

Technical Specifications (In-Cash Procurement)

**Engineering support of LEVI design development and
manufacturing**

CFE for:

Engineering support of LEVI design development and manufacturing

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1 Purpose

This document describes technical specification for the engineering work required to integrate the electrical services in the diagnostic upper and equatorial port, including the ports where the Disruption Mitigation Systems are installed.

ITER diagnostic port is composed of three integration zones: the port plug, the port interspace and the port cell. The port plug is in vacuum and the others are in the atmospheric condition. The port has several tenant systems such as diagnostic systems, DMS (Disruption Mitigation System), GDC (Glow Discharge System). The components of each tenants system are installed in the three integration zones, depending on the tenant need. See Figure 1.

There is an electrical system in the port plug (PP) to transmit electrical signal and power to the in-PP diagnostic components such as first mirror, sensor, detector, etc. This electrical system is called as LEVI (Loom Electrical Vacuum Interfaces). The main components of LEVI are the electrical feedthrough on the PP closure plate, the electrical connectors and the cables (Mineral insulated cables and kapton cables). They are shown in Figure 2. The electrical feedthrough is the safety important component (SIC) which forms the primary vacuum boundary of the torus as well as the nuclear safety barrier. It is called LEF (LEVI electrical feedthrough). The electrical connectors should be Remote Handling (RH) compatible for the maintenance of the in-PP diagnostic components. One example of the LEVI design integrated in the port plug is shown in Figure 3.

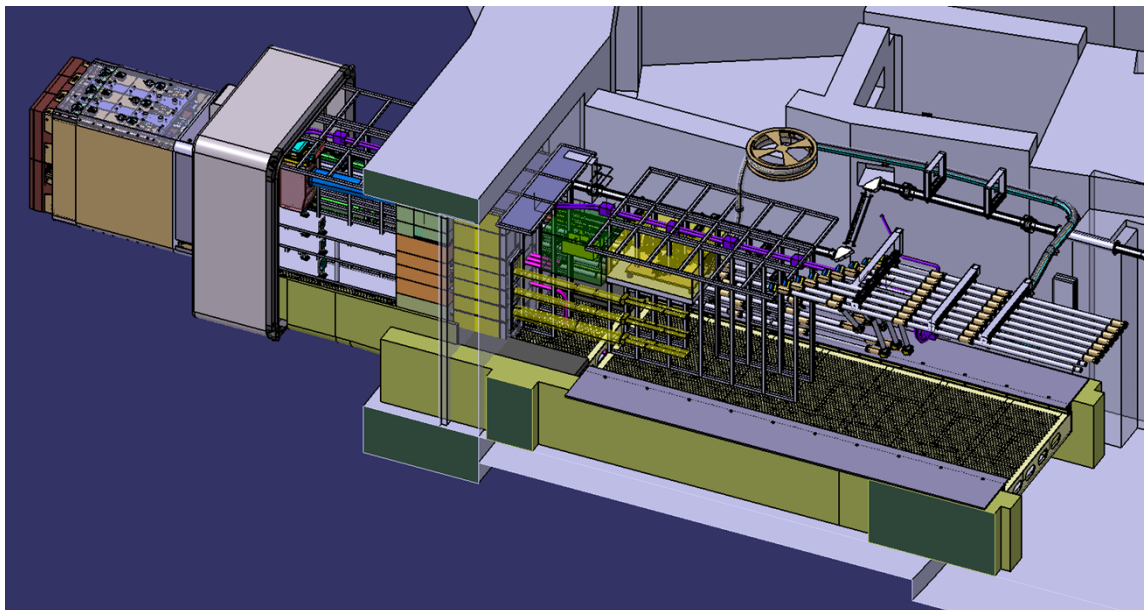


Figure 1 General layout of diagnostic port in ITER

The following aspects, which are not exclusively listed, need to be considered for the LEVI integration:

- Electrical characteristics
- Electrical signal grouping
- Cable routing design
- Electrical cross-talk, Paschen effect, insulation requirements
- ITER environment: vacuum, temperature, radiation, fire, magnetic field, etc.
- Vacuum requirement for the in-vacuum components

- RH handling requirement
- Maintenance requirement
- Mechanical interface with the tenant components and the port environment

The LEVI system is now in the final design phase, followed by some prototyping activities, nuclear safety qualification of the LEF and finally manufacturing of the final products.

The purpose of this contract is to provide the engineering support required for all these activities.

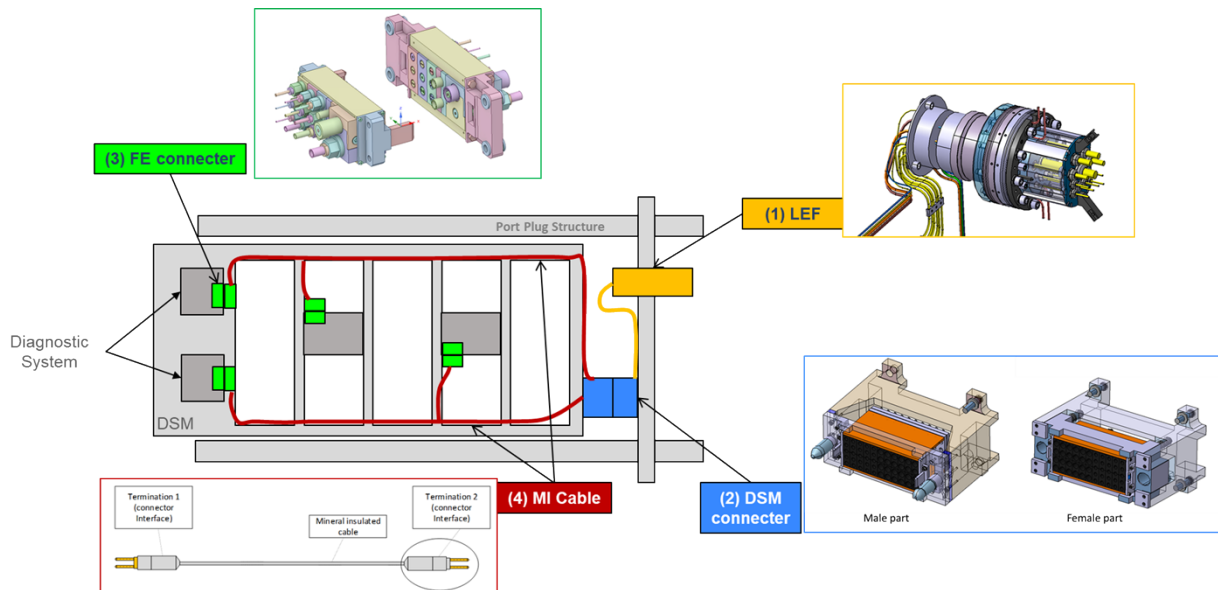


Figure 2 Schematic of the LEVI system in the diagnostic port plug

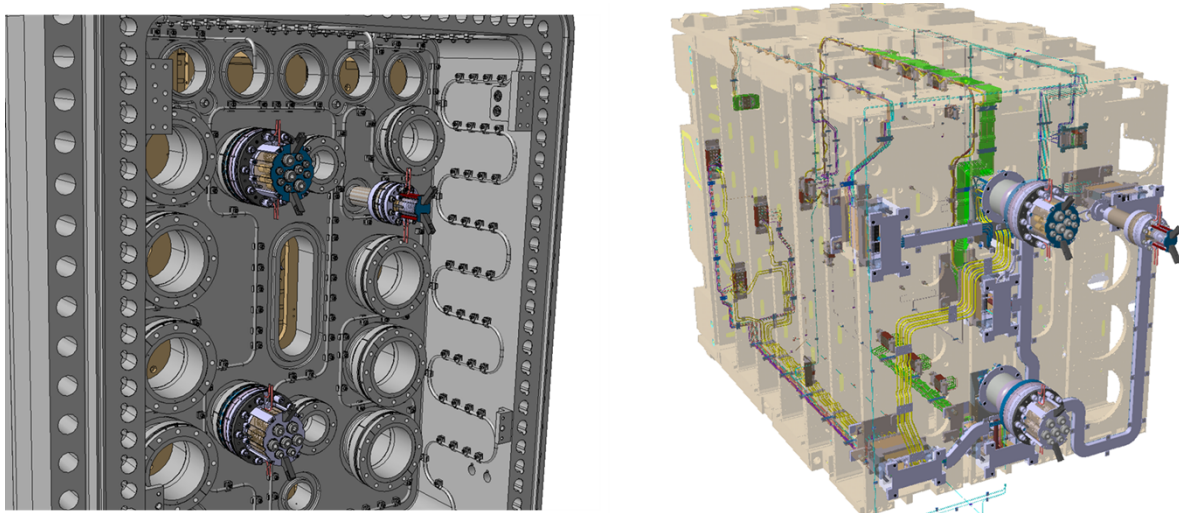


Figure 3 LEVI design in one DSM of Equatorial Port Plug #12

2 Scope

The work scope of this contract is to provide technical expertise and engineering support for the development of the electrical services (cables, connectors, electrical feedthroughs, etc), the integration into the port, and prototyping, qualification test, and manufacturing of the final products. It will include the following activities, which are not exclusively listed:

- LEVI integration design into the port plug
- Development and integration of electrical services in the port interspace and port cell
- Interface management and coordination related electrical services between port integration and the tenant systems
- Preparation of technical specification for manufacturing
- Follow-up of prototype manufacturing, component qualification activities, and in-series manufacturing activities

The contractor need to consider the following ports and their tenant systems which will have the same design concept for the electrical services.

- Equatorial ports: #2, #3, #8, #9, #11, #12, #17
- Upper ports: #2, #4, #5, #6, #7, #8, #9, #11, #14, #18

3 Definitions

BOM: Bill of Material

DMS: Disruption Mitigation System

DSM: Diagnostic Shield Module

FDR: Final Design Review

GDC: Glow Discharge System

IO: ITER Organization

IO-TRO: ITER Organization technical Responsible Officer

ISS: Interspace Support Structure

LEF: LEVI Electrical Feedthrough

LEVI: Loom Electrical Vacuum Interfaces

MI: Mineral Insulated

PCSS: Port Cell Support Structure

PP: Port Plug

RH: Remote Handling

TRO: Technical Responsible Officer

UPP: Upper Port Plug

For a complete list of ITER abbreviations see: [ITER Abbreviations \(ITER_D_2MU6W5\)](#).

4 Estimated Duration

Services are to be provided for 100% of the time at the IO-CT work site. The duration shall be for 12 months from the start date of on-site work.

5 Work Description

The contractor shall provide the technical expertise and engineering support for the design development of the electrical services in the ports. It is required to work full time at the IO-CT work site and interact with the IO Technical Responsible Officers (TROs) which are in charge of the systems interfacing the electrical services.

5.1 LEVI integration design activities in the port plug

The LEVI system takes into account seven different electrical signals in Table 1, which covers all the needs of the client systems (port plugs and tenant systems). In order to transmit these signals, the LEVI systems has the following standard components:

- LEF: the LEF assembly has various standard hermetic multi-pin feedthroughs corresponding to the signal types or standard hermetic feedthroughs dedicated to specific signals such as RF signal or high power. The configuration of these feedthroughs need to be customized for each port plug depending on the electrical signal types and the number of cables.
- Electrical connectors: the connector design consists of two main parts: the external casing and the internal replaceable connector module. Depending on the cable types and quantity, the proper connector module will be selected and assembled to the external casing.
- MI cables: there are 11 types of MI cables to cover all the signal types. These MI cables are installed mainly into the DSM structure except for some MI cables such as RF or power signal.
- Kapton cables: there are 4 types of Kapton cables to be used for the electrical line between the DSM connector and the LEF.

Table 1 LEVI signal classification and electrical characteristics

Signal Classification	Use case	Rated Voltage	Rated Current	Insulation resistance	Dielectric strength (1)	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.	-
INSTRUM II	Triaxial line	600 V	10 μ A	> 10 G Ω @ 500 VDC Room ambient environmental conditions	2200V RMS @ 60Hz	0-200MHz
INSTRUM III	Coaxial– Mainly for the mirror cleaning application.	1 kV (3kV in case of impedance mismatch)	Power handling < 2 kW	> 1 G Ω @ 2000 VDC Room ambient environmental conditions	3000V RMS @ 60Hz	0-200MHz
LV (I) / LF / HC	Control / Power line	300 V	20 A	> 1 G Ω @ 500 VDC Room ambient environmental conditions	1600V RMS @ 60Hz	DC to 30kHz
LV (II) / LF	Control / Power line	600 V	4 A	> 1 G Ω @ 500 VDC Room ambient environmental conditions	2200V RMS @ 60Hz	DC to 30kHz
LV (III) / LF	Control / Power line	1000 V	2 A	> 1 G Ω @ 2000 VDC Room ambient environmental conditions	3000V RMS @ 60Hz	DC to 30kHz
MV(I) / LF	Medium Voltage – Mainly for the glow discharge	5 kV	32 A	> 1 G Ω @ 2000 VDC Room ambient	19000V RMS @ 60Hz	DC to 60Hz

	cleaning			environmental conditions	impulse crest voltage 60000V	
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The LEVI integration design for each port plug is made by using these standard electrical components. The contractor shall provide the engineering support to the port integrator and the tenant system so that they can do the proper integration. If necessary, the guideline document for LEVI integration needs to be prepared and provided to the port integrator.

- Selection of cables, connector modules and LEF hermetic connectors
- Cable routing and clamping
- Layout of hermetic connectors in the LEF bulkhead
- Cabling among connectors and LEFs
- Review of the CAD modelling of the LEVI integration for each port plug and, if necessary, provide feedback to correct any improper design.

Especially, the contractor shall support the LEVI integration design activities in the ports (EP#8/17 and UP#2/8/14) where the DMS (Disruption Mitigation System) are installed and may give impact on the LEVI integration.

5.2 Chit closure of final design review

The contractor shall close the chits raised during the final design review. It will require technical coordination among the LEVI design team and the interfacing system ROs, including various contractors involved to the LEVI project. The contractor should prepare chit resolution memos. If necessary, the contractor has to update some technical documents which has been used as FDR input package.

5.3 LEVI interface coordination in the port

The contractor shall review all the interfaces relevant to the LEVI system of each port plug and take necessary actions to define the interfaces in a correct and proper way.

It will require to review all the cable diagrams of the tenant systems and the port integration systems in order to check whether the cable types, cabling among LEVI components, etc. are properly specified.

With regards to the interface with the ex-vessel cabling (55.NE.X0), it is necessary to make the cable consistency with the LEVI cabling such as wire gauge and signal consistency. The contractor should define the physical interface of electric connector for each signal types and agree with 55.NE.X0. Based on this agreed interface, the contractor shall propagate it to each port plug and ensure the implementation in collaboration with the port integrator and the tenant systems.

The contractor shall provide engineering expertise to support any other direct or indirect interfaces of LEVI, for example, reviewing the interface sheets between the port integration system and the tenant system to ensure that the LEVI-related interfaces are correctly defined.

5.4 Manufacturing of the LEVI electric components

The client systems (port integration systems and tenant systems) using the LEVI system are installed to the ITER machine during the first plasma phase or the PFPO-1 (Pre-Fusion Power Operation) phase. In order to meet the delivery need date for the first plasma, IO has to start the manufacturing of some LEVI components (cables and electric connectors) in 2022.

To prepare these manufacturing, the contractor shall prepare the technical specification for the manufacturing contracts. It will require bill of materials including the exact quantity of the LEVI components for each port plug and 3D model and 2D drawings which shows the detail design such as cable shape/length, electric connector size and its cable arrangement, etc. The contractor shall prepare all these inputs (what is mentioned here is not exhaustive, there may be more documents or materials) in collaboration with the client system ROs.

In order to have a proper manufacturing plan, the contractor shall collect the delivery need dates from the client system ROs and harmonize the manufacturing schedule with the delivery need dates.

During the manufacturing period, the contractor shall organize the progress meetings with the manufacturers, follow up all the manufacturing activities according the manufacturing & inspection plan, review all the inputs from the manufacturers, provide necessary inputs to the manufacturers, take necessary actions if there be any issues.

5.5 Other technical support

The contractor shall provide the following technical support;

- Preparation and follow-up of the technical meetings related to the LEVI system: if necessary, it will be required to prepare agendas, meeting minutes, and follow up the actions.
- Review the technical documents
- Manage the LEVI documentation in IDM (ITER Document Management system)

6 Responsibilities

6.1 Contractor's Responsibilities

In order to successfully perform the tasks in these Technical Specifications, the Contractor shall:

- Strictly implement the IO procedures, instructions and use templates;
- Provide experienced and trained resources to perform the tasks;
- Contractor's personnel shall possess the qualifications, professional competence and experience to carry out services in accordance with IO rules and procedures;
- Contractor's personnel shall be bound by the rules and regulations governing the IO ethics, safety and security IO rules.

6.2 IO's Responsibilities

The IO shall:

- Nominate the Responsible Officer to manage the Contract;

- Organise progress meetings on work performed;
- Provide offices at IO premises.

7 List of Deliverables and due dates

The main deliverables are provided in the table below.

D #	Description	Due Dates
D00	Quality Plan	T0 (Kick-off meeting)
D01	Preparation of manufacturing of LEVI components for first plasma systems in EP#11/12 - Contract technical specification, including bill of materials and 3D model & 2D drawings.	T0 + 2 months
D02	Summary of chit closure activities of LEVI FDR: chit resolution memos, technical documents, etc.	T0 + 4 months
D03	LEVI integration in the port plugs (EP#2/8/17 & UP#2/8/14) where DMS is installed - Schematic diagram for cabling among LEF and electric connectors - Report on CAD model of LEVI design: consistency with schematic diagram, cabling diagram, proper tagging, etc. - Report on LEVI-related interface: 55.NE.X0 ex-vessel cable, Interface sheets between port integrators and tenants - Report on cable diagrams for LEVI clients	T0 + 6 months
D04	LEVI integration in the other port plugs (EP#3/9 & UP#4/5/6/7/9/11/18) - Schematic diagram for cabling among LEF and electric connectors - Report on CAD model of LEVI design: consistency with schematic diagram, cabling diagram, proper tagging, etc. - Report on LEVI-related interface: 55.NE.X0 ex-vessel cable, Interface sheets between port integrators and tenants - Report on cable diagrams for LEVI clients	T0 + 10 months
D05	Preparation of manufacturing of LEVI components for PFPO-1 systems - Contract technical specification, including bill of materials and 3D model & 2D drawings.	T0 + 11 months
D06	Summary of the technical support: list of document reviews,	T0 + 12 months

	minutes of technical meetings, etc.	
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8 Acceptance Criteria

The deliverables will be posted in the Contractor's dedicated folder in IDM, and the acceptance by the IO will be recorded by their approval by the designated IO TRO. These criteria shall be the basis of acceptance by IO following the successful completion of the services. These will be in the form of reports as indicated in section 7, Table of deliverables.

9 Specific requirements and conditions

Person(s) to carry out the work described in this document must have proven experience, as appropriate.

- Design and Development of equipment designs for fusion or nuclear facilities;
- Experience in electrical engineering;
- Experience in electrical cabling and harnessing;
- Experience in preparation of technical specification for manufacturing contract;
- Experience in manufacturing of electrical components: cables, connectors, electrical feedthroughs, etc.
- Experience in diagrams (single line diagram, cable diagram);
- CAD skill with CATIA for 3D modelling and 2D drawings;
- Monitoring and reporting of status of projects;
- Generation of technical, administrative, and managerial documents;
- Communication with international local and remote teams in context of nuclear fusion research or similarly complex research and engineering environment;
- Organization, taking minutes and action tracking of international meetings;

10 Work Monitoring / Meeting Schedule

Work is monitored through reports on deliverables (see List of Deliverables section) and at progress meetings.

11 Delivery time breakdown

See Section 7 "List Deliverables section and due dates".

12 Quality Assurance (QA) requirements

The organisation conducting these activities should have an ITER approved QA Program or an ISO 9001 accredited quality system.

The general requirements are detailed in [ITER Procurement Quality Requirements \(ITER_D_22MFG4\)](#).

Prior to commencement of the task, a Quality Plan must be submitted for IO approval giving evidence of the above and describing the organisation for this task; the skill of workers involved in the study; any anticipated sub-contractors; and giving details of who will be the independent checker of the activities (see [Procurement Requirements for Producing a Quality Plan \(ITER_D_22MFMW\)](#)).

Documentation developed as the result of this task shall be retained by the performer of the task or the DA organization for a minimum of 5 years and then may be discarded at the direction of the IO. The use of computer software to perform a safety basis task activity such as analysis and/or modelling, etc. shall be reviewed and approved by the IO prior to its use, in accordance with Software qualification policy (ITER_D_KTU8HH).

13 CAD Design Requirements

For the contracts where CAD design tasks are involved, the following shall apply:

The Supplier shall provide a Design Plan to be approved by the IO. Such plan shall identify all design activities and design deliverables to be provided by the Contractor as part of the contract.

The Supplier shall ensure that all designs, CAD data and drawings delivered to IO comply with the Procedure for the Usage of the ITER CAD Manual ([2F6FTX](#)), and with the Procedure for the Management of CAD Work & CAD Data (Models and Drawings [2DWU2M](#)).

The reference scheme is for the Supplier to work in a fully synchronous manner on the ITER CAD platform (see detailed information about synchronous collaboration in the ITER [GNJX6A](#) - Specification for CAD data production in ITER Contracts.). This implies the usage of the CAD software versions as indicated in CAD Manual 07 - CAD Fact Sheet ([249WUL](#)) and the connection to one of the ITER project CAD data-bases. Any deviation against this requirement shall be defined in a Design Collaboration Implementation Form (DCIF) prepared and approved by DO and included in the call-for-tender package. Any cost or labour resulting from a deviation or non-conformance of the Supplier with regards to the CAD collaboration requirement shall be incurred by the Supplier.

14 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.

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 ([PRELIMINARY ANALYSIS OF THE IMPACT OF THE INB ORDER - 7TH FEBRUARY 2012 \(AW6JSB v1.0\)](#)).

Compliance with [Defined requirements for PBS 55 - Diagnostics \(NPEVB6 v2.0\)](#) or its flowed down requirements in [SRD-55 \(Diagnostics\) from DOORS \(28B39L v5.2\)](#) is mandatory.

The LEVI system includes PIC and the work scope of this contract includes some PIA activities.

“The supplier must comply with the all requirements expressed in “Provisions for implementation of the generic safety requirements by the external actors/interveners” (SBSTBM)”