Table of Contents

[1 Preamble 3](#_Toc154061627)

[2 Purpose 3](#_Toc154061628)

[3 Acronyms & Definitions 3](#_Toc154061629)

[3.1 Acronyms 3](#_Toc154061630)

[3.2 Definitions 5](#_Toc154061631)

[4 Applicable Documents & Codes and standards 5](#_Toc154061632)

[4.1 Applicable Documents 5](#_Toc154061633)

[4.2 Codes and Standards 5](#_Toc154061634)

[4.3 List of Drawings 6](#_Toc154061635)

[5 Description 6](#_Toc154061636)

[5.1 Responsibilities and licensing 9](#_Toc154061637)

[5.2 GPP structures classification 10](#_Toc154061638)

[6 Scope of work 11](#_Toc154061639)

[6.1 Items and Activities Included in the scope of work 11](#_Toc154061640)

[6.2 Documentation to be supplied during the execution of the contract. 13](#_Toc154061641)

[7 Technical Requirements 14](#_Toc154061642)

[7.1 Manufacturing Design Requirements 14](#_Toc154061643)

[7.2 Material Requirements 15](#_Toc154061644)

[7.2.1 Material Procurement 15](#_Toc154061645)

[7.3 CAD activities and engineering drawings 15](#_Toc154061646)

[7.4 Engineering analysis 15](#_Toc154061647)

[7.5 Manufacturing requirements 16](#_Toc154061648)

[7.5.1 Cleanliness and vacuum quality requirements 16](#_Toc154061649)

[7.5.2 Surface finish requirements 18](#_Toc154061650)

[7.5.3 Welding requirements 18](#_Toc154061651)

[7.5.4 Requirements relative to machining operations other than gun-drilling 29](#_Toc154061652)

[7.5.5 Requirements related to special manufacturing processes like gun drilling. 33](#_Toc154061653)

[7.5.6 Metrology and tolerances 37](#_Toc154061654)

[8 Delivery 38](#_Toc154061655)

[8.1 Requirements for labelling, cleaning and cleanliness preservation, packaging, handling, shipment and storage 38](#_Toc154061656)

[8.1.1 Scope of application 38](#_Toc154061657)

[8.1.2 Labelling and Traceability 38](#_Toc154061658)

[8.1.3 Cleaning and Cleaning Preservation 38](#_Toc154061659)

[8.1.4 Packaging and Handling 38](#_Toc154061660)

[8.1.5 Shipment, Transportation and Delivery to Port Site 38](#_Toc154061661)

[8.2 Environment, Safety and Health 39](#_Toc154061662)

[9 Inspection and testing 39](#_Toc154061663)

[9.1 Examination and tests 40](#_Toc154061664)

[9.1.1 Mechanical tests 40](#_Toc154061665)

[9.1.2 Physical, physicochemical and chemical tests 40](#_Toc154061666)

[9.1.3 Non Destructive Examination 40](#_Toc154061667)

[9.1.3.1 Visual Examination (VT) 41](#_Toc154061668)

[9.1.3.2 Surface examination 41](#_Toc154061669)

[9.1.3.3 Volumetric examination 43](#_Toc154061670)

[9.1.3.4 Leak testing 46](#_Toc154061671)

[9.1.4 NDE Operators and inspectors Qualification 47](#_Toc154061672)

[9.2 Intermediate Acceptance Tests at the Manufacturing Site 48](#_Toc154061673)

[9.3 Provisional Acceptance at Port Integrator Site 48](#_Toc154061674)

[9.4 Final Acceptance 49](#_Toc154061675)

# Preamble

This summarized Technical Specification is to be read along with the reference documents (specially drawings) listed in section 4. This document includes the summary of Scope of Work for the common manufacturing of diagnostic generic Port Plug structures (Upper and Equatorial). It contains references and main technical requirements that are applicable to the Scope of Work.

# Purpose

The purpose of this document is to summarize the most relevant requirements for the manufacture and final suply to the different Client Port Integrator Sites, of generic upper and equatorial Port Plug structures (acronyms GUPP and GEPP) in compliance with client required documents. Complete

Subcontractor should demonstrate in its response to questionnaire:

* Full knowledge of the codes, standard and nuclear regulation applied.
* Previous experience in application of the codes, standard and nuclear regulation applied in similar stainless steel Iter grade structures PIC components.
* To prove that have all the necessary machines and facilities for machining operation, welding (including EB welding), measurements, tests, preservation of cleanliness according to Iter vacuum handbook, manufacturing, assembly and storage areas level II according to RCC-MR Code, gun drilling in similar diameters, lengths, material, thickness and requirements.
* To prove that have all the necessary machines and facilities for leak testing (hot and cold), Flow test, Drain and Drying test, baking test and outgassing test.
* To guarantee shipment to destinations and Inspection at Port Integrator assembly/testing Site after delivery and reporting
* To prove that have certified and well-trained staff: design and analysis, NDT, leak test, machining including gun drilling for 2.3 m in stainless steel.
* To prove that have certified and well-trained staff in welding on staff: welders, welding coordinators and welding Engineers (ISO 14731, EN ISO 3834).
* To prove the subcontractor can produce design, manufacturing, testing, storing, handling and supply according to the following conditions from this document.

# Acronyms & Definitions

## Acronyms

The following acronyms are the main ones relevant to this document\*.

|  |  |
| --- | --- |
| Abbreviation | Description |
| A&M | Alignment & Metrology |
| ADP | Acceptance Data Package |
| ATPP | Authorization-To-Proceed Point |
| BTP | Built-To-Print |
| C&S | Codes and Standards |
| CAD | Computer Assisted Design |
| CRN | Contractor’s Release Note |
| CRO | Contract Responsible Officer |
| DA | Domestic Agency |
| DAP | Delivered At Place (Incoterm Category) |
| DR | Deviation Request |
| DSM | Diagnostic Shielding Module |
| DT | Destructive Testing |
| EDSM | Equatorial Port Plug Diagnostic Shielding Module |
| EOM | End-Of-Manufacturing |
| EPP(A) | Equatorial Port Plug (Assembly) |
| FAT | Factory Acceptance Tests |
| GEDFW | Generic Equatorial Diagnostic First Wall |
| GEPPS | Generic Equatorial Port Plug Structure |
| GUDFW | Generic Upper Diagnostic First Wall |
| GUPPS | Generic Upper Port Plug Structure |
| GM3S | General Management Specification for Service and Supply |
| HEL | Highly Exceptional Loads |
| HP | Hold Point |
| IO | ITER Organization |
| LDP | Liquid Dye Penetrant |
| MDB | Manufacturing Database |
| MIP | Manufacturing and Inspection Plan |
| MRR | Manufacturing Readiness Review |
| MTO | Material Take Off |
| NCR | Non- Conformance Report |
| NDT | Non-Destructive Testing |
| NP | Notification Point |
| NPE | Nuclear Pressure Equipment |
| PAUT | Phased Array Ultrasonic Testing |
| PE | Pressure Equipment |
| PEP | Project Execution Plan |
| PIA | Protection Important Activity |
| PP | Port Plugs |
| PPS | Product Procurement Specifications / Port Plug Structure |
| PQR | Procedure Qualification Record |
| PRO | Procurement Responsible Officer |
| QC | Quality Class |
| R | Review of document point |
| S | Surveillance point |
| SIC | Safety Important Component |
| TIG | Tungsten Inert Gas |
| TOFD | Time-Of-Flight Diffraction |
| TS | Technical Specification |
| UDSM | Upper Port Plug Diagnostic Shielding Module |
| UHV | Ultra High Vacuum |
| UPP(A) | Upper Port Plug (Assembly) |
| UT | Ultrasonic Testing |
| VQC | Vacuum Quality Class |
| VV | Vacuum Vessel |
| W | Witness point |
| WA | Windows Assembly |
| WP | Work Package |
| WPS | Welding Procedure specifications |

Table 1: Acronyms

*\*For a complete list of ITER abbreviations see:* [*ITER Abbreviations (ITER\_D\_2MU6W5)*](https://user.iter.org/?uid=2MU6W5).

## Definitions

**Candidate:** Company that has demonstrated, in the qualification phase, technical capacity to be considered as an aspirant company for the work described in this document.

**Contractor:** shall mean an economic operator who have signed the Contract in which this document is referenced. In this document as well as in the Appendix and Annexures referred here, the names Contractor and Supplier are used interchangeably.

# Applicable Documents & Codes and standards

## Applicable Documents

This section includes a brief list of main documents that need to be considered and applied for manufacturing and supply of the port plug structures.

|  |  |  |  |
| --- | --- | --- | --- |
| **No** | **Title** | **IDM ID** | **Rev** |
|  | Codes and Standards for ITER Mechanical Components | [25EW4K](https://user.iter.org/?uid=25EW4K&version=v4.0) | 4.0 |
|  | [ITER Vacuum Handbook](https://user.iter.org/?uid=2EZ9UM&version=v2.5) | [2EZ9UM](https://user.iter.org/?uid=2EZ9UM&version=v2.5) | 2.5 |
|  | [ITER Dimensional Metrology Handbook](https://user.iter.org/?uid=46FN9B&version=v2.1) | [46FN9B](https://user.iter.org/?uid=46FN9B&version=v2.1) | 2.1 |
|  | Order related 7 February 2012 relating to the general technical regulations applicable to BNI-EN, | [7M2YKE](https://user.iter.org/default.aspx?uid=7M2YKE) | 1.0 |
|  | EQ port plug structure component Drawings | VYS5WKP | 1.0 |
|  | UPPER port plug structure component Drawings | W5FAL6 | 1.0 |

Table 2: Applicable Documents

## Codes and Standards

* In general sense manufacturing methods and procedures shall follow the reference code RCC-MR 2007 for class 2 box structures in consistency with the document “Codes and Standards for ITER Mechanical Components” [[1]](#_Applicable_Documents).
* It should be noted that there are no European or International Standards with respect to proper fabrication of ultra-high vacuum (UHV) components and so in lieu of an industrial Standard all component’s fabrication shall simultaneously comply with the “ITER Vacuum Handbook” [[2]](#_Applicable_Documents).
* For all dimensional characterization activities, the “ITER Dimensional Metrology Handbook” [[3]](#_Applicable_Documents)shall be applied as well.
* EN, ISO and ASTM Standards referenced in any of above mentioned Codes and Standards shall also be considered as complementary applicable documents with regards to manufacturing requirements.
* EN, ISO and ASTM Standards mentioned in this TS shall be considered in their latest version at the time of the sign of the contract.
* In case of change of edition year or issuing standard, which supersede above mentioned, the use of new Standards is allowed only in case of demonstration of equivalency with prior written Client’s approval.
* The use of EN but non NF Standards is also allowed demonstrating equivalence with the corresponding NF version of the Standard.
* Other equivalent national or international Standards and Codes proposed by the Contractor may be acceptable with prior written Client’s approval, provided conformity assessment to all criteria is satisfied.
* As a rule, in case of discrepancy between requirements in RCC-MR 2007 (or referenced Standards) and IO-specific Codes, the later ones shall prevail.
* Nevertheless, reference Codes and Standards are established in a more detailed way (including applicable exemptions or prevalence rules) for every set of requirements included in mandatory Appendix of this Technical Specification.
* An Inspection entity selected by the Client may be used to ensure manufacturing compliance with the RCC-MR 2007 and additional requirements stated in this Technical Specification

## List of Drawings

At this first stage of the study only detailed drawings are included as description of the structures to be manufactured for the case of generic UPP and EPP.

|  |  |
| --- | --- |
| **ITEM** | **Title** |
| GEPP | EQ Port plug structure |
| GUPP | Upper Port plug structure |

Table 3: List of drawings

# Description

The ITER Project is an international effort aimed at demonstrating the scientific and technological feasibility of nuclear fusion energy. The nuclear fusion reactions occur within the volume of the ITER vacuum vessel, which is filled during operation with a hot gas (plasma).

A key aspect of the research program of ITER is the diagnosis of the plasma and the first wall, e.g. the plasma temperature, density, radiative properties, first-wall resilience, etc. For this purpose, many different types of diagnostic equipment peer into the ITER vacuum vessel from many different vantage points. The focus of the present document is one generic location known as the Upper and Equatorial Port Plug structures (GPP).

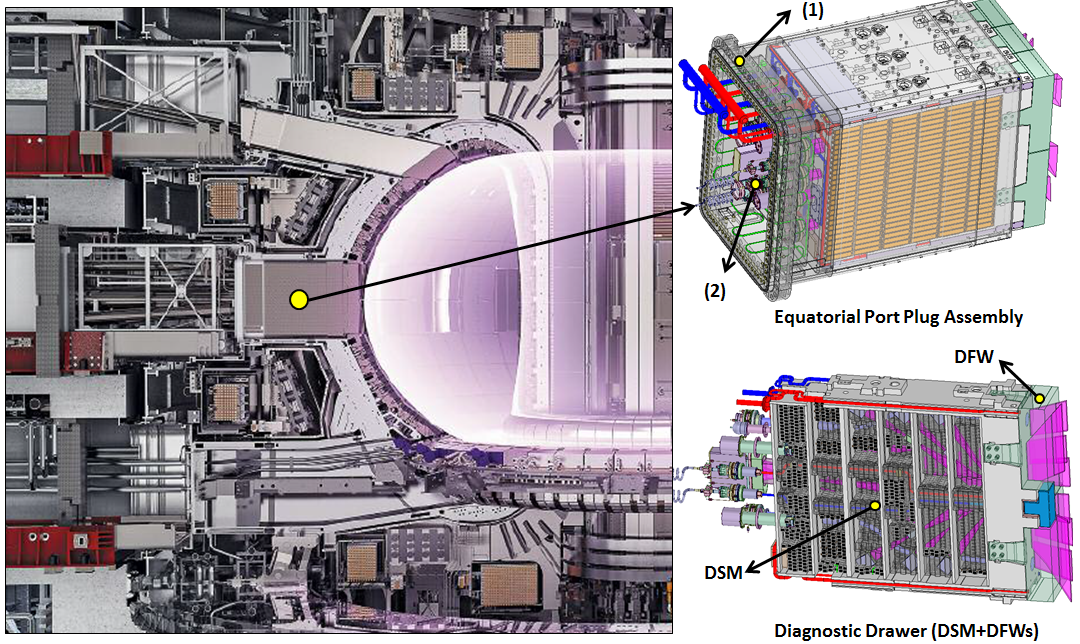


Figure 1: Location of Diagnostic Port Plug in the ITER Tokamak Machine

The diagnostic Port Plug structures are stainless steel metal boxes that house components which serve a common platform, or support/container, for a variety of diagnostics. In addition, Port Plug structures must contribute to the nuclear shielding, or plugging, of the port to protect other structures coils, personnel, etc., from nuclear radiation (neutrons, gammas). They also contain circulated water to allow cooling during operation and heating during bake-out.

In general sense, the generic Port Plug structures provides the platform upon which the diagnostic hardware rests. It must provide mechanical support, while maximizing the payload volume and maintainability in a cost-effective way.

The typical Upper Port Plug (UPP) structure is shown in Figure 2. This figure shows the port plug structure without the internal modules.

The upper port plug consists of three basic portions, (1) the trapezoid section, which forms the majority of the overall length of the structure, (2) the box section with blank closure plate, which makes the transition to a rectangular cross-section, and (3) the bolting flange, which is used to fasten the port plug to the flange of the upper port of the ITER Vacuum Vessel.

The overall length of the upper port plug structure is approximately 5.5 m, with a maximum width of approximately 1.3 m. The weight is supposed to be approximately 10 tons.



**Figure 2. Upper Port Plug structure and general dimensions**

The Equatorial Port Plug (EPP) structure is shown in Figure 3. This figure shows the port plug structure without the internal modules.

The typical Equatorial Port Plug structure consists of four basic portions, (1) four 60 mm plates, which form the majority of the overall length of the structure, (2) four forged corner pieces which join the four plates, (3) the blank closure plate, and (4) a large forging which forms the bolting flange and is used to fasten the port plug to the flange of the equatorial port of the ITER Vacuum Vessel. The closure plate may be understood as an independent plate welded to the flange forging or as part of the flange forging itself.

The overall length of the equatorial port plug structure is approximately 2.9 m, with a maximum height of approximately 2.4 m and a maximum width of 1.9 m. The weight is supposed to be approximately 15 tons.



**Figure 3. Equatorial Port Plug structure and general dimensions.**

Number of required GUPP structures and GEPP structures will be defined in future.

The Supplier shall make complementary Manufacturing Design based on the “Final Design Maturity” drawings and interface tolerance values to be provided by the Client; according to proposed, qualified (when applicable) and approved by the Client manufacturing procedures.

The Supplier will be further on responsible to produce the GPPs and will have to demonstrate that the produced and delivered GPPs are fully compliant with the Final Design Specifications.

## Responsibilities and licensing

The responsibilities between the Parties are summarised in Table 4 (below) and is further detailed in the following sections.

| **Activity** | **Client (IO)** | **Contractor** |
| --- | --- | --- |
| **Phase 1 Preliminary Design (if applicable)** |  |  |
| *Preliminary Design* |  |  |
| *Preliminary Design Review* |  |  |
| **Phase 2 Final Design (if applicable)** |  |  |
| *Final Design* |  |  |
| *Final Design Review* |  |  |
| **Phase 3 Manufacture, Assembly, FAT and Delivery** |  |  |
| Manufacturing Readiness Review | **A** | **R** |
| Manufacturing | **A** | **R** |
| Customization of PPs mating areas (optional, see scope) | **A** | **R** |
| Factory Acceptance Testing | **A** | **R** |
| Packing and Delivery to the Port Integrator Site | **A** | **R** |
| **Phase 4 Integration & Acceptance** |  |  |
| *Provisional**Acceptance* |  |  |
| *Technical Support to Integration* |  |  |
| *Testing Readiness Review* |  |  |
|  |  |  |
| *Technical Support to Testing* |  |  |
|  |  |  |
| *Final Acceptance* |  |  |

Table 4: Summary of responsibilities between the Client (IO) and the Contractor

*R = Responsible for organizing, performing and for the content*

*A = Review/Comment/Accept/Approve*

ITER is a Nuclear Facility identified in France by the number-INB-174 (“Installation Nucléaire de Base”). All activities to be carried out and all equipment to be delivered to ITER Organization must comply with French Nuclear Regulation in application of the Article 14 of the ITER Agreement.

Port plug structure is identified as Protection Important Component (PIC) and thus shall comply with requirements for basic nuclear installations.

## GPP structures classification

This section outlines the different GPP structures classifications regarding safety, quality, vacuum, PED/ESPN and alignment & metrology.

Note: These classifications rule the design, manufacturing, inspection and tests of the structures.

The diagnostics Port Plugs are specifically PIC components, defined as those required to bring and to maintain ITER in a safe state and which their failure can directly initiate an incident or accident leading to significant risks of exposure or contamination. GPP structures are part of PIC components (Port Plugs) which include the primary confinement boundary.

The flange and the closure plate form a confinement barrier and serve a shielding purpose and non-aggression to other PIC boundaries and components.

Consistently with the previous classification, the Supplier shall assume GPP structures as part of Protection Important Components regarding safety in their manufacturing procedures.

According to “Quality Classification Determination”, PPSs as PIC components are Quality Class 1 (QC1). QC1 criteria belong to any safety related class item or any item whose failure/malfunction could result in extensive machine downtime.

Those requirements are formulated in general sense and detailed particularization to every manufacturing operation is included in the different sections.

The Supplier shall consider GPP structures as QC-1 components as defined in the document “Quality Classification Determination” in their manufacturing procedures.

The Port Plugs are a primary vacuum boundary at the level of the flange. This portion of the Port Plug is therefore classified as VQC1A. The same classification is adopted for parts which constitute physical separation between water and vacuum (i.e.: plug welds).

Other portions of the port plug, which do not constitute a primary vacuum boundary, are classified as VQC1B.

The vacuum quality classification has many implications on manufacturing requirements like acceptable design and joining techniques, machining, material procurement, etc… as established in the “ITER Vacuum Handbook”.

The Supplier shall consider GPP structures as VQC-1 components as defined in the document “ITER Vacuum Handbook” in their manufacturing procedures.

Alignment & Metrology (A&M) classification is discussed in the “ITER Dimensional Metrology Handbook” which outlines the requirements for dimensional control of the components, assemblies, and systems for the ITER machine. GPP structures are classified as a A&M class 1 components corresponding to components or assemblies requiring alignment and/or dimensional control, where failure to comply in these areas will significantly impair or prevent machine assembly and/or operation and could potentially cause schedule delay more than one month or cost risk in excess of 1M€. Therefore, manufacturing related requirements for A&M class 1 component defined in the “ITER Dimensional Metrology Handbook” are included in dedicated sections. The Supplier shall consider GPP structures as A&M class 1 component as defined in the document “ITER Dimensional Metrology Handbook”.

In addition, Class B Requirements as defined in RF 6200 of RCC-MR 2007 shall be applicable on all internal surfaces in contact with the cooling water system (CWS) and vacuum. This condition rules the facilities of the workshops (further explanation is included in section 10. Manufacturing requirements. Cleanliness and vacuum quality requirements (Level II work areas are mandatory for class B).

# Scope of work

## Items and Activities Included in the scope of work.

The Scope of Work of this Contract comprises the following:

-The Supply of 14 GUPP and 7 GEPP to the different Client Port Integrator Sites in compliance with client required documents, Appendices listed, Applicable documents, the DCIF Instructions and Referenced documents.

-The creation and supply of Built-to-Print (BTP) drawings according to the 3D CATIA models including the manufacturing drawings.

-The conceptual design and manufacturing of drawings for jigs and fixtures. Note that these jigs are not defined but are required according to the needs (restraints) for the control of distortions during welding and rest of manufacturing, tests and Handling and transportation.

-The Structural verification analyses pertaining dimensional inspection, transportation and handling, welding distortion and stress relief, stress analyses supporting deviation requests and stress analyses supporting non-conformances.

-The derivation and engineering justification of the manufacturing process taking into account the tolerances and all other requirements.

-Production of manufacturing documentation.

-At the end of factory fabrication, delivery of an End Of Manufacturing (EOM) report including certificates of compliance / release notes, justification/tracking of non-conformances and Client’s acceptance through tracking sheets, as-built drawings (dimensions) and testing reports.

-The design and manufacturing of PP handling and transportation tools for use within the factory of during the delivery to the destination site of the items.

The Scope of Work also comprises the following activities:

-Technical and Management reporting and justification in meetings and with reports and presentations of the design of the handling and transportation tools mentioned in the point above before the start of manufacture.

-Full documentation of the complete manufacturing procedure and sequence of manufacturing and testing: cutting, plate straightening, forging, machining, welding, NDTs procedures, cleaning, inspection and other tests, packing, handling, and shipping.

-Qualification of other special manufacturing procedures like gun-drilling.

-Development and qualification of welding procedures in accordance with the applicable Codes and standards.

-Development and qualification of NDT procedures in accordance with the applicable Codes and standards (C&S).

- Qualification of other NDE techniques proposed by the Supplier not included in the applicable C&S according to the Client’s defined requirements, like special UT examination procedures (PA, TOFD).

- Procurement of materials specified, including product qualification when required.

- Manufacturing method and design complying with all requirements listed dedicated section.

- Manufacture of the PP structures according to approved procedures of cutting, forming, welding, inspection, cleaning, test… complying with dedicated sections.

- Testing (including final factory acceptance tests) of the PP structures according to the tests required and acceptance levels described in dedicated sections.

- Quality Assurance, complying with the requirements of dedicated section.

-Inspection and testing (at manufacturer site) and reporting.

- Packing of the PP structures, complying with dedicated sections.

- Transportation and delivery of PP structures to Port Integrator assembly/testing Site. Including Territories defined in section 16.

- Inspection at Port Integrator assembly/testing Site after delivery and reporting. Including Territories defined in section 16.

The Scope of Work may also include additional customization features on particular items. These customization features shall follow the qualified and approved manufacturing procedures according to this TS as well as the quality assurance scheme defined in the Management Specification.

## Documentation to be supplied during the execution of the contract.

- The final manufacturing sequence shall be defined by the Supplier and implemented in the Project Execution Plan (PEP). The resultant documents shall be subjected to the Client’s approval.

- Any document from the Supplier, produced during the execution of the contract, shall be sent to the Client for approval unless the documentation is explicitly earmarked as informative documentation.

- Prior to the commencement of the manufacturing stage a “Manufacturing and Inspection Plan (MIP)” as part of the PEP shall be produced by the Supplier in accordance to dedicated sections. It shall encompass drawing, verification of materials, manufacturing operations, inspection, and test to delivery.

Manufacturing documents during the execution of the contract:

Technical manufacturing documents comprise all documents pertaining technical aspects of the manufacturing phase. Those documents shall be produced by the Supplier thorough the manufacturing stage.

- BTP drawings including manufacturing drawings.

- Documents related to procurement activities.

- Documents related to fabrication process and their other than welding (marking, machining, forming, cleaning, handling…).

-Documents related to welding operations.

-Documents related to examination.

- Documents related to testing.

- Documents related to packing, shipping, and storage.

The follow-up of the manufacturing stages shall be documented through regular monthly reports on the manufacturing status to summarize the implementation of contract. These reports shall be produced in accordance with section RA-3900 of RCC-MR 2007 Code and other dedicated sections. Any delays, manufacturing problems, and alternative manufacturing methods deviating from the plan presented at the readiness review meeting shall be included.

Any divergence from the original specification for the works shall be documented by the Supplier and approved by the Client through non-conformance and deviation reports in accordance with the provisions set out in dedicated sections.

All engineering analyses performed during the manufacturing phase shall be supported and documented through analysis reports and analysis Acceptance Delivery Packages (ADPs) corresponding to the analysis activity as specified in dedicated sections.

As-Built CAD 2D drawings and 3D models that are part of the ADP files, including the outcomes of the final factory acceptance dimensional control.

Release Note (CRN): This document shall be produced before the shipment, according to the requirements set out in RA 3920 (Certificate of Compliance) in RCC MR Code 2007 and other sections.

The End-of-Manufacturing report lists all the documents produced during the fabrication phase and which demonstrate that the finally achieved quality of the components is acceptable according to dedicated sections. The End-of-Manufacturing report shall comprise at least the following:

-The Contractor’s Release note (Certificate of Compliance).

- Documents related to procurement including material certificates, product qualification reports, etc...

- The welding data package.

- Production weld data sheets and production weld test coupons.

- Manufacturing procedures including the qualification reports of special manufacturing techniques (i.e.: gun-drilling).

-Extracts from examination and test procedures including the qualification of examination techniques.

- Examination and test results.

- Engineering analyses reports required in the manufacturing phase.

- Final factory acceptance test reports.

- Shipping and delivery documents.

- Non-conformance reports.

- As built drawings.

# Technical Requirements

## Manufacturing Design Requirements

The Manufacturing Plan shall be carried out by the Supplier through the following steps:

1. The Supplier shall prepare the draft Final Manufacturing models and drawings implementing the proposed manufacturing approach. The draft Final Manufacturing models shall be checked and approved/accepted by the Client.
2. The Supplier shall prepare the Final Manufacturing drawings based on the approved/accepted draft Final Manufacturing models.
3. The Supplier shall start manufacturing based on these Final manufacturing drawings, following a Manufacturing Readiness Review (MRR).

Concerning CAD design activities, the following applies:

The Supplier shall ensure that all designs, CAD data and drawings delivered to the Client comply with the “Procedure for the Usage of the ITER CAD Manual” and with the “Procedure for the Management of CAD Work and CAD Data (Models and Drawings)”.

- Any cost or additional work resulting from a deviation or non-conformance of the Supplier with respect to the CAD collaboration requirement shall be incurred by the Supplier.

## Material Requirements

### Material Procurement

Material procurement shall follow the general requirements applicable to material procurement activities under RCC-MR 2007 Code. Requirements related to the two main ways for material procurement included in RCC-MR 2007 are applicable.

Material traceability and approval requirements are also included.

- Material procurement shall follow the general requirements applicable to material procurement activities under RCC-MR 2007 Code.

- Filler material shall be subjected to qualification when required.

- Filler material shall be subjected to Acceptance.

## CAD activities and engineering drawings

CAD activities within the scope of the Framework Contract are managed through the System for the Management of Diagrams and Drawings (SMDD) which is the single common IO repository for all Diagrams and Drawings in pdf format. This is an interface document describing how the Client’s DO and the Supplier’s DO (or external contributor) will organize themselves for a specific collaborative task in a way that all the requirements and missions related to this specific task can be fulfilled in the most efficient manner in compliance with the requirements of the French Nuclear Regulator. It describes the collaboration, responsibilities, processes and inputs/outputs of the Client and the Supplier regarding the CAD activities.

Engineering drawings define the fundamental design dimensions, tolerances and related requirements as a result of the design cycle carried out to achieve a suitable final design of GPP structures. These engineering drawings specify final dimensions of the components at the reference temperature of 20˚C without taking into account mechanical deformation under self-weight.

Despite of the fact that the design is considered as consolidated, minor modifications affecting to several dimensions may take place.

## Engineering analysis

During the fabrication, it is expected that several engineering analyses shall be performed to support particular manufacturing stages. This task is included in candidates scope. These analyses include:

* Dimensional inspection analyses.
* Transportation and handling analyses.
* Welding and stress relief distortion analyses.
* Stress analysis supporting design change requests (Deviation Requests, DRs).
* Stress analysis supporting non-conformances.

Previous engineering analyses shall be obligatory when needed or when it is explicitly specified in the corresponding section of final technical specification.

General requirements, provisions on analysis software tools, analysis models, reports, analysis validation and independent verifications pertaining engineering analysis shall meet the client requirement specified in future Technical Specification. Those provisions shall also be applicable to other engineering analysis not explicitly mentioned in this section.

## Manufacturing requirements

### Cleanliness and vacuum quality requirements

Cleanliness is required during the whole manufacturing process and the preservation of cleanliness is a good practice for any component to achieve the necessary vacuum and quality standards and to minimise the time required for recovery from any contamination incident.

All components must be subjected to a rigorous cleaning procedure, consistent with the Vacuum Classification. Cleanliness conditions are applicable from the time in which the component is cleaned and during subsequent stages (further fabrication, protection, transportation, installation on the construction site, etc.).

Operations relating to cleaning, inspection, protection, and preservation, shall be performed in accordance with the requirements specified in future Technical Specification.

Cleaning and cleaning checks shall be performed at several stages of manufacturing, assembly, test, handling, packing and delivery. Surface finish plays a major role to ensure adequate cleaning after machining. Cleaning procedure must be established to ensure needed cleanliness requirements, especially in locations where accessibility is difficult and a possibility for local spots having unacceptable surface finish requirements (e.g., gun drilled holes) exists.

During all intermediate stages of manufacturing, all surfaces including weld beads (root, filling, and capping) shall show a uniform metallic colour and are absent from evaporation patches caused by cleaning agents.

PP structures are considered as Class B components. Class B Requirements, as defined in RF 6200 of RCC-MR 2007 shall be applicable on all internal surfaces in contact with the cooling water system (CWS) and vacuum.

The ITER Vacuum Handbook (2EZ9UM v2.3) in general and particularly sections 8 and 24, attachment 2 on cleaning requirements relating to the assembly of vacuum components and appendix 4 on accepted fluids shall be satisfied as well. Appendixes 2, 13, 14, 15 and 17 of previously mentioned reference also constitutes a useful guide which is intended to assist the Supplier of vacuum components to ITER in the preparation of a clean work plan and cleaning procedures for submission to ITER for acceptance.

Only materials listed as accepted materials and cleaning fluids according to Appendix 3 and 4 of the ITER Vacuum Handbook (2EZ9UM v2.3), can be used during manufacturing, test, assembly, Storage, handling, packing and delivery.

Operations relating to cleaning, inspection, protection, and preservation, shall be performed in accordance with the requirements specified in properly identified documents as procedures or instruction sheets. A detailed clean work plan in accordance section 5, RF 6000 of RCC-MR 2007, section 24 of the ITER Vacuum Handbook (2EZ9UM v2.3) and the attachment 2 of previous document (ITER Vacuum Handbook Attachment 2 - Cleanliness Requirements Relating to the Assembly of Vacuum Equipment), shall be submitted for prior acceptance to the ITER Vacuum RO before any cleaning operations are undertaken at the Supplier’s site.

The Supplier is at liberty to propose alternative cleaning procedures to the Client for approval provided that outgassing results comply with the requirements of this Technical Specification. Compliance may be shown by the testing of coupons pieces which have been subjected to all the proposed manufacturing and cleaning cycles, that should represent the exact conditions of manufacturing stage/s.

*Additional Notes from RCC-MR 2007 clean areas:*

Supplier clean areas will satisfy the requirements pertaining level II work areas defined in RF 6242 of RCC-MR 2007, VQC-1 as defined in table 24.1 of the ITER Vacuum Handbook (2EZ9UM v2.3).

Level II work areas are required for working on these PP structure class B components. Work assembly area shall be assumed as the surrounding environment in the immediate vicinity of a component or component part (for example, internal or external surfaces). The Supplier shall submit to the Client for approval details of clean areas to be utilised during the manufacture, assembly and storage of the GPP structures.

Supplier should consider RF 6242 Level II work area defines the mandatory following conditions for the zones in workshops and storage.

Additional provisions from ITER Vacuum Handbook for VQC-1 are also mandatory.

Compliance for the cleaning procedures may be shown by the testing of coupons pieces which have been subjected to all the proposed manufacturing and cleaning cycles. Note that considerations of time and cycle routine factors need to be consider for intermediate manufacturing operations and storage (e.g., time between operation, task in different working areas, task by different subcontractors, and operations during shift change need to be considered).

In certain situations, the Manufacturer shall take measures to avoid contamination during fabrication phases prior to cleaning when any such contamination may not be eliminated by later operations preceding cleaning. The need for such provisions is particularly applicable to corrosion-resistant surfaces. Parts and sub-components shall be degreased using solvents or alkaline detergents, rinsed with demineralised water, and dried in hot gas or an oven to accepted procedures.

*Control of contaminants:*

The requirements of section RF 6400 of RCC-MR 2007 cover the control of contamination of materials in order to prevent corrosion need to be consider:

The requirements of RF 6420 are applicable to corrosion-resistant surfaces whether they are in contact with these fluids or not defined in Appendix RF1.

*Intermediate storage*

A level II storage area according to RF 6634.2 shall be required.

For intermediate storage, safe places shall be chosen, i.e., away from tracks of fork lifters and other industrial trucks. Preferably items shall be stored not on the floor to avoid, that things are falling to them and cause damage. Items shall not be stored together with carbon steel.

*Cleanliness control*

Requirements in RF 6300 of RCC-MR 2007 shall be applicable. After cleaning operations, a check shall be made to verify that the required degree of cleanliness of surfaces has been obtained. The check shall consist of performing the tests and applying the associated criteria (RF 6320) specified in table RF 6310 for the cleanliness classes.

If any degradation shall be subsequently detected (particularly during and after installation) and if this degradation is sufficient to adversely affect the degree of cleanliness obtained, checks shall be made by performing the tests specified in RF 6320 and if necessary, cleaning operations shall be repeated.

### Surface finish requirements

Surface finish requirements stated in section 8 of the “ITER Vacuum Handbook” for VQC-1 components shall be applicable to in-vessel components. The roughness conditions must be maintained on the interior surfaces and on the exterior surfaces. This should be taken with special caution in deep drilling operations where the tool can generate marks inside the drilled area due to vibrations that may be found outside the specified conditions. In these cases, it will be necessary to apply additional methods such as polishing the surface of the hole to achieve the roughness measurement. As general rule Surface roughness Ra shall not exceed 6.3 μm.

### Welding requirements

This part of the document describes the general requirements of welding operations during the manufacturing of the GEPP/GUPP structures.

Welding operations shall follow the applicable code for manufacturing operations RCC-MR 2007 for class 2 box structures. Section 4 of the Code, devoted to welding constitutes the main reference regarding welding requirements. Besides, as this section also refers to some European and ISO Standards, they shall be considered as complementary applicable documents in terms of welding requirements.

Provisions included in section 7 and attachment 1 of the ITER Vacuum Handbook (2EZ9UM v2.3) shall be considered as mandatory.

The use of any welding technique shall be preceded by the following qualifications:

* Qualification of the workshop.
* Qualification of welding procedures.
* Acceptance of filler materials.
* Qualification of filler materials.
* Qualification of welders and welding operators.

Prior to the commencement of welding operations, the capacity and technical resources of production workshops to carry out welding operations shall be demonstrated through technical qualification.

*Classification of welds and joint designs*

All structural welds present in the PP structure are classified as category 1 or 2 in consistency with the Structural Integrity Report (SIR). Only full-penetration joint weld types accessible from both sides are allowed. In addition, Plug welds are classified as category 2 welds (full-penetration, back side inaccessible with gaseous back protection).

*Welding processes*

Foreseen welding processes during PPs manufacturing are electron beam welding (EBW) for thicker parts of the tunnel, gas tungsten arc welding (GTAW/TIG) and its variants (Narrow gap TIG, automatized TIG, EBW+TIG…). The objective of the welding procedures shall be to minimize welding defects, optimize the non-destructive examination of welds and minimize welding distortions and residual stresses in the component.

While several welding processes can be applied in the PPs, it is mandatory that low distortion process, like EB, are selected and perfectly justified. In particular the expected field of distortions and strategy to compensate it, should be mandatory before starting any welding task.

Manual and automatic arc or advanced welding processes can be utilized if they are covered by the code (part RS 3100 in RCC-MR 2007).

Preference would be given to automatic or mechanized welding processes as opposed to manual processes to limit human and random errors. Manual welding may be used if necessary, but its extent should be minimized. Welding processes as well as joint details shall be designed, according to the weld categorization, so that minimize shape defects and meet tolerance requirements.

Narrow-Gap automatic TIG (NG-TIG) can be proposed as alternative to EB if this is correctly justified by distortion studies, since it is a procedure capable to produce high quality and sound welds (paragraph 7.1.3 of ITER Vacuum Handbook (2EZ9UM v2.3)).

Manual TIG can be also proposed for especial welds as the plug welds.

In case of welds where access to the back side of the joint is not possible (plug welds & pipe welds), a joint design is required that assures the root side is smooth and uniform allowing it to be reliably inspected. Samples like mock ups and preproduction welds have to be produced to guarantee the acceptance of the root profiles at the stage of the qualification. These samples will be used to confirm welding strategy and NDE techniques. This point has special importance in plug welds where weld defects can appear as, lack of fusion, lack of protection, local oxidation, other means of contamination that can produce dangerous effect as stress corrosion cracking (SCC).

For this joint configuration, the root side of the joint must be purged with inert gases and maintained during welding of root pass and first filling passes. This last requirement shall also apply to welds not accessible from the back side. These welds need to be examined by second NDE if they are in vicinity of other subsequent welds that can generate new heat affected areas over the plugs (e.g. plugs near EB welds).

Welding Procedure Qualifications shall be performed in accordance with requirements defined in proper sections in other to produce adequate Welding Procedure Specifications (WPS) that ensure during production weld soundness, which means absence of defects as well as an acceptable microstructure after the execution. Welding procedure qualification tests shall be performed in accordance with the full requirements of Standard NF EN ISO 15614-1 considering the stipulations listed in RS 3200 and attachment 1 of the ITER Vacuum Handbook (2EZ9UM v2.3) which clarify or complete those contained in the Standard. In case of any discrepancy between requirements in section 4 of RCC-MR 2007 and attachment 1 of the ITER Vacuum Handbook (2EZ9UM v2.3), most stringent ones shall prevail.

If the welds in manufacturing present difficult conditions or the IO engineers consider that their conditions cannot be reproduced by standard coupons of EN ISO 15614 (its different parts), the qualification of the procedure must be done according to pre-production coupons according to EN ISO 15613, in addition the requirements in RS 7800 cover the production of weld test coupons. Test coupons shall be welded in accordance with the corresponding production welds and whenever geometrically possible in the extension of a longitudinal weld. The welding of the test coupon shall be carried out under the supervision of the workshop inspection section by welders or welding operators carrying out the corresponding production welds, using the same welding parameters and the same type of welding equipment. Records shall be taken in the same way as in welding procedure qualification tests.

For the special case of qualification of EBW or Laser welds, the Standard NF EN ISO 15614-11 is applicable to the qualification by a preliminary welding procedure specification (pWPS) following NF EN ISO 15609-3 in case of EBW welds and NF EN ISO 15609-4 in case of laser beam welds for metallic materials without limitations.

Additional prescriptions in RS 3560 and RS 3570 shall apply as well.

*Pre-Welding Procedure Specifications*

For each joint to be welded a procedure welding specification (WPS) will be developed by the Manufacturer (note: welding activities cannot be subcontracted to other companies). WPSs will be issued ad-hoc for the PPs manufacturing project.

A preliminary WPS proposal will be firstly issued (pWPS) summarizing the welding parameters/variables related to the procedure. Weldability of material shall be demonstrated according to RS 1200 in RCC-MR 2007. These pWPS must be taken as a project of WPS and therefore, using pWPS for any other operation than for qualification test is strictly prohibited.

The code defines all the welding parameters and variables to consider in the pWPS proposals.

*Procedure Qualification Records (PQR)*

Every pWPS must be qualified through a test coupon welded according to parameters and variables previously defined in the pWPS. These coupons will be tested according to the destructive and non-destructive tests specified in the prescriptive C&Ss. The WPS is valid for an unlimited time on condition that it is not invalidated by the appearance of repeated welding defects during manufacturing or in welding production test coupons.

For special and non-conventional welding arrangements like the plug welds, the preparation, execution, and testing of test coupons supporting the Procedure Qualification (PQR) shall consider conditions such as assembly geometry, welding position, access for gas protection, execution and testing of production welds (for this specific case the use of EN ISO 15613 is mandatory)

Situations involving more than one single welding procedure like EBW welds overlapping plug welds shall be qualified considering equivalent conditions as those present in production welds.

Qualification coupons meeting all requirements in RS 3200 of RCC-MR 2007 and attachment 1 of the ITER Vacuum Handbook (2EZ9UM v2.3), as well as inspections and tests to be performed; shall be proposed by the Manufacturer and subjected to the Client’s approval.

Results of tests performed on the coupons shall be recorded in the Procedure Qualification Records. The welding and testing must be witnessed by a client’s recognised Independent Inspection Authority.

If tests are successfully passed according to the criteria stated in reference C&Ss, the initial pWPS will be rewritten into a Welding Procedure Specification (WPS) where the essential welding variables and their allowed ranges according to RS 3200 of RCC-MR 2007 and attachment 1 of the ITER Vacuum Handbook (2EZ9UM v2.3) will be defined.

Therefore, each WPS shall be supported by one or more Procedure Qualification Record (PQR or WPQR).

The PQR constitutes the record of the test weld performed and tested (more rigorously) to ensure that the proposed procedure is capable produce sound welds.

*Qualified Welding Procedure Specifications (WPS)*

The pWPS is qualified to be a WPS if results of destructive tests and non-destructive examinations are within allowable values specified in RS 3200 of RCC-MR 2007 and attachment 1 of the ITER Vacuum Handbook (2EZ9UM v2.3).

The qualification coupon shall be subjected to all the non-destructive examinations specified for the manufacture of the joints qualified by it and the coupon shall also comply with the Class 1 requirements set out in RS 7710. Acceptance criteria shall be those specified in RS 7714.

In case of destructive tests acceptance limits in RS 3234 shall apply together with acceptance levels specified in paragraph 6.3.2 of attachment 1 of the ITER Vacuum Handbook (2EZ9UM v2.3). In case of discrepancy, most stringent limits shall prevail.

Requirements for test on coupons and allowable ranges for essential variables will follow the section RS 3200 (RS 3560 and RS 3570 in case of EBW and LBW welds respectively) and examination and testing conducted according to section 3 of RCC-MR 2007 and attachment 1 of the ITER Vacuum Handbook (2EZ9UM v2.3).

Additionally, the following requirements apply as well:

* Transverse and longitudinal tensile strength shall not be less than parent material.
* In impact test the absorbed energy shall be in the accordance with the parent material standard.
* Ferrite content allowed in the weld metal is 5-12%, preferably less than 10% for the specific approval of conventional filler material equivalent to ER316L.
* Ferrite content allowed in the weld metal is max 0.5%, for the specific approval of low ferrite content filler material equivalent to ER317L (Mod). Evaluation of magnetic permeability in this case
* In micrographic examination, no cracks are allowed, no detrimental Phases, no presence of oxidation in the material.
* For specific cases IO staff can define corrosion test to prove protection of welds during execution of PQR and mockups.

Testing personnel must be qualified. Requirements on this point can be found in RF 8000 of RCC-MR 2007 (EN-ISO 9712:2012).

Destructive and non-destructive test shall follow the procedures and meet the requirements included in Examination section.

Extra requirements in attachment 1of the ITER Vacuum Handbook (2EZ9UM v2.3) also applies to the inspection and qualification of welded joints and therefore they must be taken into account.

*Validity of the qualification*

The WPS is valid for an unlimited time on condition that it is not invalidated by the appearance of repeated welding defects during manufacturing or in welding production test coupons.

*Acceptance of filler materials*

Filler material and shall be subjected to the acceptance specification (RS 2120). The acceptance of filler materials shall follow the part RS 2000 in RCC-MR 2007.

The main purpose of the acceptance tests is to establish that the lots of filler materials used in manufacture are of a constant quality like that of the lots which have undergone qualification tests.

The acceptance tests shall, therefore, be carried out under reproducible conditions and shall be related to the qualification tests carried out on filler materials outside the dilution zone.

They shall be performed in the presence of the Supplier of the filler materials Quality Control Department representatives and/or of the Manufacturer.

The Manufacturer shall draw up acceptance specifications for the supply of filler materials. This document shall be drafted in accordance with the provisions of RS 2000 and shall refer to and comply with the provisions of the technical qualification data sheet for filler materials defined in RS 5142 when such qualification is required by RS 5000. Tests to be performed on each lot of filler materials are specified in RS 2536. Additionally, a hot tensile test should be carried for filler material out at 200°C.

In case of use of filler material not referenced in RCC-MR data sheets (RS 2700 and RS 2900) the Supplier shall submit to the Client for approval a specification data sheet including the results to be obtained for the acceptance of filler materials.

An acceptance report as defined in RS 2550 shall be prepared by the Manufacturer. The full designation of the material used for the acceptance tests, the specified values and the result of each test shall be recorded in this report. This document shall identify the specification which stipulates acceptance conditions. This document shall guarantee the compliance with the specification.

*Qualification of filler materials*

The qualification of filler materials, if needed, shall follow the part RS 5000 in RCC-MR 2007. RS 5000 deals with the qualification tests performed on filler materials for which a trade designation qualification is required.

The qualification of filler materials comprises two parts, the first relating to the Supplier of the material and the second to the Manufacturer who uses the material.

Suppliers of welding materials shall issue a qualification data sheet for the undiluted material corresponding to each trade designation of this material.

The Manufacturer shall perform a reduced series of tests on a standard test coupon. The welding procedure qualification tests cover these series of tests avoiding unnecessary tests on the standard test coupons. Appropriate examinations to ensure that the selected filler material meets the required specification shall be conducted.

Inspection documents demonstrating compliance with the specification by providing a test report "2.2" in accordance with the Standard EN 10204: Metallic product Types of inspection documents shall be issued.

Minimum strength requirements will be in accordance with filler materials data sheets in RCCMR-2007. Low ferrite content (in the range of 5 to 12%) is recommended, preferably less than 10% for type ER316L and 0.5% max in case of low ferrite typical filler material as type ER317L (Mod).

A change in impurities elements, like Boron, Cobalt, and Niobium, in the chemical composition of the baseline Material Product Procurement Specification (MPPS) should be subjected to the Client’s approval.

The qualification certificate issued by the Manufacturer shall define the conditions under which the tests on the standard test coupon were carried out and the results obtained. It shall refer to the data sheet and shall specify the limits of validity of the qualification of the material (RS 5143).

*Qualification of welders and operators (WPQ)*

Individual welders shall be certified with a qualification test documented in a Welder Performance Qualification (WPQ) that prove they have the understanding and demonstrated ability to work within the specified WPS.

Qualification of welders and welding operators shall be carried out in accordance with section RS 4000 of RCC-MR 2007. Regardless code requirements, following supplementary requirements apply to the qualification of welders and operators:

* Any change in the procedural conditions (manual, part mechanized, mechanized, automatic, etc.), shall require the welder to be re-qualified.
* If using partially mechanized welding process, the qualification should be made like for welder.
* For a full-penetration T-Butt joint in plate, the range of approval for thickness applies to the thickness of the bevelled plate.
* Each qualification test coupon with full-penetration butt welds shall be subjected to radiographic examination.

No production welding operation shall be undertaken unless the specified qualifications have been completed. The qualification of welders shall be established under the Manufacturer's responsibility. The technical skill of the welders is the responsibility of the Manufacturer. Adequacy and validity shall be checked by the Client before start of production welds. The conditions governing the renewal of qualifications are defined in RS 4200. They also apply to test coupons and qualifications obtained in compliance with RS 4300.

*Welding manufacturing plan*

After the completion of the qualification process described above, the Manufacturer shall present a detailed welding manufacturing plan, which gathers all the essential elements defining the welding operations.

* The welding plan shall include at least following:
* Drawings of the PP, marking the position of all welded joints.
* Preliminary verification of materials weldability (RS 1200).
* Acceptance of filler material lots (RS 2000).
* The welding processes to be used and relevant, qualified WPSs with PQRs (RS 3000).
* Qualification certificates of welders, operators, and testing personnel WPQs (RS 4000).
* Qualification of filler material if applicable (RS 5000).
* Workshop qualification report (RS 6000).
* (IMPORTANT) Description of welding sequence (welding manufacturing plan) including tack welding, and supporting strategy (jigs, jacks, and related means of assemblies. support). Different stages during the whole process, positions and jigs arrangements will be reported through 3D models following the standards and formats described in appendix 2.
* Description of welds identification/marking during the welding operations (welding map) including applicable WPSs.
* The type and scope of non-destructive examinations foreseen.
* A list of production control test coupons needed according to RS 7820.
* Description of stress relieving treatments if applicable.
* This document shall be subjected to the Client’s approval prior the commencement of any welding activity of PPs (hold point).

*Storage and use of welding materials*

The storage conditions of welding materials shall be such that the properties of the materials are preserved as well as fully traceability of materials and consumables are ensured.

A storage and use of welding materials procedure according to RS 7200 shall be drawn up and subjected to the Client’s approval.

Additionally, the following supplementary prescriptions shall be observed:

Storage conditions and use of the welding materials will be in accordance with the quality system of the workshop and will demonstrate the adequacy of material reception, storage, stock control, drying and conservation.

All welding consumables shall be stored and handled with care and used in accordance with the conditions specified by the welding consumable Manufacturer.

Electrodes, filler wires, rods and fluxes that show signs of damage or deterioration, such as cracked or flaked coating, rusting or dirty electrode wire, shall not be used.

The manufacturing must possess and maintains an identification system for welding materials used in fabrication so that all welding materials can be traced to its origin. The identification system shall satisfy the requirements of RS 7230.

*Preparation and examination of edges and surfaces for welding*

The surfaces to be welded shall be prepared according to RS 7300.

They shall be thoroughly cleaned of oxide, scale, oil grease or other foreign substance and free of defects such as inclusions, cracks, and laminations to avoid any detrimental effect on weld quality.

Cleaning conditions during welding shall comply with RF 6000 cleanliness class B requirements in RCC-MR. See work are level II requirements and additional rules for cleanliness section.

*Base material joint preparation*

The surface edges of parts to be joined by welding are prepared by machining, grinding, or thermal cutting. When thermal cutting is used, all scales shall be removed by grinding the base metal by a minimum of 1 mm. Requirements of RS 7300 and RC 4430 shall apply.

Defects beyond the acceptance criteria shall be removed by grinding or machining. Any local loss of thickness shall be justified by stress analysis and shall not exceed 10 percent of the parts thickness. In the event of repair by welding the Supplier shall issue a nonconformity report subject to the Client’s approval.

*Base material joint cleaning*

Prior to welding, surfaces for welding shall be clean and free from paint, oil, rust, scale, slag, grease, marking materials or other foreign materials that can be detrimental during the welding cycle. Cleaning shall comply with RF 6000 cleanliness class B requirements in RCC-MR.

*Joint Fit-Up and alignment*

Requirements of RS 7370, RS 7410 and RS 7420 apply.

The edges to be welded shall be kept in the position, either by mechanical means, temporary attachments, by tack welding or by a combination.

During the whole welding operation, the edges to be welded shall be held so that the alignment tolerances are satisfied.

A special procedure to apply for EBW welds where edge tolerances and alignment become critical for the quality of the weld. The typical fit-up tolerance for EBW shall be 0.1 mm and a special procedure should be developed for this operation.

The root opening and fit-up tolerances shall be arranged to comply with RS 7370 requirements, welding procedure qualification tests, non-destructive examination methods and meet final tolerances specified in drawings. In any case for plate welds, the maximum offset will not exceed 4 mm.

For thickness transition a maximum slope of 1:4 is allowed. Other cases should be justified by detail calculation according to RCC-MR 2007 rules.

Inspections before and after alignment shall be carried out as specified in RS 7360 and RS 7380.

*Execution of Production Welds. Tack weld requirements*

Tack welds do not form part of the joint. They shall be removed before or during the welding of the joint, and their complete removal shall be ensured. However, for certain welds without backing runs and for materials other than low-alloy steels over 20 mm thick, tack welds may be incorporated in the joint subject to exemptions listed in RS 7410.

Execution of tack welds shall meet requirements stated in RS 7400 with supplementary requirements in RC 4440 and AP19.4100.

The procedure of welding of tack welds, attachments, supports and stiffeners shall be qualified (RS 3000) and welders of tack welds shall also be qualified (RS 4000).

*Welding of permanent and temporary attachments*

Welding, removal, and inspection after removal requirements for temporary or permanent attachments shall be in accordance RS 7420 requirements. Welded attachments of jigs will not cross or cover other welds present in the assembly and will be compatible with the performance of required NDT.

Temporary attachments shall be removed using a technique which does not affect the properties of the metal of the part to which they are welded. Care shall be taken that the area of the removed attachment is free of surface cracks. Grinding is allowed only with vacuum compatible grinding wheels.

Visual and surface examination shall be performed on the area where the temporary attachment has been removed to ensure that permanent materials are not gouged, nicked, or otherwise damaged.

*Execution of welds*

For the execution of the welds, provisions included in section 7 and attachment 1 of the ITER Vacuum Handbook (2EZ9UM v2.3) shall be considered as mandatory. complete cleaning of surfaces near the weld is mandatory before assembly, tack welding and welding. Any rest of dust, oil and fluids can generate oxidation problems specially in not accessible areas.

-Welds that cannot be inspected (see Sections 7.1.4 & 7.1.6) are not permitted for use on VQC 1 and VQC 3 and should be minimised for use on VQC 2 and VQC 4.

- Visual and dimensional control shall be conducted according to RS 7460 before the execution of other non-destructive examination (LP and volumetric) after possible heat treatment, if necessary, and before any machining or grinding operations of weld surfaces. It is mandatory to do VT of the weld one by one, specially in case of plugs weld with no direct access area, so VT with videoscope in root, to avoid oxidation problems due to lack of protection by purging.

Inspection of Fusion Welded Joints After any post weld treatment as for example heat treatment, only, if necessary, shall be subject to the following tests:

- Visual examination (in accordance with ISO 17637)

- Dye Penetrant testing (in accordance with ISO 3452) if permitted. (Inspection using Photothermal camera is permitted in the case where the manufacturer has qualified the method/acceptance criteria prior to the weld)

-Radiographic examination (in accordance with ISO 17636) and / or

- Ultrasonic examination (in accordance with ISO 17640 and ISO 22825 for austenitic steels and nickel alloys)

In addition, Production welding operations may only be undertaken provided the following requirements are met (RS 7410):

- All the welds shall be identified with a unique number and shall be traceable back to the welder/operator and WPS used.

- is forbidden to weld if the room temperature is below - 10°C. The part must be kept at a temperature of at least + 5°C and cooling after welding shall be sufficiently slow to avoid cracking due to internal stress.

- All welding operations shall be performed under cover from bad weather in case of field or outdoors welds.

Special suitable tool sets shall be dedicated for use only on stainless steel welds. Contact with carbon steel shall be prohibited during welding operations. Transport clamps, hooks, and other devices shall either be stainless steel or be protected with plastic or cardboard to prevent carbon steel contamination.

Expected Welding distortions must be considered during the definition of the welding plan (involved procedures, welding variables and welding sequence) to control them so that the final distortions achieved are compatible with component tolerance requirements. Selection of weld procedure, Jigs, stiffeners, sequence, machining process after welding to compensate these distortions and rest of manufacturing steps must be studied taking weld distortions into consideration.

Following the completion of a welding operation (welded joints, weld cladding, repairs), a production weld data sheet according to RS-7470 shall be prepared for each operation or group of operations involving the same welding procedure.

Preheating (RS 7520), when required by the welding procedure, shall be performed in such a way that the properties of the metal in the preheated zones are not affected. The welding procedure shall indicate the minimum and maximum preheat temperature.

Dimensional stability heat treatments on welded subassemblies shall be performed prior to the final machining in a non-oxidizing, non-carbonizing neutral atmosphere.

Post-forming or post-weld heat treatment is not required or recommended for the fabrication of SS 316 L(N) stainless steel components.

Weld over thicknesses shall not exceed the tolerances given in RS 7461. If they exceed grinding or machining should apply. Special care shall be taken to prevent the contamination of the particles of carbon steel. If a final cosmetic pass is used to improve weld surface finish, it must be covered by the relevant welding procedure qualification.

*Special Notes from RCC-MR 07 RS 7436 Weld pool protection. Root protection*

If the root passes are made by the TIG process, the back side of the weld is protected from oxidation by an inert shielding gas which, for austenitic grades, shall be argon or another rare gas, or a rare gas/neutral gas mixture containing over 50% of rare gas.

This protection shall be maintained, whatever the welding procedure, until a sufficient thickness has been deposited to prevent any back side oxidation. Minimum thickness needs to be confirmed case by case by VT is not detecting any oxidation or heat tint effect in root or heat affected areas. Any other contamination in root like presence of fumes deposits are not permitted. For this RCC-MR 07 RS 7439 Cleanliness in welding need to be consider: During welding and according to the cleanliness classification of the component or part concerned (for the production stage on the basis of which this classification is applied), precautions shall be taken to prevent pollution by arc fumes or slag, in order to satisfy the requirements of RF 6000 (the Manufacturer's attention is drawn to the fact that this requirement may influence the choice of the welding process).

*Additional notes for Weld surface finish, visual and dimensional examinations*

Weld surface finishing shall be compatible with the performance of non-destructive examination and vacuum requirements.

Requirements in RS 7450 in RCC-MR 2007 and in section 7 (paragraph 7.1.5) and attachment 1 of ITER Vacuum Handbook (2EZ9UM v2.3) are applicable.

After welding and heat treatments the surfaces of the welds and adjacent areas shall be finished so that the required NDT can be properly performed. This means removing of spatters, slag, scaly oxides, grease etc. liable to interfere with the inspections and NDT. Surface roughness Ra shall not exceed 6.3 μm in the testing areas in case the weld is inspected by ultrasounds.

For liquid penetrant testing, weld surfaces at the final or intermediate stage (root of filler passes) shall be left as welded. Cleaning for the liquid penetrant testing should be made in a way that it doesn’t mask discontinuities by plastic deformation or clogging from abrasive materials.

Visual and dimensional control shall be conducted according to RS 7460 before the execution of non-destructive examination after possible heat treatment and before any machining or grinding operations of weld surfaces.

Dimensional examination methods must be defined by the Manufacturer and shall meet the requirements in appendix in Examination section.

Visual testing (methods shall be in accordance with RMC 7100) shall cover all the welds and both weld and root surfaces when accessible. Areas from where temporary attachments have been removed shall also be inspected.

*Non-destructive examination of production welds*

In addition to previous comments, 100% of vacuum sealing welds shall be subject to helium leak testing in accordance with the requirements and procedures described in Examination section. Surface examination can be done by liquid penetrant (RES) or photothermal camera (PTC) examination. In this case, tables RS 7720.3a, b and c are applicable by changing “RES” by “PTC or RES” (AP19.4200). Requirements in parts in parts RS 7720, AP19.4200 and RC 4460 of RCC-MR 2007 shall also be applicable.

Part RS 7724 defines the acceptance criteria applicable to the examinations prescribed. They shall be met in conjunction with criteria in in section 7 (paragraph 7.1.5) and attachment 1 of ITER Vacuum Handbook (2EZ9UM v2.3). In case of discrepancy, the most stringent specification shall be taken. Testing and non-destructive examinations shall follow the procedures and meet the requirements included in Examination section.

*Repair by Welding*

In the case of need of repair for surface defects of parent material or weld defects, repairing procedure shall follow prescriptions stated RS 7600 of RCC-MR 2007. Supplementary requirements stated in paragraph 7.1.5 of ITER Vacuum Handbook (2EZ9UM v2.3) shall also apply. All repair welding operations on welds, on parts or products shall meet the same requirements as those applied to production welds.

Two repair welding operations may be performed at the same point. A third one is not allowed. The Manufacturer shall not make further welds until he has prepared a report analysing the cause of these successive repairs. The same applies to repairs which occur too regularly or to the detection of defects which might invalidate the conditions of application of the procedure, or the qualification itself of the welding procedure.

If the extent of the repairs to be carried out on a weld performed by an automatic process is likely to exceed one fifth of its length and half of its thickness, the weld shall be carried out a second time and retested.

It is forbidden to repair defects detected during the final non-destructive examination. The size and cause of these defects shall be stated in the report.

To qualify the welding procedure for repairs the dimensions of the production weld test coupons shall satisfy the requirements of the welding procedure qualification test coupon and additional requirements stated in document. They shall be sufficiently long so that all the tests, retests and simulated repairs (specified in RS 3111) required for qualification can be performed.

*The welding data package*

A detailed welding data package must be issued after completion of all welding operations according to RS 1120. It shall include:

The manufacturing plan as described in this document.

A catalogue of all joints. For each welded joint, the following shall be provided:

* A dimensional sketch.
* Base materials certificates. Conformity with the relevant requirements this Technical Specification can be certified by the Supplier through an inspection certificate 3.1 in accordance with **EN 10204** and an inspection report in case he is in possession of an appropriate quality-assurance system, certified by a competent body. Otherwise, inspection certificate type 3.2 in accordance with **EN 10204:2005** can be provided after agreement with the Client.
* Filler materials certificates. Conformity with the relevant requirements this Technical Specification can be certified by the Supplier through an inspection certificate 2.2 in accordance with EN 10204.
* The welding procedure or procedures used and the relevant welding procedure data sheets.
* The cumulated heat treatments.
* The properly referenced qualification test coupon or test coupons which validate the welding procedure.
* The type and scope of non-destructive examinations carried out and their results. list of production control test coupons.
* Qualifications and certification of NDE personnel according to RMC 8000.
* All non-conformity reports.

This document will be reviewed by the Client before each delivery.

### Requirements relative to machining operations other than gun-drilling

Machining operations are required to achieve the final dimensional requirements of the GEPP/GUPP box/trapezoidal structures after full assembly and welding. Nominal dimensions of all parts coming from previous manufacturing stages will present over thicknesses and/or extra length to allow a final machining of the whole assembly so that final dimensions are reached through removal of the extra material.

This additional material coming from part dimensions before final machining must be controlled at design stage, and also at assembly stage in order to ensure that it will be placed where needed for subsequent operations or stages. This is relevant for inner and outer walls of the box/trapezoidal structure. The lack of material could cause non-compliance with dimensional requirements which could be difficult to solve since:

* Surface of the box is the positioning support for the pads and in some cases the structural support for transmission of forces from the DSMs to the box.
* The nominal gaps between DSM pads and box pads are in the order of 1 mm and larger gaps have a negative effect on DSM vibrations.

In addition, this extra material thickness need to be used to compensate distortions during welding, among other effects.

Taking these considerations into account, the inner/outer surfaces of the box shall need care machining to achieve the dimensional requirements to allow fitting of the DSM and the corresponding attachment components (rails, pads and pins) within the tolerances defined for the assembly.

The positioning of the rails, pads and pins for DSM support shall be a priority regarding machining operations, over the outer GEPP/GUPP box/trapezoidal dimensions, which do not require the same level of adjustment as other components. This circumstance shall be considered in the machining strategy.

From the point of view of service, machining operations shall guarantee the functional tolerances and surface finish conditions stated in drawings in order to ensure a correct service of the component, particularly:

* Compliance with Remote Handling requirements.
* Compliance with assembly requirements.
* Compliance with the structural dimensions.

Machining operations related to the inner/outer surface of the box/trapezoidal and the positioning of the rails, pads and pins for DSM support section will be managed as indicated in the chart of Fig.4.



**Fig.- 4: Sequence of operations in a machining cycle.**

For any part machined, it shall be generated a unique CNC program. In this program all the data needed to do the prescribed machined operations like geometrical data, type and number of milling tools, sequence of operations, machining parameters (cutting velocity, cutting depth; travel speed), etc. will be loaded.

To minimize risks related to the machining sequence and the interference piece-tool during the execution of the machining cycle it shall be included a simulation of the material removal sequence (CAM).

Care shall be taken in manufacturing processes so as not to introduce contaminants into surfaces which may be difficult to remove later, and which might result in degraded vacuum performance.

*Cutting operations*

All materials may be cut to shape and sized or prepared for welding by machining, grinding, or thermal cutting. Shearing of plates shall be permitted, subject to the provisions of RF 3200 of RCC-MR 2007. Requirements in RF 300 of RCC-MR 2007 shall be applicable. After cutting the parts to the delivery dimensions, the edges shall be visually examined. The absence of cleavage or lamination (for example comprised by a fine layer of inclusions drawn out during rolling) shall be checked. If in doubt, a liquid penetrant examination shall be performed: Indications with one dimension exceeding 1 mm shall be considered as a recordable condition. Linear indications of 8 mm or less for plates 40 mm thick or less, and of 10 mm or less for plates more than 40 mm thick are acceptable.

As the operating conditions of plates could lead to a risk of lamellar tear, the only acceptable indications are those with a cumulative length over the most densely covered meter as follows:

* Less than 30 mm for plates up to 40 mm thick.
* Less than 40 mm for plates over 40 mm thick.

Two separate indications are considered as one if the distance between them is less than twice the length of the smaller of the two. The length of the indication is then equal to the sum of the length of the two indications plus the distance between them. If these previous criteria are not respected, no repair welds shall be authorized, and the part should be rejected.

If there are localized indications (which can be checked by shear wave ultrasonic examination) this zone can be eliminated by grinding and the part accepted if its dimensions remain within the acceptable tolerances. When selected cutting process is plasma cutting at least 1mm depth of the cut edge will be removed to eliminate the melted and the heat affected region.

*Cutting and machining fluids*

Accepted cutting and machining fluids are listed in Appendix 4 of the ITER Vacuum Handbook. The use of other cutting fluids shall require prior acceptance by the Client. They shall be water soluble, non-halogenated and phosphorus and sulphur free.

*Cleaning after cutting/machining operations.*

After machining operations have been completed, parts and sub-components shall be degreased using solvents or alkaline detergents, rinsed with demineralised water and dried in accordance with previous section of cleanliness. The use of halogenated solvents is forbidden at any stage. Accepted fluids are listed in Appendix 4 of the ITER Vacuum Handbook.

*Dimensional control and surface finish characterization of cut/machined parts*

Alignment & Metrology (A&M) classification is discussed in the ITER Dimensional Metrology Handbook (46FN9B v2.1) which outlines the mandatory requirements for dimensional control of the components, assemblies, and systems for the ITER machine. Related activities during the manufacturing of GEPP/GUPP structures are classified as a (A&M) Class 1. Surface characterization of cut/machined parts shall be performed following the methods and requirements included in dedicated sections.

*Documents prepared by the Supplier.*

Prior to start the machining operations the Manufacturer shall produce a machining implementation plan that defines all related activities to be carried out. It shall include the following:

* Identification of machining plan containing sequence of operations.
* Identification of critical operations.
* Results of dimensional inspection and mapping before machining.
* The procedure to identify or generate references in the part.
* Results of the CAM simulation of the machining of the part.
* Reference standards.
* Design change control procedures – Drawings and CAD models.
* Document control.
* Instrument calibrations and test procedures.
* Control of non-conformities.
* Data management procedures.
* Measurement procedures- data acquisition, post processing and validation.
* Reporting procedures.

This implementation plan shall be submitted to IO for approval prior to start any machining operation. Additionally, during the execution of machining operations, dimensional inspection reports shall be subjected to requirements defined in dedicated sections.

They also shall include the following information according to mandatory requirement procurement (MRP) 13 for A&M Class 1 activities:

* Identification of measuring instruments to be used (with calibration certificate).
* Identification of the part examined.
* Part /component reference drawing and if necessary CAD model identification.
* Time of examination.
* Environmental data (temperature, humidity, and pressure).
* Surface preparation (method, cleaning).
* Calibration certificate for equipment used.
* dimensional control procedure and issue.
* Scanning sequence and direction if applicable.
* Raw data files using vectored information.
* Identification of all computer files generated during the inspection.
* Interpretation of results, including explanation for any readings that are interpreted as
* not valid.
* Identification of the company responsible for dimensional control when subcontracted.
* Name and qualification certification of the operator.
* Dimensional control date and signature of the operator.
* Non-conformity reports raised (if applicable).

These reports shall be part of the final manufacturing report of the equipment.

### Requirements related to special manufacturing processes like gun drilling.

An important feature of the GEPP/GUPP structures is the cooling channels drilled inside the 60 mm plates of the GPPs sidewalls. The maximum drilling depth is up to ~ 2.3 m with diameters varying from 15 mm to 25 mm. Apart from the holes themselves, other key features such as the cross holes breakings-through of different diameters must be considered by manufacturer.

The proposed process to implement the cooling channels is the gun-drill technique. Gun-drill technique is known for making high-quality finish, and straight holes of varying depths. Gun drill is a highly developed and efficient technique for producing either deep or shallow holes in a wide variety of materials. In any case, the qualification of this process and its quality control are a key part of the manufacturing of these components.

*Process qualification*

Gun-drill constitutes a very technological process in which the success of the operation is subjected to several practice factors. Therefore, in order to achieve the adequate process parameters, especially when dealing with austenitic stainless steel, a representative (or several) qualification mock-up (capable to reproduce similar process conditions) before the starting of the drilling operation shall be required. This qualification mock-up shall be subjected to the dimensional, visual (borescope) and surface examination in order to prove the adequacy of the essential process working parameters. Other tests as control of straightness, positioning, roughness inside the hole, and magnetic permeability are requested.

The Supplier shall demonstrate the adequacy of the technological aspects of this manufacturing process in order to avoid the risk of rejection of previously conformed plates. This qualification process includes the procedures for fabrication as well as the use of the mock-up to demonstrate feasibility.

The mock-up shall be subjected to the following requirements:

The coupons shall be taken from the base material for austenitic stainless-steel plates SS316LN-IG.

* The coupons shall follow the manufacturing process, proving the validity method of the procedures and methods proposed by the Supplier.
* The dimensions of each coupon should be at least 2000 mm x 300mm x the GPP wall thickness of 60 mm.
* The mock-up shall include several crossed channels breaks-through to check the quality and the finished condition of this feature.
* Selected process operational (included in manufacturing procedures) parameters should be applied to the gun-drill operation.
* The cleaning method procedure should be in accordance with dedicated sections.
* The mock-up should be subjected to a dimensional, visual, and superficial conditions examination to check compliance with applicable requirements as defined in dedicated sections.
* The mock-up should be subjected to internal surface examination that shall be qualified using adequate calibration and reference blocks/coupons/specimens.
* The Manufacturer shall propose the NDE technique which shall be subjected to specific qualification and to the Client’s approval.
* Acceptance criteria applicable to the qualification mock-up shall be the same as specified for the process during production. Acceptance criteria are defined in the following paragraphs of dedicated sections. Special attention should be paid to the crossed channels breaks-through which should be clean and burr-free. A subsequent machining process (ie: Abrasive Flow Machining, AFW) is recommended to achieve the proper surface finish in the internal surfaces of the holes. Depending on final surface of the drills probably additional brushing need to be applied to long drills to achieve the required max roughness.
* The process qualification shall involve both the workshop and the process qualification itself in a similar way as described in RCC-MR RM-140 (product and part qualification). The process qualification shall be subjected to the Client’s approval.

*Gun-drilling tolerances and surface finish condition*

The performance of the cooling channels in service conditions and their deviations with respect to design requirements can be dependent on the actual geometrical characteristics of the holes after execution.

Thus, design dimensional and shape tolerances specified in drawings and other documents of dedicated sections shall be met to ensure that the expected thermal-hydraulic and drying/draining behaviour is achieved.

The straightness of the bores expressed in terms of deviation from the ideal configuration in mm per m of bore length shall be kept under the value of 1 mm/m.

The maximum ISO tolerance grade applied to the diameter of the bores shall be IT9.

The roughness parameter to characterize the surface finish of the bore inner machined surface shall be the mean arithmetic rugosity Ra. This value will be kept below 6.3 μm in order to guarantee that the drying and draining analysis as well as pressure drop assumptions are respected.

Maximum values of relative magnetic permeability in the internal side of the holes must be maximum of 1.03.

*Gun-drilling fluids*

Accepted process fluids, for gun drilling are listed in Appendix 4 of the ITER Vacuum Handbook (AKEFTF v1.0). The use of other cutting fluids shall require prior acceptance by IO. They shall be water soluble, non-halogenated and phosphorus and sulphur free. After gun-drilling operations have been completed, parts and sub-components shall be degreased using solvents or alkaline detergents, rinsed with demineralised water and dried in accordance with specific sections. The use of halogenated solvents is forbidden at any stage. Accepted fluids are listed in Appendix 4 of the ITER Vacuum Handbook (AKEFTF v1.0). Cleaning process and preservation of cleanliness in different states of the manufacturing need to be consider as essential variable for the qualification of the gun drilling process. Use of subcontractors in different facilities, operating times between shifts, and in general any time variation among operations need to be consider in the qualification.

*Dimensional control and surface finish characterization of holes*

Alignment & Metrology (A&M) classification is discussed in the ITER Dimensional Metrology Handbook (46FN9B v2.1) which outlines the mandatory requirements for dimensional control of the components, assemblies, and systems for the ITER machine. Related activities during the manufacturing of GPP structures are classified as a (A&M) Class 1. Specific procedures for control of straightness need to be procedure to control this parameter in whole length of the drills.

*Non-destructive examination of holes*

Internal machined surfaces shall be subjected to visual (boroscopic) examination according to the requirements of dedicated sections so that it can be demonstrated that they are free of any injurious defects, oil, grease, other liquids, ink, heat tint, oxidation, paint, dust, rust spots, not metal colour spots, abrasive particles, chips, and any other gross discontinuities or imperfections. Special attention should be paid to the crossed channels breaks-through which should be clean and burr-free. Internal surfaces of the bores shall be examined so that it shall be guaranteed the absence of defects or micro cracks potentially subjected to a fatigue and/or stress corrosion cracking, pitting, crevice or other corrosion phenomenon growth processes.

*Documents prepared by the Supplier.*

Since gun-drilling shall be subjected to a qualification, prior to start the manufacturing operations the Supplier must provide the process and the workshop qualification reports produced in the same way and subjected to similar requirements as described in part RM 140 of RCC-MR 2007. In case of doubt about the applicability of particular provisions in aforementioned section, Client’s interpretation shall be prevalent.

The process qualification report shall include:

* The manufacturing program.
* The program of tests to be performed on the qualification mock-up.
* The results of the tests on the qualification mock-up.

The manufacturing program shall detail all the parameters that can be considered as “essential variables” since they can affect to the global quality of the result of the process and include information about process variables, machining tools, cooling and cutting fluids, cleaning/handling procedures, acceptance tests samples positions, drawings, etc…

The tests program shall define all necessary test and examinations that it must be carried out.

in order to:

* Check the absence of superficial defects in the bores.
* Compliance with dimensional requirements (ovalization, Ra…).
* Ensure that acceptance tests are representative and that non-destructive examinations are suitable for the product as well as the defects inherent to the manufacturing processes are according to the requirements established.

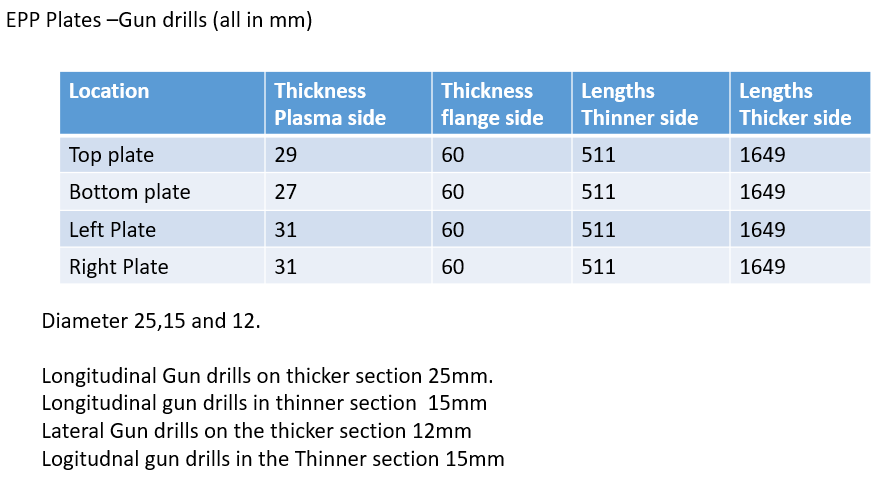
The qualification report shall also include the results of the acceptance tests and examinations performed to prove that the gun-drill process proposed is capable to provide results which meet all the requirements stated in this specification. The workshop qualification report shall include information regarding the facilities, equipment, examination, analysis and test capabilities, staff and their qualifications and the industrial experience related to production (quantities, experience, main Clients, etc…).

Once the process has been qualified, manufacturing procedures based on the qualification performed should be issued for approval. In this case they shall include:

* Cleaning, handling and storage,
* Gun-drill (process variables, machining tools, fluids, required operator qualifications,
* records to be generated during production…)
* Visual (boroscopic) examination.
* Surface examination.
* Surface characterization.
* Dimensional control.

As reference in this part of the document a Summary of drills characteristics is included:

* Diam :15-25 mm
* Length: max 2.3 m
* In plates of 60 mm thickness SS316LN-IG.
* Including Crossed and angle holes.
* 6.3 μm internal roughness measured in whole length: VT +rugosimeter.
* 1/1000 straightness roughness measured in whole length.
* Cleaning preservation
* Free of marks, coloring, contamination, oxidation, corrosion, dust, etc.
* ISO tolerance grade IT9.



**Fig 5 example of gun drills in EQ PPs case.**

If this activity is subcontracted by the main contractor, after the completion of the manufacturing stage and the associated follow-up documents, a certificate of compliance shall be also issued to certify that the result of the manufacturing stage complies with the technical and quality requirements stated in this Technical Specification. This certificate as well as follow-up documents and those related process qualification and manufacturing procedures will be part of the final manufacturing report of the component. In these cases, cleaning control and preservation of cleanliness must be justified to IO through independent reports per unit.

### Metrology and tolerances

During the different stages of the GPPs structures manufacturing activities, several dimensional controls shall be required. Such inspections could be carried out by traditional linear measuring systems (e.g., meter, caliber, micrometer, thickness gauge) or by 3D dimensional inspection equipment (e.g. CMM, laser tracker, laser scanner, photogrammetric).

The ITER Dimensional Metrology Handbook (DMH) outlines the requirements for dimensional control of the components, assemblies and systems for the ITER machine. In addition, the handbook provides significant guidance and helpful information on best practise for large volume metrology applications. Machine components and plant systems requiring alignment and/or dimensional control shall be given an Alignment and Metrology (A&M) classification, as reported in this Technical Specification. The classification reflects the importance placed on A&M for the System to function and the consequence of failure on the project.

# Delivery

## Requirements for labelling, cleaning and cleanliness preservation, packaging, handling, shipment, and storage

### Scope of application

The following generic requirements shall apply for the shipments of equipment from the manufacture/assembly site to the Ports Integrators Site or for the shipments from the manufacture/assembly site to any intermediate site. Suitable precautions shall be taken to avoid damage to the equipment for transportation. The components shall be fitted with the required accelerometers or other sensors and shall be packed as defined below. The equipment shall be subject to control and inspection, as defined below.

As support structures and transportation means are considered to be part of the Scope of Work, dedicated section will set out the requirements for the design and manufacturing of such equipment.

### Labelling and Traceability

All components and the main subcomponents shall be clearly marked in a permanent way and in a visible place with the IO official numbering system according to the document “ITER Numbering System for Components and Parts”.

### Cleaning and Cleaning Preservation

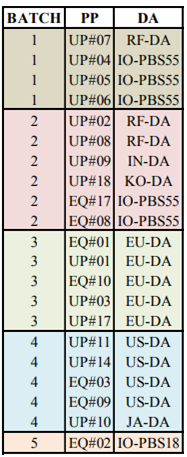
During cleaning, particular attention shall be given to the removal of weld spatter, debris and other foreign matter, particularly from the coolant passages and sealing surfaces. Final cleaning shall ensure effective cleaning without damage to the surface finish, material properties or metallurgical structure of the material. The demonstration of meeting the above cleaning requirements represents a Hold Point (HP).

### Packaging and Handling

Any special Client’s or regulatory transportation requirements shall be documented and provided to the Contractor prior to shipment. The Contractor shall design and supply appropriate packaging, adequate to prevent damage during shipping, lifting, and handling operations. Each shipment shall be accompanied by a Delivery Report shall be prepared by the Contractor and signed by a representative of the Client and its Contractor.

### Shipment, Transportation and Delivery to Port Site

GPPs shall be delivered to Port integrator site following DAP Incoterms. DA/Port integrators side destinations are included in following figure for reference:



**Fig 5 PPs destinations.**

Before the shipment, a Release Note shall be prepared in accordance with the “ITER Requirements Regarding Contractor’s Release Note” and approved by the Client. Upon receipt of the package, the Client shall open the package and make a visual inspection of its content. In the case of anomalies, the Client shall make any additional relevant remark on the inspection. A decision on acceptance of the delivery of the components will be made by the Client. If the components are in an acceptable condition, the Client will sign the Delivery Report. The signature of the Delivery Reports shall be Hold Point (HP). Upon approval, the client shall clear the HP within 30 calendar days.

## Environment, Safety and Health

The Contractor and Subcontractors shall observe all applicable environment, safety and health provisions for work done at the Port Integrator Site, as well as specific requirements set out in future Technical Specification. Any activity by the Contractor and Subcontractors on the ITER Construction Site shall be subjected to the Internal Regulations. Applicable provisions regarding environment, safety and health shall be communicated by the Client to the Contractor at least 30 (thirty) calendar days in advance of the activities to be performed at the Port Integrator Site.

# Inspection and testing

During the different stages of the GPPs manufacturing several inspections and testing operations shall be required in order to provide demonstration of compliance with requirements of future Technical Specification. Inspection and testing operations and methods shall be subjected to the client approval. Inspection and testing operations will be listed in the MIPs.

The Contractor and Subcontractors shall supply procedures regarding all testing operations, for approval by the Client.

This section covers both destructive and non-destructive examination methods. The first part is devoted to establish requirements on test conditions of mechanical tests to be performed in base materials, welding qualification coupons, etc…

The second part deals with special physical, physic-chemical and chemical tests to determine microstructural characteristics of materials, ferrite content, inclusions, etc…

The next part is devoted to the general requirements pertaining non-destructive examination and finally, documents to be prepared by the Supplier are outlined.

Provisions included in the ITER Vacuum Handbook (2EZ9UM v2.3) in general and particularly in section 7 and attachment 1 shall be considered as well for all welds which form a vacuum / pressure boundary.

## Examination and tests

### Mechanical tests

Mechanical tests include all tests to be performed in materials particularly metals and alloys that are intended to the determination of the mechanical properties (base materials and welds in qualification and production).

These mechanical properties allow evaluating such materials for strength and quality to ensure safety towards their end-use. Test conditions, requirements, dimensions of specimens, sampling methods, dimension and location of test specimens and other particularities related to mechanical tests shall comply with the set of Standards referenced in RMC 1200 of RCC-MR 2007 considering all modifications or additional specifications included in abovementioned RCC-MR 2007 section.

They include:

* Tensile tests
* Bend tests
* Charpy impact tests.
* Hardness tests.

### Physical, physicochemical, and chemical tests

These analyses are intended to characterize the metallurgical characteristics of materials, chemical composition, microstructure and ferrite content.

They comprise:

* Determination of metal structure.
* Grain size and inclusion content measurement.
* Ferrite content measurement.
* Chemical composition determination.
* Magnetic permeability tests

### Non-Destructive Examination

Non-destructive examinations and tests shall be carried out using approved procedures.

#### Visual Examination (VT)

Visual examination shall follow a procedure developed in accordance section RMC 7100 of RCC-MR 2007. The visual inspection examination shall be performed as first test to confirm any machining, and welding process (an even other non-destructive tests).

All surfaces to be examined shall be clean and free from all foreign matter, which may adversely affect evaluation of the test results. An examination report shall be issued by the Manufacturer. The examination report shall include the following information:

* Identification of Manufacturer, purchase order and equipment.
* Identification of the part, weld or area subjected to examination. The simplified version of the reference grade shall be provided.
* Designation of the visual examination specification used.
* Time of examination.
* Method used.
* Equipment used.
* In case of welds area, if it is executed in intermediate stage of the weld.
* Results of interpretation.
* The name of the Inspector.
* Identification of the company responsible for examination when the work is subcontracted out.
* Examination date and the signature of the Inspector.

#### Surface examination

According to the “ITER Vacuum Handbook” the use of liquid dye penetrant techniques for crack detection is not recommended when normal liquid dye penetrant inspection fluids are used. Therefore, only the use of the ITER vacuum qualified liquid dye penetrant (LDP) is permitted if cleaning is performed according to procedures qualified and approved by the IO.

Liquid penetrant examination methods comply with the requirements of **RMC 4000** in RCC-MR 2007, with following amendments.

* The sensitivity of the product families to be used shall be at least at level 2, in conformity with EN ISO 3452-2.
* The range of products shall, as minimum, achieve following performance: 100 % finding of defects with size of 20 μm and at least 75 % finding with size of 10 μm.
* If recycled products are used or if liquid penetrant is stored in open containers, the sensitivity of penetrant shall be tested before examination takes place using reference part 2 described in Standard EN ISO 3452-3.
* For austenitic stainless steel the maximum amount of chloride plus fluoride is 200 ppm and for sulphur also 200 ppm in the products used in PT.
* Temperature of the part examined should be in range of 10-50 ºC throughout the whole testing process.
* Dwell time shall be at least 20 minutes and the penetrant film shall remain damp for the entire dwell time.

An indication is classified as a “linear” when its largest dimension is more than 3 times than its smallest dimension. All the other indications are classified as “round”. If indications appear, “controlled” removal followed by a PT shall be allowed before final characterization. “Controlled” removal may be continued if it does not compromise the dimensional conformance or volumetric testability and that no welding repair is needed. If the indications still are unacceptable, they shall be recorded in an examination report before being removed. PT shall be made after visual testing and before any machining or grounding operations of weld surfaces. All the welds over their entire length shall be tested. Testing shall also cover adjacent base metal of 15 mm of both sides from weld. In case of full penetrated welds, both weld and root surfaces shall be tested when accessible. Areas from where temporary attachments have been removed shall also be inspected.

All liquid penetrant examinations shall be performed in accordance with conditions specified in the corresponding procedure which shall meet the requirements given in relevant paragraphs above and include, as a minimum, the following information:

* Type of item being examined, and type of material used.
* Reference to relevant chapters of the RCC-MR and to other applicable documents.
* Examination equipment: equipment and products used for cleaning and liquid penetrant examination.
* Examination conditions: test areas and surface condition.
* Examination procedures: penetrant process, examination parameters (temperature of parts, dwell time, etc.).

After examinations have been performed, a testing final report shall be made according to the code requirements including the following points:

* Identification of Manufacturer, purchase order, and equipment.
* Identification of part or weld, including grade (ferritic or austenitic steel) and fabrication process (forging, rolling, casting, buttering, or cladding, etc.).
* Designation of the examination document used.
* Stage of examination.
* Surface preparation (method, cleaning).
* Type of products used (brand, type, and reference).
* Examination procedure (method of penetrant application, dwell time, compliance with temperature and lighting requirements).
* Name and qualification of the Inspector.
* Identification of Subcontractor conducting the examination, where applicable.
* Date of examination and Inspector's signature.

Unacceptable indications observed shall be recorded. Any indications initially considered unacceptable but interpreted as non-characteristic of an unacceptable defect, and therefore not considered, shall be reported. Interpretation results are given by recording the position and dimensions of unacceptable indications, possibly on sketches.

Photo thermal testing is an alternative surface examination method allowed by the ITER Vacuum Handbook (2EZ9UM v2.3). It is a non-contact examination system capable to detect cracks on the surface of metals and up to 1 mm underneath using a scanned laser beam on the surface that relies on the detection of infrared emission after the transient thermal excitation of the inspected structure. The combination of an infrared sensor (internal) and a laser (external) as an excitation source is called PTC. Absorption of the restored and focused laser beam transiently heats the surface to be inspected. The infrared detector measures the IR emission of the surface adjacent to the heating spot and on-line analysis of the image enables the cracks, acting as a thermal barrier, to be clearly shown by their characteristic flaw footprint.

Examination using photo thermal camera is permitted by the ITER Vacuum Handbook (2EZ9UM v2.3) and provided that the Manufacturer qualifies the method/acceptance criteria prior to the weld qualification. Requirement in RCC-MR 2007 A19.4200 shall be applicable.

This method is not currently covered in RCC-MR 2007. Therefore, the qualification of the examination method shall be carried out following the EN Standard CEN/TR 14748: Non-destructive testing - Methodology for qualification of non-destructive tests.

The qualification program shall cover the following steps:

* Definition of the objective and method object of qualification.
* Preparation of a weld map containing all the welds to be examined by PTC and the type of defects which can appear.
* Establish a draft procedure based on experience and know-how acquired with this technique. The procedure shall describe the fundamental characteristics of the PTC equipment and will define nominal test conditions.
* Testing of the method and influential parameters.
* Identification of the range of acceptable parameter variations.
* Performing blank tests to probe the robustness of the method on representative welds with defects.
* Update of the draft procedure with the outcomes of previous stages.
* Preparation of a qualification file containing final procedures and all the justifications for each parameter including the limits of application of the procedure.
* Verification of the qualification file by IO.
* If this method is used, the reference blocks and performance tests shall be the same as LPT.
* After examinations have been performed, a testing final report shall be made according to the code requirements including the following points:
* Identification of Manufacturer, purchase order, and equipment.
* Identification of part or weld, including grade (ferritic or austenitic steel) and fabrication process (forging, rolling, casting, buttering, or cladding, etc.).
* Designation of the examination document used.
* Stage of examination.
* Surface preparation (method, cleaning).
* Type of equipment used.
* Examination procedure.
* Unacceptable indications observed shall be recorded. Any indications initially considered unacceptable but interpreted as non-characteristic of an unacceptable defect, and therefore not considered, shall be reported. Interpretation results are given by recording the position and dimensions of unacceptable indications, possibly on sketches.
* Name and qualification of the Inspector.
* Identification of Subcontractor conducting the examination, where applicable.
* Date of examination and Inspector's signature.

#### Volumetric examination

For volumetric testing of the welds radiographic testing is the preferred technique, but in the case it is not possible due any reason, also UT examination can be used, but subjected to prior qualification and Client’s approval.

In case that the single manual probe reflection method cannot be feasibly qualified due to technical reasons alternative automated techniques giving overall equivalent results can be proposed by the Manufacturer for approval and qualification.

Automated techniques like phased array (PAUT) or time of diffraction (TOFD) can be adopted. Their use shall be subjected to specific qualification and to Client’s approval.

The program of qualification of UT examination is particularly focused to one side accessible welds (e.g., plug welds). Test and qualification mock-ups shall be representative of the geometrical shape of the weld considering the welding process, fit-up parameters, welding positions, repeatability and other welding conditions that can impact on the quality of the weld. For this purpose, a set of representative coupons shall be produced.

*Radiographic Examination (RT)*

RT examination shall comply with requirements detailed in RMC 3000 of RCC-MR 2007.

This type of examination shall be made after heat treatment and surface finishing.

* The entire length of the weld shall be tested. Testing shall also cover adjacent base metal over a distance of:
* At least 10 mm in relation to the actual groove when e > 30 mm.
* At least 5 mm in relation to the actual groove when e ≤ 30 mm.
* All radiographic examinations shall be performed in accordance with conditions specified in the corresponding procedure which shall meet the requirements given in paragraphs above and include, as a minimum, the following information:
* Type of item being examined, and type of material used (shape, size range and type of material used).
* Reference to relevant chapters of the RCC-MR and to other applicable documents,
* Examination equipment: equipment and products used for cleaning and liquid penetrant examination, radiation sources (type and size), films, intensifying screens, filters, blocking, penetrameter type, location markers, film processing and examination equipment, etc.
* Examination conditions: test areas and surface condition.
* Examination procedure: composition of the cassettes containing the films; type, location and number of penetrameters, type of identification markings and exposure conditions (location of source or radiographic apparatus with relation to test area).
* Film processing conditions.
* Types of film which can be used.
* Instructions for film viewing (double film; double or single film).
* Film quality requirements: density, image quality, etc.,
* Acceptance criteria.

After examinations have been performed, a testing final report shall be made according to the code requirements including the following points:

* Identification of Manufacturer, purchase order and equipment.
* Identification of part, weld or area subjected to examination, including grade of steel, designation of the examination documents used.
* Time of examination.
* Thickness of radiographed area.
* Type and characteristics (size) of radiation source.
* Film classification and commercial brand name of film.
* Type, number and thickness of screens and filters.
* Type of penetrameter.
* Location of radiation source with relation to test area and source-to-film distance.
* Exposure time.
* Film processing conditions.
* Diameter of the smallest visible hole (or wire).
* Interpretation of film results, for welded joints, the nature and size of detected indications.
* Name and qualification of the operator and of the Inspector who interprets the films.
* Identification of the Subcontractor conducting the examination, where applicable.
* Date of examination and Inspector's signature.

*Ultrasonic Examination (UT)*

UT examination shall comply with requirements detailed in section RMC 2000 of RCC-MR

2007.

This type of examination shall be made after heat treatment and surface finishing.

All those welds without access to the back side subjected to 100% volumetric inspection shall be examined using the UT technique (plug-welds). A detailed examination procedure shall be established and qualified under RCC-MR 2007 (RMC 2100).

In case that the single manual probe reflection method cannot be feasibly qualified due to technical reasons alternative automated techniques giving overall equivalent results (RMC

2110) can be proposed by the Manufacturer for approval and qualification according to prescriptions in RMC 2170. Requirements in RCC-MR 2007 A19.4200 shall also be applicable.

Automated techniques like phased array (PAUT) or time of diffraction (TOFD) are no covered in RCC-MR 2007. Their use shall be subjected to specific qualification and to the Client’s approval.

In the case of PAUT and TOFD techniques, technical requirements and qualification procedures from the following Standards shall be applicable:

* EN 583-6:2010 Non-destructive testing - Ultrasonic examination - Part 6: Time-off light diffraction technique as a method for detection and sizing of discontinuities.
* EN ISO 13588:2013 Non-destructive testing of welds - Ultrasonic testing - Use of automated phased array technology.

Technical requirements associated to other automated UT techniques neither covered in RCC-MR 2007 nor mentioned above (creeping wave) shall be defined by the Client prior to any qualification activity. The program of qualification of UT examination is particularly focused to one side accessible welds (e.g., plug welds).

Test and qualification mock-ups shall be representative of the geometrical shape of the weld considering the welding process, fit-up parameters, welding positions, repeatability and other welding conditions that can impact on the quality of the weld. For this purpose, a set of representative coupons shall be produced.

Calibration blocks used for examinations shall be supplied together with the final component.

All the welds over their entire length shall be tested. Testing shall also cover adjacent base metal over a distance of:

* At least 10 mm in relation to the actual groove when e > 30 mm.
* At least 5 mm in relation to the actual groove when e ≤ 30 mm.
* Ultrasonic inspection reports shall be stored for record and shall include the following items as a minimum:
* Exact location and length of the welds inspected.
* Equipment used (instrument maker, model, and identity; transducer type, identity, size, frequency, and angle).
* Beam angle(s) used.
* Coupland used (brand name or type).
* Calibrations block identification.
* Base metal type and thickness, weld process, surface condition such as any unusual condition of weld.
* Bead (ground, undercut, etc.), weld joint design.
* Specific acceptance class criteria for examination.
* All reflections which are interpreted as failing to meet the specified requirements (as defined in Subsection 3/11 above).
* Dates of inspection and signature of ultrasonic examination operator.
* Evaluation of weld(s) examined, evaluation date, name and signature of evaluator.
* In case of using phased array ultrasonic testing (PAUT) and time-of-flight diffraction (TOFD) techniques, permanent records of all interpretable indications shall be stored electronically.

#### Leak testing

Leak testing examination shall be subjected to the requirements set out in section RMC 7400 of RCC-MR 2007 and section 25 of the ITER Vacuum Handbook (2EZ9UM v2.3). In case of discrepancy the later reference shall prevail. Appendix 12 ITER Vacuum Handbook (2EZ9UM v2.3) offers an advisory guidance on vacuum leak tightness and testing consistent with previous mentioned requirements. The leak test procedure for acceptance tests shall be accepted in advance by the Client’s vacuum RO. The procedure shall describe how the leak test will be performed and include configuration diagrams and full details of the equipment to be used.

Guidance on acceptable methods of carrying out leak testing is given in Appendix 12 of the ITER Vacuum Handbook (2EZ9UM v2.3). The acceptance leak test method shall ensure leak tightness is proven across all vacuum boundaries. Test conditions (pressure, temperature) for the acceptance leak test shall be as close as practical to the design conditions.

Testing shall be carried out with the component at ambient temperature and as close as practical to both its maximum and minimum design temperatures.

The direction of the pressure differential shall normally be in the same direction as during operation exhibited by the components. Exceptions will be considered for the larger ITER components for tests prior to the final commissioning tests.

A method of cold leak testing any welded connections shall be accepted in advance.

A representative of the Client may inspect the Supplier’s leak testing equipment and witness a proof of procedure prior to the acceptance leak test. Acceptance leak tests shall be witnessed or, where there are many tests agreed to form the acceptance leak testing, a representative sample of the test shall be witnessed. The Client’s Vacuum RO shall nominate or approve the\ Vacuum Specialist to witness the acceptance leak tests. The Client may require that other critical leak tests to be implemented as part of a manufacturing process being witnessed. Those tests to be witnessed by the Client, including the acceptance tests, shall be defined in the Quality Plan.

After examinations have been performed, a testing final report shall be issued by the Manufacturer. The examination report shall contain full records of the tests carried out. They shall be compiled to maintain traceability of the leak test history of a particular item.

The records shall become part of the final document package for the component concerned.

Records shall include the following:

* Identification of the Manufacturer, the purchase order and equipment.
* Identification of the part, weld or the area subjected to examination.
* Designation of the examination documents.
* Time of examination.
* Examination equipment (the trademark and model of the helium mass spectrometer leak detector used in the test).
* Surface preparation (surface condition and cleanliness).
* Examination conditions and in particular, calibration and setting conditions.
* The nominal value of all standard leaks used, their date of calibration, ageing and temperature characteristics, and the ambient temperature(s) experienced during the tests.
* Results of all tests showing whether it was a pass or fail and if a failure, the measured leak rate and the location of the leak plus the steps taken for repair or elimination.
* Data records of the output of the leak detector for all the global tests specified including the standard leak calibration and response time determination. These data records shall include the date and time of all the tests as well as any other data necessary to allow a full analysis of the results, such as the start and finish of helium gas application to the item under test.
* A record of the helium concentration during the leak test.
* A record of the system total pressure and temperature during a temperature cycle as it may pinpoint the time when a leak opened and be instrumental in the subsequent diagnosis of the leak.
* The magnitude and location (if applicable) of all leaks identified during testing. This includes leaks of size lower than the acceptance criteria for which no remedial action may have been taken.

A full record of any residual gas scans taken with appropriate time markers to identify the scans to the position in the component leak test cycle.

* Interpretation results.
* Name and qualification of the Inspector.
* Identification of the Subcontractor conducting the examination, where applicable.
* Date of examination and Inspector's signature.

### NDE Operators and inspectors Qualification

Only personnel qualified and certified in accordance with RCC-MR 2007 can perform NDE.

Qualification requirements in RF-8000 (EN-ISO 9712:2012) shall apply. In particular:

* Personnel performing ultrasonic examination would be in accordance EN-ISO 9712:2012 at minimum level 2.
* Personnel performing automated examination would be trained for the specific scanning equipment and qualified to at least Level 2 according to EN-ISO 9712:2012. Certification of personnel responsible for performance or assessment of non-destructive examination results follow all requirements described in RMC 8000 including the certification system, definitions, required qualifications and certification provisions.

The following rules shall apply:

* Only personnel qualified and certified in accordance with EN-ISO 9712:2012 can perform NDE (including leak tests)
* Only personnel qualified and certified level 3 in accordance with EN-ISO 9712:2012 can approve NDE procedures. (including leak tests).

## Intermediate Acceptance Tests at the Manufacturing Site

Apart from the dimensional control, several acceptance tests shall be performed at the Manufacturer site prior to the delivery of the PPs. These comprise:

* Flow and draining/drying performance.
* Pressure testing.
* Vacuum baking.
* Leak testing.
* Outgassing measurement.

For the following tests, acceptance values have been derived from design requirements and assessed only through analytical studies. Considering that these values may be understood as design criteria and there is no experimental certainty of the feasibility of these acceptance values, the first items to be ordered, both UPP and EPP structures shall be subjected to the validation of acceptance testing values for the following tests:

* Flow test.
* Draining/drying performance.

After the first tests on Client’s validation items, acceptance limits shall be validated or relaxed depending on the assessment performed by the Client during the validation tests and after the analysis of test data. In the situation that certain limits have to be relaxed, the Client shall provide the Supplier with the new definition of the acceptance limits consistent with the validation testing for the concerned tests which in turn, shall supersede those included in the Technical Specification. Client’s factory acceptance criteria shall comprise the following:

* Identification of the components and parts in the Scope of Work.
* Approval of the End-of-manufacturing report by the Client and sign of the Certificate of Compliance.
* Successful completion of the final factory dimensional control.
* Successful completion of all acceptance tests.
* Control of stamping and marking of manufactured items.
* Checks of the final cleaning.
* Checks of packing provisions and the transportation plan to ensure that the integrity of the component is preserved until arrival at the site.
* Conformance with requirements as set out in the main Contract and this Technical Specification.

## Provisional Acceptance at Port Integrator Site

The components shall be provisionally accepted by the Client from the moment that the components have been delivered, documented, and successfully tested in accordance with Technical Specification. The Client will further on issue a Provisional Acceptance Certificate which will formalize and conclude the provisional acceptance process.

The Certificate of Provisional Acceptance shall be signed by both the Client and the Contractor, after the acceptance of each component and its related documentation.

Ownership of the components shall be transferred from the Contractor to the Client upon Provisional Acceptance at the Client Port Integrator Site.

The transfer of ownership to the Client shall not relieve the Contractor of its obligations under this Contract and enforce the remedy of observed of non-conformities of the components during the warranty period.

The Contractor shall bear the risk of loss or damages to the components during the execution of this Contract up to delivery (at the arrival of the components an inspection will be held to check and formalize eventual damage incurred during transport). Any risk of loss or damage shall be transferred from the Contractor to the Client upon delivery and Provisional Acceptance.

## Final Acceptance

The Contractor shall provide commercial warranty as per IO Supply Contract General Conditions covering repair or replacement of the components up to one year after the Provisional Acceptance of the item. The Final Acceptance shall be granted upon expiry of the warranty period and when all defects or damages have been rectified.

The Final Acceptance Certificate shall be signed by both the Client and the Contractor.