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Route de Vinon-sur-Verdon - CS 90 046 - 13067 St Paul Lez Durance Cedex - France

Technical Summary

Call for Nomination

Development and Supply of Coaxial Mineral Insulated Cables for High RF Power

Ref: IO/20/CFT/70000686/LLU

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1. Purpose

The purpose of this Framework Contract is to develop and supply coaxial Mineral Insulated Cables (MIC) terminated with RF connector for the LEVI (Loom Electrical Vacuum Interface) system. The coaxial MIC transmits High RF (Radio Freqency) Power in order to clean the first mirror in the diagnostic port plug of ITER. It also includes prototyping and testing required for design verification and qualification.

2. Background

ITER is the first nuclear fusion machine which will demonstrate the scientific and technological feasiblity with the fusion power Q (output power/inpu power) = 10. To achieve this project goal, it is essential to measure a plasma with diagnostic systems. Many diagnostic systems measure optical signals and they have a set of mirrors near the plasma to relay the signal to a detector located outside of the machine. The mirrors, especially located close to the plasma, are vulerable to dust deposition which leads to reflectivity degradation. In order to improve the machine availiability, we will do in-situ cleaning of the mirror with RF discharge. The RF power generated in the diagnostic room will be transmitted with coaxial lines to the mirror installed in the diagnsotic port plug through the vacuum and safety confinement barrier of the machine. The electrical system in the port plug, which is called “LEVI”, is used for this RF power transmission.
The scope of this contract is to develop the mineral insulation (MI) coaxial cable for high RF power which can sustain the environment of the ITER machine.

2.1 LEVI brief description

The LEVI (Loom Electrical Vacuum Interface) system is an electrical system installed into the diagnostic port plug to provide the electrical lines to transmit electric signal and power to the in-vessel diagnostic components.

The system consists of the four main parts:

- LEF (LEVI Electrical Feedthrough): it allows the electric line to penetrate the safety confinement as well as the vacuum boundary. It is bolted to the closure plate of the port plug and sealed with double metal gaskets.

- DSM (Diagnostic Shield Module) connector: it is a Remote Handling (RH) compatible electrical connector that connects the DSM-side cables with the cables on the PP closure plate side.
- FE (Front-end) connector: it is a RH-compatible electrical connector that connects the DSM-side cables with the cables on the diagnostic component which are installed to the DSM.
- MI Cable (MIC): it is the cable used to transmit the electric signal between the diagnostic component and the LEF in the port plug and have several electric junctions with connectors and LEF.

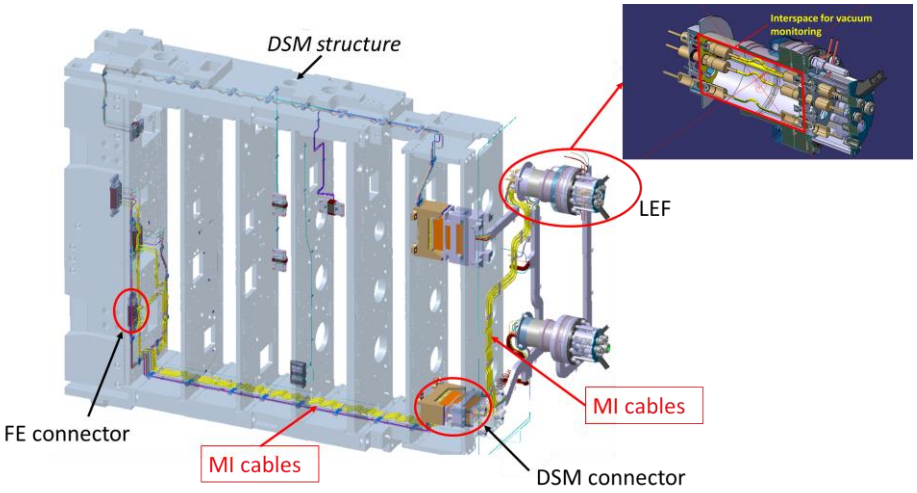

Figure 1 LEVI design integrated into a diagnostic port plug

2.2 Coaxial lines for mirror cleaning

Coaxial lines for RF power transmission are one of the electrical lines required for the LEVI. The coaxial line is used for cleaning of the first mirrors by RF discharge in order to maintain and restore the mirror reflectivity.

These coaxial lines have to be made of MIC to sustain the harsh environment in the port plug of ITER : ultra-high vacuum, high neutron/gamma radiation, high temperature, etc. The coaxial line should be capable of handling the high power required for RF discharge cleaning. To connect with the electric connectors (FE and DSM) and the LEF, the coaxial cable should to be terminated with RF connectors at both ends.

For each RF coaxial line, three MICs are required to complete the line: one between FE connector and DSM connector, one between DSM connector and the LEF, and one for the LEF which is used to connect the hermetic feedthroughs within the vacuum monitoring interface.

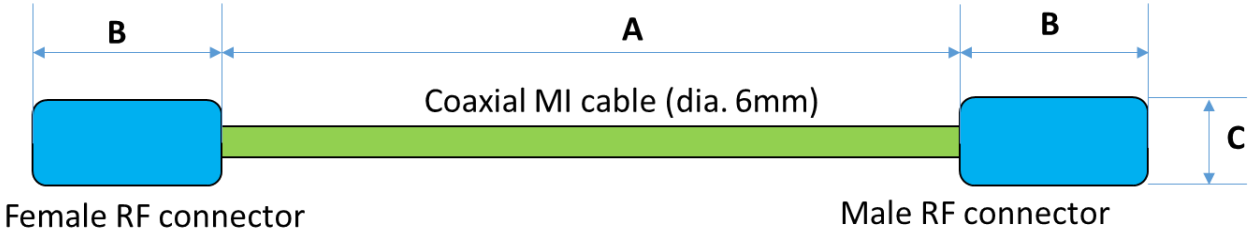

Figure 2 Coaxial MIC terminated with RF connector

3. Scope of work

The scope of the work is to develop the coaxil MIC terminated with RF connectors at both ends which satisfies all the technical requirements required for mirror cleaning and port integration The developed design should be verified and qualified through prototyping and testing. Finally the contractor shall manufacture and suppy the in-series final products of the coaxial MI Cables.

The coaxial MIC termintated with RF connectors should satisfy the following technical requirements:

- Total quantity: 231± 30 cables
  - MICs terminated with RH-compatible HN connectors: 154 ± 20 cables
  - MICs terminated with standard HN connectors: 77 ± 10 cables

- Coaxil MIC
  - Outer diameter: 6 mm
  - Cable length: < 5m
  - Conductor size: 11 AWG
  - Coaxial MIC material:
    - Outer sheath material (2 layers): outer part in 316L Stainless Steel/ inner part in copper
    - Insulant: Alumina (SiO2) or Magnesia (MgO)
    - Conductor: Copper

- RF connector
  - Connection type:
    - push-on, pull-off (misalignment tolerance < 0.3 mm) for RH-compatible connector
    - standard self-locking for non-RH connector
  - Dimension: Outer diameter < 20 mm for RH-compatible connector, outer diameter < 23 mm for non-RH connector

Connector type of coaxial MIC	Dimension (See Figure 2)		
	A	B	C
RH-compatible connector	< 5 m	< 90 mm	< 20 mm
non-RH connector	< 0.3 m	< 90 mm	< 23 mm

  - Termination type: NH type
  - RF connector material
    - Conductor: Copper
    - Insulant: Alumina (SiO2) or Magnesia (MgO)
    - Metal part: 316L Stainless Steel (if other material is used, it should be compliant with ITER vacuum handbook [ITER_D_2EZ9UM v2.3] and avoid magnetic material exposed to EM wave)

- Electrical charateristics
  - Rated Voltage: 1kV (3kV in case of impedance mismatch)
  - Power handling (input power, P_{in}): 500W < P_{in} <2kW
  - Insulation resistance: > 1GΩ @ 2000 VDC room ambient environmental conditions
  - Dielectric strength: 3000V RMS @ 60Hz
  - Frequency range: 0 – 200 MHz
  - Charateristic impedance: 50 Ω +/- 10 Ω @100MHz
  - Voltage Standing Wave Ratio: <1.15 in 10MHz – 200MHz

- Insertion loss (not due to mismatching): <0.01 dB from DC to 200 MHz
- Transfer impedance: < 7m Ω + 0.5nH
- Minimum shielding effectiveness: 100 dB

- Other requirements
  - Maximum temperature: < 350 ^{o}C during operation, 500 thermal cycling (room temperatue - 240^{o}C) for baking
  - Radiation hardness: ~ 1x10^{9}Gy gamma dose and ~1x10^{19} n/cm2 neutron fluence
  - Vacuum class: UHV (Ultra-High Vacuum)
  - Leak tightness: 1x10^{-10} Pa m3/s air equivalent
  - Outgassing rate @ 100^{o}C: 1x10^{-9} for hydrogen isotopes, 1x10^{-11} for impurities
  - Durability (number of matings): up to 100
  - Ambient magnetic field: 4 T static

As a general statement, the details of the task to be provided by the Contractor will be defined in the Task Order Technical Specification specifically depending on the actual requirement, and describing the technical scope and the deliverables.

4. Experience

The candidate must have adequate experience and expertise for the work and activities as detailed below.

- Termination of coaxial MI cable with RF connector
- Ceramic-to-metal bonding
- Vacuum-compatible manufacturing (machining, cleaning, outgasing, clean room, etc)
- MI cable bending
- Vacuum leak and outgassing test
- Thermal cycling
- Welding required to seal the MI cable outersheath and the RF connector body
- Welding for electrical conductor (Laser welding or Micro-TIG welding)
- Crimping of conductor and pin
- Quality control

5. Duration of services

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 end of 2021.

6. 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 form the tender procedure.

7. Tentative Schedule of this Call for Tender

The indicative Call for Tender milestones are:

Call for Nomination	End of April 2021
Issuing of Prequalification Invitations	End of May 2021
Issuing of Call for Tender	End of July 2021
Submission of Tenders	Mid of September 2021
Award of Contract	End of December 2021

8. Reference

Further information on the ITER Organization procurement can be found at:
http://www.iter.org/org/team/adm/proc