Design and Manufacture of the IVC Busbar System

for the ITER IVC Power Supplies

Call for Nomination

1 Purpose

The Call for Nomination is to select companies to bid for the design, manufacture, Factory Acceptance Test (FAT) and delivery of the IVC busbar system for the ITER In-Vessel Coil Power Supplies (IVC PS).

2 Background

The ITER Organization (IO) is a joint international research and development project for which the initial construction activities are underway. The seven members of the IO are; the European Union (represented by F4E), Japan, the People's Republic of China, India, the Republic of Korea, the Russian Federation and the USA.

The project aims to demonstrate the scientific and technological feasibility of fusion power for peaceful purposes and to gain necessary data for the design, construction and operation of the first electricity-producing fusion plant. It will also test a number of key technologies, including the heating, control, diagnostic and remote maintenance that will be needed for a full-scale fusion power station.

The ITER site is in the Bouches du Rhône district of France. It includes the Headquarters of the IO and a construction worksite. The construction of the facility is on-going. Further information is available on the IO website: http://www.iter.org .

The IVC busbar system consists of water-cooled copper busbars to connect the coils and the power suppliers (located at the Level 4 of the ITER tokamak building) and their auxiliary systems such as cooling and I&C. More than half of the busbars are captive components which need to be installed before of the 1st plasma.

The rated operational current of the busbar is 15kA continuously and higher at pulses and the fault current can reach up to 150kA. The rated operational voltage of the busbar is 200V and 2.4kV (two different types). The cross section area of each water-cooled copper pole is about 49mm by 98mm. There are two cooling channels in each pole so that the cooling water returns in the same pole. The cross section area of the busbar (two poles with insulation and steel case) is about 125mm by 135mm. The total length of the busbars is about 2000m. The busbars will be joined in their final position by flexible links or rigid connections depending on locations. The busbars and cooling water sensors and valves will be subject to 10MGy nuclear radiation (mainly gamma radiation) over their entire operational life. The control cubicles will be located in an area of low nuclear radiation therefore no special nuclear hardness requirement for the electronic components. The parameters quoted here are for information only at this stage and subject to change.

The areas in the Tokamak building where the IVC busbars will be installed are congested. The building is classified as a nuclear building, hence special requirements for the IVC busbars, e.g., penetration and confinement.

3 Scope of work

The scope of work is expected to include design, manufacture, FAT and deliver of the IVC busbar system, and the installation will not be in the scope of work.

The design shall include R&D work and small scale samples in order to verify the design and to define manufacturing solutions.

At the manufacturing stage, manufacturing of a full size prototype is expected to be required to qualify the processes, materials, tooling and technicians.

A preliminary scope of work is summarized below:

Design Phase of the Contract

a) Design of busbar (copper) insulation and casing system
   - Busbar conductor
   - Busbar insulation (Test Voltage 5.8 kV)
   - Busbar steel casing
   - Busbar insulation process
   - Insulation system qualification program (electrical and mechanical before and after 10MGy irradiation)
   - Samples at a small scale

b) Design of busbar segments and connections
   - Design of busbar segments and connections (both flexible and rigid)
   - Engineering calculation, analysis and reports to support the design
   - Built-to-Print 2D drawings of the busbar segments and connections
   - Engineering bill of material
   - Samples at a small scale

c) Design of busbar supports system
   - 3D design of busbar supports taking installation requirements into account
   - Engineering calculation, analysis and reports of the supports
   - Built-to-print 2D drawings of the supports
   - Engineering bill of material
   - Samples at a small scale

d) Design of busbar confinement barrier penetration for specified leak rate and fire resistance requirements
   - Busbar crossing the L4 floor slab (the slab is a nuclear safety barrier)
   - Busbar crossing the port cell wall (the wall is a zone barrier inside a large nuclear confinement area)

e) Design of busbar water cooling system
   - Hydraulic/thermal design and analysis
   - 3D models
   - PFD and P&ID diagrams

- Built-to-print 2D drawings
- Engineering bill of material

f) Design of busbar control and instrumentation
   - Control and instrumentation of the busbar cooling system

g) Input detailed 3D model of the entire design to the IO's ENOVIA/CATIA system
   - Update of the design model in timely manner
   - Input the preliminary design model
   - Input the final design model

h) System-level design, installation, maintenance and RAMI
   - System level design (system diagrams and drawings, seismic analysis and etc.)
   - System installation
   - System maintenance
   - System RAMI analysis

Manufacturing Phase of the Contract

i) Manufacture and test of a full size prototype, including relevant technical dossier (Quality Assurance, Manufacturing Inspection Plan, procedures, materials certificates, test plans, test results ant etc.)
   - Busbar copper conductor extrusion trials
   - Copper conductor 3D bending trials
   - Prototyping of two full-size busbar segments
   - Busbar rigid connection and in-situ insulation
   - Busbar flexible connection
   - Busbar connection to the coil's feedthrough
   - Busbar supports
   - Busbar feedthrough to cross the safety barriers
   - Manufacturing bill of material

j) Manufacture and test, including relevant technical dossier (Quality Assurance, Manufacturing Inspection Plan, procedures, materials certificates, test plans, test results ant etc.)
   - Busbar segments
   - Busbar rigid connection and in-situ insulation
   - Busbar flexible connection
   - Busbar connection to the coil's feedthrough
   - Busbar supports
   - Busbar feedthrough to cross the safety barriers
   - Busbar water cooling system
   - Busbar control and instrumentation
   - Manufacturing bill of material

k) Shipping
   - Shipment of Busbar items and relevant technical dossier to the ITER site

l) Instructions, Manuals, Maintenance and Spare Parts
- Requirements and Instructions of installation
- Operation manual
- Maintenance plan and manual
- Advised spare parts

m) On-site Acceptance Test

The above is based on today's planning which can be subject to change, and the IO shall clarify the detailed contract strategy and the required scopes at the later stage.

4 Tentative Timetable

Tentative Schedule

Pre-Qualification	August 2017
Potential meeting for pre-qualified companies	October 2017
Call for tender	October 2017
Tender submission	December 2017
Award / Signature	March 2018

The ITER Organization may combine Pre-qualification and CFT process at its option.

5 Experience

The Candidates will need to demonstrate that they have the capabilities to successfully perform the entire scope of work mentioned above. The Candidates shall have proven experiences in design and manufacturing complex projects operating in nuclear environment such as the IVC Busbar.

6 Candidature

Participation is open to any legal entity either an individual or a group (consortium) which is established in an ITER Member State. A legal entity 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 IO.

The consortium groupings shall be presented at the pre-qualification stage. The tenderer's composition cannot be modified without the approval of the ITER Organization after the pre-qualification.

Legal entities belonging to the same legal grouping are allowed to participate separately if they are able to demonstrate independent technical and financial capacities. Candidates (individual or consortium) must comply with the selection criteria. The IO reserves the right to disregard duplicated reference projects and may exclude such legal entities from the pre-qualification procedure.

7 Annexes

More information is provided in two annexes to this document.

The Annex 1 is a provisional 3D model of the space and routes that have been reserved for the busbars. The space and routes are still subject to change.

The Annex 2 provides an estimation of the quantities of the drawings and analyses in order to give an overview to any interested companies.

These two annexes, although technical, are for the information of the Call for Nomination, and will not form part of the future contract.

[1] 3D model (a 3dxml file) of the busbar system (tentative space and route reservation)
[2] **IVC PS busbar system drawing & analysis workload estimation (TVFDFR v1.1)**