IDM UID
9AVFZK

VERSION CREATED ON / VERSION / STATUS
25 Jul 2023 / 1.1 / Approved

EXTERNAL REFERENCE / VERSION

Technical Specifications (In-Cash Procurement)

Technical Summary for the PS system of the MCTB

Technical Summary for:
Design, Manufacture, installation and commissioning of the Power Supply system for the ITER Magnet Cold Test Bench (MCTB)

Technical Summary for: Design, Manufacture, installation and commissioning of the Power Supply system for the ITER Magnet Cold Test Bench (MCTB)

1 Purpose

The ITER Organization (IO) intends to issue a Call for Tender (CFT) for the design, manufacture delivery and commissioning of the power supply for the ITER Magnet Cold Test Bench (MCTB).

The information and technical details provided in the document are preliminary and are shared the companies to check their interest and capabilities for this contract. The final technical specification that will be issued during the CFT will be the only document to be considered for biding.

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 ITER machine will be composed of several superconducting magnets. Each magnet, sized to handle up to 68 kA, can produce a maximum magnetic field of 11.8 T, measures up to 9 x 17 meters and weights up to 360 tons. Due to the imposing size and weight, the installation and reparation of such components is very challenging.

Consequently, in order to limit the risk of failure after installation, IO is building a specific test bench (Magnet Cold Test Facility – MCTB) to perform superconducting magnets tests before the installation. In the scope of this project, IO plans to issue a call for tender for procuring the power supply system that will be used to generate the current to the magnets under tests. **This contract is intended to be a full turnkey contract.**

3 Description of the system to be designed, manufactured and delivered

The scope of the system to be delivered is depicted in Figure 1.

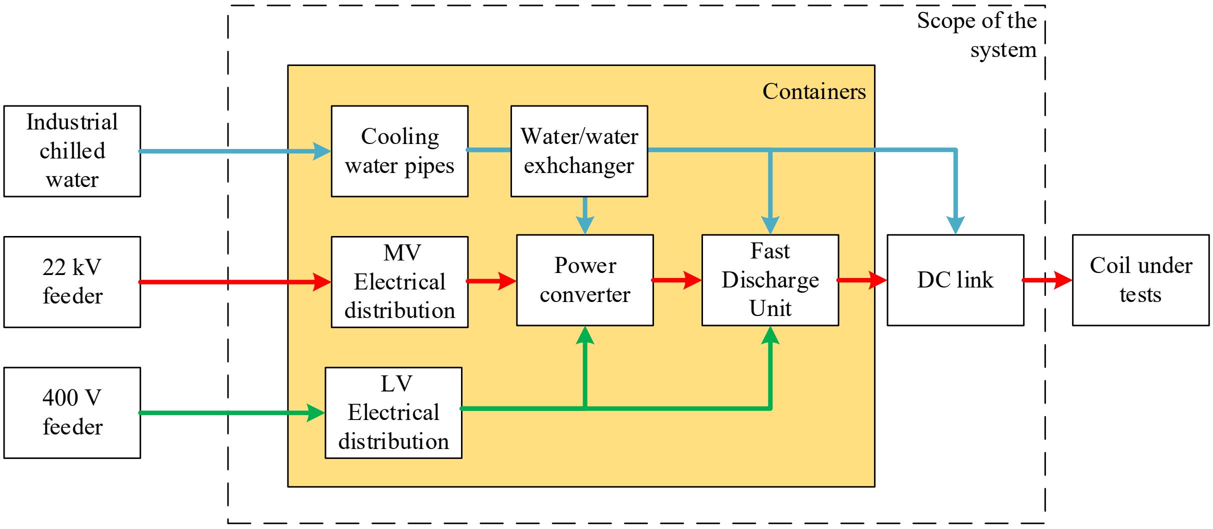

Figure 1. Scope of the MCTB's power supply system

The main technical requirements are listed in the sections hereafter.

3.1 Functional requirement and operating modes

The parameters of the magnet under tests are given in Table 1.

	Value	Comments/Assumptions
Inductance	351 mH	
Maximum permanent current	68 kA	

Table 1. Main magnet parameters to be considered for the design of the power supply.

The operating modes and magnet's current profile are showed in Figure 2.

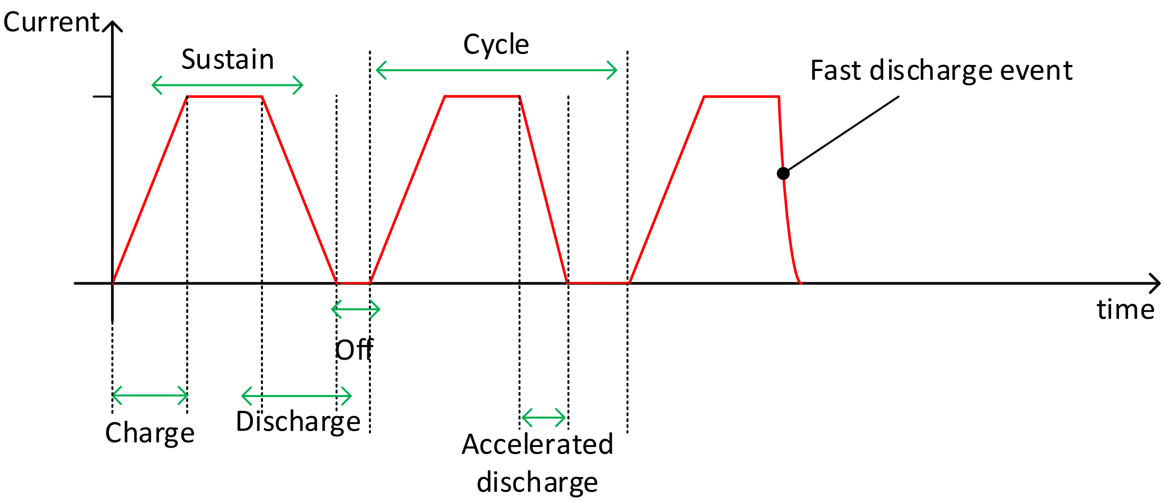

Figure 2. Operating modes and magnet's current profile

The main operating modes are described in Table 2.

Mode	Description	Requirements
Charge	The magnet is being charged to reach the new current reference. The current reference does not always correspond to the maximum current and the initial current is not always zero.	Maximum charging rate: 10 A/s
Sustain	The current is maintained constant according the current reference provided by the test facility global control system. The power supplies compensate voltage drops and losses	Maximum permanent current : 70 kA Accuracy/stability of the set current : ± 680 A
Discharge/accelerated discharged	The magnet is being discharged to reach the new current reference.	Maximum discharge rate: - 40 A/s
Off	The power supply does not provide current to the load	
Fast Discharge Event	In case of abnormal situation, a fast discharge can be required by the ITER's control system.	See section 3.3.

Table 2. description of the main operating modes

The main coil to be tested is the TF coil. However, the PS system shall be able to operate also with the PF1 coil (maximum operating current 48 kA, self-inductance 700 mH and maximum stored energy 806 MJ). The PS control system shall be adapted in order to cope with these parameters; however, the Power Converter and FDR ratings shall remain those designed for the TF coil tests.

3.2 Power Converter

The power converter will always generate a positive current (2 quadrants operation).The voltage ratings have to be derived from the magnet parameters, current profile requirements, internal voltage drops… Investigations are still in progress but the required voltage at the coil terminals would be in the range of ± 20 V.

During a fast discharge event, the operation of the FDU will generate a high voltage. Consequently, a freewheeling switch has to be implemented at the output terminal of the power supply to maintain the voltage at the power supply's output terminals to a low value and to carry the discharge current. In addition, the power supply shall be isolated from ground with the adequate voltage level. The technical requirements for the freewheeling switch can be derived from the requirements of the FDU (see next section).

3.3 Fast Discharge Unit

One Fast Discharge Unit (FDU) shall be in series with the under-test magnet, for rapid discharge of the stored magnetic energy. The technical requirements for the FDU are summarized in Table 3.

Parameter	Value
Rated nominal current, continuous duty, unidirectional	70 kA DC
Current cut off	70 kA DC
Discharge equivalent time constant	<5 seconds
Energy to be dissipated	811 MJ
Maximum voltage to be applied to the coil during discharge	4.1 kV

Table 3. Technical requirements for the Fast Discharge Unit

In order to assure a correct safety level, it is requested to implement redundant FDU's actuators (i.e. one main circuit breaker and one back-up circuit breaker), independently controlled from two different circuits/control systems. The FDU's resistors and other passive components do not need to be redundant.

3.4 Electrical feeders

Two different electrical feeders will be available for supplying the system.
For the main power, a 22 kV – 50 Hz feeder will be available. The main parameters and interface requirements are provided in Table 4.

Feeder parameters	Voltage operating range	22 kV ± 10 %
	Frequency range	50 Hz ± 1 %

Table 4. Parameters of the 22 kV-50 Hz feeder

If required, reactive power compensator and harmonics filters may have to be implemented by the contractor to meet the interface requirements limits.

For the auxiliary systems, a low voltage 400 V – 50 Hz feeder will be available. The feeder parameters and interface requirement correspond to the ones of classic industrial application.

The exact location of the two feeders is still under investigation. However, the distance between the feeder and the power supply is in the range of 50-100 meters. The contractor will be responsible to select, procure and install the cables, cable trays between the feeders and the power supply, as well as the required protections.

3.5 DC link

A DC link is used to connect the power supply to the magnet under tests. Between the power supply and the magnet under tests, a length of 50 meters has been estimated. The technology of the DC link (rigid copper busbars, water-cooled cables…) has to be selected by the contractor. The DC link shall be sized considering the permanent nominal current as well as the fault current. Moreover, it shall be correctly fixed on the floor, walls, and roofs… to avoid displacements in the case of faults and damages risks due to collisions with other components. The design, manufacturing and installation of the DC link will be included in the contractor's scope of work.

3.6 Cooling system

Chilled industrial water feeders will be available in the building near the power supply, at a distance of about 30 meters. The temperature of the water at the feeder is 6 °C. The implementation of water-to-water exchanger will be required to 1) isolate the power supply's cold-water loop from the industrial water loop, 2) process the cooling water to meet the power supply requirements (conductivity, temperature, flow rate…)…

The contract's scope will cover the design, procurement and installation of the cooling system, from the water feeder to the components to be cooled.

3.7 Mechanical and physical integration

The power supply is planned to be installed in an outdoor location, showed in magenta in Figure 3, while the magnet under tests and the associated systems will be installed in a building (green area in Figure 3).

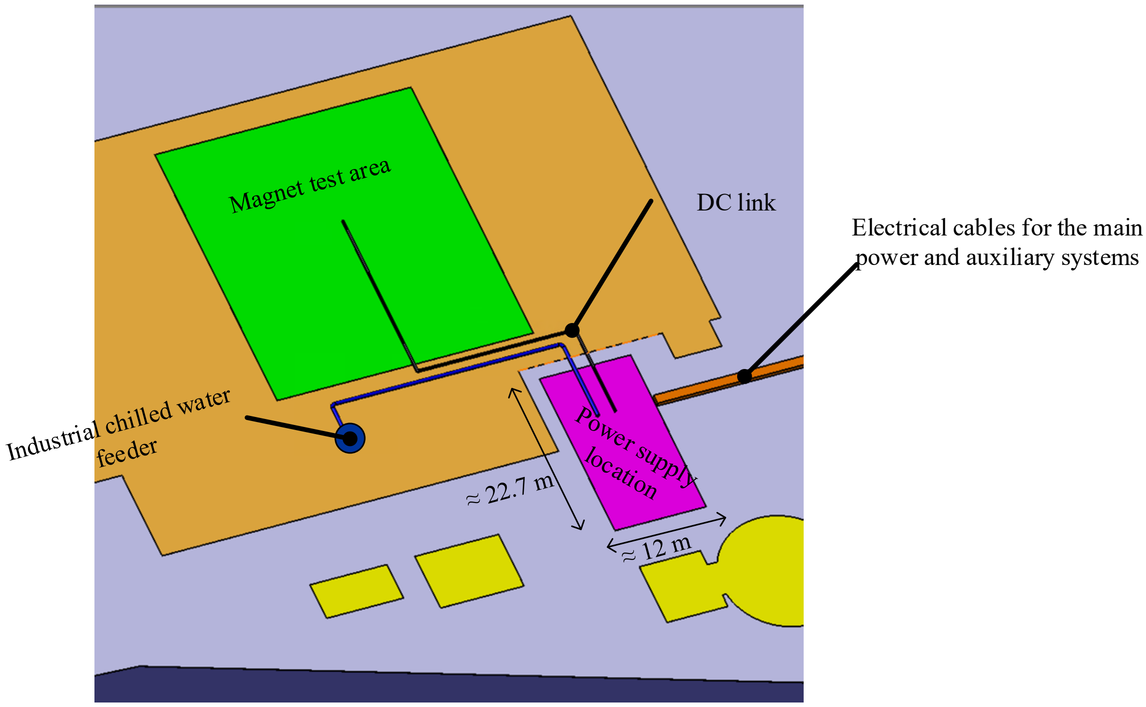

Figure 3. Mechanical and physical integration of the system

The implementation of the system in containers is welcomed to facilitate installation and decommissioning but other options can be proposed by the contractor. If required metallic structures are foreseen, they will be under the responsibilities of the contractor.

4 Scope of work

This contract is planned to be a full turnkey contract. The scope of work includes the design, manufacturing, Factory Acceptance Tests (FAT), delivery, installation, commissioning and after-sales support of the complete system as described in Figure 1.

In addition, the contractor is expected to provide all the technical documentation packages required to fulfil the IO's design procedures (design reviews, readiness reviews…).
The preliminary tasks list is indicated hereafter[1]:

(i) Design of the system
   a. Identification of the ratings of the power supply (voltage, power…)
   b. Interface validation and specifications (heat load, cable cross section…)
   c. Specification of the major components

[1] Specific IO procedures and the milestones list for this project will be shared in the call for tender's technical specifications

d. Design of the components
e. Control software development
f. Justification of the design, using relevant methods and tools (calculations, simulations…)
g. Preparation of the design reviews, according to the IO's procedures

(ii) Manufacturing of the system & delivery of the system
a. Preparation of the Manufacturing and Manufacturing of the system
b. Performance of Factory Acceptance Test according the IO's requirements and the approved test plan
c. Shipment of the system to the ITER site
d. Management of administrative procedures (customs, export control…)

(iii) Assembly and installation

(iv) On-site acceptance testing and commissioning
a. Preparation of the commissioning plan
b. Performance of the commissioning. It shall be noted that the magnet under tests cannot be used for commissioning the system
c. Support to IO for completing the French legal inspection of the system.

(v) After sales support for operation and maintenance
a. Provision of spare parts
b. Performance of preventive and curative maintenance
c. Possible system updates according the test results and return of experience (could be considered in future contracts)

5 Preliminary tendering schedule

The preliminary tendering schedule for this CFT is presented in Table 5.

Call for Nomination	July 2023
Pre-Qualification launch	Sept. 2023
Call for tender launch	Nov. 2023
Tender submission	Jan. 2024
Award / Signature	April 2024

Table 5. Preliminary tendering schedule

The ITER Organization may combine Pre-qualification (PQ) and CFT process at its discretion.

6 Expected contract duration

The design, manufacturing, delivery, installation, on-site acceptance testing and commissioning of the system in the scope of this Technical Summary (as per bullets (i) to (iv) of section 4) shall be completed no later than 12 months from the date of contract award.

7 Experience

The Candidates will need to demonstrate, during the PQ phase, that they have the capabilities to successfully perform the entire scope of work mentioned above. The Candidates shall have proven experiences in full turnkey contract for similar system to the one described in this document.

8 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.