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Technical Specifications (In-Cash Procurement)

Technical summary for Welding Preparation in Pit works (WPP)

Preliminary technical description of the scope of the WPP contract issued to the market to check the interest and capabilities of potential tenderers.

Technical Summary for Welding Preparation in Pit (WPP) contract

1 Purpose

The ITER Organization (IO) intends to issue a Restricted Tender procedure for the Welding Preparation in Pit works (WPP).

The information and technical details provided in the present document are preliminary with the purpose to assess the interest and capabilities of potential candidates for this scope of works.

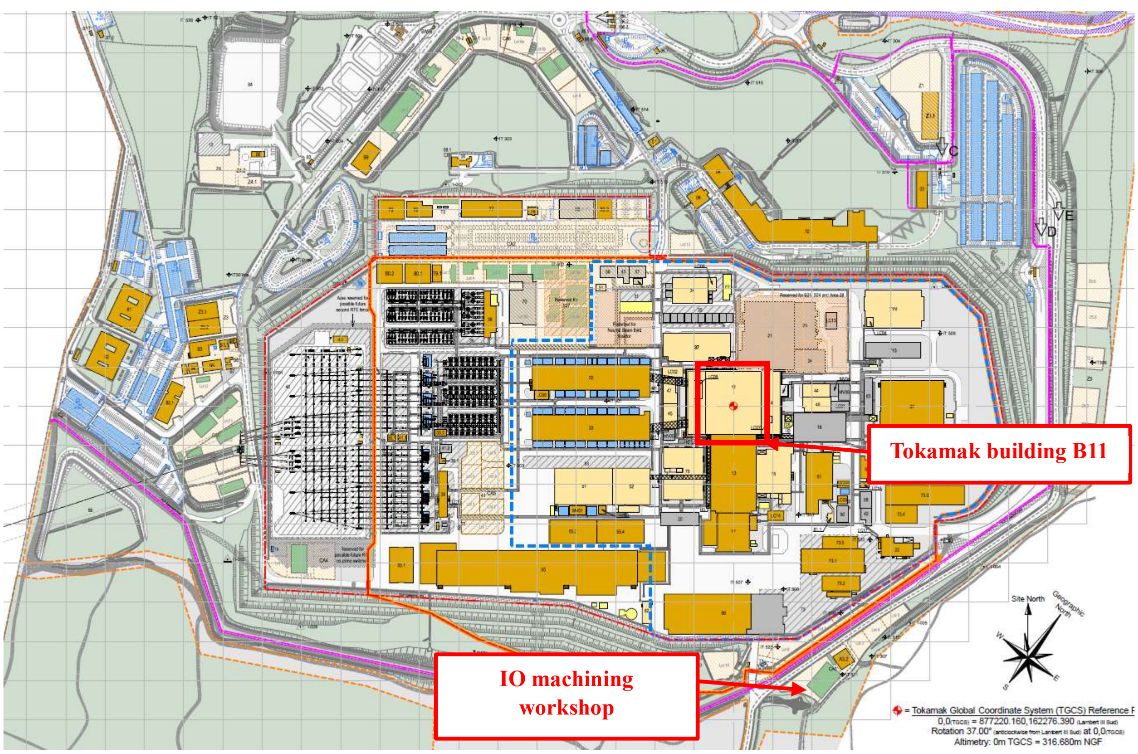
2 Background

The ITER Organization (IO) is a joint international research and development project for which the initial construction activities are underway. The seven members of the IO are: the European Union (represented by Fusion For Energy (F4E)), Japan, the People's Republic of China, India, the Republic of Korea, the Russian Federation and the USA.

The project aims to demonstrate the scientific and technological feasibility of fusion power for peaceful purposes and to gain necessary data for the design, construction and operation of the first electricity-producing fusion plant. It will also test a number of key technologies, including the heating, control, diagnostic and remote maintenance that will be needed for a full-scale fusion power station.

The ITER site is in the Bouches du Rhône district of France. It includes the Headquarters of the IO and a construction worksite. The construction of the facility is on-going. Further information is available on the IO website: http://www.iter.org.

The ITER platform is made of about 40 buildings serving the Tokamak machine located in the pit of the Tokamak building (B11). The location of works is shown in the figure below.



The ITER platform also houses a machining workshop composed of several equipment described in the list below. The Contractor may be proposed to use and operate the IO machining workshop in addition to the Contractor's external machining capacity to optimize the schedule of delivery.

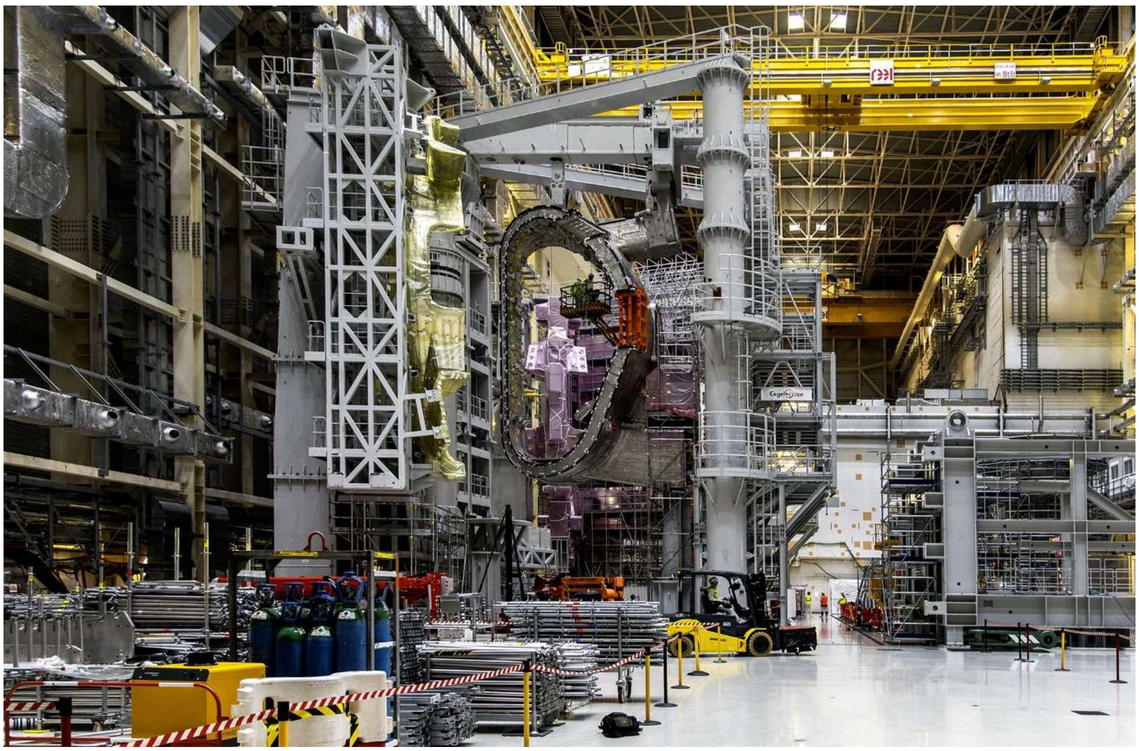
List of equipment in IO machining workshop:

- Zayer milling machine Arion 4000 Five-Axis of different sizes. Travel: 4000x3100x1100 mm
- DMG milling machine X3600mm Y1100mm Z900mm, axe B swivel permanent +/-90°. Permissible load 5000Kg. NC SIEMENS 840DSL with Celos
- Haas 3-axis CNC machine VF-3 model with few key parameters:
  - Max. weight of component on table: 1.5 t
  - Max component dimensions: 1.2 x 0.45 m
  - Air and water cooling
- Cazeneuve parallel lathe: chuck diameter 250mm, diameter passing over the bench 583mm, X255mm, Z 950mm. NC SIEMENS by learning
- Cazeneuve FV340 Conventional Milling Machine: X850mm, Y340mm, Z500mm, table dimension 1300mm x 320mm, max load 320Kg
- Drilling Machine: H1000mm drilling diameter 50mm
- Metrology lab with coordinate measuring machine from Mitutoyo (Model Crysta Apex) with a resolution of 0.1µm

Additional equipment will be added.

3 Tokamak assembly sequences

The Tokamak is assembled from nine Sector Modules, each encompassing a toroidal angle of 40°, and comprising a 40° Vacuum Vessel sector (VV), two Toroidal Field Coils (TFC), a 40° Vacuum Vessel Thermal Shield sector (VVTS), and the associated interconnections and supports. The components are delivered to the site individually, and sub assembled into Sector Modules using purpose-built jigs and fixtures in the Assembly Building as part of the Sector Module Sub-Sector Assembly (SMSA) contract. The Sector Modules are then transferred to the Tokamak Pit sequentially.

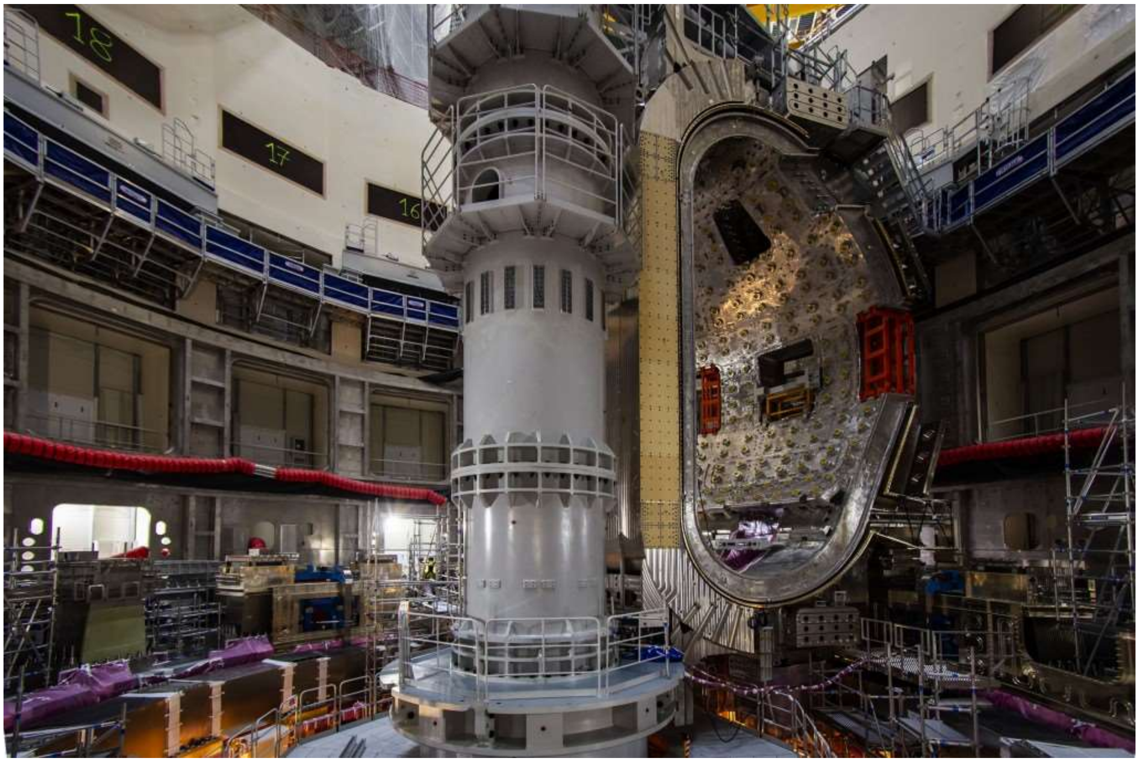


Once in the Tokamak Pit, the TFCs are precisely aligned and attached to their permanent supports as part of the Sector Module in-Pit Assembly (SMPA) Contract. In addition, this contract performs the interconnections between the TFCs when the 2nd and subsequent Sector Module's TFCs are lifted, aligned and secured to their gravity supports.
After the completion of the 9 sectors landing and the completion of all intercoil connections in the pit, the next main activity is embedded in the so-called A4 scope whose main objectives are:

- The load transfer of all TFC on their gravity support (SMPA scope).
- The installation and the tightening of all the Pre-compression rings upper and lower (SMPA scope).
- The load transfer of the VV on their gravity support (WPP scope)
- The removal of all associated tools (SMPA and WPP scopes).

The TFC load transfer can be performed in parallel with the WPP contract scope.
There is a potential to have some indirect co-activities with the VV ports assembly and welding contract in case some work anticipation is possible with ports and bellows positioning and welding.

The same applies to the VV welding contract and Diagnostic assembly contract which could be performed sequentially before and/or in between VVTS assembly and VV landing activities.



As part of the Welding Preparation in Pit (WPP) Contract, three main activities are considered:

- The VVTS sectors are connected sequentially to each other between two Sector Modules in the Tokamak Pit. Technically, this scope of work can be performed as soon as 2 sectors are in the pit.
- The handling, positioning, and bolting of the VVGS between the cryostat and the VV sector.
- The alignment and the landing of the VV sectors on the Vacuum Vessel Gravity Support (VVGS), this operation is possible only once the interconnections on each of its neighbor TFCs are completed (three Sector Modules in the Tokamak Pit is the minimum pre-requisite to start this activity), the center VV sector is then aligned to its target position and secured to the VVGS.

VV Sectors overall dimension (m)	7.9 (Length) x 6.6 (Width) x 13.8 (Height)
Material	SS 316 L(N)-IG
Unit Mass	440 tons

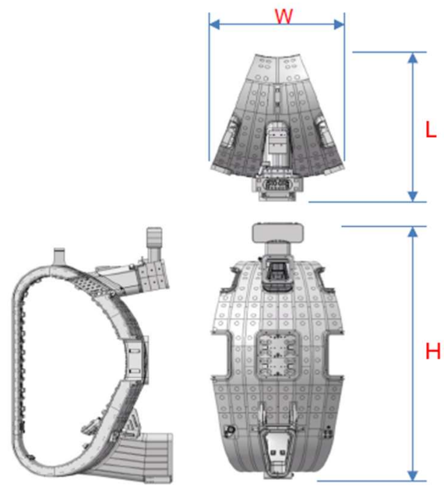


Figure 3-1: VV Basic Weight and Dimensions

Once all nine Sector Modules have completed their VVTS field joint connections and the VV has been secured to the VVGS, the Sector Welding (SW) contract will join the VV sectors welding the field joints according to a plan which aims to minimize deformations.
In parallel, SMPA will start the A4 scope which includes the load transfer of the TFC torus, removal of the Central Column tooling (no longer required to support the Radial Beams) and assembly of the upper and lower Pre-Compression Rings to the TFCs.

This market survey is for the WPP contract. There will be coactivity with several other contracts:

- SMSA contract at the start (for the landing of the sector in the pit),
- SMPA contract for the sector interconnection and the A4 scope,
- In-vessel Diagnostic, Fueling and Instrumentation (IDFI) contract,
- Port Positioning Assembly and Welding (PPAW) contract (for Cryostat/Building Bellows assembly and welding scope)
- SW contract at the end,
- Transverse contracts including radiographic test, scaffolding, crane operation ...

<u>Cleanliness & FME:</u>

The ITER Tokamak machine is composed mainly of VQC (Vacuum Quality Class) components assembled and operated under clean conditions in order to comply with vacuum and with the machine operation requirements (i.e. comply with thermal shield emissivity requirement).

These clean conditions apply in worksite 1 (Tokamak pit and crane hall, B13 and B17) and a cleanliness protocol shall be applied. It defines rules necessary to maintain the requested level of cleanliness and establishes requirements regarding workers and material access, clean clothes, works (including dirty works) and housekeeping.

In addition, works by WPP Contractor in the worksite 1 (in particular in the pit), are subject to the Foreign Material Exclusion (FME) process which aims at preventing any risk of loss object in the machine. Any foreign material would be detrimental for the operation.

4 Scope of work

4.1 VV landing scope

The Group 1 is focused on the necessary activities to perform on the VV prior to the start of sector welding and prioritization of the release of predecessors to the start of in-cryostat/ex-vessel assembly (related to removal of the radial beams).

The main components and activities in Group 1 are shown in Figure 4-1:

1. Vacuum Vessel Alignment and Stability
2. Radial Beam and VV alignment unit
3. Upper Stability Rods and Outboard Bracing Tools
4. VV Counterweights and Mid Plane Bracing Tool
5. VVGS and Lower Strut Installation
6. Inboard Bracing Arms and Inter-VV Stops

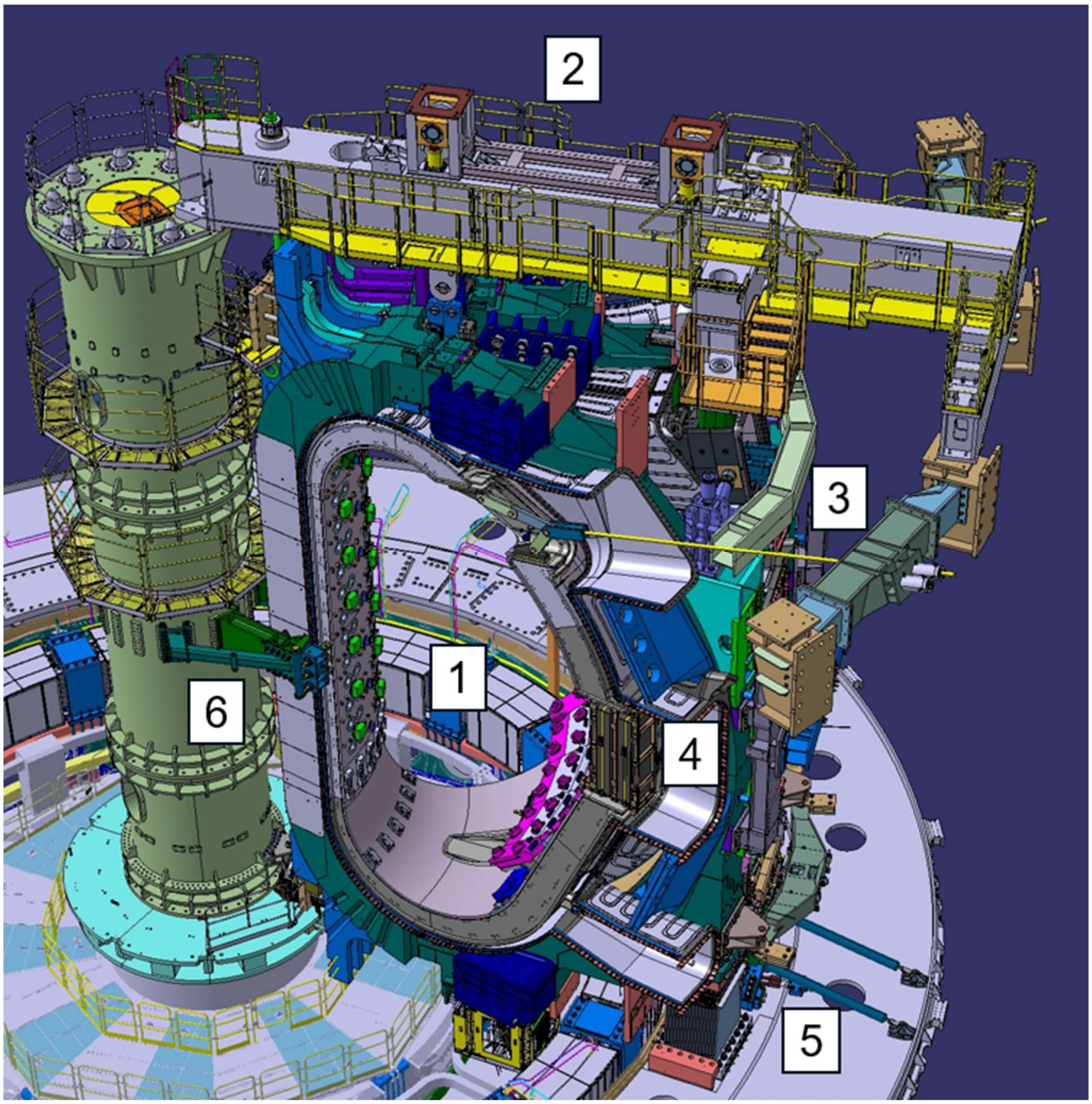


Figure 4-1: Single Sector Overview

In order to land the VV onto the VVGS sector by sector, the VV must be stabilized from tilting radially inboard by use of stability clamps as shown in Figure 4-2. The WPP Contractor will install the upper stability rods and lower strut. The upper stability rods are secured to the VV upper port by temporary welded pads, and to the concrete building by the radial beam support anchor frames.

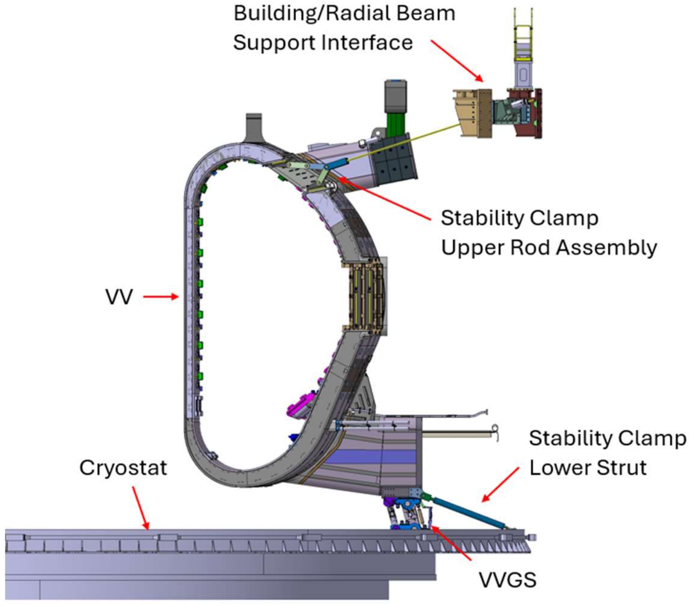


Figure 4-2: Landed VV Side View

The main activities related to the alignment of the VV will start when three side by side sectors are lifted to the Pit (SMSA scope) and the adjoining inter-coil connections are completed between the TFCs (SMPA scope). The main predecessor for the stability clamp installation is the installation of the IOIS (Intermediate Outer Inter-coil Structure) by the SMPA contractor.

The WPP Contractor will develop and implement the methodology for aligning the VV to its target position and tolerance. The target position and tolerance (expected to be in the range of +/- 3mm) will be provided by the IO. During the alignment, the VV will be continuously measured using the fiducial network in-vessel. Radial, vertical and toroidal adjustment can be performed using the jacks on the radial beam VV alignment unit shown in Figure 4-3. Radial and toroidal tilting of the VV can be adjusted by removing or adding weights to the counterweight frames in the equatorial port shown in Figure 4-4, or by engaging the stability clamp upper rods or lower strut.

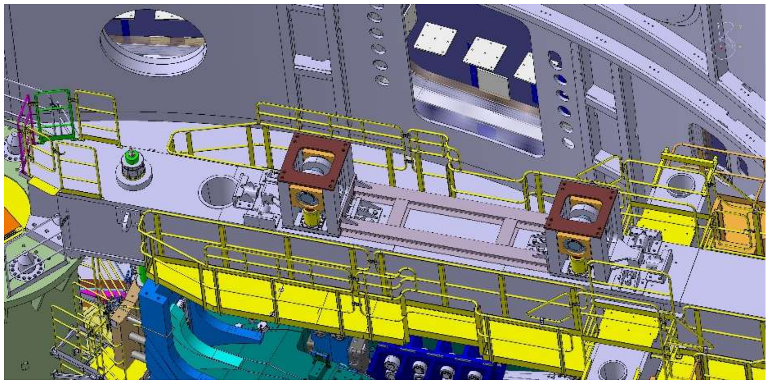


Figure 4-3: VV Alignment Unit

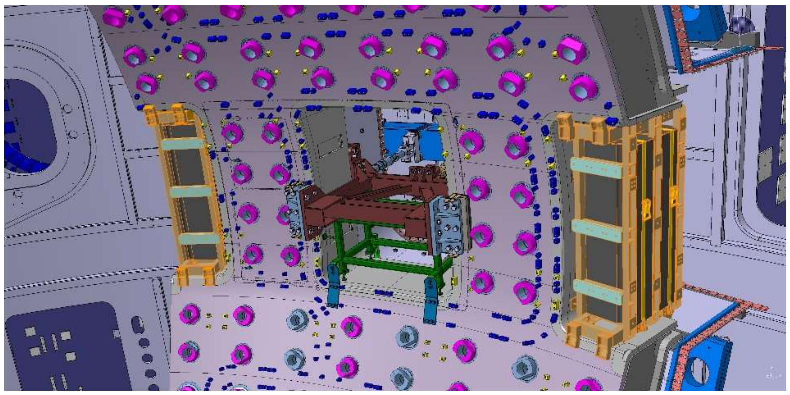


Figure 4-4: VV Counterweights

The WPP Contractor will develop and implement the methodology for aligning the VVGS (~11 tons) to the target position and securing it to the VV and Cryostat Base with the use of M72 super bolts shown in Figure 4-6. The sequence for the VVGS positioning and alignment includes the installation of 2D machined electrical insulation shims and 3D machined alignment shims. The 3D machined alignment shims are based on reverse engineering the as-built surveys of the VV and VVGS. The custom machining of all shims is the responsibility of WPP Contractor.

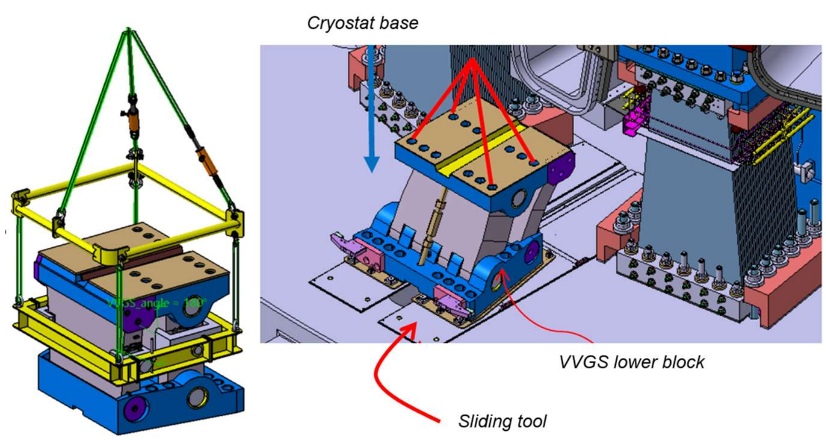


Figure 4-5: VVGS Lifting and Positioning

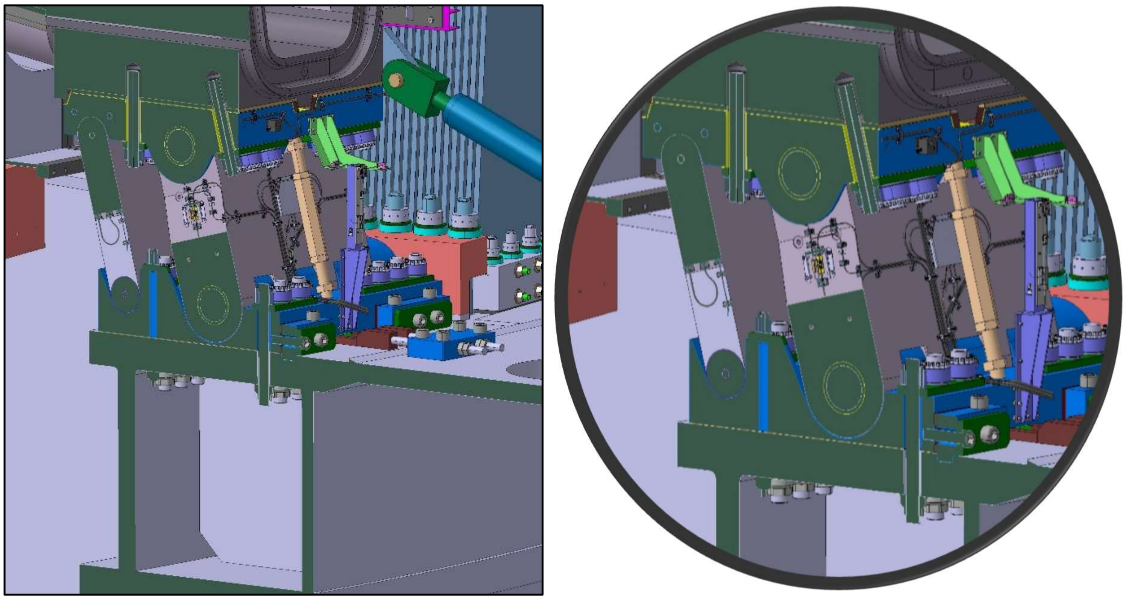


Figure 4-6: VVGS Section Cut with M72 Super Bolts

The VV must be unconstrained during the alignment to the target position. Therefore, the bracing tools must be disengaged by the WPP Contractor before the start of the alignment or load transfer. The Mid-Plane Bracing tool (MPB) and Divertor Level Stabilizer (DLS) will be dismantled and removed by the WPP Contractor since they are no longer required for seismic restraint when the VVGS is connected to the VV.

The Inboard Bracing Arms shown in Figure 4-7 are disengaged only by retracting the yellow bolts. The Outboard Frames, also shown in Figure 4-7, are disengaged by retracting the orange pads.

The MPB, shown in Figure 4-8, is installed in the center of the Sector Module in the equatorial port. The DLS, shown in Figure 4-9, is installed in the VV Lower Port Stub Extension. The MPB weighs in total ~10 tons while the DLS weighs in total ~6 tons. Both the DLS and MPB are removed by dismantling sub-assemblies (~1 to 5 tons) and lifting them out of the pit. The IO will provide the dismantling bespoke tooling to the WPP Contractor.

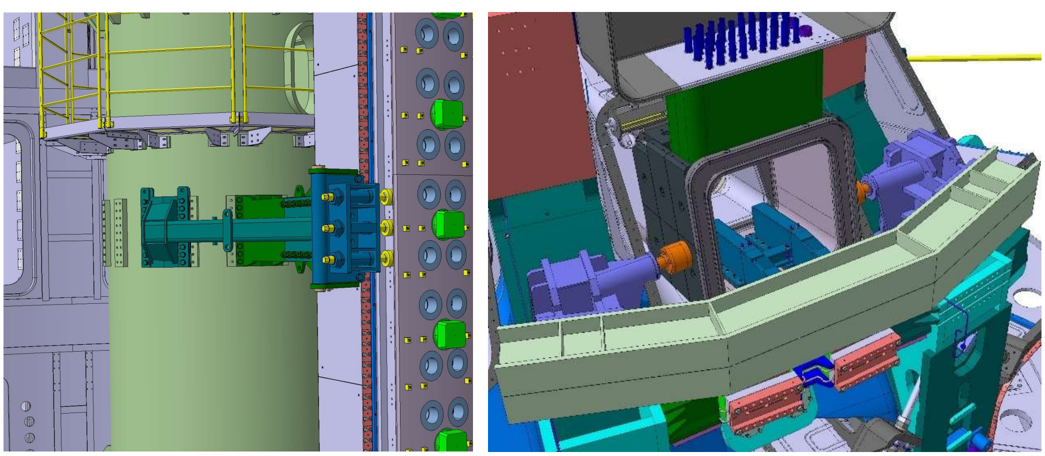


Figure 4-7: Inboard Bracing Arms and Outboard Frames

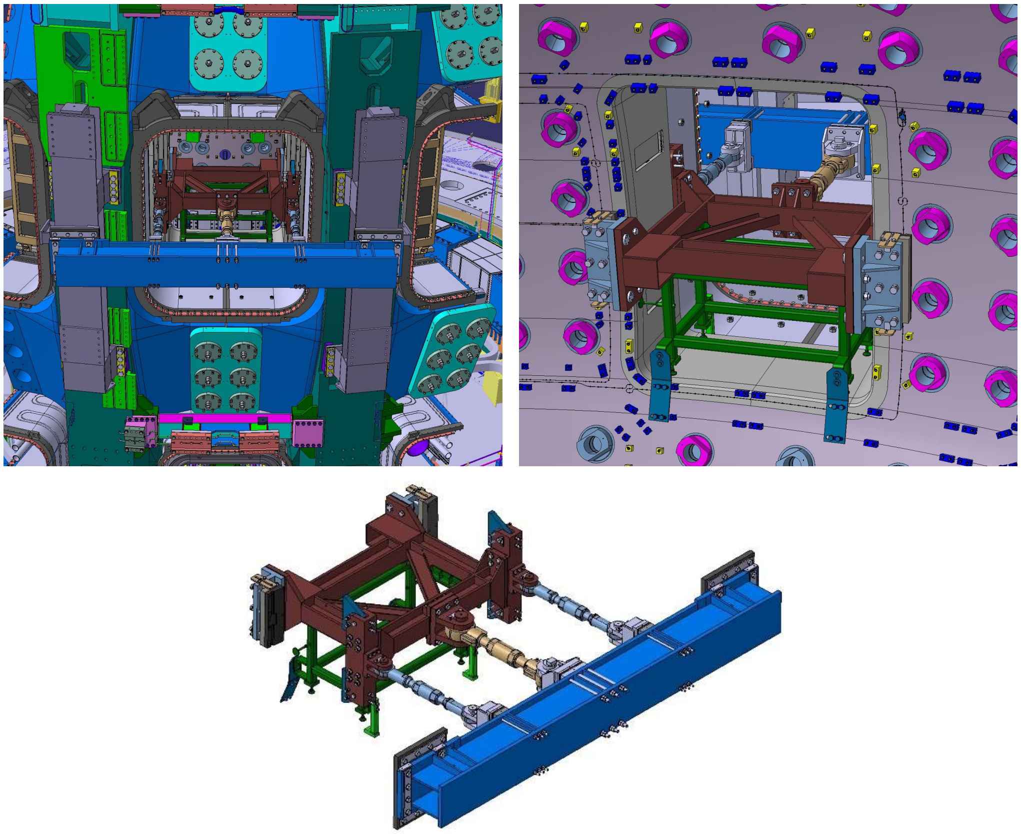


Figure 4-8: Mid Plane Bracing Tool

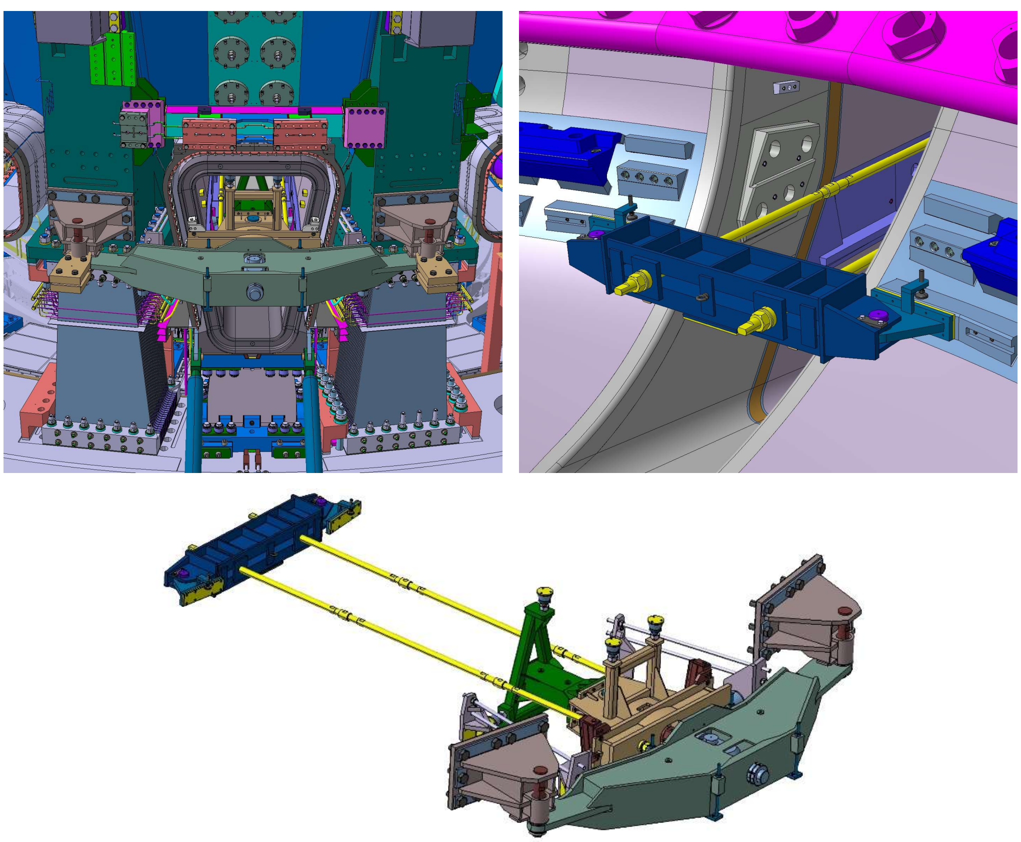


Figure 4-9: Divertor Level Bracing Tool Removal

4.2 VVTS connection scope

ITER Thermal Shield is a critical system that aims to provide an appropriate thermal barrier to the superconducting magnets, avoiding heat exchange by thermal radiation between magnets and the surrounding warm surfaces. The VVTS is interposed between the vacuum vessel and the cryogenic magnet structure.

The WPP Group 2 scope is focused on the VVTS (Vacuum Vessel Thermal Shield) pit assembly activities that are a predecessor or parallel activities to the VV sector welding. This includes:

1. VVTS In-Pit Joint Installation, including in-vessel access
2. VVTS Equatorial Port Shroud Installation
3. VVTS Permanent Support Installation and Temporary Support Removal
4. STS (Side Thermal Shield) to VVTS connection
5. Installation of Hook Covers

The In-Pit Joint installation is the connection of two adjacent VVTS sectors from the inside of the vacuum vessel through 124 splice plates of different shapes, see Figure 4-10. The installation of the splice plates is a predecessor to VV welding since the VVTS sits between the VV and the TFC (when the VV welding is complete, there is no longer access to the VVTS), see Figure 4-11.

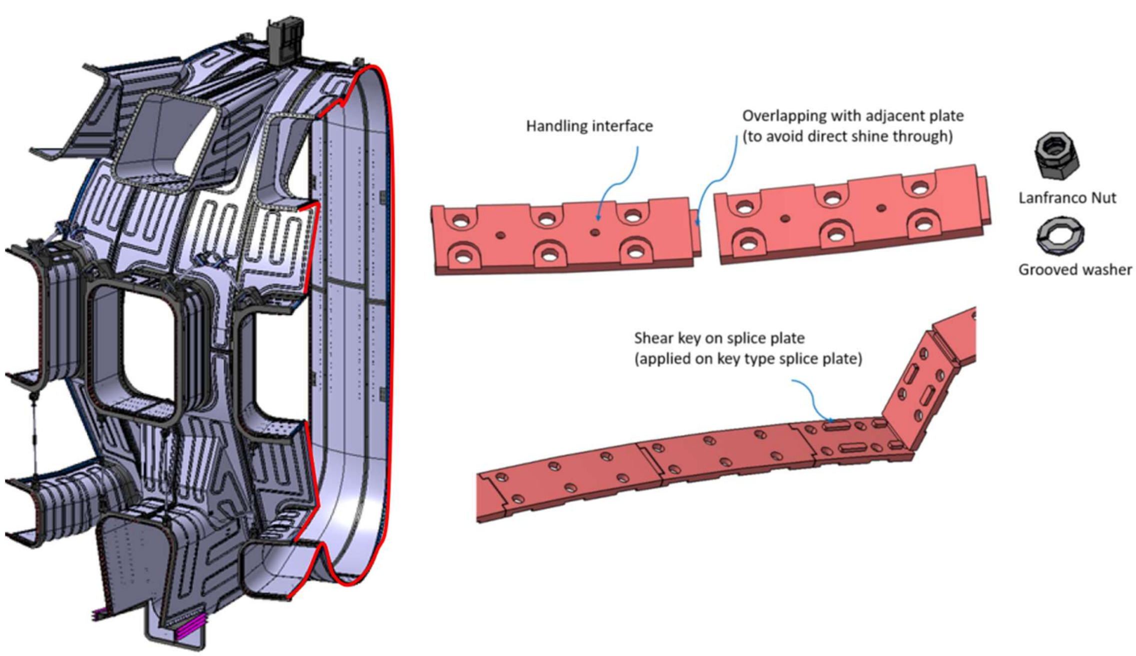


Figure 4-10: VVTS Field Joint Splice Plates

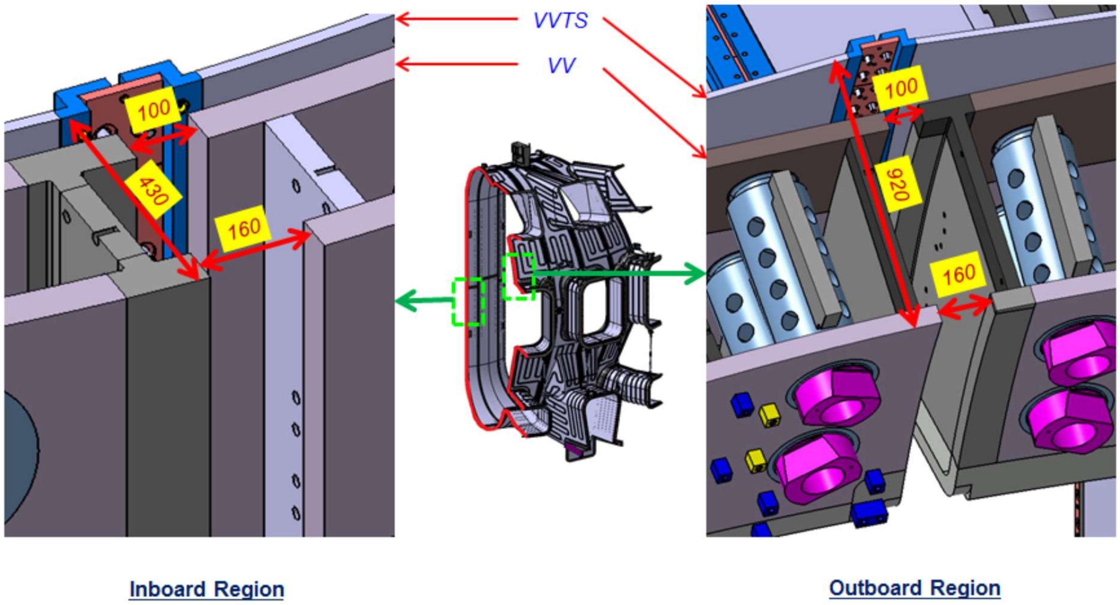


Figure 4-11: VVTS Proximity to VV

IO will supply the blocks of 304 grade stainless steel and the nominal CAD models to the WPP Contractor for machining the splice plates. If custom machining is required, the as-built data of existing sectors and customized CAD models of the associated splice plates will be provided by the IO Metrology and Reverse Engineering team for the WPP contractor to prepare for the machining.

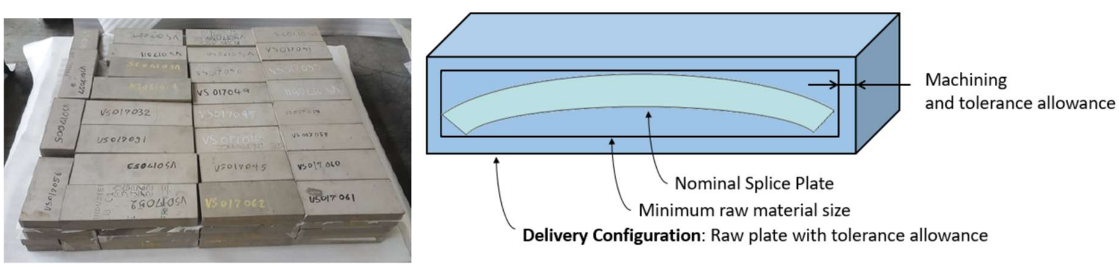


Figure 4-12: VVTS Machining Blocks

Using specialized tooling, the WPP Contractor will align the two adjacent VVTS sectors, then perform the installation of each splice plate. Noting that, as shown in Figure 4-14, the working environment and access for the installation of the VVTS splice plates is extremely challenging. Special care will be needed to ensure suitable access, the weld preparation of the VV is not damaged and that there is no risk to drop or lose small items such as fasteners.

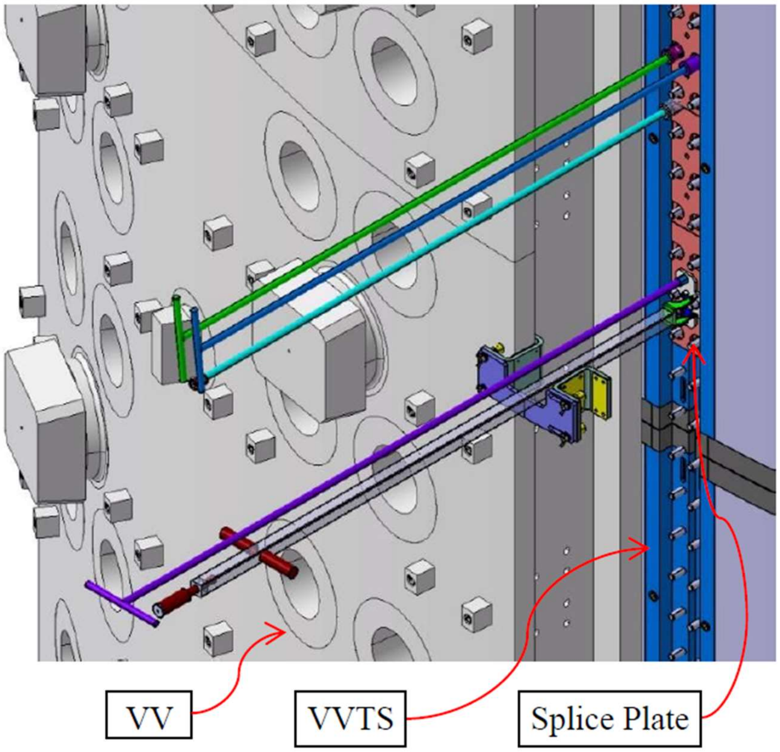


Figure 4-13: VVTS Installation Tool Example

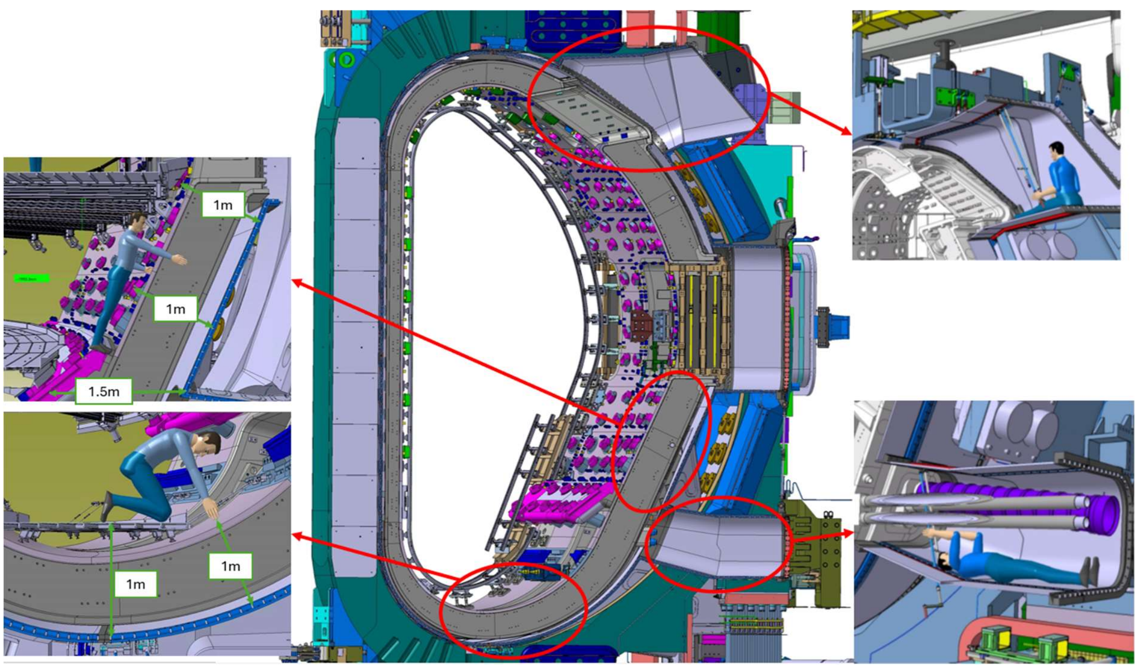


Figure 4-14: VVTS Field Joint Challenging Access

Following the connection of the VVTS sector field joints, the associated Equatorial Shrouds are lifted to the Tokamak Pit and are aligned to the field joint and secured to the VVTS sectors by WPP Contractor, as seen in Figure 4-15. The lateral left and right shrouds, when pre-assembled, have a total weight of ~3.5 tons. The IO will provide the lifting tooling and counterweight (if required) for the installation.

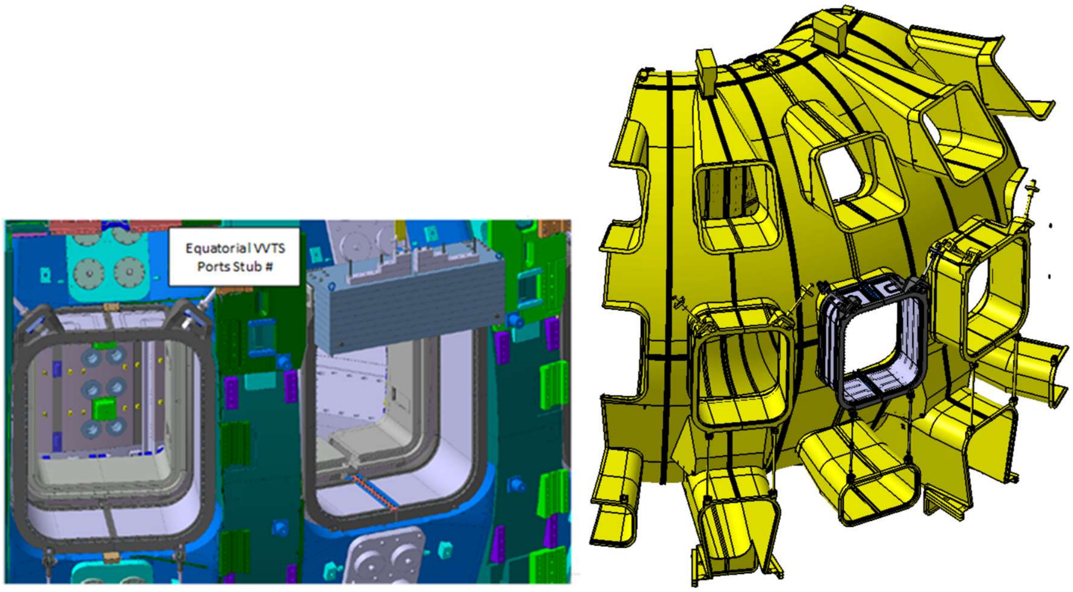


Figure 4-15: Equatorial VVTS Shroud Installation

The VVTS temporary supports hold the VVTS sector connected to the TFCs until the completion of the VVTS full torus (9 sectors). At this point, the permanent supports on the 9 field joint Equatorial Shrouds are connected to the TFC so that WPP Contractor can remove the temporary supports. Some of the temporary supports may be required to be adjusted by WPP Contractor as part of the alignment of the VVTS in pit when attaching the field joint splice plates.

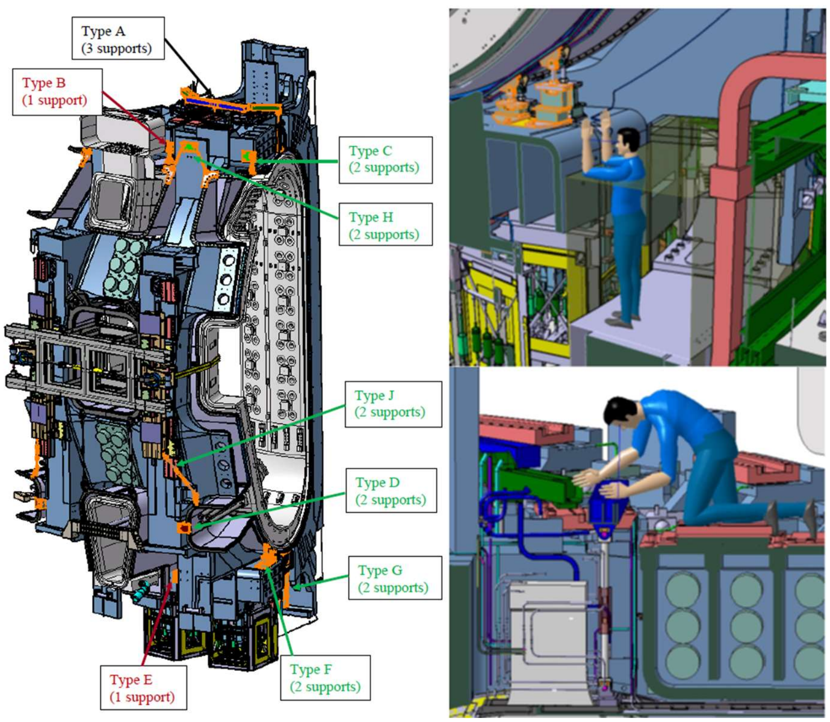


Figure 4-16: VVTS Temporary Supports

Once the Radial Beams are removed from the Sector Modules, it will allow the access to install the nine hook covers of the VVTS by WPP Contractor. After the load transfer, the connection between the Side Thermal Shield (STS) and the VVTS lower port area will be performed on all nine sectors by WPP Contractor.

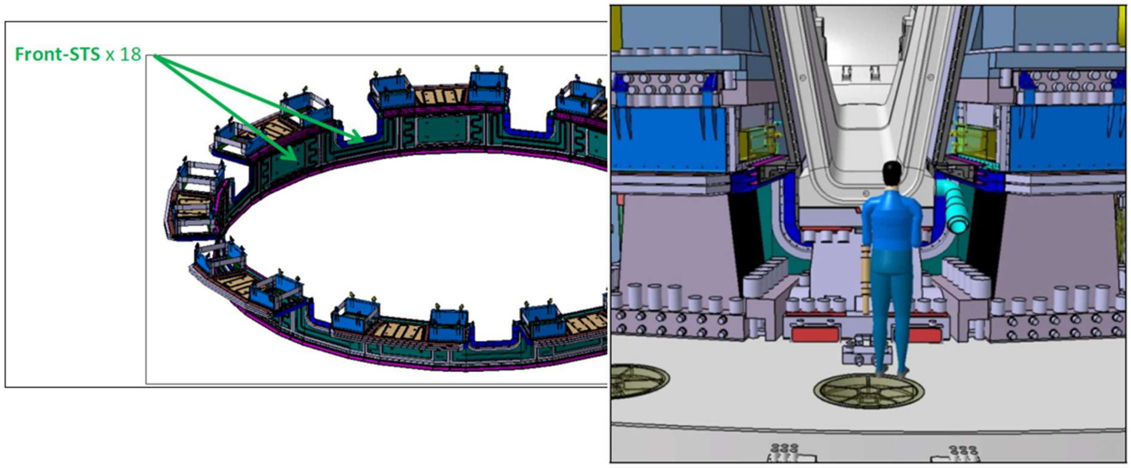


Figure 4-17: VVTS to STS Connection

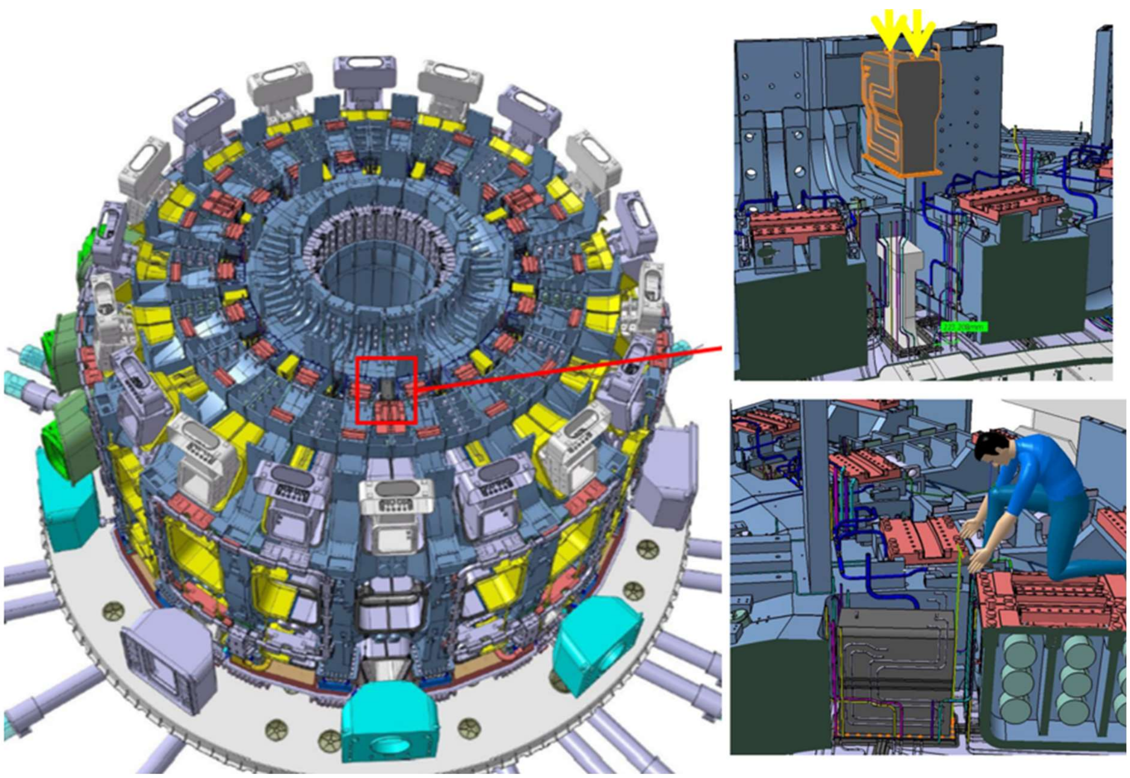


Figure 4-18: VVTS Hook Cover Installation

4.3 Tooling scope

The WPP Contractor will be responsible for the detailed design and supply of specific assembly tooling.

The list of tools to be designed and manufactured by the Contractor includes:

1. VV Stability Clamps
2. VVTS Field Joint Alignment Tools
3. VVTS Splice Plate Installation Tools
4. VVGS Assembly Tools (for insertion, alignment, shim assembly, bolt installation, lifting, etc)

4.3.1 VV Stability Clamps

As part of the Group 1 scope of works described in §4.1, the final design and supply of the stability clamps (including all needed tools to install the stability clamp) will be required by the WPP Contractor. The IO has performed a detailed conceptual design, including definition of the load cases to be considered by the clamps. The WPP Contractor shall, as part of the final design, complete the mechanical analysis of the tools, assess the reaction loads on the interfaces, confirm the assembly feasibility and manage all necessary drawings and inspection plans for the manufacturing. Final Design Review (FDR) and Manufacturing Readiness Review (MRR) will need to be conducted by the WPP Contractor.

The stability clamp upper rod assembly, shown in Figure 4-19, weighs ~8.5 tons and is connected to the VV in both lateral upper ports near the field joint via temporary welded pads as shown in Figure 4-20. Temporary welds will be done on the VV which is a Protection Important Component (PIC). Appropriate welding, removal and NDE (Non-Destructive Examination) are required according to the RCC-MR.
The upper rods are then connected to a support structure which is attached to the existing Radial Beam (RB) supports shown in brown in Figure 4-21.
The stability clamp lower strut, shown in Figure 4-22, are required to resist the loads associated with the VV rotation when landed on the VVGS.

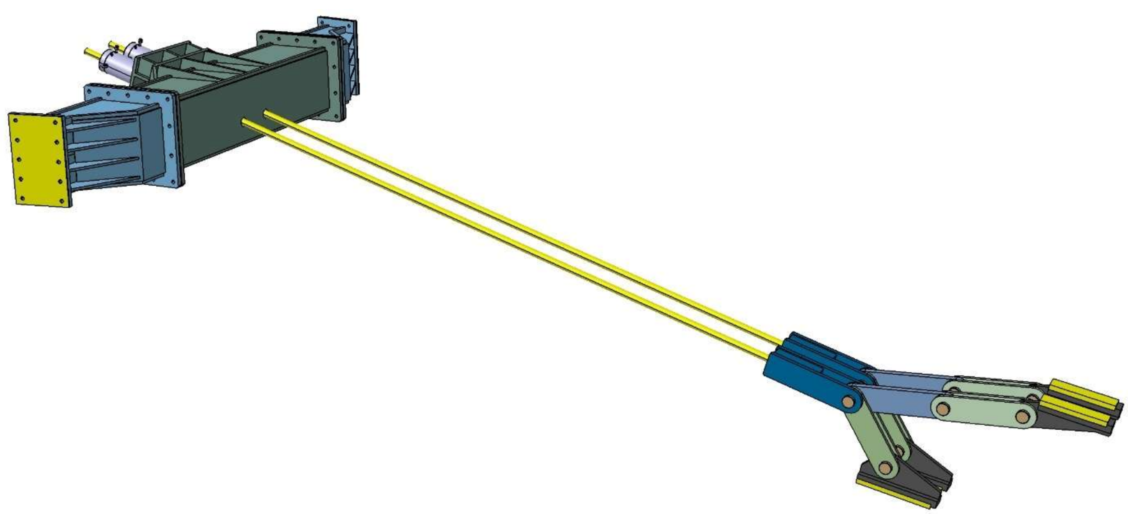


Figure 4-19: Upper Rods Assembly

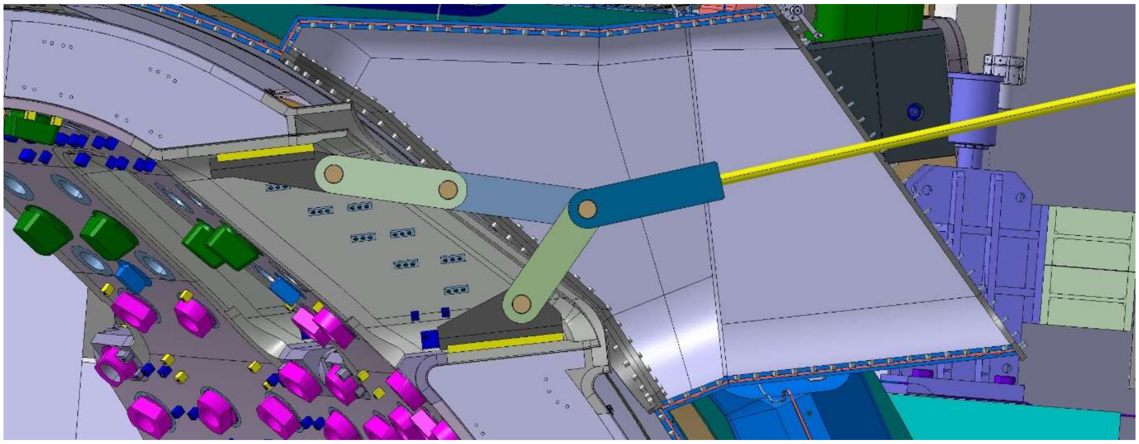


Figure 4-20: Stability Clamp Upper Rod VV connection

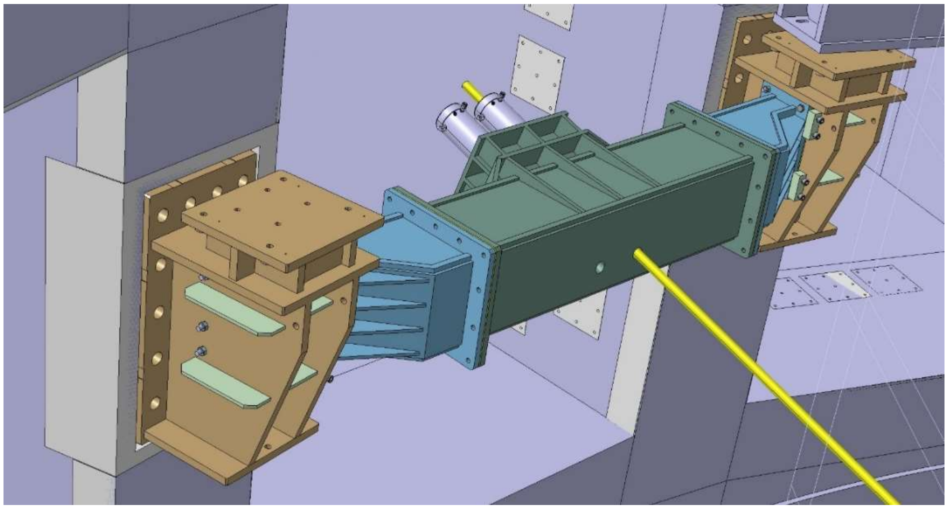


Figure 4-21: Upper Rod connection to the RB support and Building

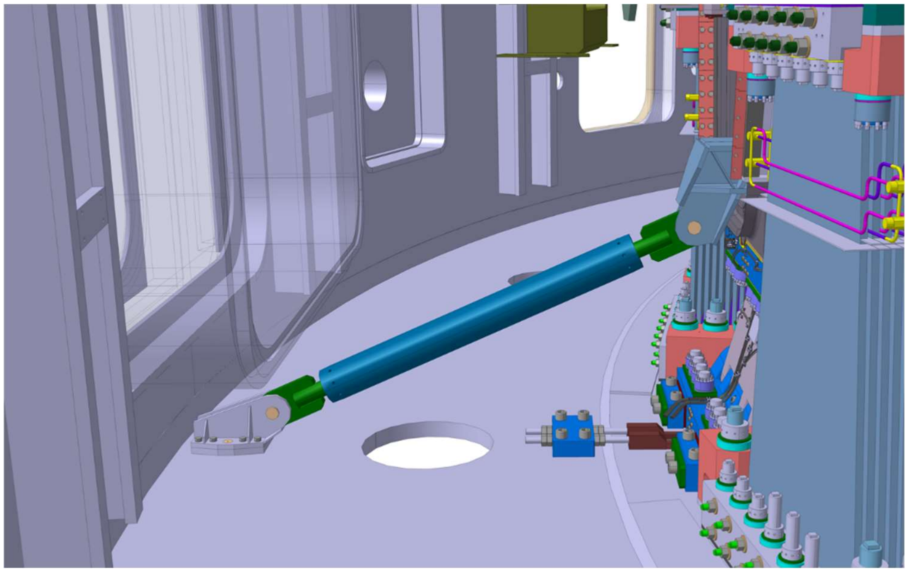


Figure 4-22: Lower Strut Connected to Cryostat Base

4.3.2 VVTS Field Joint Alignment Tools

As part of Group 2 scope of works described in §4.2, the VVTS sectors will be aligned together by pulling the panels in several axis distributed around the VVTS field joint sufficiently to secure key splice plates, thus locking the position of the flanges and avoiding the custom machining of the splice plates.

Shown in Figure 4-23, is an IO concept of a tool that could be imagined for alignment on the location of the shroud flanges. The WPP Contractor will be required to develop a detailed conceptual and final design of the alignment tools, strategy and methodology, considering the constraints imposed by the challenging environment. Upon the IO approving of the final design, the WPP Contractor is then responsible for the manufacturing and supply of the tools.

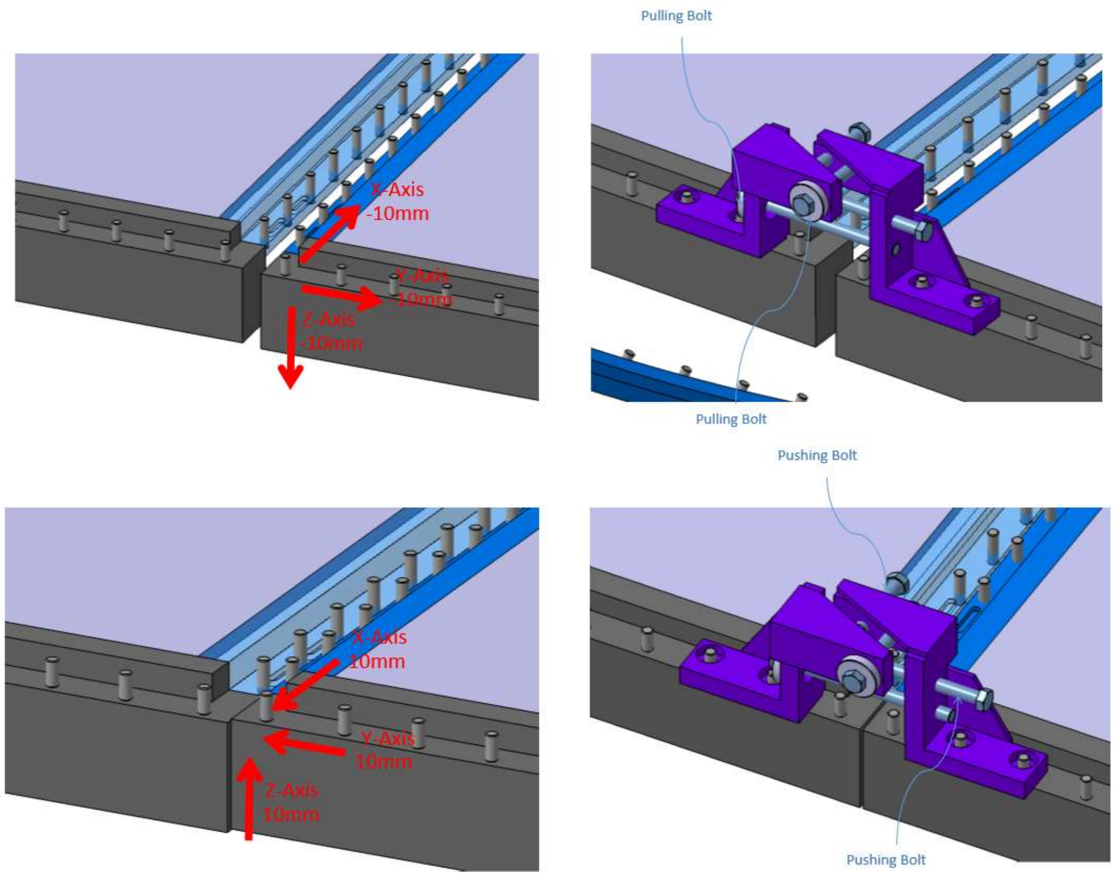


Figure 4-23: VVTS field joint alignment tools

4.3.3 VVTS Splice Plate Installation Tools

As part of Group 2 scope of works described in §4.2, the VVTS splice plates must be carefully and efficiently installed in the pit from inside the VV. The IO has one prototype installation tool shown in Figure 4-13 which will be provided to the WPP Contractor. However, the WPP Contractor will be responsible for developing an optimized solution for the splice plate installation. The optimized solution must comply with all material requirements, protection of the VV weld preparation, foreign material exclusion/dropped item protection and other working environment constraints. The WPP Contractor must demonstrate value engineering in the solution, showing a clear benefit to the assembly efficiency with the optimized tool.

Upon the IO approving of the final design, the WPP Contractor is then responsible for the manufacturing and supply of the tools.

4.3.4 VVGS Assembly Tools

As part of the Group 1 scope of works described in §4.1, the VVGS Assembly will require specific tooling to lift, align, translate, bolt, shim, etc..., considering the challenging environment. The WPP Contractor will be required to develop a detailed conceptual and final design of the VVGS assembly tools, strategy and methodology. Upon IO approving of the final design, the WPP Contractor is then responsible for the manufacturing and supply of the tools. The WPP Contractor must demonstrate value engineering in the solution, showing a clear benefit to the assembly efficiency with the optimized tool.

5 Expected contract and main activities durations

This Contract covers all activities needed to place and align the VV sectors on their gravity supports (Engineering Work Packages (EWP)/Installation Work Packages (IWP) Group 1) and to perform the VVTS inter-connection (EWP/IWP Group 2). The scope includes the design, manufacturing and supply of tools and stability clamps used to hold the VV sectors in their aligned position during welding and to complete the installation of the VVTS scope as describe in §4.3.

The Contract will consist of 3 lots:

- Lot 1: production of IWP documentation and support to EWP documentation updates;
- Lot 2: design, manufacturing and installation of tools; and
- Lot 3: execution works on-site.

All 3 lots will be awarded at Contract signature.

Due to the start of site execution in the 3rd quarter of 2026 (i.e. Lot 3), Lot 1 and Lot 2 will be launched in parallel after Contract signature (expected Q2 2025).

As part of Lot 1, the Contractor will be expected to work collaboratively with the IO to develop processes, procedures and resource allocation to ensure efficient sequence and site execution to not only comply with the schedule requirements but to optimize the tools and processes to reduce the works execution durations.

The scope of works as described in §4 is expected to be executed within an estimated duration of 4 years from the date of Contract signature, with a key intermediate milestone to get all 9 VV sectors aligned and stabilized to release their welding at 3 years from Contract signature, and according to the following preliminary durations of the main activities in Table 5-1:

Note: below are the estimated durations for the main scope of works. These activities could be performed in parallel and the total estimated duration will not necessarily be on the critical path. A detailed schedule of works will be provided in the Request for Proposal.

Activity	Repetition	Estimated duration
Final alignment and landing of 1 VV	9	2 months
Interconnection of VVTS	9	4 months
VVTS shrouds and remaining scope	9	1 month
Removal of the stability clamps	9	1 month

Table 5-1: Main on-site activity durations

6 Experience

The Candidate experience shall include the resource capability to perform the full cycle of large mechanical assembly within precise tolerances. This includes engineering and design activities related to preparation of site execution and necessary tooling as well as suitably qualified and experienced personnel required to execute the works.

Prior to Contract signature, the Candidates may be requested to perform demonstration of capabilities keys to the Contract such as machining of shims within required tolerances.

7 Eligibility

Participation is open to all legal persons participating either individually or in a grouping (consortium) which is established in an ITER Member State:

- European Union,
- Republic of India,
- Japan,
- People's Republic of China,
- Republic of Korea,
- Russian Federation,
- United States of America.

The ITER Organization may decide to broaden the eligibility to other countries as deemed appropriate.

A legal person cannot participate individually or as a consortium partner in more than one application or tender. A consortium may be a permanent, legally established grouping or a grouping, which has been constituted informally for a specific tender procedure. All members of a consortium (i.e. the leader and all other members) are jointly and severally liable to the ITER Organization. The consortium cannot be modified later without the approval of the ITER Organization.

Legal entities belonging to the same legal grouping are allowed to participate separately if they are able to demonstrate independent technical and financial capacities. Bidders' (individual or consortium) must comply with the selection criteria. IO reserves the right to disregard duplicated references and may exclude such legal entities from the tender procedure.