

Technical Summary

Manufacturing and Supply of ITER's Diagnostics Electrical Feedthroughs.

Ref: IO/22/CFT/10024759/LLU

1. Purpose

This Framework contract main objective is to provide the electrical feedthroughs used as part of the nuclear confinement barrier for the LEVI system.

2. Background

The LEVI (Loom Electrical Vacuum Interfaces) is the electrical system which provides the electrical signal and power to the in-vessel components of the diagnostic port plug (PP). It consists of several electrical components and mechanical parts:

- LEF (LEVI Electrical Feedthrough) which transmits the electric line across the vacuum boundary and the safety confinement barrier
- Diagnostics Shield Module (DSM) connector which provides the electrical junction between the DSM and the PP closure plate
- Front-End (FE) connector which provides the cable connection from the DSM to the diagnostic component installed in the DSM.
- Cables: due to the harsh environment (Ultra-High Vacuum, high temperature, high neutron/gamma fluence, strong magnetic field), MI (Mineral Insulated) cables are used except for some Kapton Cables on the PP closure plate.

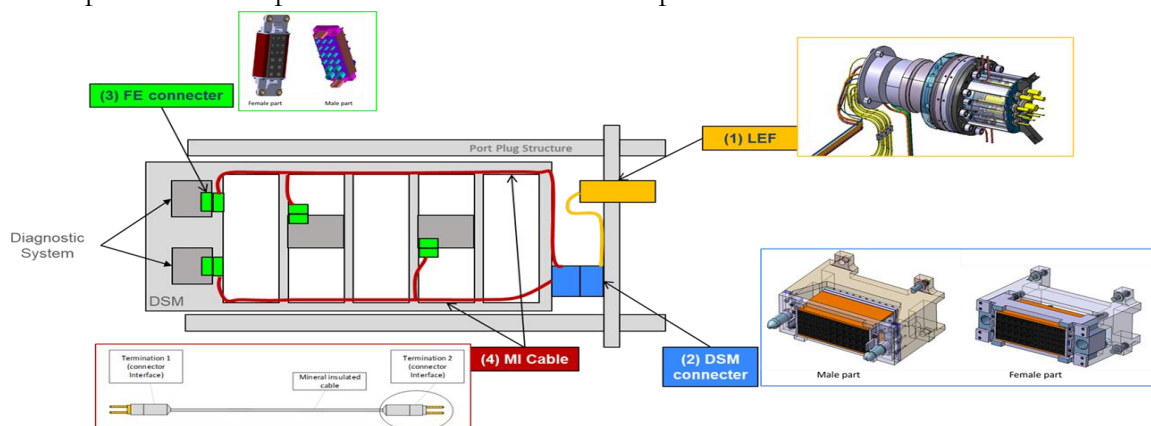


Figure 1 LEVI layout in the diagnostic port plug

The LEF is a safety important component (SIC) to provide the nuclear safety confinement for radioactive products or toxic material (Tritium, activated dust, Be). It also forms the primary ultra-high vacuum boundary for the tokamak machine. To meet this requirement, the LEF has two confinement barrier.

The LEF is composed of following four sub-assemblies:

- LEF Sub-Assembly.
- Mating Flange Sub-Assembly.
- IVS (In Vacuum Support) Sub-Assembly. □ Air Flange Sub-Assembly.

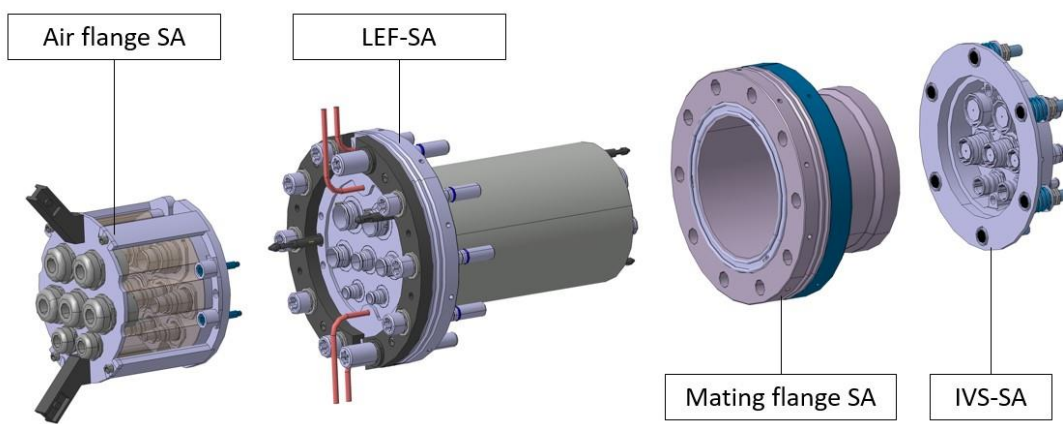


Figure 2 LEF assembly

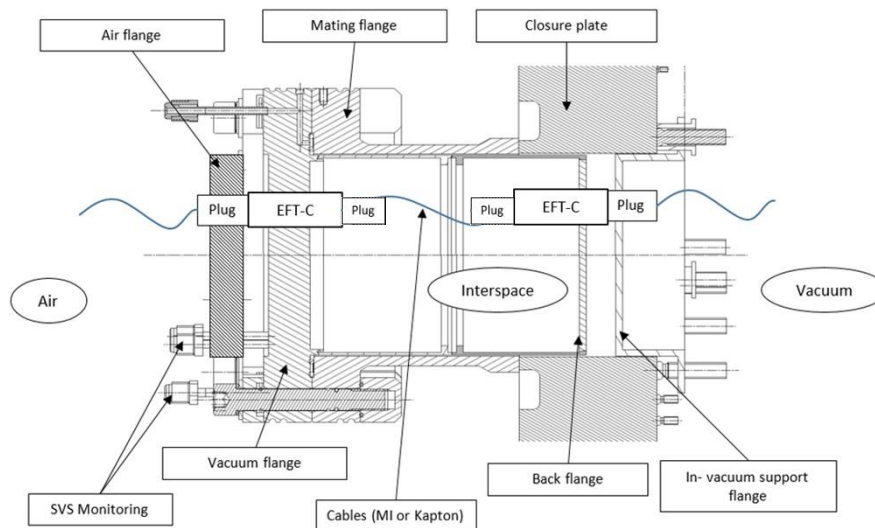


Figure 3 LEF concept (Cut View)

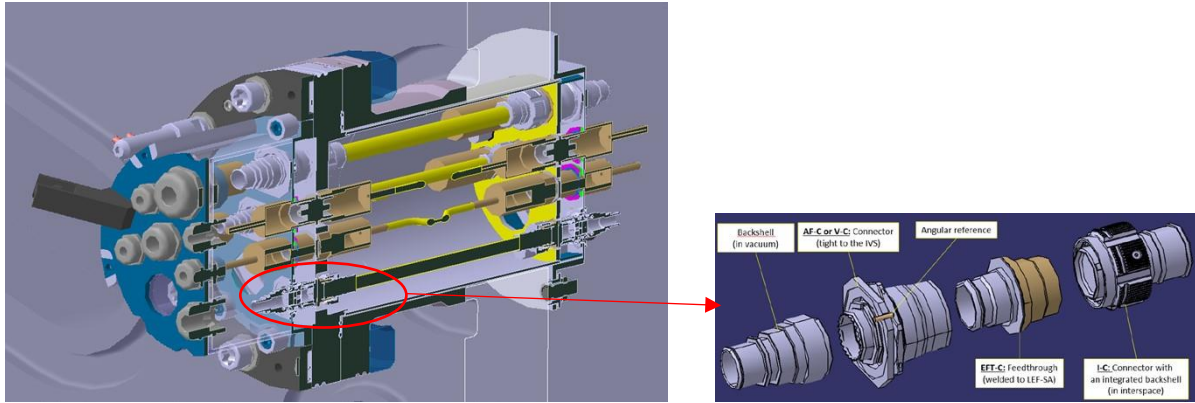


Figure 4 An example of the LEF design integrated with multi-pin feedthroughs and connectors (left) and the detail view for the assembly of a multi-pin feedthrough and two connectors (receptacle and plug)

Between each sub-assembly, some connectors accommodate the electrical junctions to provide the electrical services.

The LEF is designed to be replaceable during ITER lifetime. Therefore the connectors (“receptacle”) between the LEF’s back flange and the IVS are compatible with blind mating. The connectors between the air flange and the LEF’s vacuum flange are also compatible with blind mating. On the other hand, the connectors (“plug”) within the interspace are joined with a threaded nut.

3. Scope of Work

The scope of work covered in this Summary is to:

1. Provide the electrical feedthroughs used as part of the nuclear confinement barrier for the LEVI system.
 - a. QA compliance with nuclear safety standards
 - b. Functional qualification based either in documentation/testing of feedthroughs compliant with ITER environment and requirements
 - c. Manufacturing and FAT of electrical feedthroughs and it’s connectors (EFT –C and connectors highlighted in and)
 - d. Documentation to allow traceability for manufacturing of Safety Important Components

As a general statement, the details of the task to be provided by the awarded Contractor will be defined in the Task Order Technical Specification

These Technical Specifications will be defined specifically for each Task Order depending on the actual requirement and will include a technical scope, the organization of the Task Order within IO and a description of the deliverables.

4. Work Description

The LEVI system must accommodate several signal types as required by different diagnostic systems, therefore the awarded contractor shall provide the connector’s design (i.e hermetic electrical feedthrough connectors + connection plug) compatible with the ones listed in Table 2

A preliminary list of requirements for these electrical feedthroughs is listed below:

- All feedthroughs must have a weldable interface to allow integration within the LEF
- Feedthroughs must be push pull type to allow RH compatibility. Each connector shall be able to sustain an axial misalignment of +/-0.8mm and +/-5°.
- The port plug is baked 500 times on the ITER Life-time. The connectors and accessories shall be able to withstand 500 baking cycles from 20°C to 240°C while keeping the electrical and mechanical properties
- Operating temperatures for the feedthroughs is between 20 and 120°C
- All the boundaries between UHV/Interspace/AIR shall be leak tested and remain He leak tight to $2.69 \times 10^{-10} \text{ Pa.m}^3 \cdot \text{s}^{-1}$ (helium-equivalent; normal pressure), whatever the conditions.
- All the materials shall be halogen free.
- The connectors shall withstand a cumulated dose greater than 10 MGy and $1 \cdot 10^{17} \text{ n/cm}^2$ neutron fluence while keeping electrical and mechanical properties. The compliance can be justified by the material selection with support from IO experts

Two batches are expected for in-series products. The quantity is preliminarily estimated in Table 1. This quantity is required for the multi-pin feedthrough, the receptacle, and the plug, respectively. The quantity will be finalized after the pre-qualification phase of the tendering process.

Table 1 Preliminary quantity of the in-series product

| Signal Category | No. of pins | Cable AWG to interface | Quantity for Batch#1 | | | Quantity for batch#2 | | |
|---------------------|-------------|------------------------|----------------------|-------|-------|----------------------|-------|-------|
| | | | products | Spare | total | products | Spare | total |
| Instrum I (TC) | 120 | 30 | 0 | 0 | 0 | 12 | 2 | 14 |
| Instrum I (TC) | 54 | 30 | 8 | 2 | 10 | 8 | 2 | 10 |
| Instrum I (TC) | 18 | 30 | 0 | 0 | 0 | 10 | 2 | 12 |
| Instrum I (LV I/LF) | 121 | 22 - 26 | 6 | 1 | 7 | 4 | 1 | 5 |
| Instrum I (LV I/LF) | 55 | 22 - 26 | 2 | 1 | 3 | 4 | 1 | 5 |
| Instrum I (LV I/LF) | 19 | 22 - 26 | 4 | 1 | 5 | 0 | 0 | 0 |
| LV I/LF/HC | 4 | 8 - 12 | 0 | 0 | 0 | 24 | 5 | 29 |
| LV II/LF | 26 | 20 - 26 | 2 | 1 | 3 | 4 | 1 | 5 |
| LV III/LF | 2 | 20 - 26 | 4 | 1 | 5 | 0 | 0 | 0 |
| LV III/LF | 8 | 20 - 26 | 6 | 1 | 7 | 8 | 2 | 10 |
| Total Quantity | | | 32 | 8 | 40 | 74 | 16 | 90 |

Table 2 Electrical signal characteristics of LEVI

| Signal Classification | Use case | Rated Voltage | Rated Current | insulation resistance | Dielectric strength | Frequency range |
|-------------------------|---|---------------|---------------|---|-------------------------------|-----------------|
| INSTRUM I | Instrumentation (thermocouples, switches, ...) | 50 V | 0.5 A | > 0.1 G Ω @ 500 VDC Room ambient environmental conditions | 200V RMS test voltage @ 60Hz. | - |
| LV (I) / LF / HC | Control / Power line | 300 V | 20 A | > 1 G Ω @ 500 VDC Room ambient environmental conditions | 1000V RMS @ 60Hz | DC to 30kHz |
| LV (II) / LF | Control / Power line | 600 V | 4 A | > 1 G Ω @ 500 VDC Room ambient environmental conditions | 1200V RMS @ 60Hz | DC to 30kHz |
| LV (III) / LF | Control / Power line | 1000 V | 2 A | > 1 G Ω @ 2000 VDC Room ambient environmental conditions | 2000V RMS @ 60Hz | DC to 30kHz |

5. Required Experience and Facilities

The candidate shall have facilities and experience such that they can perform:

- Manufacturing of Ultra High Vacuum Electrical feedthroughs and related technologies
 - Glass to metal sealing
 - Ceramic to metal sealing
- Leak tightness measurements
- Capability to perform electrical testing
- High Precision machining
- Quality control and technical control which can be applicable to the nuclear safety component

6. Duration of Service

The contract will be carried out over an initial firm period of four (4) years and an optional period of two (2) years. The contract is scheduled to come into force in end of 2023.

7. Candidature

Participation is open to all legal persons participating either individually or in a grouping (consortium) which is established in an ITER Member State. A legal person cannot participate individually or as a consortium partner in more than one application or tender. A consortium may be a permanent, legally-established grouping or a grouping, which has been constituted informally for a specific tender procedure.

All members of a consortium (i.e. the leader and all other members) are jointly and severally liable to the ITER Organization. The consortium cannot be modified later without the approval of the ITER Organization.

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

8. Tentative schedule

The indicative Call for Tender milestones are:

- | | |
|---|-----------------------------|
| • Call for Nomination | Beginning of December 2022 |
| • Issuing of Prequalification Invitations | Beginning of February, 2023 |
| • Issuing of Call for Tender | Mid of May, 2023 |
| • Submission of Tenders | End of June, 2023 |
| • Award of Contract | End of September 2023 |

9. Reference

Further information on the ITER Organization procurement can be found at:

<http://www.iter.org/org/team/adm/proc>