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Technical Requirements Specification

Final design, qualification and supply of the PPMI optic fibre feedthroughs

This Technical Specification is to be read in combination with the General Management Specification for Service and Supply (GM3S) – [AD01] that constitutes a full part of the technical requirements.
In case of conflict, the content of the Technical Specification supersedes the content of Ref [1].

Approval Process			
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1 Preamble

This Technical Specification is to be read in combination with the General Management Specification for Service and Supply (GM3S) – [AD01] that constitutes a full part of the technical requirements.

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2 Purpose

ITER is a large-scale scientific experiment that aims to demonstrate the technological and scientific feasibility of fusion energy. ITER is identified in France as a Nuclear Facility according to the INB order 7th February 2012 (“Installation Nucléaire de Base”).

During its operational lifetime, ITER will test key technologies necessary for the next step: the demonstration fusion power plant that will prove that it is possible to exploit fusion energy for commercial use. ITER is based on the 'tokamak' concept of magnetic confinement, in which the plasma is contained in a doughnut-shaped Vacuum Vessel (VV). The fuel — a mixture of deuterium and tritium, two isotopes of hydrogen — is heated to temperatures in excess of 150 million °C, forming a hot plasma. Strong magnetic fields are used to keep the plasma away from the walls; these are produced by superconducting coils surrounding the vessel, and by an electrical current driven through the plasma.

The VV is a hermetically-sealed steel container that houses the fusion reaction and acts as a first safety confinement barrier. It operates approximately at 100°C and can be baked up to 240°C to guarantee clean ultra-high vacuum needed to operate plasmas.

Each OFF is designed for the transmission of 21 optical fibres (3 bundles of 7 fibres each); from those only 16 are required, leaving 5 spare fibres.

The OFF have two vacuum boundaries with permanently pumped interspace between them.

The OFF implement the safety function of first confinement barrier (SIC-1) and are classified as PIC (Protection Important Component). This classification imposes strict requirements on the design, manufacturing, inspection and capability to withstand the loads during accidental events without failure of the component’s safety function.

This Technical Specification and its Appendixes define the technical requirements related to the supply of the IN-55.PPMI Optical Fibre Feedthroughs (OFF) to ensure that the supplied components are compliant with the project, quality and nuclear safety requirements.

This technical specification addresses the OFF forming part of the first confinement boundary. The OFF will be bolted to a port stub welded to the Port Plug flange Equatorial and Upper Ports by full penetration butt welding (see Figure 2-1). This port stub and its weld is outside the scope of this Technical Specification.

The OFF are located in Upper and Equatorial Ports and form a primary vacuum boundary.

There are 3 OFF in Upper Ports: UP#2, #8, #14.

There are 2 OFF in Equatorial Port: EP #8, #17.

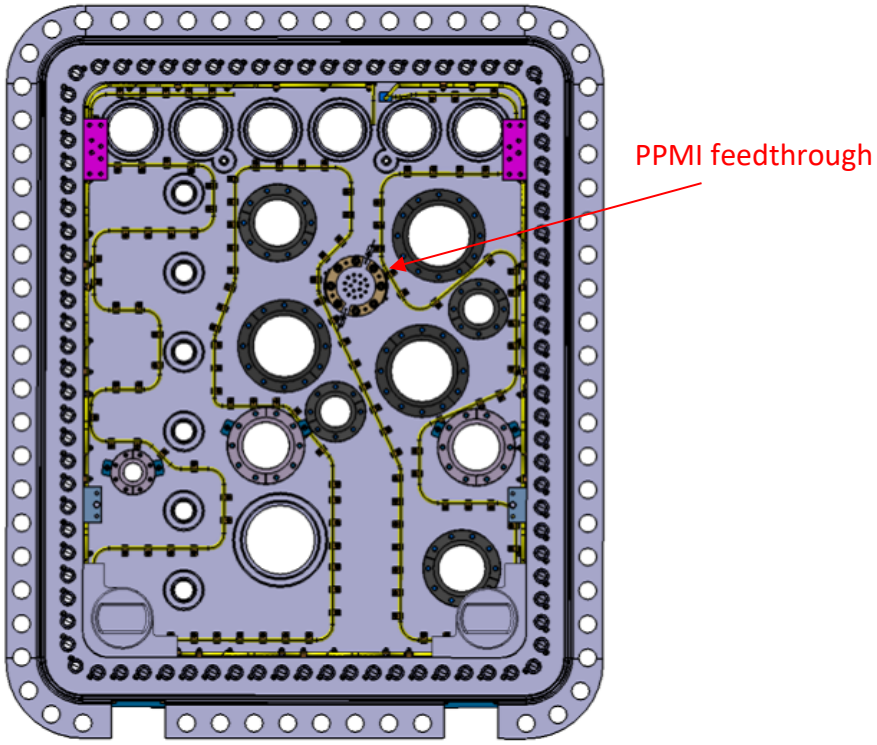

Figure 2-1: Optical Fibre Feedthrough (upper) and allocation in Upper Port (Equatorial)

Regardless their location, they are provided with the same structure and functionality represented on the Figure 2-2 and Figure 2-3.

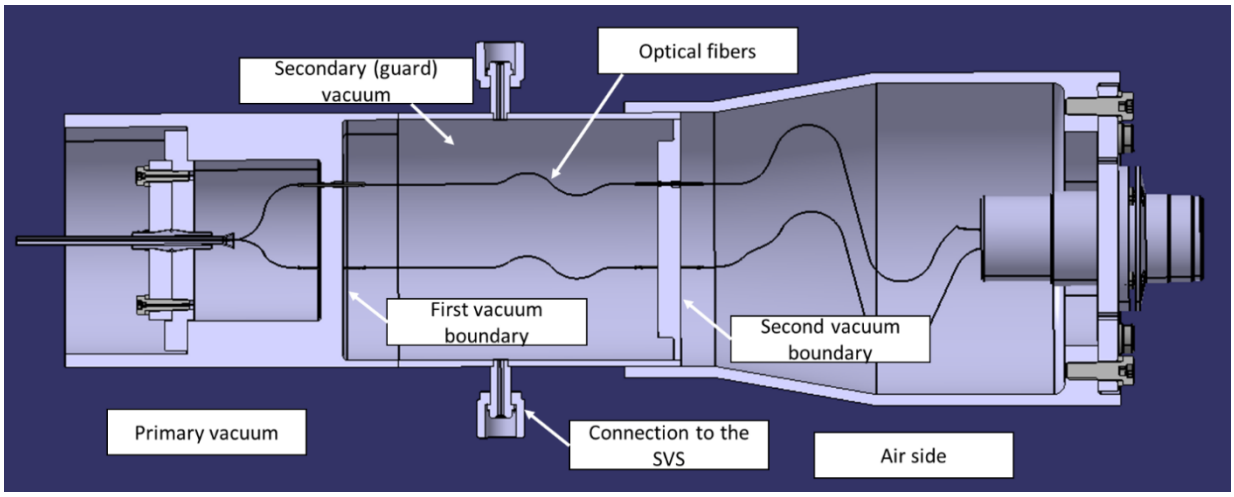

Figure 2-2 Optical Fibre Feedthrough internal architecture

The ITER Organization (IO) will provide to the Contractor the reference design of the system as well as related reference and applicable documents, e.g. final Design Description Document, CAD models and drawings at final design maturity.
The Contractor is responsible for the development of the OFF manufacturing design, for the OFF full-scale prototype manufacturing and qualification, for the welding and brazing qualifications

and for the OFF series manufacturing. It includes demonstration that the produced and delivered OFF are fully compliant with this technical specification.

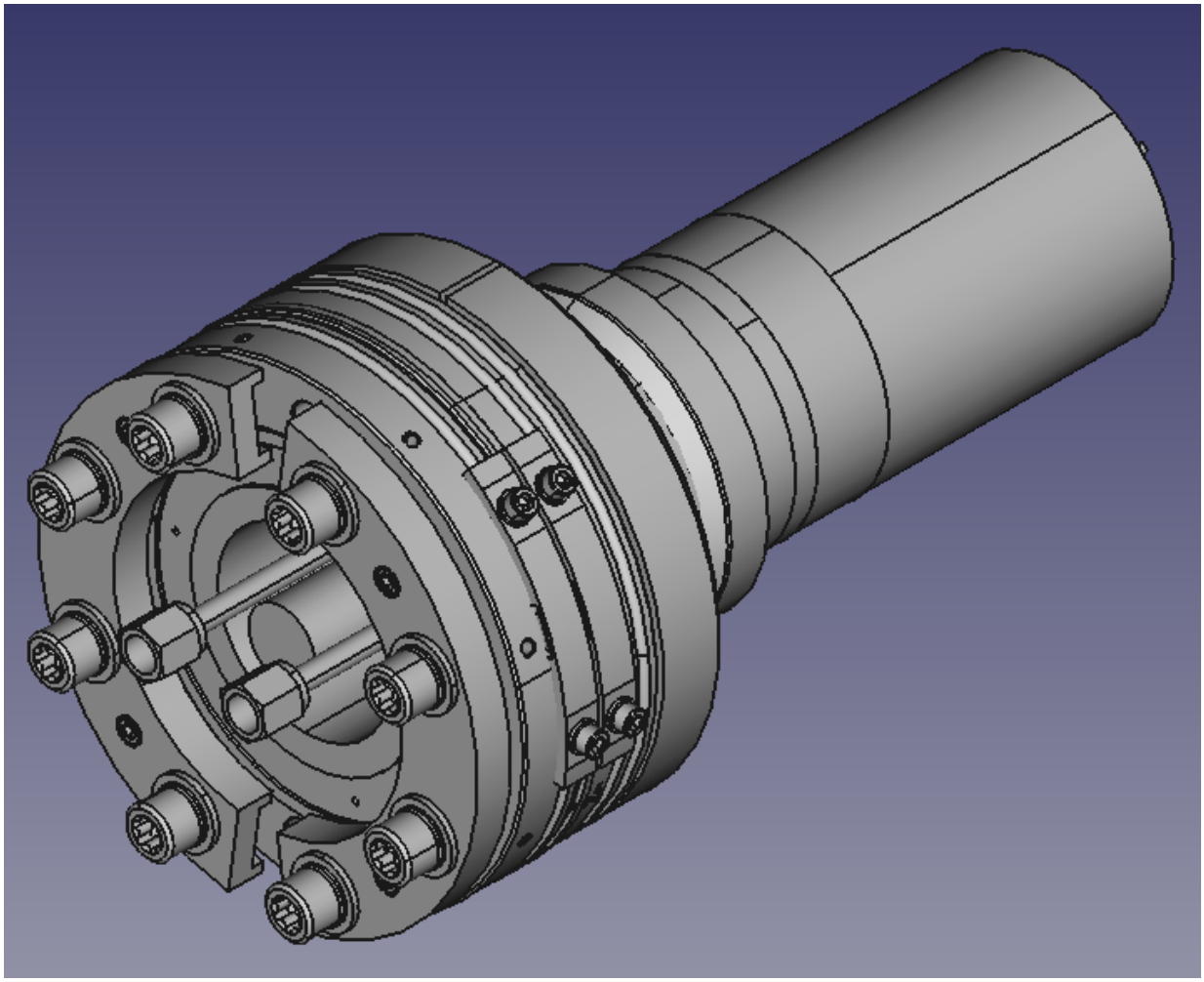

Figure 2-3 Optical Fibre Feedthrough external architecture using a standard ITER flange

[REQ-1]

The Contractor shall demonstrate its capability to reproduce the design of the OFF delivered and tested during the previous R&D phase and for which IO has confirmed positive results, see [ITER_D_TMZPJ6 - WP2 Manufacture drawings and documentation] and [ITER_D_VVL82R - WP3 Qualification test report].

Alternatively, in the case where the Contractor proposes a design significantly changed compared to that already qualified, the design shall be validated on sample products by the Supplier.

3 Acronyms & Definitions

3.1 Acronyms

The following acronyms are the main one relevant to this document.

Abbreviation	Description
CAD	Computer Aided Design
CRN	Contractors Release Note
CRO	Contract Responsible Officer
DO	Design Office
DR	Deviation Request
DRR	Delivery Readiness Review
EN	European Standards
ESPN	Équipement Sous Pression Nucléaire (Nuclear Pressure Equipment)
GAD	General Assembly Drawing
GM3S	General Management Specification for Service and Supply
HP	Hold Point
IEC	International Electrotechnical Commission
INB	Basic Nuclear Installation (from French "Installation Nucléaire de Base")
IO	ITER Organization
ISO	International Organization for Standardization
IVH	ITER Vacuum Handbook
MC	Maintenance Class
MQP	Management and Quality Program
MRR	Manufacturing Readiness Review
MTO	Material Take Off
NCR	Non-Conformity Report
NDT	Non-Destructive Test
NP	Notification Point
OFF	Optical Fibre Feedthrough
PIA	Protection Important Activity
PIC	Protection Important Component
PNI	ITER Part Number
PRO	Procurement Responsible Officer
RCC-MR	Regles de Conception et de Construction des Matériels mécaniques des ilots nucléaires RNR, applicables aux structures à haute température (Design and construction code retained for the Vacuum Vessel)
SIC	Safety Important Classification
SRO	Safety Responsible Officer
SVS	Service Vacuum System
VV	Vacuum Vessel
WP	Witness Point

For a complete list of ITER abbreviations see: ITER_D_2MU6W5 - ITER Abbreviations

3.2 Definitions

Contractor: shall mean an economic operator who have signed the Contract in which this document is referenced.

PIC – Component important for protecting the interests of public security (including nuclear safety, radioprotection and prevention and fight against malevolent acts and civil security actions in the case of an accident), health and sanitation, the protection of nature and of the environment. i.e. structure, equipment, system (programmed or not), material, component or software that is present in the basic nuclear installation or that is under the responsibility of the nuclear operator and that implements a function required for the demonstration mentioned under the second paragraph of Article L. 593-1 of the Environmental Code or that ensures that this function is implemented per articles 1.3 and 2.5.1 of Order 7th February 2012.

PIA – Any activity which is related to or can impact a Protection Important Component.

Defined requirements – Any requirement that has been assigned to a Protection Important Component or a Protection Important Activity so that it may perform the function, with the characteristics expected, as specified in article 1.3 of the Order of 7 February 2012.

Upper Port Design OFF assembly – the type of assembly of the optical fibre feedthrough designed to accommodate up to 21 optical fibres. This type of assembly will be installed in the Upper Ports of the VV.

Equatorial Port Design OFF assembly – the type of assembly of the optical fibre feedthrough designed to accommodate up to 21 optical fibres. This type of assembly will be installed in the Equatorial Ports of the VV.

3.2.1 Definitions specified in RCC-MR 2007

The relevant definitions of the stakeholders are specified in RCC MR 2007 Section 1, Subsection A, **Chapter RA 2000**.

The ITER Organization is an Operator within the context of the RCC-MR Code in accordance with provisions of the mentioned Section, **Paragraph RA 2112**.

The Contractor in this Technical Specification is a Manufacturer within the context of the RCC-MR. Definition of a Manufacturer is outlined in the **Paragraph RA 2130** of above-mentioned Section.

The Sub-contractor in this Technical Specification is a Supplier within the context of the RCC-MR. Definition of a Supplier is outlined in the **Paragraph RA 2150** of above-mentioned Section.

Definition of an Inspector is outlined in the **Paragraph RA 2170**.

Definitions of Contractor and Sub-contractor as outlined in the **Paragraphs RA 2120** and **RA 2140** respectively are not applicable in the context of this Technical Specification.

4 Applicable Documents & Codes and standards

4.1 Applicable Documents

This is the responsibility of the Contractor to identify and request for any documents that would not have been transmitted by IO, including the below list of reference documents.

This Technical Specification takes precedence over the referenced documents. In case of conflicting information, this is the responsibility of the Contractor to seek clarification from IO.

Upon notification of any revision of the applicable document transmitted officially to the Contractor, the Contractor shall advise within 4 weeks of any impact on the execution of the contract. Without any response after this period, no impact will be considered.

[REQ-1]

The following IO documents shall be applied under the scope of this Technical Specification. The last approved version shall be considered as applicable.

Ref	Title	IDM Doc ID	Version
AD01	General Management Specification for Service and Supply (GM3S)	82MXQK	1.4
AD02	Appendix B Welding Specification for Optical Fiber Feedthrough	2VEGGR	v1.0
AD03	Appendix C Brazing Specification for Optical Fiber Feedthrough	2Z82VZ	v1.1
AD04	ITER Vacuum Handbook	2EZ9UM	v2.5
AD05	Appendix 2 Environmental Cleanliness	2EL9Y6	v1.4
AD06	Appendix 3 Materials	27Y4QC	v1.20
AD07	Appendix 4 Accepted Fluids	2ELN8N	v1.14
AD08	Appendix 10 Vacuum Cables	2ETNLM	v1.2
AD09	Appendix 12 Leak Testing	2EYZ5F	v1.4
AD10	Appendix 13 Cleaning and Cleanliness	2ELUQH	v1.2
AD11	Requirements for Producing a Contractors Release Note	22F52F	v5.0
AD12	ITER Numbering System for Components and Parts	28QDBS	v5.0
AD13	Defined requirements for PBS17-OI	XX7B6U	v1.0
AD14	ITER Procurement Quality Requirements	22MFG4	v5.1
AD15	Generic Requirements for the Competences and Qualifications of External Interveners	SBT3UA	v1.0
AD16	Requirements for Producing a Quality Plan	22MFMW	v4.0
AD17	Procedure for the management of Deviation Request	2LZJHB	v8.1
AD18	Procedure for Management of Nonconformities	22F53X	v9.1
AD19	Propagation of the Defined Requirements for Protection Important Components Through the Chain of External Interveners	BG2GYB	v3.3
AD20	Provisions for Implementation of the Generic Safety Requirements by the External Actors/Interveners	SBSTBM	v2.2
AD21	Surveillance Plan for PBS17-OI	27ECGM	v1.1
AD22	ITER Policy on Safety, Security and Environment Protection Management	43UJN7	v3.1

AD23	https://www.swagelok.com/downloads/webcatalogs/EN/MS-01-24.PDF	N/A	N/A
AD24	Sub-System Requirement Document s-SRD-Port Plugs Mechanical Instrumentation (IN-55.PPMI)	8M6W3D	v1.1
AD25	Qualification Plan for IN-55.PPMI Optical Fiber Feedthrough	6KJKTU	v1.3

4.2 Applicable Codes and Standards

This is the responsibility of the Contractor to procure the relevant Codes and Standards applicable to that scope of work.

[REQ-2]

The standards listed in Table 4-1 shall be applied at the different stages of the contract execution.

Table 4-1 Applicable standards

Standard	Description
RCC-MR 2007[1]	Design and construction rules for mechanical components of nuclear installations
EN 10204:2004	Metallic products - Types of inspection documents
IEC 60068-3-3	Seismic test methods for equipment
IEEE 323-2003	IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations
IEC 60793-1-40	Optical fibres - Part 1-40: Measurement methods and test procedures - Attenuation
IEC 60793-1-31	Optical fibres – Measurement methods and test procedures - Tensile strength
IEC 60216-1: 2013	Electrical insulation materials – Thermal endurance properties. Part 1: Aging procedures and evaluation of test results
EN 13134: 2000	Brazing. Procedure Approval
EN ISO 13585: 2012	Brazing - Qualification test of brazers and brazing operators
ISO 18279	Brazing — Imperfections in brazed joints
EN 12797	Brazing — Destructive tests of brazed joints
EN 12799	Brazing — Non-destructive examination of brazed joints
EN ISO 9712: 2012	Non-destructive testing — Qualification and certification of NDT personnel
EN ISO 9606-1:2013	Qualification test of welders – Fusion welding – Part1: Steels (superseded EN 287-1:2011)
EN ISO 9712:2012	Non-destructive testing – Qualification and certification of NDT personnel – General principles

[1] Appendix B Welding Specification defines specific Sections, Subsections and Chapters of the RCC-MR 2007 applicable for the design, qualification, manufacturing and testing.

EN ISO 14732:2013	Welding Personnel – Approval testing of welding operators for fusion welding and resistance weld setters for fully mechanized and automatic welding of metallic materials
ISO 17025 :2005 +AC1:2006	General requirements for the competence of testing and calibration laboratories
ISO 2768-1	General tolerances. Part 1: tolerances for linear and angular dimensions without individual tolerance indications.
ISO 2768-2	General tolerances. Part 2: geometrical tolerances for features without individual tolerance indications.
EN ISO 6892-1:2009	Metallic materials – Tensile testing – Part 1: Method of test at room temperature
EN ISO 6892-2:2011	Metallic materials – Tensile testing – Part 2: Method of test at elevated temperature
EN 10216-5:2013	Seamless steel tubes for pressure purposes – Technical delivery conditions. Part 5: Stainless steel tubes

5 Scope of Work

This section defines the specific scope of work, in addition to the contract execution requirement as defined in Ref [1].

5.1 Scope of Service #1

5.1.1 Design finalization

[REQ-3]

The purpose of this task is to analyse the reference design developed by IO and provided to the Contractor as input data. The design shall be completed and analysed against following aspects:

- Manufacturability
- Assembly process
- Maintainability
- Inspectability
- Vacuum quality
- Temperature resistance characteristics
- Compliance with RCC-MR requirements
- The result of this study shall be a proposal of improvements (if any) of the reference design submitted to IO for acceptance.

[REQ-4]

In particular, the Manufacturability assessment shall include the following steps:

- Detection of possible manufacturing problems
- Selection of the materials
- Selection of the manufacturing processes
- Preliminary design of assembly process of the OFF

Manufacturability assessment shall lead to the optimization of the manufacturing and assembly processes and manufacturing cost improvement.

The result of this assessment shall be a proposal of the manufacturing design submitted to IO for acceptance.

5.1.2 Design requirements

The OFF is designed to connect in-vessel and ex-vessel cables and allow transmission of measured signals from sensors located inside the VV to the data acquisition system, by routing optical fibres through the VV.

They are made of a 114 mm diameter stainless steel tube with a double barrier inside. Bundles of optical fibres are routed through the barriers being inserted in small diameter tubes (1.6 mm in the reference design) that are brazed to the stainless plate. The sealing of the fibres inside the small diameter tube is ensured by brazing of the fibres to the tubes. The pressure between the 2 barriers is continuously monitored by Service Vacuum System (SVS) which also implement leak detection and leak localization function.

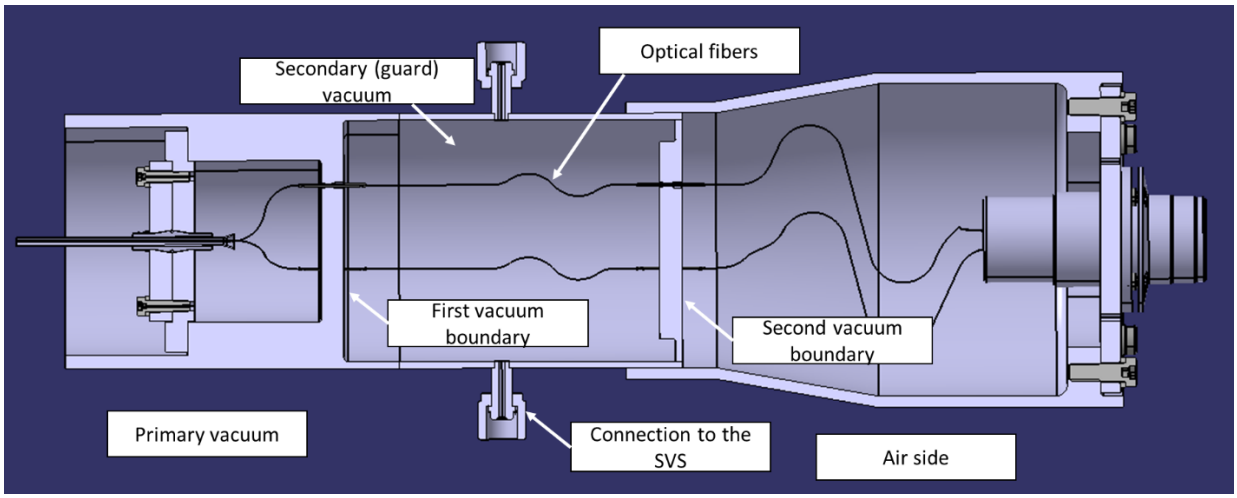

Figure 5-1 Optical Fibre Feedthrough conceptual internal layout. Note that the flange connecting to the port is not shown.

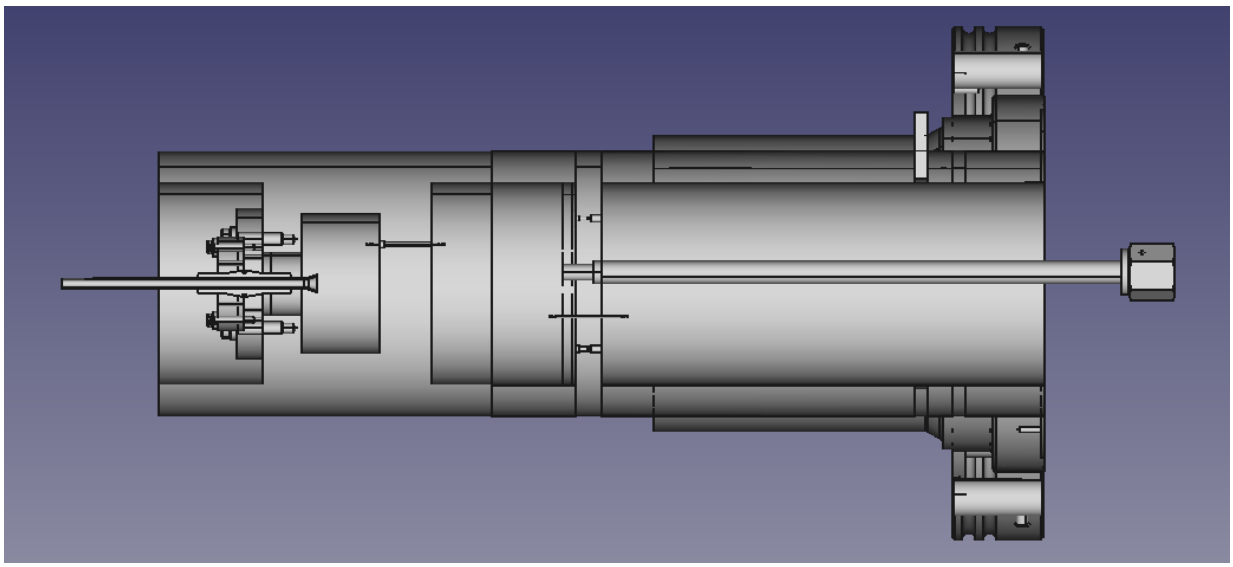

Figure 5-2 Optical Fibre Feedthrough preliminary internal layout with flange connecting to the port and SVS connectors parallel to feedthrough axis.

5.1.2.1 List of parts

The parts comprised with the OFF assembly are identified on the Figure 5-3. The internal structure of the OFF assemblies of Upper Port Design and Equatorial Port Design are similar in terms of parts, the difference is in the parts quantities.

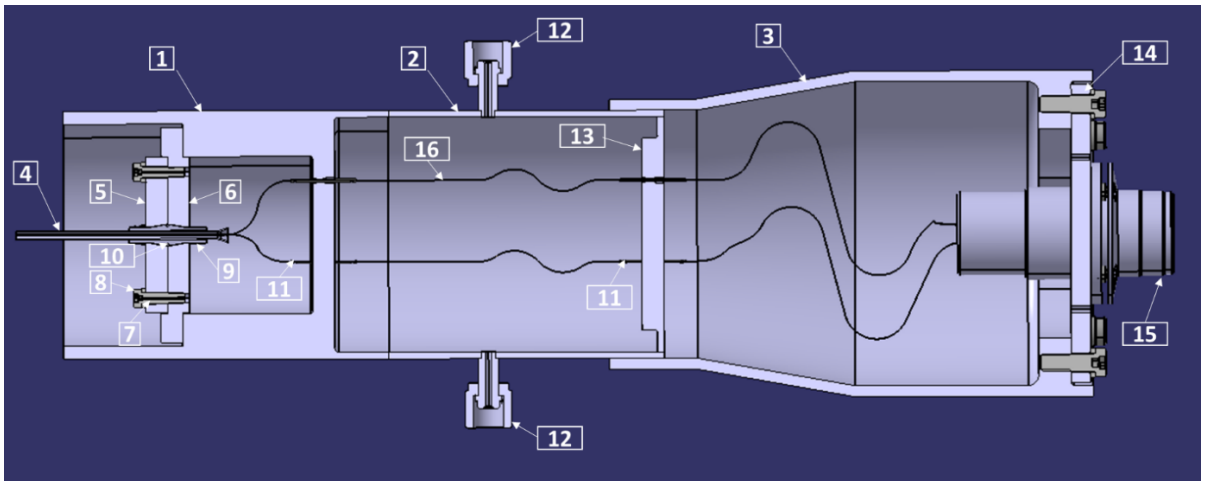

Figure 5-3 Optical Fibre Feedthrough parts identification, internal view. Flange not shown.

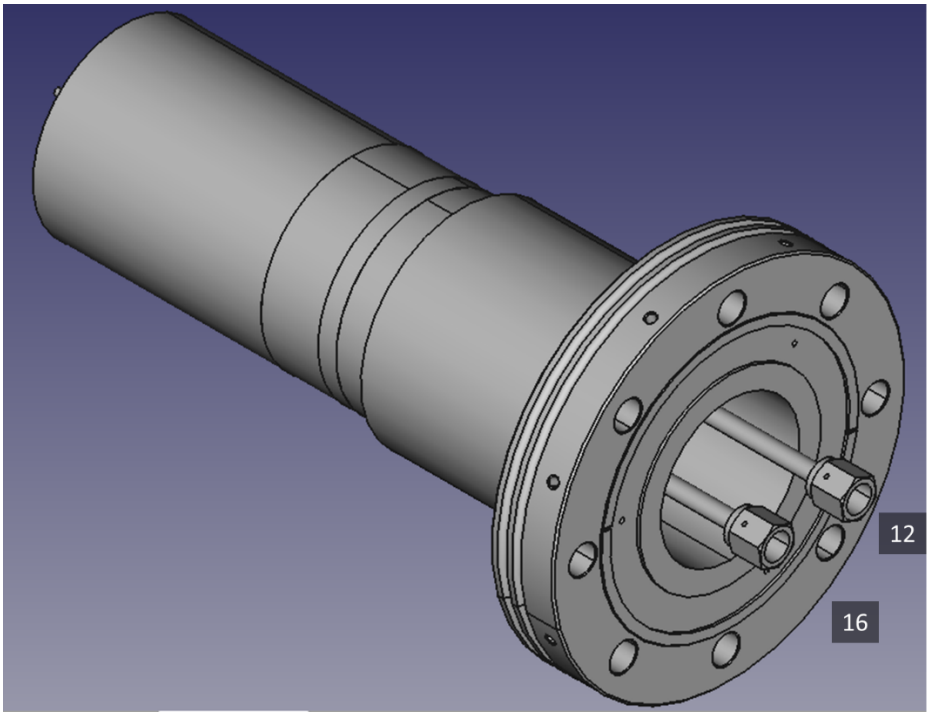

Figure 5-4 Optical Fibre Feedthrough parts identification, external view, with flange and SVS connectors integrated in the feedthrough design.

The current preliminary design contains the components shown in the Table 5-1, given just as information.

Table 5-1 Description and quantity of the OFF parts

Number	Description	Quantity per Design assembly	Standard component[2]
1	First supporting cylinder (first vacuum boundary)	1	N
2	Second supporting cylinder	1	N
3	Third supporting cylinder	1	N
4	Optical cable	1	N
5	Optical cable alignment plate 1	1	N
6	Optical cable alignment plate 2	1	N
7	Bolts	8	N
8	Washers	8	Y
9	Optical cable support (comprises two equal halves)	1	N
10	Ring for fixation of optical cables support	1	N
11	Tube with optical fibres	3	N
12	Connection flange to the SVS	2	Y
13	Vacuum plate (second vacuum boundary)	1	N
14	Connectors support plate	1	N
15	Air-side connectors (optional)	2	Y
16	DN100 flange	1	Y

5.1.2.2 Dimensions

[REQ-5]

The nominal dimensions of the Upper Port Design and Equatorial Port Design OFF assemblies are indicated on the models. The Contractor shall create the Manufacturing Drawings according to it.

5.1.2.3 Safety requirements

See Section 10

5.1.2.4 Optical fibres requirements

[REQ-6]

Optical fibres in each OFF assembly shall comply with the requirements defined in Table 5-2.

[2] The component is classified as “standard” if it can be procured off-the-shelf and no custom machining is needed.

Table 5-2 – Requirements for optical fibres

Parameter	Requirement
Type of optical fibre	Single mode
Wavelength	1500 - 1600 nm
Attenuation at 1550 nm, dB/km	≤ 7
Cladding diameter	125 ± 1 µm
Coating diameter	165 ± 5 µm
Coating composition	>99% copper
Bending radius	> 23 mm

[REQ-7]

The optical fibres used in the OFF shall be radiation resistant.

Total neutron fluence and gamma-radiation dose for optical fibres inside the Vacuum Vessel may reach at the end of ITER operations F ~ (10^{18}-10^{20}) n/cm^2 and D ~ (10^7-10^9) Gy.

A dedicated irradiation campaign was organized in the nuclear reactor IVG-1M in Kazakhstan in 2019. During the campaign, the radiation hardened optical fibres from several suppliers were tested. The Radiation Induced Attenuation (RIA) was measured to assess the impact of radiation on measurement accuracy.

As a result, one or both of the suppliers in Table 5-3 shall be selected for the procurement of the optical fibres to be used in the OFF.

Table 5-3: List of optical fibres suppliers to be selected for the OFF

Company name	Contacts
IVG Fibre, Canada	www.ivgfibre.com, (416)848 0258
FORC Photonics, Russia	www.forc-photonics.ru, info@forc-photonics.ru

5.1.2.5 Materials requirements

Materials used for OFF manufacturing are restricted by the vacuum requirements.

[REQ-8]

The specification of raw material and parts shall be approved by IO before procurement. The procurement of material and parts shall be included to the Manufacturing Inspection Plan.

[REQ-9]

All material, fluids, tapes, markers, grinding wheels etc. used on the component (including those used during machining, welding and NDT operations) shall be in accordance with ITER Vacuum Handbook (IVH) for use on VQC-1A components. If materials used in vacuum are not included in the IVH, the appropriate proposal shall be submitted and approved by the ITER Vacuum RO before the manufacturing.

[REQ-10]

The use of adhesive tape for the protection and packaging of items shall be restricted to prevent the risk of contamination from the tape and it shall be fully removable leaving no residue, using

isopropyl alcohol or acetone as solvent to remove all traces of the adhesive. If adhesive tape is used on austenitic stainless steel, the tape shall meet leachable chloride and fluoride limits of 15 ppm and 10 ppm, respectively.

[REQ-11]

One of the following grades of the stainless steel shall be used in the OFF manufacturing:

- Steel type 316L (1.4404)
- Steel type 304L (1.4307)

[REQ-12]

Procurement of materials shall be in accordance with the following EN standards (or their equivalents):
EN 10216-5 – for stainless steel tubes
EN 10028-7 – for stainless steel flat products
EN 10222 – for steel forgings

[REQ-13]

Metals impurities shall not exceed the following limits:

- 0.05 weight % Cobalt
- 0.01 weight % Niobium
- 0.01 weight % Tantalum

Any modification to these limits shall be discussed in advance with IO and the supplier is responsible of presenting all explanations and rationale for the proposed modification. Material composition assays of specific materials shall be performed by the supplier if requested by IO.

[REQ-14]

All materials to be used for the qualification purposes and subsequent fabrication, shall be procured with their inspection documents. In particular, the certificate type 3.1 in accordance with EN 10204 shall be provided. The materials certificate and certificate of conformity shall indicate measured values of the impurities in [REQ-13].

[REQ-15]

Organic materials and halogens shall not be used.

[REQ-16]

Scope of mechanical tests, apart from tests at room temperature (20º C) in accordance with EN ISO 6892-1:2009, shall also include tensile tests at elevated temperature (in accordance with EN ISO 6892-2:2011). Tensile tests shall be performed at 250º C.

[REQ-17]

All brazing consumables, i.e. filler, flux, stop-off etc. shall be compatible with requirements for impurities content specified in [REQ-13] and vacuum requirements specified in the Section 5.1.2.6.

Additionally, the requirements for procurement of welding consumables are specified in the Appendix B Welding Specification.

5.1.2.6 Vacuum design requirements

[REQ-18]

Crevices, blind holes, cracks, trapped volumes, etc., shall be avoided as these will act as dirt and liquid traps and will prevent pumping performance.

[REQ-19]

The design of brazed joints shall be such as to minimize the risk of trapped volumes.

[REQ-20]

The bolts for use in vacuum shall be locked after loading to prevent them becoming free and causing damage to other parts of the vacuum system.

[REQ-21]

Bolts shall be treated to prevent seizing. The bolts shall be coated with copper (purity of 99.9 %) by the process of electrodeposition. An intermediate nickel bond coat shall be deposited prior the copper coating.

The Nickel plating shall have 1 µm average thickness (+/- 10%).

The Copper coatings shall have 5 µm average thickness (+/- 10%).

[REQ-22]

The maximum acceptable leak rate as defined for the VQC 1 components shall not exceed $1x10^{-10}$ $Pa.m^3/s$ air equivalent. All leak tests performed during the contract execution shall use this value as acceptance criteria. Leak tests shall be performed at room temperature (20 °C), operating temperature (100 °C) and maximum (baking) temperature (240 °C). The component shall be subjected to three thermal cycles from room to baking temperature prior to the leak test. Section 5.1.7 for Qualification tests and Section 5.2.5 for Factory Acceptance Test describe the environmental parameters for the leak tests.

[REQ-23]

The outgassing rate of materials used in the OFF shall not exceed maximum steady state outgassing rate at outgassing temperature 100° C:

- $1x10^{-7}$ $Pa.m^3.s^{-1}.m^{-2}$ for Hydrogen isotopes
- $1x10^{-9}$ $Pa.m^3.s^{-1}.m^{-2}$ for impurities

[REQ-24]

The optical fibres alignment plates (#5, #6 on the Figure 5-3) shall have additional holes to ensure the pumping from the torus vacuum side and connectors support plate #14 shall have holes to ensure introducing of helium during the He leak test of the second barrier.

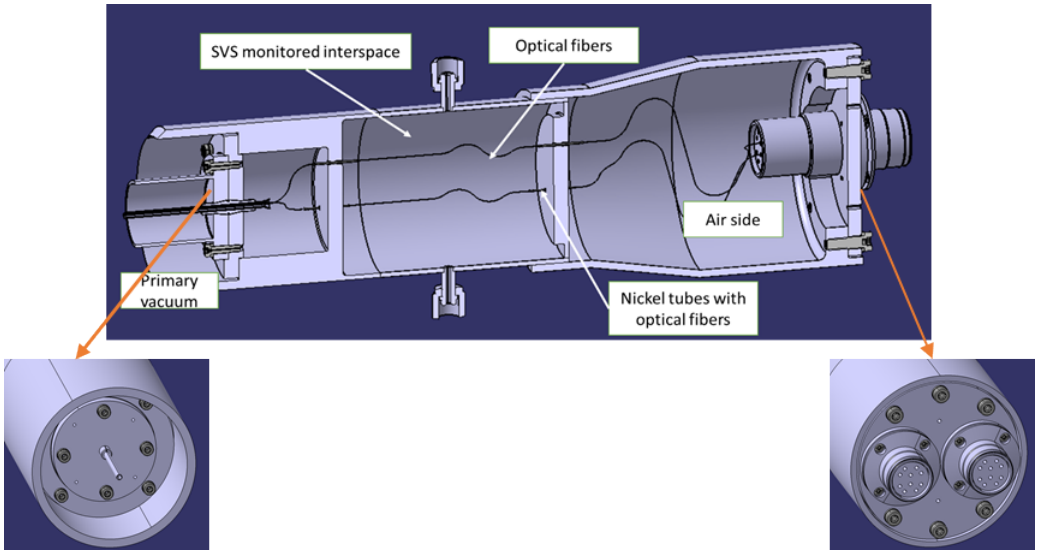

Figure 5-5 OFF with holes for pumping and He leak test

[REQ-25]

The design of bolts used on the vacuum side of the OFF shall be compatible with high vacuum environment (e.g. to have additional holes to avoid trapped volumes and to ensure pumping).

5.1.2.7 Optical cables tubes design

[REQ-26]

Optical cables tubes shall have an outer diameter 4mm (-0, +0.05mm) and inner maximal diameter 3 mm.

[REQ-27]

Minimum bending radius of the optical cable shall be 15 mm.

[REQ-28]

The length of the optical cables tubes shall be equal to their nominal length as to be confirmed by IO at MRR with a tolerance of +/- 10 mm for cable lengths < 5m and +/- 0.2% for cable lengths ≥ 5m.

[REQ-29]

The material of the optical cables tubes shall be stainless steel in accordance with the material requirements from Section 5.1.2.5. The stainless steel tubes shall be procured in accordance with the standard EN 10216-5. The stainless tubes shall be solution annealed.

[REQ-30]

The terminations of the optical cables tubes shall be machined to prevent damaging of the optical fibres by sharp edges.

5.1.2.8 SVS connection flanges design

[REQ-31]

The OFF shall accommodate two SVS connection flanges for connection to the ITER Service Vacuum System. The SVS connection flanges shall be placed symmetrically on the OFF body.

[REQ-32]

The identified commercial connector's assembly for the connection to the SVS monitoring system, agreed with the interfacing ITER Vacuum system, is taken from Swagelok Catalogue [AD23]. The items and their ordering numbers which shall be supplied as part of the OFF assemblies are identified in the Table 5-4.

Table 5-4 SVS connection flanges components

Item	Ordering Number	Material	Quantity
Female Nut	SS-4-VCR-1	316L	2
Gland Male Weld	SS-4-VCR-3-4 MTW	316L	2

[REQ-33]

The Contractor shall also procure the plugs and gaskets for protection of the flanges and interspace during transportation and storage.

5.1.2.9 Air-side connectors design

[REQ-34]

The connectors shall be located on the air side of the OFF for demountable connection with the optical cables coming from the data acquisition system.

[REQ-35]

The connectors shall have sufficient number of pins to accommodate all number of optical fibres in the OFF assemblies.

The type of the air-side connectors recommended for use by IO is LEMO F2 or F7 Fibre Optic Contact 5K series. For design details and ordering information refer to the LEMO catalogue of Fibre Optics Connectors: https://www.lemo.com/catalog/ROW/UK_English/f7_contacts.pdf

5.1.2.10 Weld Design

[REQ-36]

Welding joints design shall comply with provisions of the RCC-MR 2007 Section I, Subsection C specified for the box structure components of the class 2.

[REQ-37]

Manufacturing design of the component shall allow required NDT to the extent specified. Welds which can't be inspected, are not permitted.

[REQ-38]

Design shall allow execution of the He leak testing of each OFF assemblies at the final stage of fabrication.

[REQ-39]

The welds shall be designed in accordance with Appendix B Welding Specification.

[REQ-40]

Final welding documentation as requested in the Appendix B and outlined in Section 17 shall be accepted by IO prior to delivery of the components on site.

5.1.2.11 Maintenance and Inspection Plan

The OFF is a Maintenance Class 2 (MC2) component. This comprises any maintenance task which is not perform by RH means. It may require special PPE (Personal Protective Equipment) for workers, such as air suit or breathing mask

[REQ-41]

The Maintenance, Test and Inspection Plan shall be provided for the developed manufacturing design of the Optical Fibre Feedthrough.

The OFF implements the safety function "First confinement barrier", therefore following safety requirements shall be applied:

- Maintenance procedures required to demonstrate that safety function is implemented shall be specified and executed.
- Maintenance procedures shall demonstrate the compliance with design code requirements.
- Maintenance, Test and Inspection plan shall include in-service inspections, monitoring and/or tests or compensatory measures taken to ensure that the OFF can continue to provide its safety function with the required level of reliability.
- Test records, personnel training requirements, etc to be specified as part of the maintenance procedures.

[REQ-42]

The Maintenance, Test and Inspection Plan shall define preventive and corrective maintenance tasks.

Preventive maintenance consist of routing activities to ensure that there is no degradation or damage of the components.

Corrective maintenance defines activities to be performed in case of failure of the safety function and consist in applying the repair procedure.

The repair procedure shall contain at least the procedure for welding a blank if there is a leak.

[REQ-43]

The specification of each maintenance task shall include as minimum:

- The scope and workflow of actions to be performed;
- Applicable standards (if exist);
- The acceptance criteria for each maintenance task;
- Number of personnel required to perform the task;
- Identification of tools required to perform the task.

[REQ-44]

All maintenance, test and inspection records shall be recorded and archived. The Contractor shall provide the template for maintenance records. This template shall include as minimum:

- Date of the maintenance;
- Reason for maintenance;
- Type of the maintenance – scheduled/unscheduled;
- Component's tag: Functional Reference, PNI, Serial Number;
- Component's classification: PIC, VQC, QC, etc;
- Performance of the maintenance (performed inspections and tests with results);
- Damages found, reasons for repair;
- List of performed operations;
- Identification of hazardous/toxic materials. Dose rate in case of hand-on maintenance in the port cell.

5.1.3 Operating requirements

[REQ-45]

The Optical Fibre Feedthrough (OFF) shall be designed to the nominal environment conditions shown in Table 5-5, including the given pressure values for each of its zones: 1. vacuum, 2. interspace and 3. air-side.

Table 5-5: Temperature and Pressure environment of the OFF during operation

Parameter	Plasma operation	Baking	Maximum value
Temperature, °C	100	200	240
Pressure, MPa	$P_1 = 0$ $P_2 = 0.05$ $P_3 = 0.1$	$P_1 = 0$ $P_2 = 0.05$ $P_3 = 0.1$	$P_1 = 0.2$ $P_2 = 0.05$ $P_3 = 0.3$

Level of irradiation in the locations of the OFF is not expected to impact the properties of the selected materials of the OFF, it is assumed that the maximum allowable damage will not exceed 0.5 dpa (displacements-per-atom).

[REQ-46]

However, the Contractor shall consider the radiation conditions in manufacturing design development. For the OFF location, the level of 14 MeV neutron radiation is estimated to be 10^5 n/cm^2/s which correspond to the dose level of 10 Gy. The total dose level for neutron and gamma-radiation in the locations of the OFF is 1 MGy.

5.1.4 *Interface requirements*

The OFF interface with the following components of the machine during the ITER operation:

- Vacuum Vessel – OFF is welded to the VV stubs in the Upper Ports and VV Equatorial Port flange. The OFF will use an ITER standard DN100 flange.
- Service Vacuum System – The Vacuum Pumping System provides vacuum in the torus, cryostat, and auxiliary systems, including diagnostics at the level necessary for the operation of ITER. The physical interface occurs at the SVS Pipe that connects to the OFF. The OFF is connected to the SVS through the SVS connection flanges (#12 on Figure 5-3);
- Ex-vessel cables – cables from the air-side connectors of the OFF to the data acquisition system (#15 on Figure 5-3).
- Optical in-port connectors – optical connectors located inside the ports of the VV and intended to connect the optical fibes of in-vessel cables with fibres of the OFF.

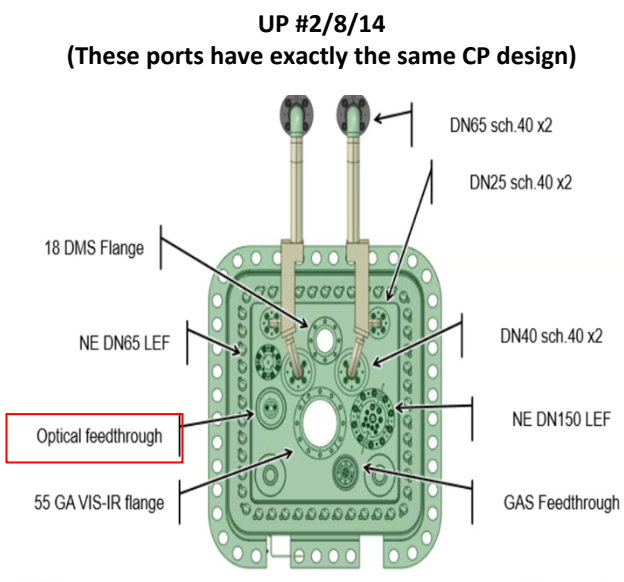

Figure 5-6 "Upper Port Design" OFF assembly interfaces

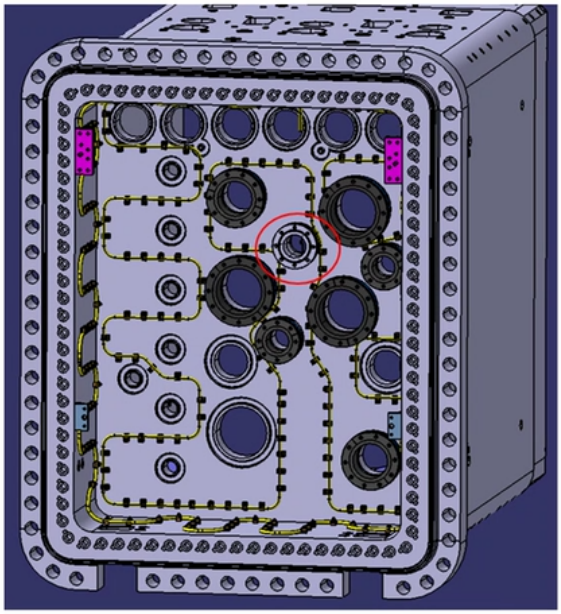

Figure 5-7 "Equatorial Port Design" OFF assembly interfaces

5.1.5 *Qualification of brazing procedure*

The objective of the qualification program is to develop and qualify the brazing procedure, which at once:

- Ensures component performance as far as safety requirements concern;
- Preserves functionality of the optical fibres;
- Satisfies requirements of applicable codes and standards;
- Ensures repeatability of the result during manufacturing.

The qualification program includes:

- Qualification of the brazing procedure through the qualification tests;
- Qualification of the brazing personnel;
- Production of the Brazing Procedure Specification.

[REQ-47]

Qualification of the brazing procedure shall be done according to the requirements specified in the Appendix C Brazing Specification.

The Appendix C defines the requirements for:

- Applicable and Reference standards;
- Design of the mock-up for qualification;
- Qualification tests and acceptance criteria;
- Brazing Data Package.

[REQ-48]

Brazing procedure specification and related quality control procedure, developed and accepted by IO during qualification of the brazing, shall be integrated in the manufacturing and inspection plan.

[REQ-49]

Qualification of brazing procedure shall be witnessed by ITER recognised Independent Inspection Authority (IIA).

The detailed requirements that shall be applied to the all stages of the qualification are listed in the Appendix C Brazing Specification.

5.1.6 Qualification of welding procedure

[REQ-50]

The welding procedures used for the OFF manufacturing shall be properly qualified in accordance with the RCC MR, SECTION IV for Class 2 welds and additional requirements specified in the Appendix B.

[REQ-51]

Qualification of welding procedure shall be witnessed by ITER recognised Independent Inspection Authority (IIA).

[REQ-52]

Execution of production welds shall be performed only by welders and operators who possess suitable qualification as specified in the Appendix B.

[REQ-53]

Qualification of each welding procedure shall be subject to IO approval before fabrication of components can start.

The detailed requirements that shall be applied to the all stages of the qualification are listed in the Appendix B Welding Specification.

5.1.7 Qualification of a full-scale prototype

[REQ-54]

The Contractor shall propose a design of the full-scale prototype for the IO acceptance.

[REQ-55]

The full-scale prototype for qualification shall include all elements that affect the performance of confinement function and functionality of the OFF to transmit signals:

- All internal welds;
- Brazed joints;

- Optical fibres;
- Internal support structures.

[REQ-56]

The full-scale prototype shall meet the following requirements:

- The full-scale prototype shall be representative of the same design as the serial production. Any differences shall be identified and shall not affect performance of the safety function.
- The full-scale prototype shall be manufactured using production facilities and processes as for serial production units;
- The full-scale prototype shall have the same configuration as to produce thermal and mechanical stresses representative of the design being qualified;
- Materials of the full-scale prototype shall be the same or equivalent to the OFF serial production ice.
- The full-scale prototype shall include a maximum number of brazed joints to be as high as possible representative of the final component (NB: OFF includes a maximum of 3 bundles of optical fibres).
- The full-scale prototype shall include at least one air-side connector.
- The full-scale prototype shall be assembled in a manner and a position that simulates it's expected installation. Any mounting limitations shall be specified in the test report.

[REQ-57]

The Contractor shall manufacture and qualify a full-scale prototype performing the tests described in Table 5-6.

The qualification tests are divided in two groups: functional tests and environmental tests. Functional tests check the performance of the system with respect to the functional requirements - leak tests and optical insertion loss tests. Environmental tests simulate operational and accidental loads of the OFF and require functional tests afterwards to check that functional requirements are still met.

- **Functional tests**:
  - Helium leak test
  - Insertion loss test (this test is performed for validation of characteristics of the optical fibres in the feedthrough and it's not related to the performance of safety function)
  - Pull test of optical fibres
- **Environmental tests:**
  - Preconditioning
    - Operational vibration test
    - Thermal cycling test
    - Thermal aging
  - Design basis events tests
    - Seismic test
    - Fire resistance test
    - Pneumatic pressure test
    - Mechanical shock test

The reference standards for the OFF qualification are the following:

- **IEEE 323-2003** Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations
- **IEEE 317-213** Standard for Electric Penetration Assemblies in Containment Structures for Nuclear Power Generating Stations **(Clause 6 Qualification)**

Table 5-6 Qualification tests for the full-scale prototype

Test name	Test objective	Test description	Reference standard	Acceptance criteria
Functional tests:				
Helium leak test	Validation of containment integrity of the feedthrough	Measurement of the leak rate. Feedthrough interspace is pumped up to pressure of 10^{-3} Pa.	Appendix 12 of the IVH [AD09]	Maximum leak rate for OFF is 10^{-10} Pa.m^3/s air equivalent
Insertion loss measurement	Validation the capability of the feedthrough to transmit optical signals	Measurement of the optical power in the fibres	IEC 60793-1-40	Insertion losses shall not exceed 1 dB at room temperature (20ºC) and 2 dB at operating temperature (100ºC).
Pull test	Check the tensile strength of the fibre and the strength of the fibre fixation inside the OFF	Applying 3 cycles of 5N force for 10 s	IEC 60793-1-31	Optical losses are ≤ 1 dB at room temperature
Environmental tests:				
Operational vibration test	Simulation of the inertial operation loads and evaluation of the impact on the feedthrough performance	Test shall produce a test response spectrum larger than the required response spectrum (will be provided as input).	IEC 60068-3-3	Functional tests
Thermal cycle test	Applying three thermal cycles, simulation of the differential pressure load during normal operation and assessment of the leak tightness	The test prototype subjected to not less than 500 cycles from ambient to 240ºC for each cycle. One cycle equates to a temperature increase of at least 220ºC and a decrease of at least 220ºC. Dwell time at maximum temperature will be 10 minutes for each cycle. The pressure will be atmospheric (0.1 MPa) during the whole test.	ITER Vacuum Handbook [AD04] Appendix 12 of the IVH [AD09]	Functional tests

Thermal aging test	Test full-scale prototype shall be thermally age conditioned to simulate operation for the installed life.	The full lifetime of the component shall be considered (30000 hours at 100 °C)[3]	IEC 60216-1	Functional tests
Seismic test (SL-2 accident)	Simulation of the seismic event SL-2 and evaluation of the impact on the feedthrough performance	Test shall produce a test response spectrum larger than the required response spectrum (will be provided as input).	IEC 60068-3-3	Functional tests
Fire resistance test (Internal fire accident)	Simulation of the fire event and evaluation of the impact on the feedthrough performance	Fire resistance test simulates the fire event and consists on subjecting one of the barriers of the full scale prototype to a continuous temperature of 300ºC for 120 minutes.	TBD by test procedure	Functional tests
Pneumatic pressure test (LOCA and VV ICE accidents)	Simulation of the LOCA and VV ICE accidents and evaluation of the impact on the feedthrough performance	Test simulates accidental pressure loads and consists on applying of 0.16 MPa (LOCA) and 0.3 MPa (VV ICE) to the first and second boundary of the feedthrough. The pressure in the feedthrough interspace is 10^{-3} Pa. Acceptance criteria is 10^{-10} Pa.m^3/s for LOCA and 10^{-5} Pa.m^3/s for VV ICE.	ASME Boiler and Pressure Vessel Code, Section III, Division 1, Subsection NE, Article NE-6000 2019	Functional tests

[REQ-58]

Leak test and insertion loss measurement shall be carried out before environmental test sequence after each environmental test.

[REQ-59]

Pull test shall be carried out before and after environmental test sequence.

[REQ-60]

Seismic test shall be carried out before fire test in the same test specimen.

[REQ-61]

Upon completion of qualification tests, the Contractor shall issue the Qualification Synthesis Report according to [ITER_D_X3AUHZ - IO Template of Qualification Synthesis Report].

5.1.8 Final Design Review (FDR)

[REQ-62]

[3] It is proposed to perform accelerated aging tests with higher temperature and a reduced duration. For example, using 240 °C as the accelerated aging temperature, the corresponding duration would be just 9 hours, considering a conservative Q10 factor of 1.8. The temperature and the duration of the aging tests shall be mutually agreed between the contractor and the IO.

It shall be demonstrated at the FDR that the design satisfies all requirements of this technical specification.

[REQ-63]

Non-exhaustive list of documents that shall be provided by the time of FDR are identified in Section 0.

[REQ-64]

The preparation of the FDR shall be entirely under the responsibility of the Contractor. It may be carried out as in-person meeting at the Contractor's or IO premises.

[REQ-65]

The MRR shall follow the procedure Design Review Procedure (2832CF).

5.1.9 Manufacturing Readiness Review (MRR)

The main objective of the MRR is to verify the feasibility, manufacturability and reliability of the manufacturing design. Main topics of the review are the following:

- CAD data of the manufacturing design (DM, GAD, manufacturing drawings);
- MIP and manufacturing procedures;
- Implemented qualification program;
- Results of full-scale prototype qualification campaign;
- Time schedule of production phase;
- Quality control program to be implemented during production phase.

[REQ-66]

It shall be demonstrated at the MRR that the manufacturing design satisfies all requirements of this technical specification.

[REQ-67]

It shall be demonstrated that manufacturing design is complete, technically correct, constructible and that the manufacturing is ready to start without incurring unacceptable risks.

[REQ-68]

Non-exhaustive list of documents that shall be provided by the time of MRR are identified in Section 0.

[REQ-69]

The preparation of the MRR shall be entirely under the responsibility of the Contractor. It may be carried out as in-person meeting at the Contractor's or IO premises.

[REQ-70]

The MRR shall follow the procedure ITER_D_44SZYP - Working Instruction for Manufacturing Readiness Review .

5.1.10 Service Duration

The maximum expected duration for this activity is 17 months.

5.2 Scope of Supply #1

5.2.1 Description

In the frame of the contract two types of OFF assemblies shall be supplied. OFF assemblies "Upper Port Design" are intended to transmit 21 optical fibres and will be installed in the Upper Ports of the VV, as shown on Figure 5-8. OFF assemblies "Equatorial Port Design" transmit 21 optical fibres and will be installed in the Equatorial Ports of the VV, as shown on Figure 5-8.

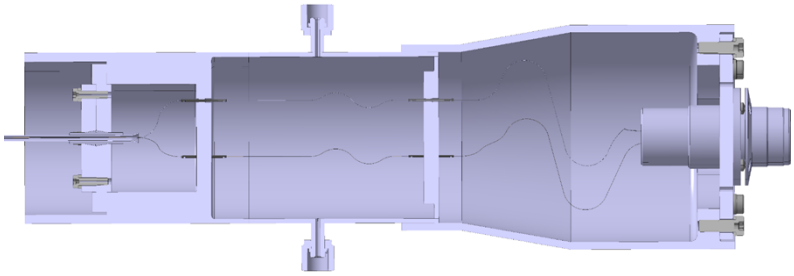

Figure 5-8: Optical Fibre Feedthrough assembly

The quantity of the OFF assemblies of each type and of their main parts are listed in Table 5-7.

The detailed list of parts comprised within the OFF assemblies of both types are described in Section 5.1.2.1.

The OFF shall be delivered fully assembled.

Table 5-7 Scope of supply

	Description	**Quantity of items (including one spare of each type)**	**Length of the optical fibres per assembly**	**Length of the optical cables tubes per assembly**	**Quantity of the air-side connectors per assembly**	**Quantity of the SVS connection flanges**
Design OFF Assembly	OFF accommodating 16 optical fibres	5+2	3 m per fibre	2 m per fibre	1	2
OFF full-scale prototype[4]	OFF full-scale prototype for qualification of manufacturing design	1	3 m per fibre	2 m per fibre	1	2

The distribution of the optical fibres and the lengths of the optical cables per each OFF assembly is indicated in the models that will be provided by IO. The final lengths of the optical cables and optical fibres distribution inside them will be provided by IO by the time of the MRR.

[4] The values for the full-scale prototype are indicative for purpose of estimation of the overall scope of procurement. The final values will be defined by the design of the full-scale prototype.

5.2.2 Design requirements

All design requirements detailed in section 5.1.2 apply as well to this scope of work.

5.2.3 Quality Control Provisions

As approved in the outcome of MRR from Section 5.1.9

5.2.4 Manufacturing requirements

5.2.4.1 Fabrication processes

5.2.4.1.1 Cleanliness and vacuum quality requirements

Cleanliness and preservation of cleanliness are required during the whole manufacturing process. All components must be subjected to a rigorous cleaning procedure, consistent with the Vacuum Classification.

[REQ-71]

Storage of welding/brazing materials shall comply with provisions of RCC-MR Section 5 RS 7200.

Storage of raw stainless steel materials shall comply with storage requirements specified in the Appendix B (chapter 1.7.6)

[REQ-72]

All OFF shall be cleaned to Ultra High Vacuum Standards. Standard cleaning procedure for Stainless Steel components is described in Appendix 13 of IVH.

[REQ-73]

Work area within the workshop perimeter shall be at least of the level II (class B) according to the RCC-MR (**Clause RF 6242**) or higher.

Workshop shall be compatible with requirements regarding contamination as listed in RCC MR 2007, Section V**, Clause RF 6400.**

[REQ-74]

Forming tools shall be cleaned thoroughly before use to avoid cross contamination. All lubricants used in the forming operations shall be removed from the workpiece. Only tools dedicated to stainless steel shall be employed; this particularly applies to grinding wheels and wire brushes.

The requirements regarding cleanliness during manufacturing listed in Appendix B Chapter 4.2 are applicable at each stage of the manufacturing.

[REQ-75]

All OFF assemblies shall be subjected to a rigorous cleaning procedure, consistent with VQC 1A. Extra washing and polishing can be applied for better quality.

[REQ-76]

A detailed Clean Work Plan shall be submitted by the Supplier for prior acceptance by the IO before any cleaning operations are undertaken at the Supplier's site. The Clean Work Plan shall specify how cleanliness will be maintained throughout the manufacturing process of the OFF. The Clean Work Plan shall state when specific cleaning procedures will be applied to the OFF and all the controls which will be in place to maintain cleanliness of the OFF including handling.

[REQ-77]

Parts and sub-components shall be degreased using solvents or alkaline detergents (using one of the accepted cleaning fluids for VQC 1A usage given in Appendix 4 of the ITER VHB), rinsed with demineralized water, and dried in hot gas or an oven to accepted procedures.

[REQ-78]

Halogenated solvents shall not be used at any stage of the manufacturing.

[REQ-79]

Abrasive techniques to clean or to attempt to improve the appearance of the surface of the OFF shall be kept to an absolute minimum and preferably avoided. The use of grinding wheels, wire brushes, files, harsh abrasives, sand, shot or dry bead blasting, polishing pastes and the like is prohibited.

[REQ-80]

Acid treatment of any sort is to be avoided as it may result in degradation of vacuum performance.

[REQ-81]

If pickling of steel or copper components is performed, this shall be followed by passivation.

[REQ-82]

Pickling and passivation shall be followed immediately by an appropriate cleaning process.

[REQ-83]

Powder free latex or nitrile gloves (over cotton or linen if desirable) shall always be used when handling components. Coloured gloves are not acceptable.

[REQ-84]

After final cleaning of the OFF, the Supplier shall perform a wet wipe test using the procedure described in Appendix 13 of the ITER VHB.

[REQ-85]

After the component has been cleaned and is completely dry, it shall be packed carefully to ensure that it remains clean and free from damage.

[REQ-86]

The supplier shall have the responsibility of ensuring that all staff fully understand all health and safety information issued by the manufacturer or supplier of any chemical or equipment to be used. Neither ITER nor any of its agents shall be responsible for any consequences arising from the application of any cleaning process described in this handbook unless it is under their direct control.

5.2.4.1.2 Surface finish requirements

[REQ-87]

The maximum average surface roughness of metallic surfaces shall not exceed 6,3 μm measured by electric stylus. Surface roughness is defined in accordance with ISO 4287: 2000.

[REQ-88]

Abrasive techniques to clean or to attempt to improve the appearance of the surfaces of vacuum components shall be kept to an absolute minimum and are preferably avoided.

[REQ-89]

The use of files, harsh abrasives, sand, shot or dry bead blasting, polishing pastes and the like is prohibited and shall not be used without prior agreement.

[REQ-90]

If grinding is essential on VQC 1 systems, the grinding wheel shall be free of organic components and shall have been manufactured in an oil-free, clean environment.

The material and manufacturing process of the grinding wheel shall be accepted by the IO before use.

5.2.4.1.3 Machining requirements

[REQ-91]

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.

[REQ-92]

Cutting fluids shall be water soluble, non-halogenated and phosphorus and sulphur Free. The maximum allowable content of halogens, phosphorus, and sulphur is 200 ppm (each).

Accepted cutting fluids are listed in Appendix 4 of ITER VHB. The use of other cutting fluids requires prior acceptance.

[REQ-93]

The requirements for machining processes defined in the Appendix B Welding Specification shall be applied at each stage of manufacturing.

5.2.4.1.4 Marking

[REQ-94]

All items shall be clearly marked in a permanent way, preferably laser marked, and in a visible place.

[REQ-95]

The marking shall be also written on a temporary tag attached to the both ends of the fibre, this tag will be removed after on site installation.

[REQ-96]

Marking methods shall be selected is accordance with Section 4.2.3 of Appendix B Welding Specification. Nevertheless, chemical etching shall not be used to mark the items

[REQ-97]

Optical fibres within the OFF shall have unique making on each fibre's end in order to identify the fibres during the assembly process.

The recommended by IO method of marking is to use the protective splice sleeve (see Figure 5-9) at the fibre's end. In this method the inner metal tube is extracted from the protective splice sleeve and marked with a sticker and put back in a sleeve. The protective splice sleeve is put in a fusion splicer for baking.

Figure 5-9 Protective splice sleeve (example, for information only)

5.2.4.2 Welding and Non-Destructive Testing

[REQ-98]

All vacuum boundaries welds shall be full penetration butt welds.

[REQ-99]

100% of welds shall be subject to NDT inspection.

[REQ-100]

All vacuum boundary welds of category 2 shall be subject to 100% volumetric examination.

[REQ-101]

Radiographic testing shall be used as a reference method for volumetric testing of welds. Application of ultrasound examination shall be subject to IO acceptance if proven, that the reference method is not feasible.

[REQ-102]

Penetrant Testing shall be performed on each weld after the first pass.

[REQ-103]

Penetrant Testing shall be performed on each weld after completion of welding operations

5.2.4.3 Metrology and tolerances

[REQ-104]

Unless otherwise specified in the 2D drawings, all the dimensions shall satisfy the tolerance Class “m” of ISO 2768-1 and tolerance Class “k” of ISO 2768-2.

[REQ-105]

For the series components the tolerances for the interface between OFF and VV ports shall be confirmed by IO in order to ensure that maximum 1 mm misalignment and 1 mm gap are preserved for assembly of OFF onto the VV.

5.2.5 Factory Acceptance Test

[REQ-106]

All OFF shall be inspected after the manufacturing to ensure the quality of the final component.

[REQ-107]

All welded joints shall pass the Non Destructive Examination in accordance with Appendix B Welding Specification.

[REQ-108]

All brazed joints shall pass the Non Destructive Examination in accordance with Appendix C Brazing Specification.

[REQ-109]

All OFF shall be leak tested after the manufacturing according to the Appendix 12 of ITER VHB. The OFF shall be subjected to three thermal cycles from 20^{o}C to 240^{o}C prior to the leak test. Feedthroughs interspace shall be pumped up to pressure of 10^{-3} Pa.

[REQ-110]

The pull test of optical fibres shall be performed after the OFF assembly.

[REQ-111]

The dimensional inspection shall be performed at the final acceptance stage.

5.2.6 Shipment Procedure

5.2.6.1 Handling

[REQ-112]

After final cleaning, the handling of the OFF shall be controlled to preserve cleanliness.

[REQ-113]

The suitability of any given area used for handling of the OFF shall be assessed on a regular basis by monitoring the airborne particulate count and shall not exceed 5.0×10^6 particles of size > 0.5 µm per m^3.

[REQ-114]

The provisions shall be applied in the handling area in accordance with the cleanliness requirements:

- Segregated clean area.
- Limited Access to authorised personnel.
- Authorised equipment operated to approved procedures.
- Management of equipment (e.g. no vacuum pumps exhausting into clean area).
- Daily cleaning of area including floors and surfaces.
- Sticky mats at area entry.
- Daily air quality checks. Results stored in component document package.
- Weekly cleanliness test of area with results stored in component document package.

[REQ-115]

The personnel working in the handling area shall be trained and follow the provisions:

- Protective hair nets.
- Powder free latex or nitrile outer gloves.
- Clean white overalls.
- Overshoes.
- Clean job specific footwear.

[REQ-116]

After the final cleaning powder free latex or nitrile gloves (over cotton or linen if desirable) shall always be used when handling components. Coloured gloves are not acceptable.

5.2.6.2 Packing

[REQ-117]

Packing conditions and materials shall be defined in a packing procedure. This procedure shall be subjected to the IO's approval.

[REQ-118]

The supplier shall design and supply appropriate packaging, adequate to prevent damage during shipping, lifting and handling operations.

[REQ-119]

All components shall be shipped dry internally and externally.

[REQ-120]

To prevent damage and possible contamination during transit, the packaging of components shall be done as soon as possible after acceptance testing and final cleaning at the supplier's premises. Cleaning and packaging operations may be witnessed by ITER.

[REQ-121]

Vacuum components shall be handled as little as possible after final cleaning. All subsequent operations shall be carried out in clean conditions (as required in Section 13.1).

[REQ-122]

The interspace volumes which have been pumped for leak testing shall be backfilled with dry nitrogen or air (<4000 ppm H2O) at a positive pressure of 0.12 MPa and valved off.

[REQ-123]

All sealing surfaces shall be protected against damage using compatible covers.

[REQ-124]

Each OFF assembly shall be packed in its own rigid packing case or container non-returnable. In the packing case, all components shall be cushioned and blocked to prevent movement and any physical damage to the component or wrapping material during transport.

[REQ-125]

All packing shall be sealed in heat sealed polyethylene bags to prevent contamination during transportation and storage and marked externally. Optical fibres shall be coiled and entirely enclosed in the bag.

[REQ-126]

The packing shall protect the OFF from thermal and mechanical stresses (particularly shock loads resulting from dropping and mal-handling) which may adversely affect the operation of the OFF.

[REQ-127]

Each packing shall be provided with shock indicators.

[REQ-128]

The Contractor shall provide detailed procedure subjected to the IO's approval for unpacking. The procedure shall describe how the OFF must be removed from the packing safely and without damage.

[REQ-129]

The Contractor shall provide the Preservation Procedures to define the process for management and implementation of preservation requirements according to the ITER_D_WRCKZB - WI for Preservation Activities during Storage, Construction and On site before turnover and ITER_D_XT2VTE - Template for Equipment Preservation Procedure.

[REQ-130]

All packing shall be sealed in heat sealed polyethylene bags to prevent contamination during transportation and storage and marked externally. Optical fibres shall be coiled and entirely enclosed in the bag.

[REQ-131]

The Contractor shall provide detailed procedure subjected to the IO's approval for unpacking. The procedure shall describe how the OFF must be removed from the packing safely and without damage.

5.2.6.3 Labelling of packing case

[REQ-132]

Each OFF packing case shall be clearly marked in a permanent way and in a visible place.

All such marking shall be in English and French.

A detailed component identification system together with printed label templates will be provided by the IO.

[REQ-133]

Handling instructions shall be clearly marked on the outer walls of the packing case.

[REQ-134]

The mark on the packing case shall allow each component to be uniquely identified.

Components labels shall include as minimum:

1) Title of components
2) Components numbering system tags – Manufacturing Part Numbers, ITER Part Numbers, Serial Numbers.
3) Components Classification, e.g. PIC/SIC, QC, VQC, etc.
4) Handling instructions.
5) Chemical or radiological hazards (if any).

5.2.6.4 Delivery Readiness Review

Each OFF and associated components are, tested, cleaned, labelled, packed, protected and received on-site ready for installation.

The Delivery Readiness Review (DRR) is a Hold Point to ensure that the components can be released for shipment.

The purpose of the DRR:

- To perform the final check and the verification of components, packages and corresponding documentation before they leave the Sending Entity and transport to the IO;
- To validate that the IO has all mandatory documentation, customs documents, and/or any other technical or logistical information that is needed so that the material can be adequately managed through transportation, reception, storage, and ultimately into ITER construction and assembly.

DRR mandatory documents:

- Contractor Release Note (CRN)
- Delivery Report
- Packing List (PL)
- Equipment Storage and Preservation Form
- Shipping Plan of Load (SPL) with a specific transportation quality plan containing special requirements for the lifting, handling, etc. – to be prepared by the Logistics Service Provider.

The DRR shall follow the procedure ITER_D_X3NEGB - Working Instruction for the Delivery Readiness Review (DRR) .

5.2.6.5 Shipment

[REQ-135]

The contractor shall bear the risk of loss or damages to the components during the execution of this Contract up to delivery, including inspection against any failure of the components during transport.

[REQ-136]

The Contractor shall ensure that the transport organization, and the transport company are insured for damage and/or loss of the components.

[REQ-137]

Any risk of loss or damage shall be transferred from the contractor to the IO upon the second signature of the Contractor release note, i.e. the one occurring after reception at IO.

[REQ-138]

IO shall be informed and approve delivery at least 48hours prior to delivery in order to prepare access for the driver, by providing ID card.

5.2.6.6 Arrival at ITER site

Upon receipt of the package, the IO will open the package and make a visual inspection of its content to check:

- The integrity of the package, including identifying visible damage;
- The number and type of components contained in the shipment;
- The enclosed documentation;
- The reading of the shock indicators;
- The integrity of the components.

If the components are in an acceptable condition, the IO will sign the Delivery Report.

5.2.6.7 Final Acceptance

IO may perform additional tests to verify the compliance of the components with the requirements in the context of this contract.

The decision on the Final Acceptance will be made by IO based on the results of this inspection.

[REQ-139]

Ownership of the components shall be transferred from contractor to the IO upon Final Acceptance at the ITER Site.

[REQ-140]

The contractor shall provide a standard commercial warranty covering repair or replacement of the interrogators up to 2 years after the Final Acceptance of the components.

[REQ-141]

The transfer of ownership to the IO shall not relieve any contractor of its obligations under this contract and derived technical specifications in case of non-conformities of the components for the duration of the warranty period.

5.2.7 Delivery Time

The maximum expected duration from the closure of the MRR, see Section 5.1.9, to the supply of the scope of work is 7 months.

6 Location for Scope of Work Execution

The Contractor shall perform the work at their own location

7 IO Documents & IO Free issue items

No input nor free issue item is expected from IO

7.1 IO Documents:

Under this scope of work, IO will deliver the following documents by the stated date:

Ref	Title	Doc ID	Expected date*
RD1	WP2 Manufacture drawings and documentation	TMZPJ6	T0
RD2	WP3 Qualification test report	VVL82R	T0
RD3	Copper Antiseize coating specification for Invessel components	TLLFHC	T0
RD4	Template for Equipment Preservation Procedure	XT2VTE	T0
RD5	WI for Preservation Activities during Storage, Construction and On site before turnover	WRCKZB	T0
RD6	Qualification Plan for 17.OI Optical Fibre Feedthrough	YSQJVE	T0
RD7	IO Template of Qualification Synthesis Report	X3AUHZ	T0
RD8	Qualification guidelines	WGFF3G	T0
RD9	Procedure for the Usage of the ITER CAD Manual	2F6FTX	T0
RD10	Procedure for the CAD management plan	2DWU2M	T0
RD11	Specification for CAD data Production in ITER direct contracts	P7Q3J7	T0
RD12	CAD Manual 07 - CAD Fact Sheet	249WUL	T0
RD13	DCIF for the contract for Procurement of Optical Fibre Feedthrough	395MKE	T0
RD14	Working Instruction for Manufacturing Readiness Review	44SZYP	T0
RD15	Working Instruction for the Delivery Readiness Review (DRR)	X3NEGB	T0

(*) T0 = Commencement Date of the contract ; X in months.

7.2 Free issue items:

The following elements will be provided by IO:

- The standard flanges made of low impurity steel for the manufacturing of the feedthrough series. Note that for the prototype the use of a standard DN100 made of SS316L(N) is acceptable,
- The metal coated optic fibre will also be provided, to the length required to produce both the prototype and all the feedthrough series.

8 List of deliverables

The Supplier shall provide IO with the documents and data required in the application of this technical specification, the GM3S Ref [1] and any other requirement derived from the application of the contract.

You can find here below a minimum list of deliverables that are required within the expected timing:

Deliverable		Expected Timing (T0+x) *
D# 1	KoM documentation	T0+1
D# 2	Qualification documentation	T0+9
D# 3	FDR documentation	T0+12
D# 4	MRR documentation	T0+17
D# 5	DRR documentation + supply of components	T0+24

(*) T0 = Commencement Date of the contract ; X in months.

Non-exhaustive list of documents to be delivered with each deliverable:

Deliverable related	Family document	Document
KoM documentation	Management	Quality Plan
		Detailed Work Schedule
FDR and MRR documentation	Models	Design Plan for CAD activities
		Manufacturing drawings
		3D CAD Detailed Models
		List of parts
		Materials specification
		Description of the manufacturing processes (preliminary MIP)
		Maintenance and Inspection Plan
		Manufacturing Design Report
		Detailed list of Protection Important Activities
Qualification documentation	Welding	Preliminary Welding Data Package (see Appendix B for exhaustive list of the documents)
		Welding Data Package (see Appendix B for exhaustive list of the documents)
		Non-destructive Examination procedures (see Appendix B for exhaustive list of the documents)
	Brazing	Preliminary Brazing Data Package (see Appendix C for exhaustive list of the documents)
		Brazing Procedure Qualification Record
		Brazing Procedure Approval Record
		Final Report

		Brazing Data Package (see Appendix C for exhaustive list of the documents)
	Environmental	Design report of the full-scale prototype for qualification
		Manufacturing drawings of the full-scale prototype for qualification
		Equipment Identification file
		Qualification Test Procedures
		Qualification Tests Reports
		Qualification Synthesis Report
		Qualification Preservation Sheet
MRR documentation	Manufacturing	Manufacturing and Inspection Plan
		Manufacturing Specification
		Materials specifications
		Purchase specification for optical fibres
		Clean Work Plan
		Cleanliness Preservation Plan
		Leak Test Plan
		Factory Acceptance Test Plan
		General Assembly Drawings
		Packing Plan (including unpacking procedures)
		Preservation Procedures
		Detailed list of Protection Important Activities
MRR documentation	Certificates	Materials certificates
		Final Welding Documentation (as defined in Appendix B Welding Specification)
		Final Brazing Documentation (as defined in Appendix C Brazing Specification)
		Certificate of conformance for optical fibres
		Certificates of conformance for materials used
		Certificates of conformance with Clean Work Plan and manufacturing specifications
		Certificates of conformance with cleanliness requirements
DRR documentation	FAT	Factory Acceptance Test Reports
	Logistics	Contractor Release Note (CRN)
		Delivery Report
		Packing List (PL)
		Equipment Storage and Preservation Form
		Shipping Plan of Load (SPL)
		Delivery of the OFF assemblies to IO site
All phases	Common to all	Detailed Defined Requirements Document

	phases	List of applicable documents
		List of documents to be known for each job position/workstation
		Abilities mastering document
		Names/abilities matching matrix

Supplier shall prepare their document schedule based on the above and using the template available in the GM3S Ref [1] appendix II (click here to download).

9 Quality Assurance requirements

The Quality class under this contract is QC-1, [AD01] GM3S section 7 applies in line with the defined Quality Class.

10 Safety requirements

The scope under this contract covers for PIC and/or PIA and/or PE/NPE components, [AD01] GM3S section 5.3 applies.

The OFF are specifically SIC-1, the components defined as “those required to bring and to maintain ITER in a safe state”.

Table 10-1 Safety function to be fulfilled by the Optical Fibre Feedthrough

Safety Function		**Detailed Safety Functions**	
1	Confinement of radioactivity and Beryllium[5]	1b)	Building confinement barriers

10.1 General Safety Requirements

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

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

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

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

[5] Decree 2012/1248 part III.1: The confinement is also applicable to beryllium confinement

The Contractor also shall be familiar with [AD22] ITER_D_43UJN7 - ITER Policy on Safety, Security and Environment Protection Management.The ITER Policy on Safety, Security and Environment Protection Management" presents the strategical objectives of ITER Organization in order to comply with the requirements of the Order 7th February 2012.

[REQ-142]

For the Protection Important Components, structures and systems of the nuclear facility, and Protection Important Activities the contractor shall ensure that a specific management system is implemented for his own activities and for the activities done by any Supplier and Subcontractor following the requirements of the Order 7th February 2012 ITER_D_7M2YKF - Order dated 7 February 2012 relating to the general technical regulations applicable to INB - EN.

The PICs require control and guaranty of the quality of the PICs during the design and manufacturing phase to ensure its safety functions can be maintained in all postulated situations. This is accomplished through the guidelines provided for in the Propagation of the Defined Requirements for Protection Important Components through the Chain of External Interveners ITER_D_BG2GYB - Propagation of the Defined Requirements for Protection Important Components Through the Chain of External Interveners.

[REQ-143]

The Contractor shall guaranty that the defined requirements identified for Protection Important Components and activities are properly cascaded down in its chain of external contractors through their own technical specification. When necessary for the Protection Important Activities related to the nuclear safety demonstration and in particular for assessing the results of the studies, the requirements of the Title III of the INB Order Article 3.8 must be taken into account.

[REQ-144]

The Contractor shall grant access rights to the IO and Host regulatory body representatives to its facilities and records and those of its Contractors and Subcontractors for the purposes of surveillance of defined requirements during the design of a PIC as required by the French Order dated 7th February 2012 ITER_D_7M2YKF - Order dated 7 February 2012 relating to the general technical regulations applicable to INB - EN. This surveillance shall also include the examination of all protection-important activities and the follow-up and verification of all corrective actions which are to be implemented according to Surveillance Plan for PBS 55 - Diagnostics (URAXP3)

[REQ-145]

For each PIA performed by the Contractor or one of its sub-contractor (disregarding the level in the supply chain), it shall be demonstrated that:

- The PIA is performed in accordance with procedure and using means for meeting a priori the related defined requirement.
- The PIA is traced to check a posteriori whether the defined requirement were met.

10.2 Protection Important Activities (PIAs)

The list of Protection Important Activities (PIAs) identified for the OFF at different stages of the life cycle is listed in 55.PPMI - Surveillance Plan Annex 2: List of Protection Important Activities (PIAs) (8NSLK7)

[REQ-146]

The Contractor shall monitor each PIA, to ensure that:

- the activity is carried out in compliance with the requirements defined for the activity and, if necessary, for the PIC concerned;

- appropriate corrective and preventive actions have been defined and implemented.

10.3 Propagation of the Defined Requirements

The Contractor can find the initial list of the Defined Requirements associated with the OFF in Section 5.1 of the [AD24] Sub-System Requirement Document s-SRD-Port Plugs Mechanical Instrumentation (IN-55.PPMI) (8M6W3D)

[REQ-147]

The Contractor shall propagate the initial Defined Requirements into the technical requirements according to the procedure ITER_D_BG2GYB - Propagation of the Defined Requirements for Protection Important Components Through the Chain of External Interveners.

[REQ-148]

The Contractor and its external contractors shall include the approved previous level list of Defined Requirements in their technical specifications for the next sublevels in the contractor chain. Any list of Defined Requirements shall be reviewed by IO SRO.

[REQ-149]

The Contractor shall convert the initial defined requirements into technical requirements in order to make them appropriate for the OFF design development, qualification, manufacturing, testing and delivery.

[REQ-150]

The translation of the defined requirements into the technical requirements shall be established through the Detailed Defined Requirements Document. The Contractor shall prepare the Detailed Defined Requirements Document and submit for IO acceptance. The Detailed Defined Requirements Document may be issued in the form of compliance matrix.

10.4 Requirements for the competences and qualifications of the personnel

The requirements in terms of competences and qualifications must be implemented by the external interveners in order to satisfy the requirements of article 2.5.5 of the INB Order:

"The protection-important activities, their technical control, the monitoring and assessment actions must be carried out by persons with the appropriate competences and qualifications."

[REQ-151]

The Contractor implement the requirements for the competences and qualification of the personnel according to the procedure ITER_D_SBT3UA - Generic Requirements for the Competences and Qualifications of External Interveners

[REQ-152]

The contractor is responsible for the implementation of requirements mentioned in this section and shall ensure that its own contractors implement similar provisions.

[REQ-153]

The Contractor shall prepare and submit for IO acceptance the List of the Applicable Documents. The List shall be prepared on the basis of the Reference Documents listed in this technical specification, RPrS, MQP system.

[REQ-154]

The Contractor shall prepare and submit for IO acceptance the "List of documents to be known for each job position/workstation". A given person shall be aware of the contents of these documents. Acquaintance of these documents shall be formalized. The acquaintance for the new versions of the applicable documents shall be updated.

[REQ-155]

The Contractor shall prepare and submit for IO acceptance the "Abilities mastering document". This document shall define:

- Abilities for each position and/or workstation (e.g. education, training, experience, accreditation)
- The number of people needed and level in each of the abilities
- Level of acquaintance for each field of abilities. These levels shall show the capacity of the people to work autonomously or nor, for instance "beginner", "autonomous", "referent" etc.

[REQ-156]

The Contractor shall prepare and submit for IO acceptance the "Names/abilities matching matrix". The Contractor shall provide a nominative matrix that shall show, for the contract, each employee's abilities and levels as above mentioned. This matrix shall demonstrate the adequacy between the abilities of the employees and the abilities required by the various workstation/position.

10.5 Other applicable classifications

This section outlines the specific requirements imposed by the OFF classification.

Table 10-2 Component classification

Classification	Class
Safety Class	PIC/SIC-1
Quality Class	QC 1
Vacuum Quality Class	VQC-1A
Seismic Class	SC 1
Tritium Class	TC 2B
ESPN	N/A[6]
RCC-MR	Class II Box structures
Maintenance	MC2
Radwaste	Medium

10.5.1 Vacuum Quality Classification

Vacuum Class VQC 1A is assigned to the OFF according to the ITER Vacuum Handbook [AD04].

VQC 1A components are defined as Torus primary vacuum components and which form a part of the vacuum boundary.

The vacuum quality classification has many implications on the design and manufacturing requirements of the OFF.

[REQ-157]

[6] ESPN non-classified, but OFF are welded to the Vacuum Vessel which is ESPN

The Contractor shall design and manufacture the OFF according to the requirements applicable for the VQC-1A components. The exhaustive list of vacuum quality requirements is established in the ITER Vacuum Handbook and its Appendixes:

- ITER Vacuum Handbook ITER_D_2EZ9UM - ITER Vacuum Handbook
- Appendix 2 Environmental Cleanliness ITER_D_2EL9Y6 - Appendix 2 Environmental Cleanliness
- Appendix 3 Materials ITER_D_27Y4QC - Appendix 3 Materials
- Appendix 4 Accepted Fluids ITER_D_2ELN8N - Appendix 4 Accepted Fluids
- Appendix 10 Vacuum Cables ITER_D_2ETNLM - Appendix 10 Vacuum Cables
- Appendix 12 Leak Testing ITER_D_2EYZ5F - Appendix 12 Leak Testing
- Appendix 13 Cleaning and Cleanliness ITER_D_2ELUQH - Appendix 13 Cleaning and Cleanliness

10.5.2 Seismic Classification

The OFF is classified as SC1 (S).

[REQ-158]

Structural stability of OFF shall be maintained in the event of an earthquake, i.e. no rupture of piping, no collapse of structures, limited plastic strain. No deformation of the OFF shall prevent other SIC-1 and SIC-2 components to perform their safety functions.

The ability of the OFF to perform its safety function during the seismic event shall be verified by the qualification test as required in Section 5.1.7.

10.5.3 Tritium Classification

The OFF are classified as TC-2B which means “Non pressure coded first static barrier”. The requirements imposed by tritium classification are covered by the requirements to the VQC1 components. No special requirements are applicable.

10.5.4 RCC-MR Classification

The OFF is classified according to the RCC-MR 2007 as class 2 box structure. For the requirements imposed by the RCC-MR 2007 standard refer to the Appendix B Welding Specification.

11 Specific General Management requirements

Requirement for [AD01] GM3S section 6 applies completed with the below specific requirements:

11.1 Control Points

To ensure a close oversight of the entire activities foreseen in the present technical specification, a system of Control Points will be implemented by the IO in order to keep track of the work advance in accordance with the approved Manufacturing and Inspection Plans (MIP).

The control points shall be integrated into the agreed schedule and defined as the following:

- A **Notification Point (NP)** is a milestone where the Contractor is required to notify the IO that it has completed a specific task or a specific deliverable and is proceeding to the next task or to the next action on the specific deliverable. A NP is meant to enable the IO personnel to follow the progress of the Contract and possibly to witness a critical

manufacturing step at the Contractor's premises. The Notification shall be sent by the Contractor to the IO at least 10 working days prior to the scheduled manufacturing step. The IO shall decide whether or not they want to attend. A NP shall not affect the production flow of the Contractor that shall continue the work even without a reply from the IO.

- A **Hold Point (HP)** is a milestone where the Contractor is required to notify the IO, that it has completed a specific task or a specific deliverable and must stop the associated processes until a HP Clearance is issued. The HP Clearance shall be issued on the basis of clearly identified Quality Control and data and Acceptance test results to be provided to the IO at the time of the request. The IO shall have a maximum of 5 working days to review the Contractors data and to notify the Contractor of its decision. In case of clearance the Contractor shall resume its activity. In case of rejection, the Contractor shall develop a recovery plan that shall be submitted and reviewed by the IO within 10 working days of submission.
- A **Witness Point (WP)** is a milestone which identifies an operation to be witnessed. Adequate notice shall be given to the IO, in order to allow the IO to participate to the operation.

11.2 Hold Points

Control Point	Control Point Description	Deliverables
1. Phase I: Design Development		
HP-1	Manufacturing drawings	D# 3
2. Phase II: Qualification		
HP-2	Preliminary Welding Data Package	D# 2
HP-3	Preliminary Brazing Data Package	D# 2
HP-4	Environmental Qualification Test Procedures	D# 2
HP-5	Welding Data Package	D# 2
HP-6	Brazing Data Package	D# 2
HP-7	Non-Destructive Examination Procedures	D# 2
HP-8	Full-scale prototype manufacturing drawings	D# 2
HP-9	Environmental Qualification Test Reports Environmental Qualification Synthesis Report	D# 2
3. Phase III: Final Design Review		
HP-10	FDR documentation	D# 3
HP-12	Flange design	D# 6
4. Phase IV: Manufacturing Readiness Review		
HP-13	Material certificates	D# 4
HP-14	Certificates of conformance	D# 4
HP-15	MRR documentation	D# 4
5. Phase V: Factory Acceptance Test		
HP-16	FAT reports	D# 5
6. Phase VI: Delivery		
HP-17	Delivery Readiness Review documentation	D# 5

11.3 Work Monitoring

11.3.1 Data management

[REQ-159]

The Contractor shall provide a Verification Control Plan (VCP), also called compliance matrix, showing, for each of the requirements in this Contract, how they intend to comply and verify compliance. The VCP shall be updated, at least, in each phase of this contract.

11.3.2 Monitoring and Access Rights

Planned and documented audits may be performed by the IO to verify the compliance with the technical and quality assurance requirements of the Contract.

[REQ-160]

The IO representatives shall be authorized to access the Contractor's documentation, premises and personnel to carry out surveillance, audit and follow-up activities.

[REQ-161]

These activities may be extended to the Contractor's Subcontractors. The contractor shall therefore ensure that IO's right to conduct periodic audits, reviews, surveillance and inspection of the quality system and verification of its compliance with all quality and technical requirements of the Contract, is incorporated into any subcontract.

[REQ-162]

The Contractor shall grant access rights to the IO and French nuclear regulatory authorities representatives to its facilities and records and those of its suppliers and subcontractors for the purposes of surveillance of defined requirements during the design, construction/manufacturing, commission, assembly, maintenance and surveillance of a PIC. This surveillance also includes the examination of all PIA and the follow-up and verification of all corrective actions which are to be implemented.

11.3.3 Periodic meetings

[REQ-163]

The Contract shall start with an official Kick-Off Meeting where the following items (as a minimum) shall be discussed and agreed:

- Confirmation of the specifications, specific requirements and contractual input.
- The Contractor's Quality Plan.
- The Detailed Work Schedule of the contractual activities, including milestones.
- The Contract Risk Register.

[REQ-164]

Progress meetings shall be conducted throughout the whole duration of the Contract at a minimum frequency of one per calendar month. The meetings shall be held by video conference or in-person at the IO's premises or at the Contractor's premises.

[REQ-165]

The Minutes of Meeting (MoM) shall be prepared by the Contractor and submitted to the IO no later than one week after the meeting.

11.3.4 Reviews

The IO and the Contractor may organise Status Reviews (SRs), Quality Control Reviews (QCRs) and Safety Review. These may be focused on particular areas of production and will be organised by IO as required by the progress and performance.

[REQ-166]

The contractor shall organize the Final Design Review (FDR), Manufacturing Readiness Review (MRR) and Delivery Readiness Review (DRR).

11.4 Meeting Schedule

[AD01] GM3S section 6.1.6 applies. In addition, the Contractor shall organize follow-up meetings every two weeks.

11.5 CAD design requirements

This contract requires for CAD activities, [AD01] GM3S section 6.2.2.2 applies

12 Appendices

This technical specification comes with the Appendices listed below. The last approved version shall be considered as applicable.

Appendix	AD	Title	IDM reference
B	02	Welding Specification	2VEGGR
C	03	Brazing Specification	2Z82VZ