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Call for Nomination Documents

Call for Nomination: Summary of Technical Specification for the Conductor Manufacturing of the ITER In-Vessel Coils

This document gives a general overview of the ITER In-Vessel coils system and will serve as a main document for the Call for Nomination for the manufacturing of the ITER In-Vessel Coils Conductor.

Call for Nomination

Summary of Technical Specification for the Conductor Manufacturing of the ITER In-Vessel Coils

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1 Purpose

This document gives a general overview of the ITER In-Vessel coils system and will serve as a main document for the Call for Nomination for the manufacturing of the ITER In-Vessel Coils Conductor.

It is related to the production of the stainless steel mineral insulated conductor (SSMIC) for the vertical stabilization (VS) and Edge Localized Mode (ELM) coils which are part of the ITER in-vessel coil (IVC) system.

The in-vessel environment is severe, characterized by large transient electromagnetic fields, high radiation flux, and high temperature. To withstand these conditions and provide the required functionality the IVCs are made of stainless steel mineral insulated conductor (SSMIC).

2 Scope of the supply

The Supplier shall provide the IO with total length of 5000-6000 m. of Stainless Steel Mineral Insulated Conductor for both coils and feeders. The conductor will be supplied either in discrete straight pieces or spooled on a reel. Detailed information will be given in the Call for Tender documentations.

3 Procurement Strategy

IO will be fully responsible for this procurement.
It is intended to split the procurement of the IVC into three main supply contracts and one large support contract. Splitting the scope in this way should allow any potential advantages offered by different need dates to be fully exploited, and recognizes the differences in design for the two types of coil.
The three main supply contracts will cover the following items:

- Conductors: prototypes, supply for ELM and VS coils and feeders + spares;
- ELM coils: prototypes, supply + spares;
- VS coil and feeder manufacture, trials on full-size mock-up(s) + in-situ manufacture/installation.

In addition, a large support contract will include the design and installation of full size mock up(s) (may be coordinated with Construction Department), among other tasks. Furthermore, it is expected that various R&D and support/expert contracts (all deliverable-based) will be placed.

This Call for Nomination refers <u>only to the Conductor manufacturing</u>. Multiple suppliers can be selected for phase I (process qualification and production of one unit length) in order to maintain competition and keep the cost within acceptable limits. One supplier will be selected for the series manufacturing, with one back-up supplier if costs are comparable, to mitigate schedule risks.

4 Definitions

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

ELM coils	Edge localized mode coils
VS coils	Vertical stabilisation coils
IVC	In-Vessel coils
VV	Vacuum Vessel
IO	ITER Organization
RO	Responsible Officer
SS	Stainless Steel
TBD	To be defined

5 Description of ITER In-Vessel coils system

ITER is project now underway in France to construct a device that will demonstrate nuclear fusion power at a power plant relevant scale. ITER relies on magnetic confinement of a deuterium – tritium plasma to achieve thermonuclear conditions. The main components of the magnetic field are supplied by superconducting coils located outside the ITER vacuum vessel. However, a set of in-vessel coils (IVCs) is required to make local adjustments to the field on a fast time scale.

ITER is incorporating two types of In-Vessel Coils (IVCs): ELM Coils to mitigate Edge Localized Modes and VS Coils to provide Vertical Stabilization of the plasma. Strong coupling with the plasma is required so that the ELM and VS Coils can meet their performance requirements. Accordingly, the IVCs are in close proximity to the plasma, mounted just behind the Blanket Shield Modules. This location results in a radiation and temperature environment that is severe necessitating new solutions for material selection as well as challenging analysis and design solutions. Fitting the coil systems in between the blanket shield modules and the vacuum vessel leads to difficult integration with diagnostics and cooling water manifolds.

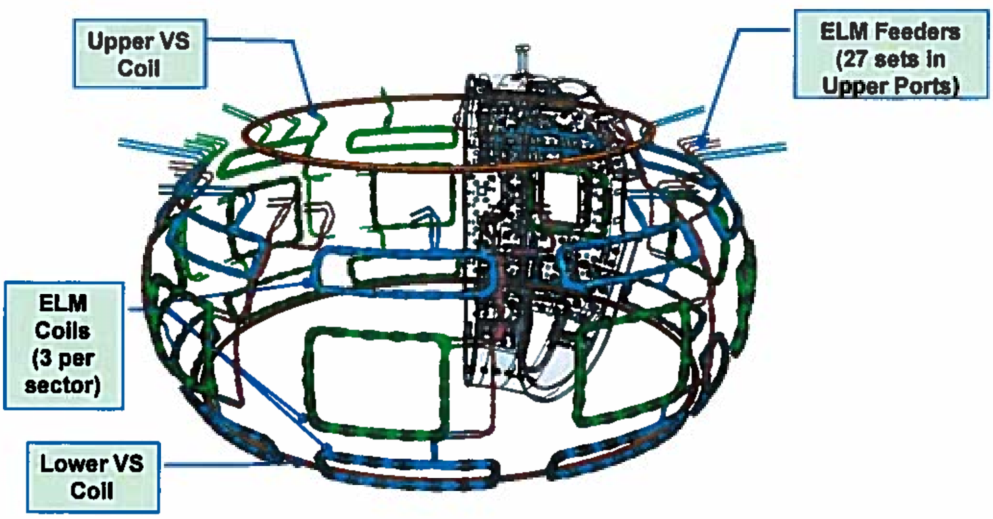

Figure 1: Layout of the IVCs inside the machine

The ELM coils consist of three (upper, midplane, and lower) 6-turn rectangular "picture frame coils", for a total of 27 coils mounted to the vacuum vessel and positioned behind the blanket shield modules (BSM).

The VS coils consist of one upper and one lower 4-turn solenoidal "ring" coil connected in an anti-series "saddle" arrangement. The coils are mounted to the vacuum vessel and positioned behind the blanket shield modules.

All IVCs are supported via bolts to the rails which are welded to the VV wall.

6 Introduction to IVC Conductor.

The in-vessel environment is severe, characterized by large transient electromagnetic fields, high radiation flux, and high temperature. To withstand this environment and provide the required functionality a "mineral insulated conductor" (MIC) technology has been selected for the IVC conductor. Figure 3 shows the MIC configuration, consisting of an axially water-cooled copper conductor surrounded by mineral insulation and a stainless steel jacket.

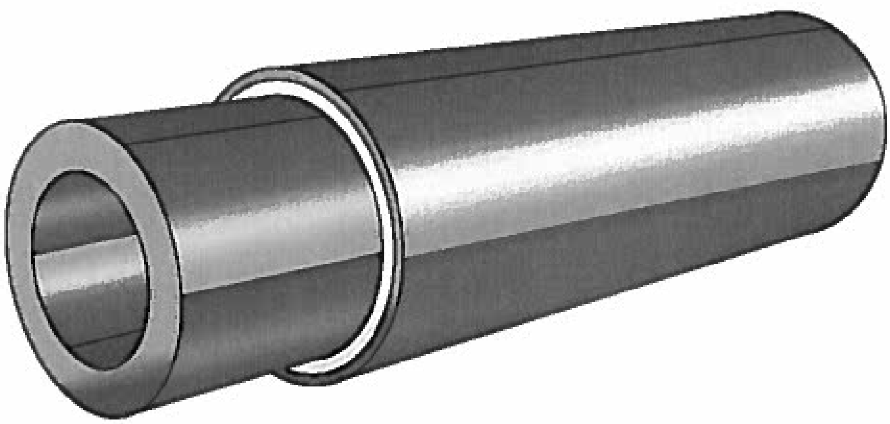

Figure 2: Mineral Insulated Conductor

Cross-section of the Mineral-Insulated Conductor for ITER ELM and VS in-vessel coils is as shown in Figure 3. Geometry and materials are listed in Table 1.

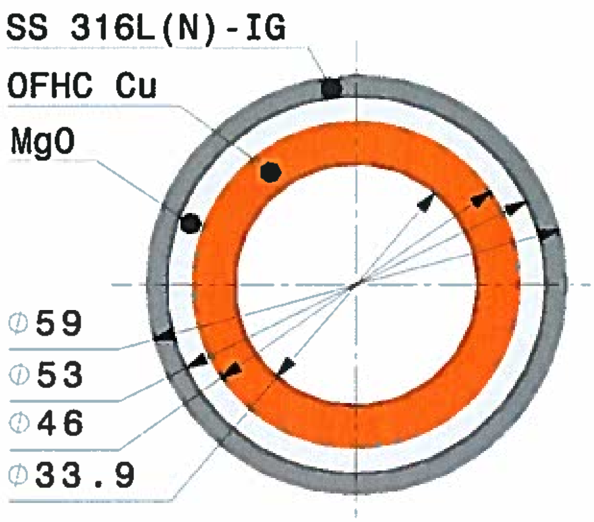

Figure 3. Cross-section of the Mineral-Insulated Conductor for ITER ELM and VS in-vessel coils

Table 1. Geometry and materials for ITER in-vessel coils Mineral-Insulated Conductor

Conductor Parameter	ITER IVC MIC
Jacket material	SS 316L(N)-IG
Jacket outer diameter*, mm	59
Jacket inner diameter, mm	53
Jacket thickness, mm	3
Conductor material	OFHC (C10200)
Copper conductor outer diameter, mm	46
Copper conductor inner diameter, mm	33.9
Copper conductor thickness, mm	6.05
Insulation material	Magnesium Oxide
Insulation thickness, mm	3.5

Tolerance for the conductor will be defined to ensure the thickness of the insulation and with acceptable effect to the mechanical strength of the jacket and copper tube.

A key component of the MIC is the mineral insulation which will consist of compressed MgO powder. The insulation provides three main functions, namely structural support of the copper conductor, thermal conduction between the stainless steel jacket and the copper conductor, and electrical insulation between the stainless steel jacket and copper conductor. The latter two functions depend on properties of the MgO which are known to be affected by radiation flux and fluence.

Although prior research has addressed these effects, the results are known to be highly dependent on the composition of the MgO (grain size, compaction, impurity content) as well as the spectrum of flux and fluence.

7 Tools

All tools and equipment required for the production either bespoke or standard are the responsibility of the contractor.

After compaction the conductor will be coiled on a 4 m spool for transport to the coil manufacturer and/or ITER Organization.

8 Conform extruded process for long Cu tubes.

The fabrication of the IV-Coils for ITER will require Cu tubes of a total length in excess of 80 m. Basically it will be necessary to use a continuous process and produce the required lengths in one single go. The conform technology is a well-established technology for the continuous production of Cu (hollow) sections including tubes.

Particular attention shall be given to the verification of the efficacy of the "weld process" that takes place within the "extrusion shoe".

A strict requirement is not to have any joints in the coils.

9 Tests

All testing operations to be carried out by the Supplier shall be described in the Call for Tender documentation. The Supplier shall prepare Test Procedures for all testing operations and submit them to the IO for acceptance.

The Supplier shall perform factory testing before shipping the components to the IO. For each milestone the Supplier shall provide support necessary to test the component/system to demonstrate that the required performance meet the criteria.

In order to allow the IO to perform the on-site testing, the Supplier shall prepare sufficiently in advance and submit to the IO the information related to testing tasks (type, prerequisites, interfaces, etc...), including any kind of activities during site reception test, on-site component test, on-site system test and on-site system commissioning.

10 Storage

The conductor unit length, rolled on a spooler and packed should be stored at the supplier premises for certain duration of time. Storage conditions will be described in details in the Call for Tender documentations.

11 Transportation

The conductor length needed for the VS coil installation, as described in section 2, should be delivered to ITER premises.

The rest, needed for the manufacturing of the ELM coils will be stored until the ELM coils supplier organizes the transportation to his premises.

12 Tentative Schedule

Activities	Schedule
Call for Nomination	April 2016
Pre-Qualification of Companies	June-July 2016
Invitation for Call for Tender	July – August 2016
Tender submission	September – October 2016
Contract signature	December 2016 – January 2017
Delivery of VS coils conductor To IO premises	2 years from Contract signature
Delivery of ELM coils conductor To coil supplier (to be defined)	3-4 years from Contract signature

Table 2. Tentative Schedule for Call for Tender activities

13 Experience requirements

The ITER Organization is looking for suppliers which experience and knowledge is based on the following main criteria:

- Understanding of the manufacturing requirements;
- Experience in compaction process;
- Experience with an appropriate procurement for material and associated inspection/testing;
- Knowledge/experience in handling of MgO;
- Relevant QA/QC;
- Presence of required machining equipment;
- Sufficient equipment and facilities to meet the requirements as related to the scope of work;
- Sufficient storage space;

During the selection phase, ITER Organization reserves the right to contact some or all of each nominated company's references to ask if: (1) the nominated company delivered a quality product which was compliant with the customer's requirements; (2) the company's performance conformed with the terms and conditions of its contract, including the delivery schedule; and (3) the company was reasonable and cooperative during performance and committed to customer satisfaction.

14 Candidature

Candidature is open to all companies participating either individually or in a grouping (consortium) which is established in an ITER Member State. 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 groupings shall be presented at the tender submission stage. The consortium cannot be modified later without the approval of the ITER Organization.