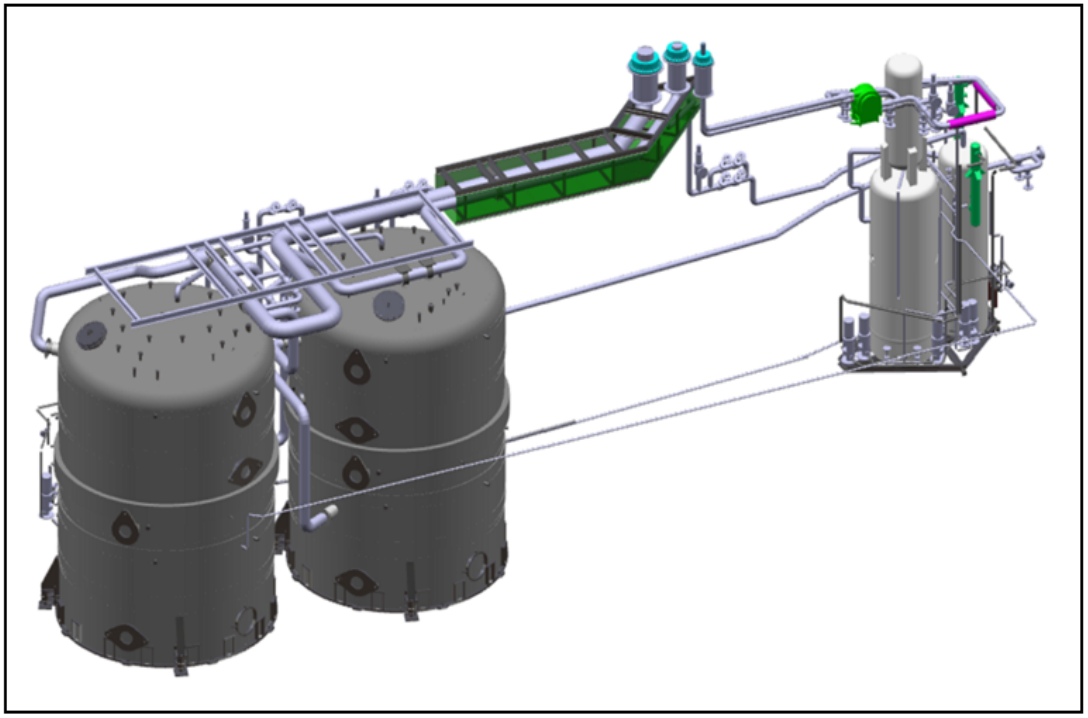
The system is ESPN.



Vacuum Vessel Pressure Suppression System (VVPSS)

The Vacuum Vessel Pressure Suppression System (VVPSS) is designed to protect the ITER Vacuum Vessel. The system within phase 1 scope includes:

- A set of 4 Vapour Suppression Tanks (VSTs) (out of scope)
- 2 Relief Lines (RL) connecting the VV volume to the VSTs with associated insulation and support (portion within Drain Tank Room):
- One line (DN300), to manage the small accident and connected to one of the VST.
- One line (DN500) to manage larger accidents and connected in parallel to other three VSTs
- Hydrogen Mitigation System (HMS) managing hydrogen deflagration issue (portion within Dain Tank Room):
- Scrubbing Pool Tank
- Wet Recombiner Unit
- Scrubber Unit
- Passive Autocatalytic Recombiner
- Other piping, valves, pump etc.



The VST, Scrubbing Pool Tank and Wet Recombiner Unit are ESPN. RL is non-ESP(N). The rest of pipe is ESP

Busbars for In Vessel Coils

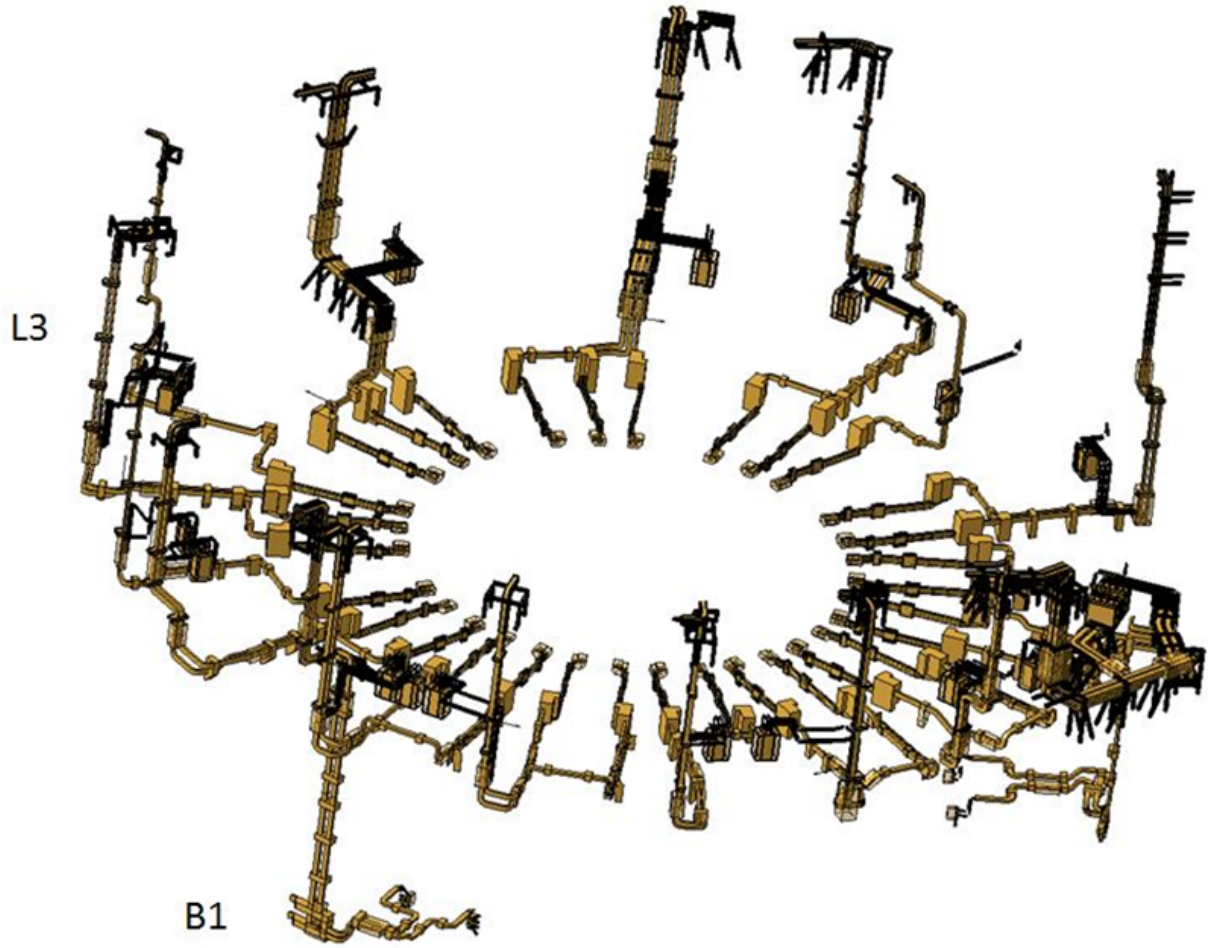
There are 27 ELM coils and one VS3 coil. The VS3 coil has eight separate coil turns, hence 8 Busbars, In total there are 35 Busbars.

The four VS3 coil turns are fed through the ports at Building 11-B1. All 27 ELMs coil and the remaining four VS3 coil turns are fed through the ports at L2.

The Busbars are routed from the feeders to the vertical shafts via the port cells. They rise in the vertical shafts and pass thought the Building 11-L4 floor (or Building 11-L3 ceiling).

Each Busbar is divided in sections and consists of two conductor poles (copper), insulations, shielding, necessary auxiliary components such as supports, clamps and etc. and instrumentation.

The IVC Busbar include Busbar segments, Busbar supports, Busbar connections, Busbar cooling and Busbar cooling instrumentation. The first segments of Busbar which penetrates the L3 ceiling are also indivisible part of the L3 Busbar because they are integrated pieces and captive components.



Tokamak Cooling Water system (TCWS)

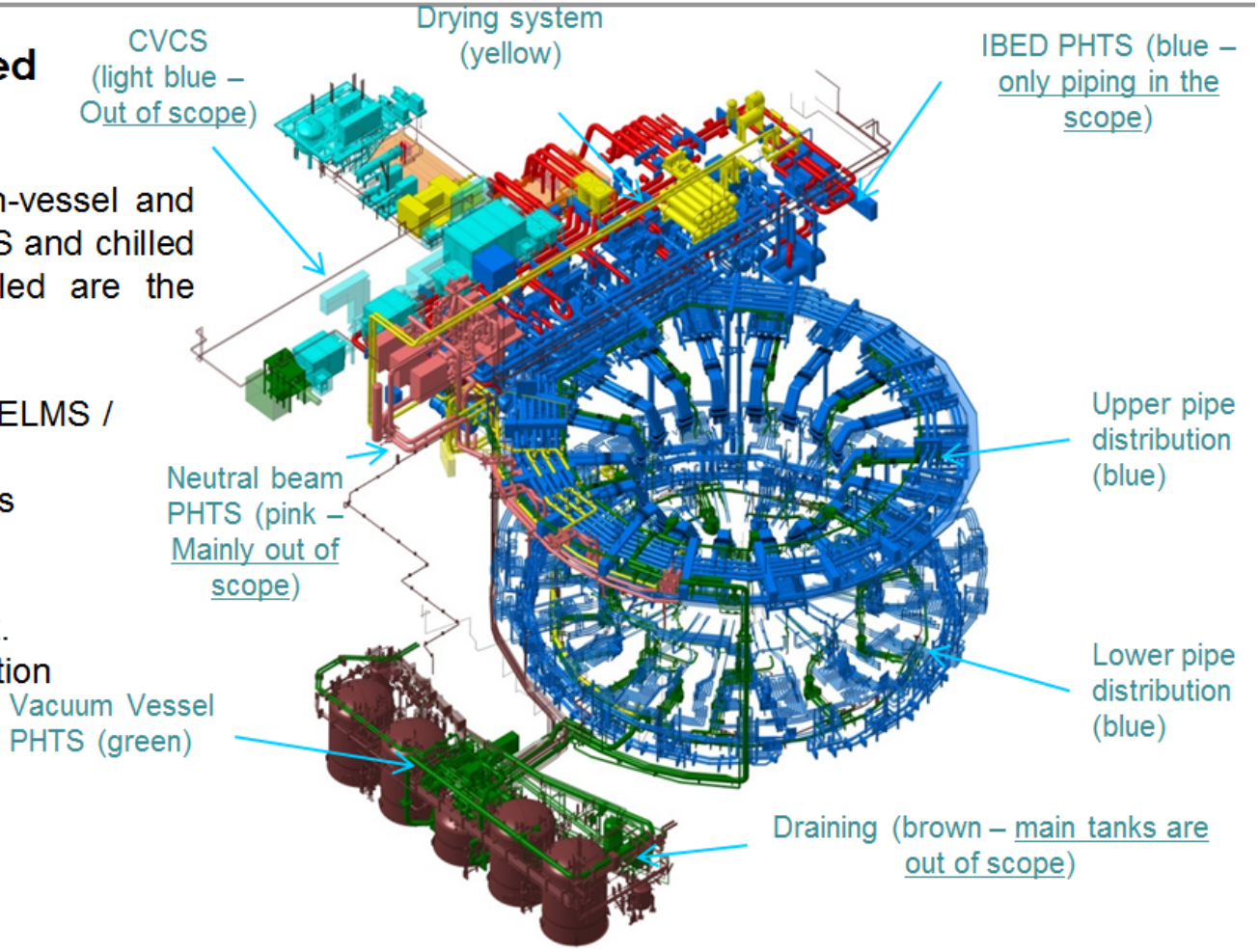
TCWS Systems are PIC and ESPN classified

Scope of TCWS is to remove the heat from the in-vessel and vacuum vessel components by transferring it to CWS and chilled water systems. TCWS sub-systems to be installed are the followings:

- VV-PHTS, cooling vacuum vessel clients
- Captive parts of IBED-PHTS, Integrated Blanket / ELMS / Divertor (IBED)
- Captive parts of NBI-PHTS, Neutral Beam Injectors
- Draining and the refilling system
- Drying system

All these systems are located in TOKAMAK Complex.
Scope of work includes pipe and supports prefabrication

Approx. pipe length 28,000 m – Stainless Steel
Number of valves 2000
Weight of supports 200 tons

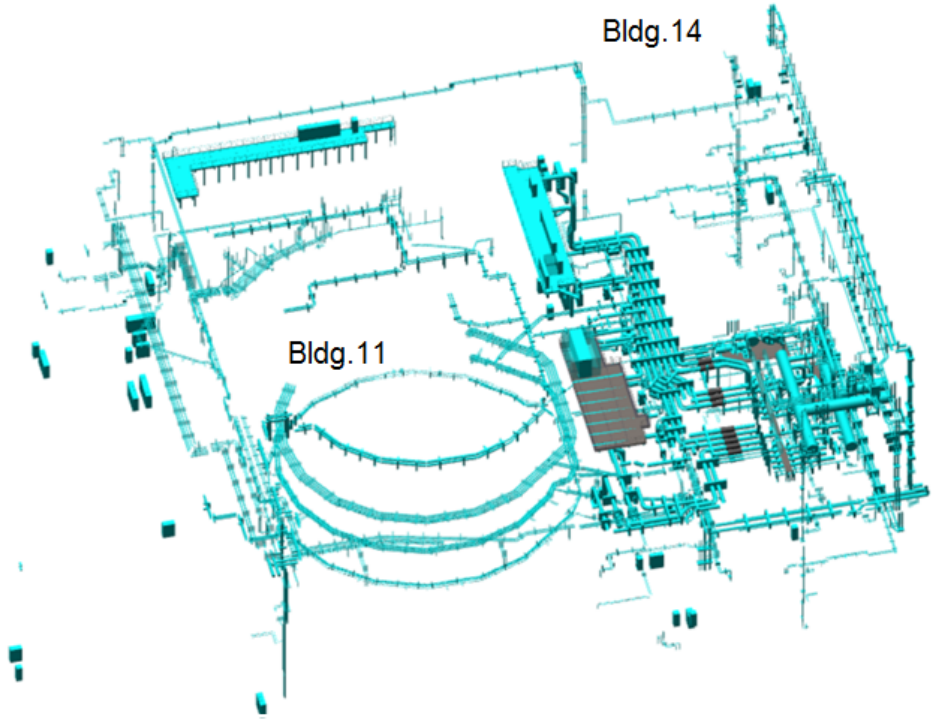


CCWS – CHWS

Component Cooling Water System (CCWS)
Chilled Water System (CHWS)

Function: transfer heat from Tokamak and auxiliary systems to Heat Rejection System (HRS).

- Location: throughout the Tokamak Complex;
- Scope of work is limited to the installation inside of the Buildings;
- Scope of work includes pipe and supports prefabrication;
- Scope of work includes Cubicles, cables and E&I for pipes already installed in some area

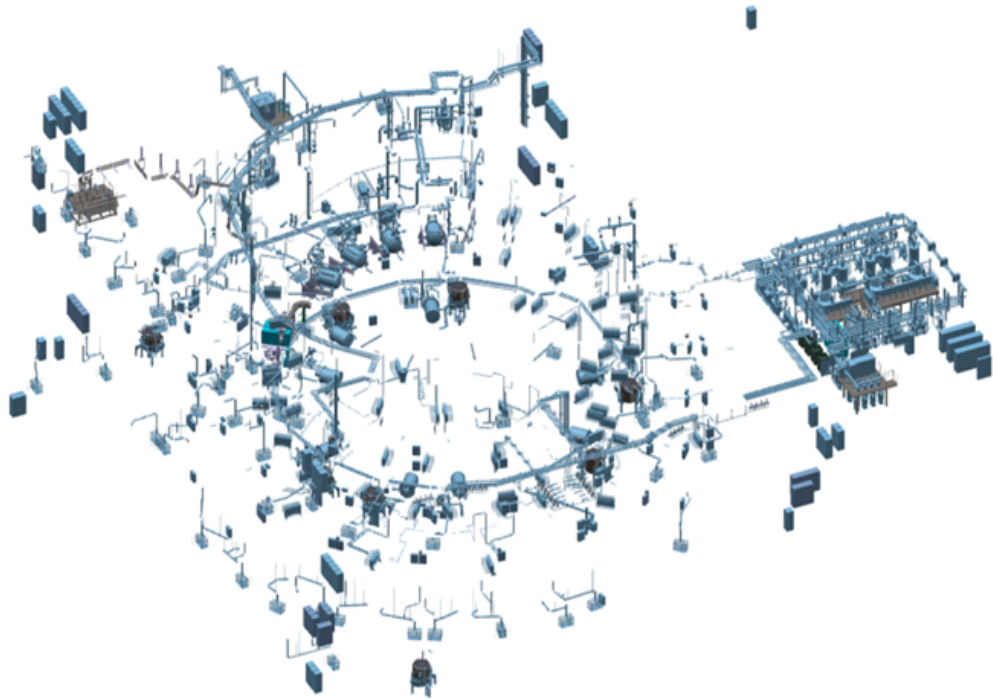


Total length about: 14,000 m Stainless Steel (440 ton of pipe work) in scope
The scope is split between TCC0/1/2 contracts depending on the area

Vacuum system - Piping

Vacuum System Pipe Runs are required to interconnect vacuum systems of the ITER vacuum system. The pipe runs form a vacuum network distributed throughout the Tokomak complex.
The scope is split between TCC0/1/2 contracts depending on the area

Vacuum manifolds:
Pipework component parts (tees, elbows, pipes, hangers, supports, etc.) to be manufactured and installed.
Vacuum connections to clients:
Vacuum components (valves, bellows, etc.) pre-manufactured to be installed

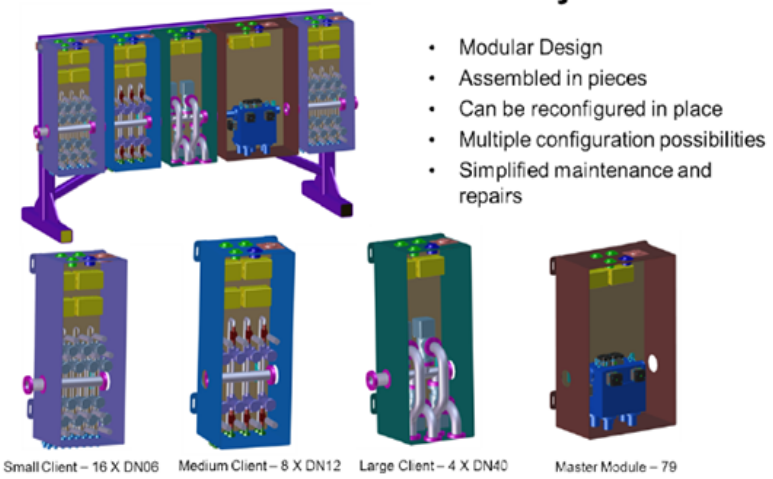


All the pipework components /Pre-manufactured Spools/Pipe Runs installation at IO under this contract shall comply with the French Order of 7th February 2012 establishing the general rules for licensed nuclear installations components .

Vacuum system – SVS Boxes and CGVS

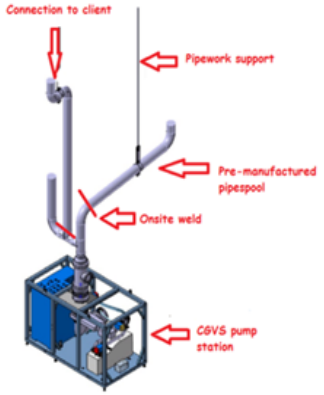
Distribution Boxes contain the pipework, valves and pressure gauges necessary to control and regulate these vacuum services to clients. These SVS distribution boxes are located in various locations in Bldg. 11 and 14. There are 79 individual box locations. Each Distribution Box consists of a Master Module that connects to Client modules of different sizes. There are three different sizes of client module, small, medium and large. Different combinations of client module are required depending on the client requirements at the location of each box. Master Modules and Client Modules are connected to each other by way of an ISO-K style vacuum flange and quick connector according to Technical. The Modules are bolted to a support frame to create a Distribution Box assembly.
The scope is split between TCC1/2 contracts depending on the area.

Distribution Module Layout



Cryo Guard Vacuum System
The CGVS is a distributed system across 68 locations which comprise of vacuum pumping units with embedded instrumentation, pipework , supports between pumping stations and its clients and remote control cubicle as well as back end components required for client pressure monitoring.
There are 68 CGVS units and associated connecting pipes in Building 11, level B2/B1/L3; building 14, level L1; and cryobridge.
Components to be installed are as follows;
- CGVS pumping unit
- associated pipe run connecting it to up to 4 clients

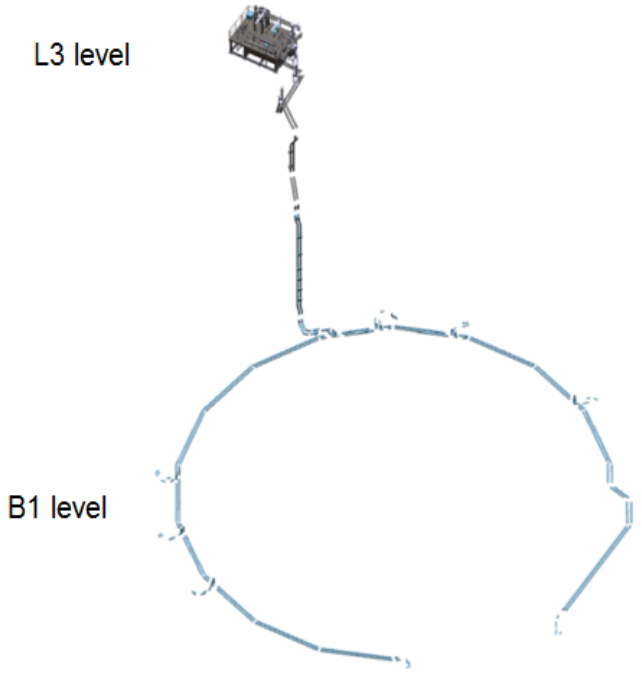
The scope is split between two contracts depending on the area



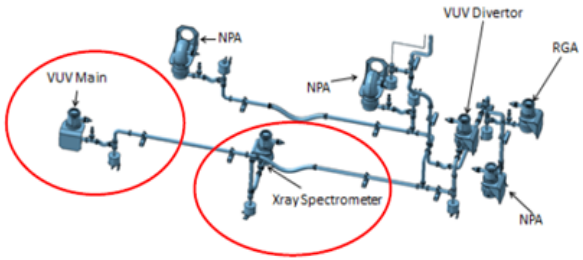
Vacuum system – Warm regeneration and Type 2 Diagnostic system

The general layout comprises of Warm Regeneration Box which connects to the Warm Regeneration Line via a shaft to the clients in B1 level. The scope is split between TCC1/2 contracts depending on the area.

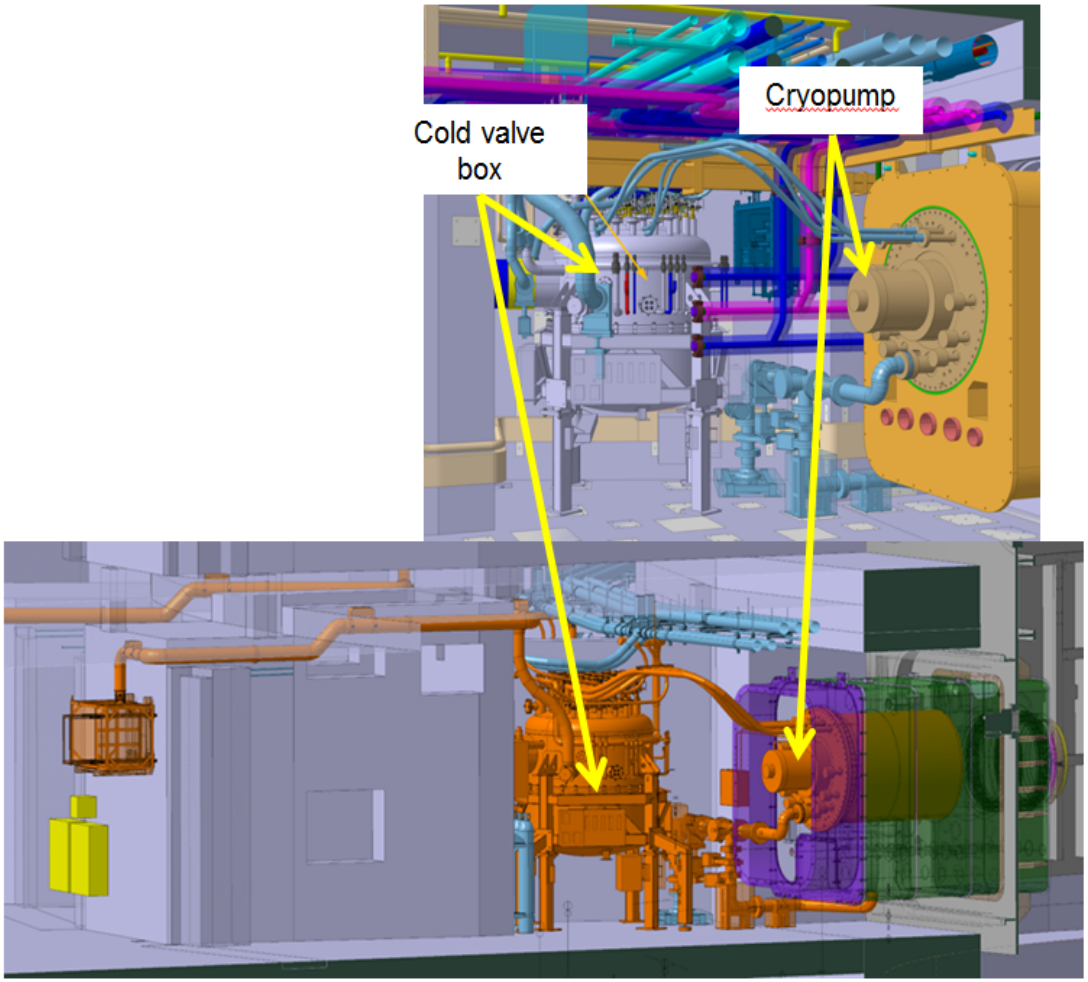
Components to be installed are:
- Warm Regeneration Box
- Warm Regeneration Lines



SSC to be installed are listed below, these items make up the Type 2 Vacuum Pumping for 2 systems:
2 sets of Turbo Molecular Pumps, fittings, pipework, flanges, isolation valves, ballistic shields, gages
The scope is split between two contracts depending on the area.



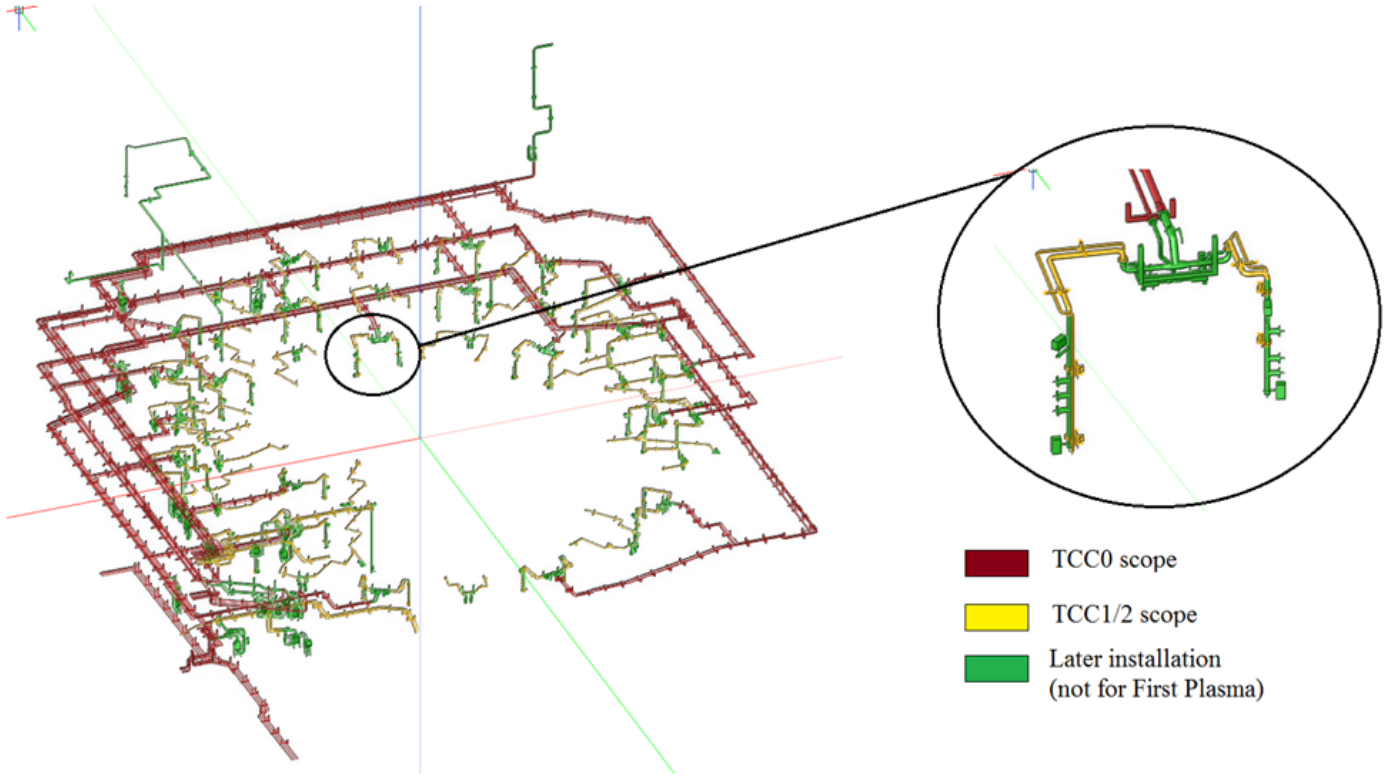
Vacuum system – Torus and Cryostat Pumping Systems



Components to be installed are:
6 Torus Cryopumps
6 Torus Cryopump Valve Actuator Control Box
6 Torus Cryopump Cold Valve Box
2 Cryostat Cryopumps
2 Cryostat Cryopump Valve Actuator Control Box
2 Cryostst Cryopump Cold Valve Box
A typical configuration is shown in the Figures.

The Torus Cryopump pumps (TCP) the main Vacuum Vessel (VV). The pump is bolted to the Torus Cryopump Housing (TCPH).
The Cryostat Cryopump (CCP), including it's installation, is identical to the TCP
When installed in the in TCPH the TCP forms a vacuum containment boundary and part of the 1st confinement system. Under the scope of this installation there is a double metallic vacuum seal that shall be fitted to the pump prior to installation.
The pump is approximately 3.5 metres long and 1.8 metres in diameter and weighs approximately 8 tonnes.
The Valve Actuator Control Box (VACB) contains electrical and pneumatic components to control the actuator of the TCP.
The Cold Valve Box is required to provide the cryogenic supply and return for operation of the TCP/CCP.
The CVB is connected to the TCP/CCP (via flexible Johnston Type Cryojumpers).
The CVB is also connected to the cryogenic supply, required pneumatic systems and the Warm Regeneration Lines, CGVS and Purge systems.

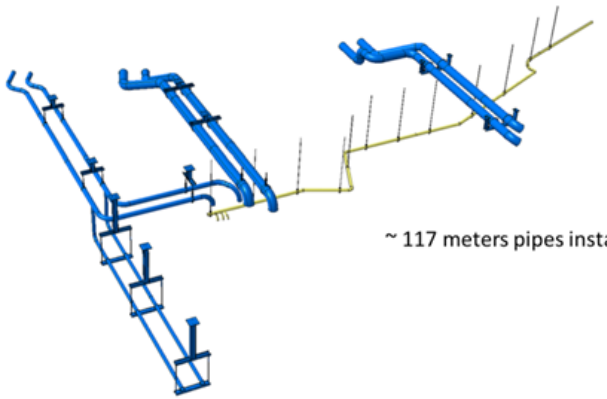
Tritium pipes



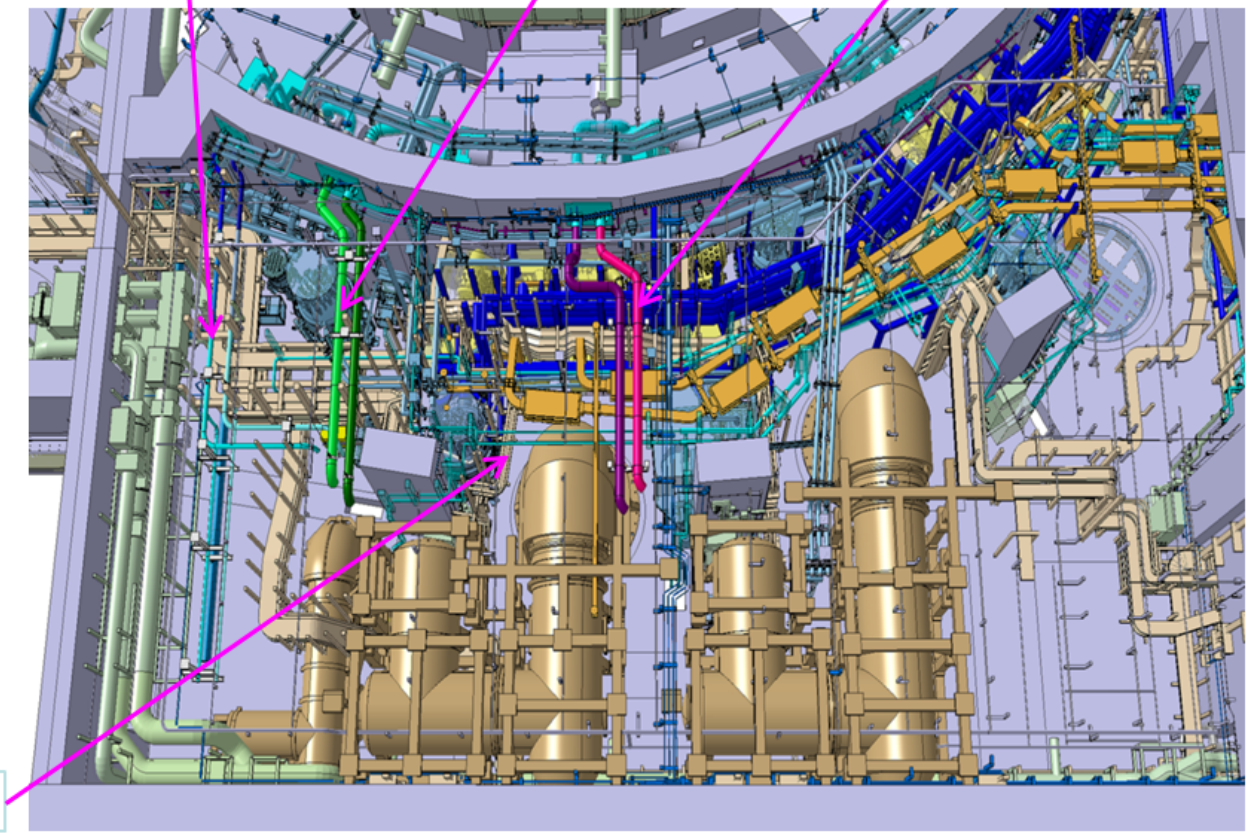
System is PIC

Limited scope for this contract

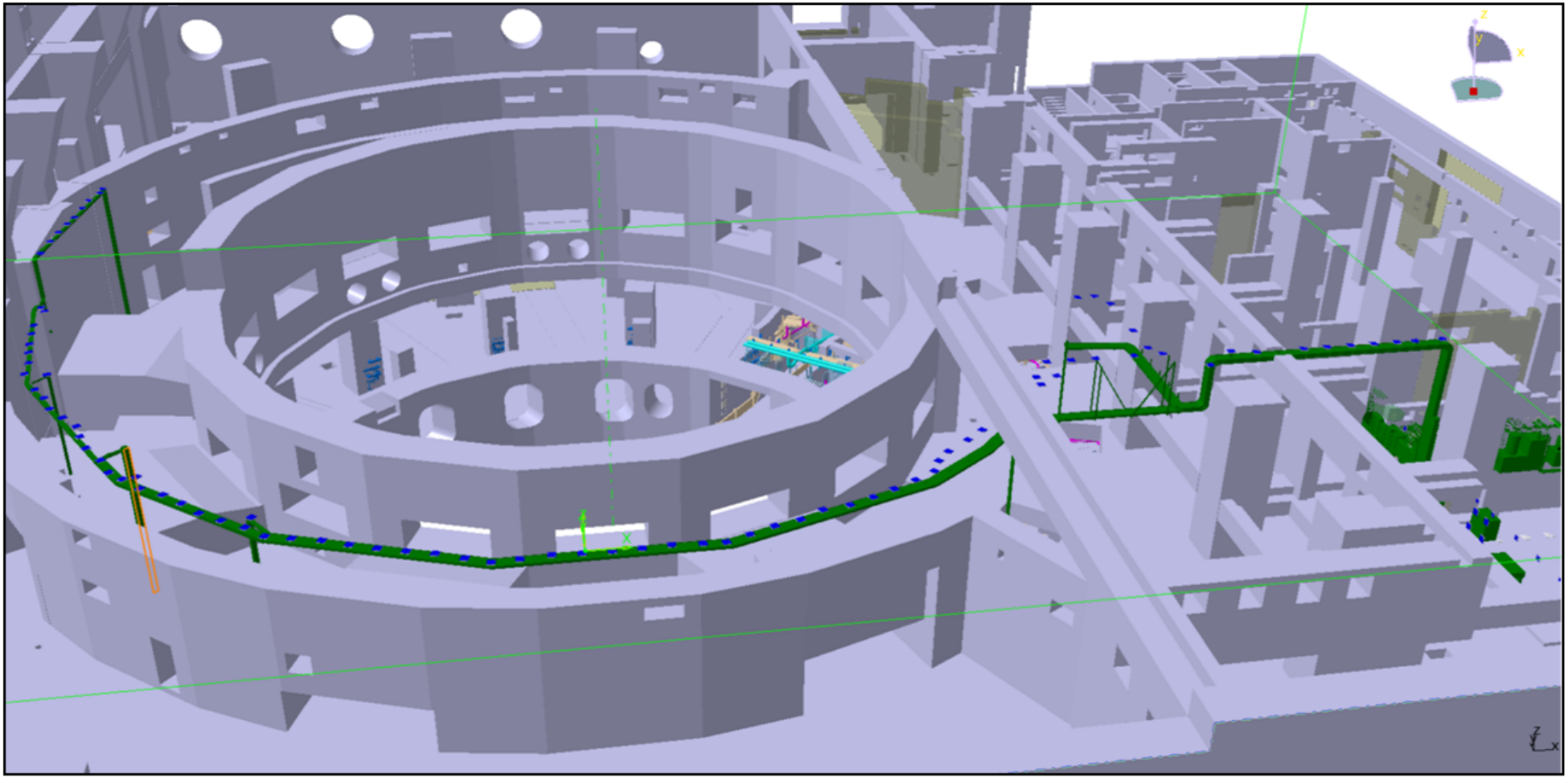
Neutral Beam cooling water



Captive ESPN pipes only, length 120 m



Diagnostic systems – Detail of NAS piping – small bore tubing



Various scope of installation Works

The scope is split between TCC1/2 contracts depending on the area.

Steel structure for platforms and walkways and supports for piping	
Item	**Material**
Steel structure for piping supports	Carbon steel and stainless steel
Steel structure for platforms	Structural Carbon steel

Procurement strategy

Overview of the procurement strategy related to the installation works		
Material	**Quantity (% of total)**	
Pipe Raw material	10%	
Spool prefabrication	60%	
Steel structure for platforms	100%	
Support prefabrication	60%	
Paint / coat	90%	
Anchors	50%	

I&C – Cabling – Cubicles

CUBICLES (Installation only)

The scope is split between TCC1 and 2 contracts. The main scope is in TCC1

	Total
Estimated Floor and wall mounted Cubicle	1500

I&C – Cubicles

I&C main Components (Installation only)

The scope included for the I&C preliminary Instruments and equipment list are:
- Conduits and fittings and their support system and all accessories (bolts, nuts, etc.) for interfacing the raceways with the Instruments or Instruments rack.

The scope is split between TCC1 and 2 contracts with main scope in TCC1.

Estimated I&C Components	Total
Pressure Instruments and Switch	1,464
Temperature Instruments and Switch	3,050
Flow Instruments and Switch	488
Level Instruments and Switch	146
Valves Positioner, Position Switch, Open/Close Commend	11,346