

Call for Nomination

Vacuum Vessel Assembly Welding

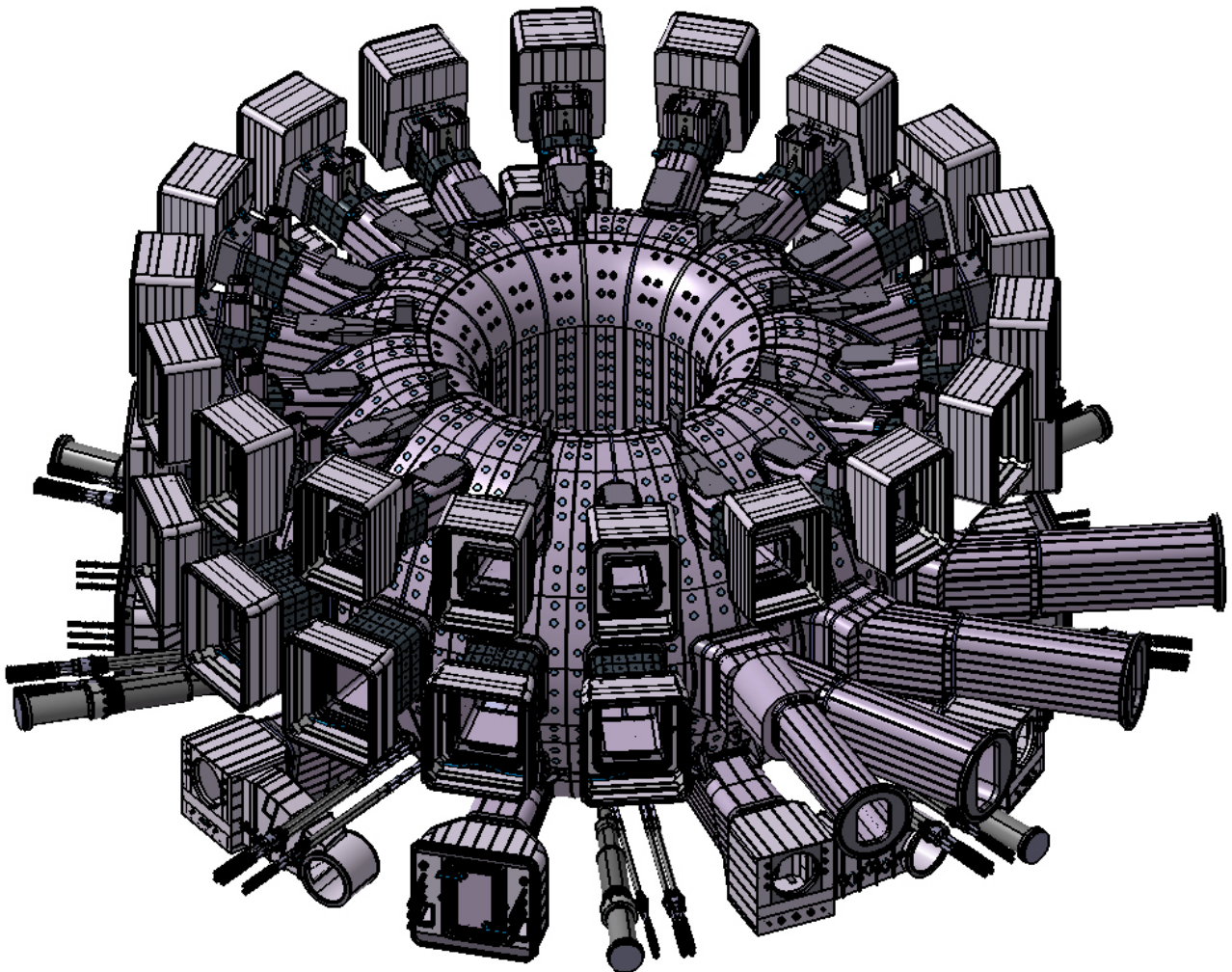
Purpose

ITER will be the world's largest experimental facility to demonstrate the scientific and technical feasibility of fusion power. The Vacuum Vessel (VV) system provides the high vacuum boundary for the plasma, and is the primary confinement for the radioactive inventory.

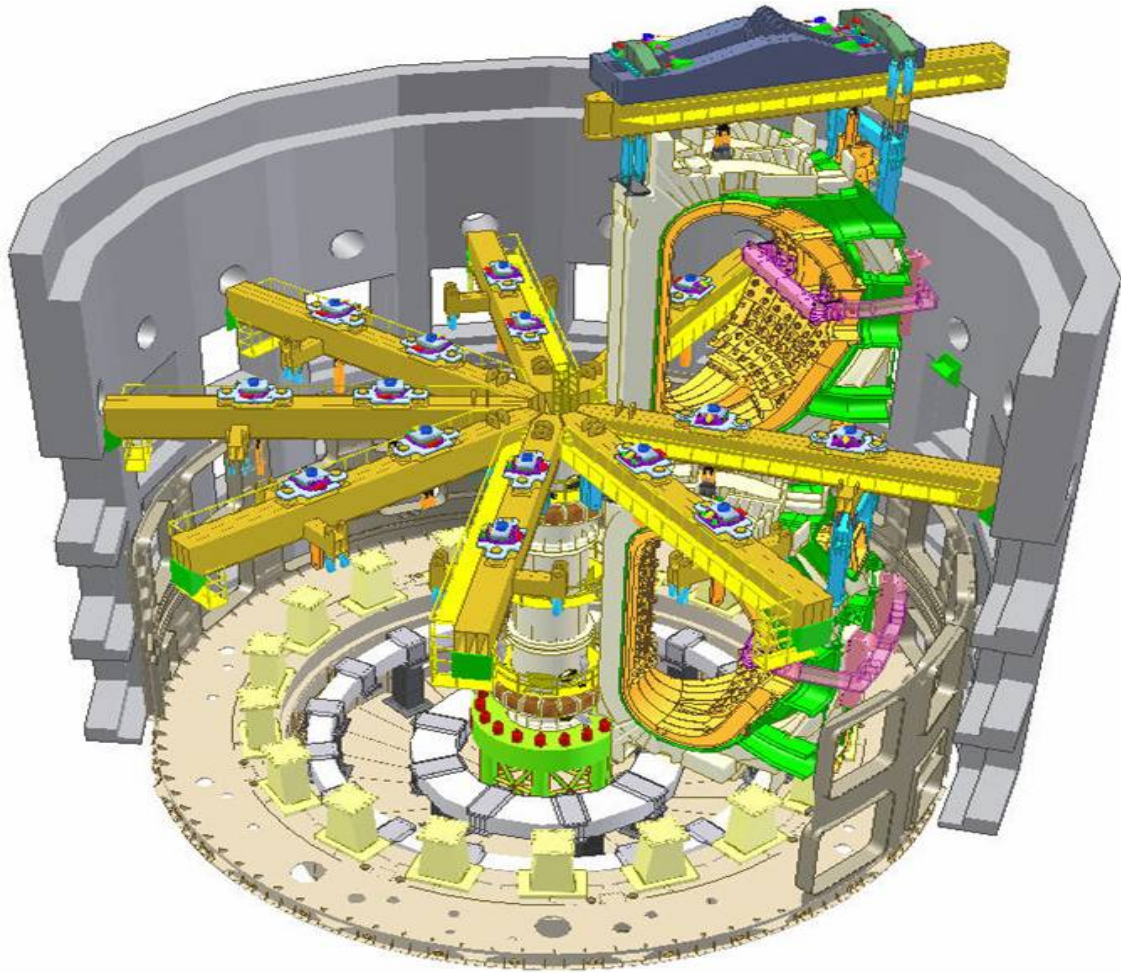
This document outlines the technical requirements for the qualification, performance and testing of the site assembly welds that connect the 9 Vacuum Vessel sectors and 53 Port Structures that constitute the ITER Vacuum Vessel system.

Background

The main vessel is a torus-shaped, double-wall structure, with toroidal and poloidal stiffening ribs between the inner and the outer walls to reinforce the structure.



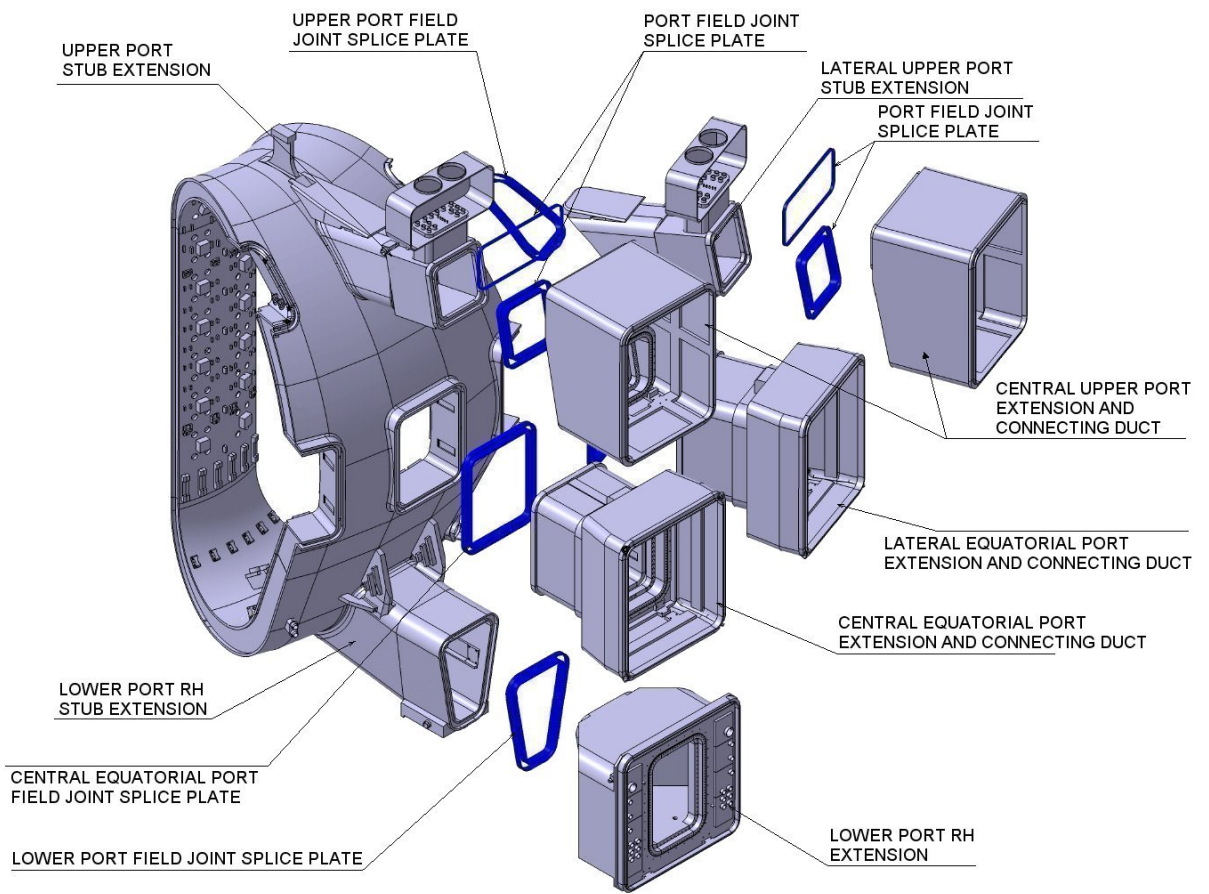
To meet size and weight limitations for transportation and on-site handling, the main vessel is divided toroidally into 9 x 40° sectors that are joined with site field welds to be performed during the assembly of the components at the IO site.



Assembly of the components

The joints are made using customised splice plates, to accommodate dimensional differences between the VV sectors, to facilitate their relative alignment, and to provide access to the components surrounding the vessel. The nominal thickness of the sector-to-sector welded joints is 60mm stainless steel.

The port structures include the ports at the VV upper, equatorial and lower level. The ports at the equatorial level are subdivided into the regular ports (located radially with respect to the torus axis) and neutral beam (NB) ports (located tangentially to the torus). For all ports, the port stubs are integrated with the main vessel and the port stub extension are welded either in the factory (i.e., out of the scope of this document) or on site (i.e., within the scope). The port extensions are always welded on site. NB ports are equipped with the connecting ducts that are also welded on site (unlike all other connecting ducts that are welded to the port extensions in the factory). The nominal thickness of the field welded joints for ports is 40 or 60 mm.



Typical sector showing ports

Components (Ref: Appendix A)

Main Vessel

- Double-walled, all welded structure, fabricated in SS 316 L (N) – ITER Grade (IG).
- Shell thickness 60 mm
- 9 x 40° vessel sectors to be assembled on site via field joints. Each sector includes central upper and lower port stub extensions
- Use of splice plates require 2 welds per shell – i.e., 4 welds per field joint
- Splice plate width 100 mm (outer shell), 160 mm (inner shell)
- In-Wall Shielding

Upper Port Structures

- 9 port stub extensions
- 18 port extensions

Equatorial Port Structures

- 14 regular port extensions
- 3 NB port extensions
- 4 NB connecting ducts
- 1 port stub extension (installed as two halves)

Lower Port Structures

- 5 regular (remote maintenance / diagnostic) port extensions
- 4 pumping port extensions

Note: all welds are between components in SS 316 L (N) – ITER Grade (IG),

The following is an example of what will be required of the supplier.

Components to be welded	Qty	Joint length each (m)	Weld length each (m)	Total weld length system (m)
Main Vessel Sector	9	25.5	102	918
Upper Port Stub Extension	9	7	28	252
Upper Port Extension	18	5.2	21	378
Equatorial Port Stub Extension	1	9	36	36
Equatorial Port Extension	17	8.3	33	561
Lower Port Extension	9	8.2	33	297
System Total				2442

There is a possibility of other, associated work, being released. Typically, lower penetrations and Cryostat bellows, however the design of these components are not sufficiently mature to give greater detail at this point in time.

The task shall be divided into three distinct phases: Development, Pre-Production and Production.

Development Phase

A welding process suitable for welding the vacuum vessel sectors and ports structures via splice plates must be developed, qualified and approved, together with associated tooling, methods, techniques and procedures concerned with the fabrication and construction of the components in accordance with the requirements of the Design and Construction Rules for Mechanical Components of Nuclear Installations (RCC-MR 2007) and IO procedures.

Assumptions with regard to tolerances have been made by the IO. To this end, tolerance analysis, control and monitoring are important aspects of this contract. In addition to performing the assembly within tolerance requirements, confirmation of the expectations made by the IO will influence final design.

It is anticipated that the following programme steps will be required. Note that this is indicative and not an exhaustive list:-

- Research & Development (R&D) program. This will include a critical review of past and present R&D to identify the most suitable welding technology whilst achieving the maximum productivity consistent with quality. Suitable repair process shall be selected and developed
- Ensure a consistent and repeatable welding process. The objective is to **limit shrinkage variation** to 2.5mm per joint These values have been used as the basis for tolerance analyses carried out by IO
- Demonstrate and validate equipment and processes on **representative** mock-ups.
- Preparation and qualification for all Welding Procedure Specifications
- Preparation and qualification for all NDE procedures, including leak testing.
- Handling, aligning and fixturing the splice plates
- Design and supply of all associated tooling, including back side protection

Pre-Production Phase

- Supply of the equipment, identified during the development phase, required to complete the work in the prescribed time. This includes the welding machines, any purpose-built deployment systems such as rails, robots, etc., back-side protection, hand tools, and all consumables.

Production

- Supply, supervision and support of the welding teams required to complete the work within the time prescribed.
- Preparation and testing using NDE operations.
- Final machining, control, cleaning and delivery of the splice plates. (Un-machined splice plates are supplied by ITER).
- Positioning of splice plates
- Ensure that during the execution of the work suitably qualified welding engineers with authority to make decisions and supervise the work are available on site.
- Detailed planning of the work. The supplier is responsible for planning the welding tasks that will comply with the time requirements of the project.
- Design and manufacture of jigs, fixtures and tooling.
- Manufacture prototypes and testing.
- Preparing and maintaining all the qualifications for welding personnel
- Preparing and maintaining all the qualifications for testing personnel and testing procedures
- QA documentation during qualification and implementation.
- The acceptance criteria for the completion of the tasks includes ultra-high vacuum leak and pressure testing

Tentative timetable:-

Pre-Qualification		November	2011
Tender launch	January	2012 return	May 2012
Contract placement		3 rd Quarter	2012

Tentative contract milestones

- R&D completion of Vessel December 2014
- R&D completion of Ports June 2015
- Production welding machines February 2016
- First Weld August 2016
- Completion of Contract January 2019

Licensing, Regulatory and Code Requirements

By definition of the French Order 12 Dec 2005, the ITER Vacuum Vessel including ports is an assembly of Nuclear Pressure equipments. According to Equipements Sous Pression Nucléaire (ESPN) terminology, the ITER Organization (IO) will be the Manufacturer of the Vacuum Vessel and regulatory checks will be carried out by an Agreed Notified Body (ANB), in charge of ESPN Conformity Assessment. The applicable design and manufacturing Code is RCC-MR 2007.

The Supplier shall select high quality welding processes backed by industrial experience, with the objective to minimise welding defects, optimise the non-destructive examination of welds and minimise welding distortions taking into account the requirements of RCC-MR 2007.

Narrow Gap TIG (automatic) is suggested as a baseline method to be used for the Field Joints. Other types of welding (typically Narrow Gap MIG/MAG [mechanised] or a combination of both) can be considered as a way to improve productivity and minimise distortion, as long as the requirements of the applicable code or standard are satisfied.

Facilities

The supplier shall have suitable facilities for carrying out welding and NDE development, including representative mock-ups as necessary.

Experience

The supplier and its personnel shall have suitable experience. This includes but is not limited to:

- Fabrication and assembly, in particular to close tolerances and accurate metrology
- Large Nuclear and or Pressure vessel components.
- Welding of complex stainless steel thick (more than 40mm) sections.
- Narrow Gap TIG/MIG/MAG (as detailed above) welding or a process suitable for this application.
- Extensive experience in the qualification and performance of coded welds
- Expertise on volumetric examination of austenitic stainless steel welds (Radiography and Ultrasonic).
- Experience in the practical application of adaptive welding techniques.
- Experience in the requirements for ultra high vacuum conditions
- Experience in large scale assembly operations on client's site, to a demanding schedule
- Experience in cleanliness in production in on-site environment

Technical Capacity

Consideration should be given to the need for the following proof requirements in the tender phase.

The candidate, which may be a single company with/without sub-contractors or a consortium, shall possess the full range of professional competences and experience at a level commensurate with the work to be carried out.

The candidate shall demonstrate his experience of very efficient organisation of his team at a client's site to minimise the scheduled duration and costs.

The candidate shall demonstrate his experience of carrying out on-site operations in France, and his understanding of relevant labour and safety regulations and requirements.

The qualified personnel shall include CAD operators, welding engineers, welders, NDE experts and personnel, fitters, inspectors and planners.

The candidate shall have an accredited Quality Assurance system.

Candidature

Participation is open to all legal persons, participating either individually or in a grouping (consortiums), which are established in an ITER Member State. 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.

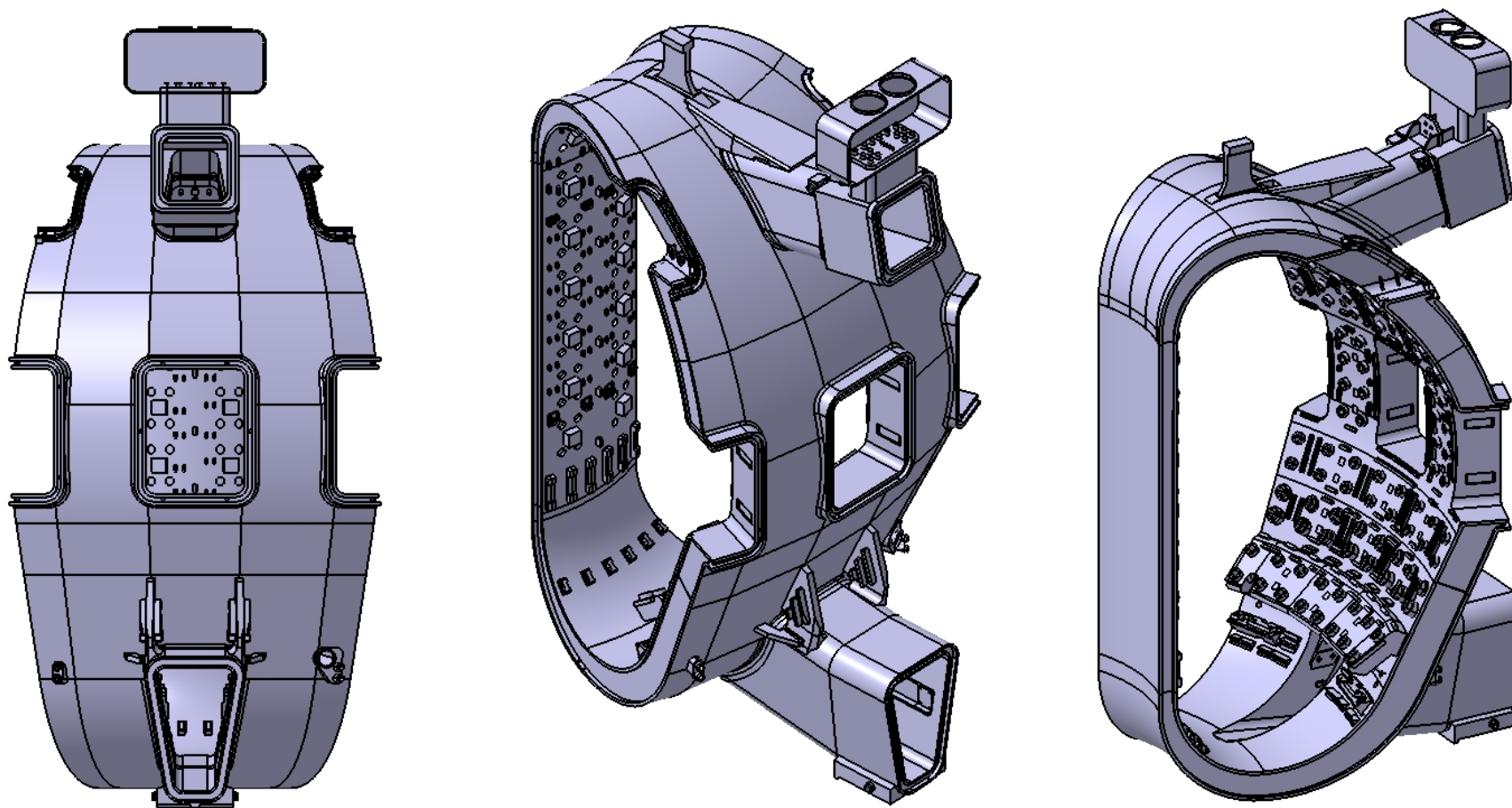
No more than one tender offer can be submitted by a legal person whatever the form of participation (as an individual legal entity or as leader or member of a consortium). In the event that a legal person submits more than one tender, all applications in which that person has participated will be excluded. A legal person may participate in one or more tender offer as a subcontractor.

Following this expression of interest the ITER Organization will launch a pre-qualification procedure to all legal persons proposed by the Domestic Agencies or ITER Organization. The consortium groupings shall be presented at the pre-qualification stage. The consortium cannot be modified without the approval of the ITER Organization after pre-qualification.

Appendix A *Components of the VV for Assembly*

Components

Double walled all welded structure made from SS 316 L (N) – ITER Grade (IG) x 60 mm thick.



**VV Sector Assembly
General View**

Sectors 7 to 9
(Sectors 4 to 6 are identical)

