TECHNICAL SUMMARY FOR CALL FOR NOMINATION

DISRUPTION MITIGATION SYSTEM CRYODISTRIBUTION NETWORKS

This Technical Summary **is issued for Call For Nomination** of the DMS Cryodistribution Network which includes the **design and manufacturing of cryogenic transfer lines to be installed in ITER Tokamak Building for Disruption Mitigation System.** Installation of this network is out of the present scope.

1 PURPOSE

The purpose of this Call For Nomination is to establish a list of candidates who will be invited to participate in a tender process, starting with a pre-qualification for a contract covering design and manufacturing of DMS Cryogenic distribution Network in the ITER Tokamak Building. The present document aims at presenting the scope of work as well as summarizing main technical features to be fulfilled by potential candidates.

2 BACKGROUND

The goal of ITER is to demonstrate the scientific and technological feasibility of fusion power for peaceful purposes. As one of the few options for large-scale, non-carbon future supply of energy, fusion has the potential to make an important contribution to sustainable energy supplies. Fusion can deliver safe and environmentally benign energy, using abundant and widely available fuel, without the production of greenhouse gases or long-term nuclear waste. The partners of the project are the European Union, Japan, China, the Republic of India, the Republic of Korea, the Russian Federation and the USA. ITER is constructed in Europe, at Cadarache in the south of France.

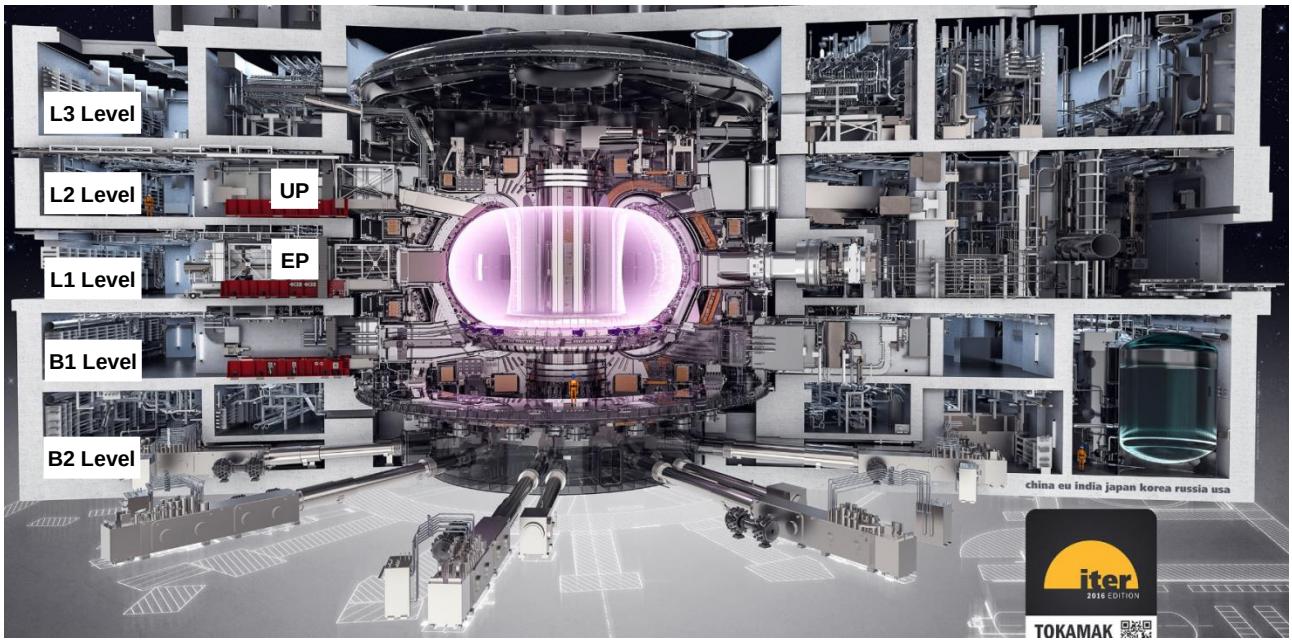

Figure 1 – ITER Tokamak Complex

The ITER DMS Cryogenic distribution Network to be procured under the scope of this ITER Organization direct procurement is required for the distribution of cryogenic fluids from the different Cold-Valve Boxes [CVBs] to the Shattered Pellets Injectors [SPIs] located at several Upper and Equatorial Ports of the ITER Tokamak.

Those SPIs devices aim at protecting the plasma-facing components against the heat and forces that arise during the disruption, and at the same time it must tame the runaway electrons that [if generated] could lead to melting of the first wall and leaks in the water cooling circuits. Pellets enable the injection of massive quantities of neon and deuterium into the plasma in the form of solid ice. To ensure that the plasma can assimilate these quantities, the pellets are shattered into small pieces just before they enter the vacuum vessel. The largest pellets for ITER disruption mitigation are larger than a wine cork, with a diameter of 28 mm. Despite this "enormous" size for a cryogenic pellet, several of these have to be fired at the same time to reach the required quantities to stop the worst-case runaway electron beam in ITER.

3 SCOPE OF WORK

Scope of work includes:

- Preliminary Design
- Final Design
- Manufacturing
- Factory Acceptance Tests
- Packing
- Delivery at ITER site

Refer to §5 for exclusions.

3.1 Technical Description

The ITER DMS Cryodistribution Network is composed of the four following independent networks:

- **Network 01**: cold Helium is supplied **from CVB-13** to SPIs located at **EP-17 and UP-14**.
- **Network 02**: cold Helium is supplied **from DNB** to SPIs located at **UP-02 and EP-02**.
- **Network 03**: cold Helium is supplied **from CVB-07** to SPIs located at **EP-08 and UP-08**.
- **Network 04**: cold Helium is supplied **from CVB-12** to SPIs located at **EP-11**.

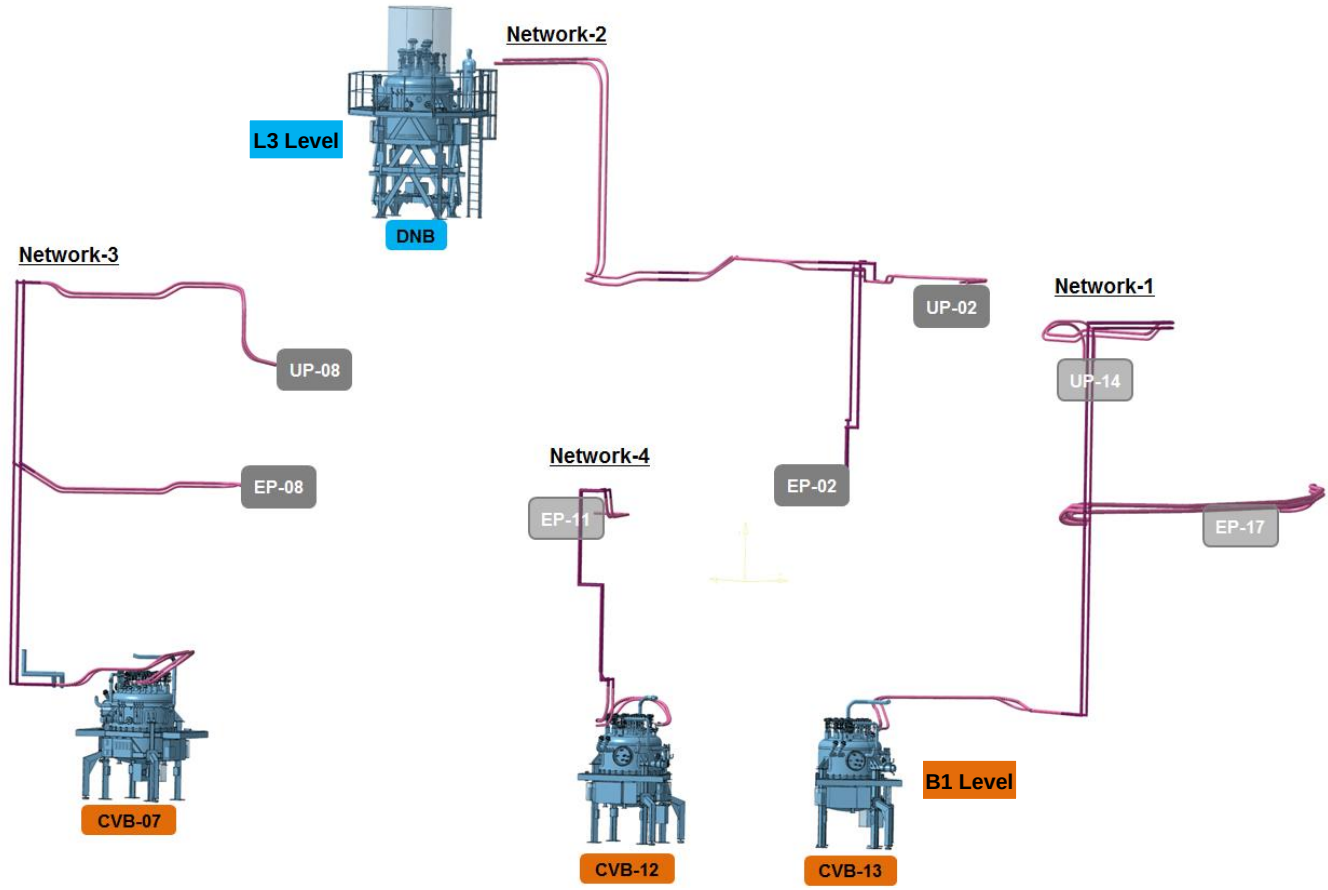

Figure 2 – DMS Cryodistribution Network

Each of those four networks is composed of **two independent single flow cryolines**. One is supplying **supercritical Helium** at 5K and 0.5 MPa to the Shattered Pellets Injectors while the other one is returning Helium at 100K with a pressure of 0.2 MPa.

Each single flow cryoline is composed of:

- ✓ **Rigid spools** in vertical shafts and its relative penetrations.
- ✓ **Flexible line Type 01 - "cryojumpers"** with dismountable cryogenic flange [so called "Johnston Coupling"] to connect to distribution cold boxes in B1 port cells, upper and equatorial ports or at L3 level. Cryojumpers are used to ease integration and maintenance in port cells where the available space is very limited. Johnston Couplings significantly simplifies installation and maintenance operation compared to a full welded solution which would require cutting, welding and testing operation.
- ✓ **Flexible line Type 02** with no dismountable cryogenic flanges but ending with rigid pipe ready for but-welding and MLI wrapping on site for its connection. This type of line shall be used for port cell to port cell penetration where no fast connection/disconnection is required compared with Type 01.

3.2 Main Technical Requirements

Main technical requirements to be fulfilled are summarized here below. Detailed technical specification will be provided with tendering package.

3.2.1 Mechanical Design

Process Lines	Max. Allowable		Thermal Cycles	
	P	T	Number	Range of T
Supply Line	2.0 MPag	313 K	<1000	4K - 300 K
Return Line	1.0 MPag	313 K	<1000	4K - 300 K

Table 1 – Process Lines Mechanical Design

Vacuum Jackets	Max. Allowable	
Localisation	Max. OVJ external P	T
Port Cells [Flexibles]	0.06 MPag	313 K
Shafts rrigid spools]	0.2 MPag	313 K

Table 2 – OVJs Mechanical Design

3.2.2 Process and required performances

Process media is **100% Helium** with flow being in the range of **1g/s to 5 g/s** with operating pressure up to **0.5 MPa** and operating temperature from **5K to 100K**.

The heat loads shall be in the range of **0.3 W/m for rigid spools up to 0.8 W/m for flexible section.**

3.2.3 Preliminary Process Lines' Sizing

The **rigid spools** sizing have been estimated to be in the range of **DN10 to DN32** while **Ø14 mm up to Ø39 mm** have been estimated for the **flexible** part. Refer to Appendix 1.

3.2.4 Codes and Standards

CE Markings shall be implemented in accordance with the requirements of European Directives for pressure equipment. Demonstration of compliance for the pressure equipment shall include to the following European Directives: 2014/68/UE, and its transposition in French law French Decree 2015-799 dated July 1st 2015, which replaces PED (97/23/CE) and ESP old French Decrees.

Harmonised standards, i.e. European Commission approved standards, shall be used as the **preferred method** of demonstrating compliance to the essential requirements of CE marking directives.

3.3 Preliminary Bill of Quantities

Here is preliminary bill of quantities.

	# Quantity	Internal Ø	External Ø	Length
Flexibles [Cryo-Jumpers in PC or PC to PC flexibles]	#16	Ø14/18 mm	To be defined by supplier according with Heat Losses criteria.	5m to 12m
	#03	Ø21/25 mm		7m to 10m
	#09	Ø30/34 mm		5m to 10m
	#04	Ø39/44 mm		7m to 25m
	Total #32			**Total ~ 250m**
Rigid spools [Vertical Shafts]	#17	DN10	DN65	3m spooling
	#04	DN20	DN65	
	#13	DN32	DN80	
	Total #34			**Total ~ 110m**
Supports for flexibles	**#32 + #12**	2 in each PC [x13] + 6 for L3/NB Cell Ceiling Flexibles + 3 per shaft for Rigid spools		

Table 3 – Preliminary Bill of Quantities

The exact number of rigid spools as well as flexibles' lengths, lines internal & external diameters and supports' quantities will be fixed at final design. The above table aims at giving order of magnitude only.

4 NUCLEAR AND QUALITY REQUIREMENTS

4.1 Nuclear and Quality Classification

The ITER DMS Cryodistribution Network is classified as **Non-PIC/Non-SIC** component regarding with the safety function N-025 [nuclear confinement]. The system classification of the ITER DMS Cryodistribution Network is provided in the following table.

Component	Safety Class	Seismic Class	Vacuum Class	Quality Class
DMS Cryo-Network	Non PIC/SIC	SC1 (S)	4 A	QC1

Table 4 – DMS Cryo-Network Nuclear & Quality classification

4.2 Materials

The material used for the DMS cryogenic distribution networks structural metallic components, i.e. corrugated pipes, rigid pipes, flanges, Johnston couplings and supports shall be **Austenitic Stainless Steel**, to be selected from:

- ✓ **EN 1.4306 or 1.4435** or equivalent stainless steel allowed by applicable C&S to be used down to 4K, for the parts in contact with the process, including pressure pipes and couplings.
- ✓ **EN 1.4404 or EN 1.4307** or equivalent stainless steel allowed by applicable C&S to be used down to 80K for the OVJ, and vacuum pumping components (vacuum hoses/manifolds, vacuum valves).

Materials used shall be **non-halogenated and non-flammable.**

Materials shall **preserve their function under radiative environmental condition**.
In particular the **following non-metallic materials are suggested** for use:

- ✓ **EPDM** for vacuum flanges gaskets/O-rings, relief valves room-temperature gaskets/O-rings
- ✓ **PEEK or VESPEL SP-1** for cryogenic seals in JCs
- ✓ **Glass fibres reinforced epoxy resins** for cryogenic supports/spacers
- ✓ **Glass fibres spacers coupled to aluminium foils MLI**

5 EXCLUSIONS

Installation as well as **On Site Acceptance tests** of those lines is **out of scope of work**.

To ensure proper fitting of interfaces, **Johnston Couplings are out of scope of supply**.
Those devices will be provided to supplier for integration at their workshop.

6 SCHEDULE

Tentative timetable is as follows:

Issue of Call for Nomination	April, 2019
Invitation to Tender	June, 2019
Contract Awards	November, 2019
Project Kick-Off	January, 2020
FDR	August, 2020
Delivery	August, 2021
Start of Installation	September, 2021

Table 5 – Bidding and Project Timetable

7 . 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 ITER organization.

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 prequalification.

The UK is not a party to the ITER Agreement but part of EURATOM (European Atomic Energy Community). In the most likely scenario of a BREXIT without a withdrawal agreement between the EU and the UK or a delay of the BREXIT date (no deal BREXIT), then until such a date, the UK remains a full member of the EU and until that date UK entities retain the right to participate in IO procurement procedures. However, as from a no deal BREXIT date, any UK bidding as a prime contractor or consortium partner will be rejected from the procurement procedures as UK entities will no longer have the right to participate in IO procurement procedures.

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.

APPENDIX 1 – PROCESS INPUT DATA SUMMARY