EXPERIMENTAL VERIFICATION FOR THE ITER TOKAMAK VACUUM VESSEL PRESSURE SUPPRESSION SYSTEM

Call for Nominations

IO/14/CFN/10868

Purpose

The purpose of this contract is to provide engineering, technical, experimental and analysis support for the ITER Vacuum Vessel Pressure Suppression System (VVPSS). This system is designed to protect the Vacuum Vessel (VV) from over pressurization caused by in-vessel coolant leakage or other loss of vacuum accidents. This work is in support of the ITER Organization for the evaluation and verification of the VVPSS Condensation Distributor assembly to meet the performance requirements of the VVPSS. This work has been preceded by analytical and scaled experimental studies which will be made available in the Call for Tender.

Background

ITER ("The way" in Latin) is a next generation fusion tokamak designed "to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes". With a long lifespan over than 30 years, it is intended that ITER will be a single step between the current set of fusion experiment and DEMO, a fusion power plant designed to demonstrate safe and reliable, commercial electricity production.
The ITER Organization consists of 7 Parties, acting through the Domestic Agencies (CN, EU, IN, JA, KO, RF, US) each of them will have a role in supplying most of the systems. The ITER Organization has the overall responsibility for the design and operation of the machine.
The Tokamak is the part of the ITER machine closest to the thermonuclear plasma and includes:

- The Vacuum Vessel and Vacuum Vessel Ports
- The Thermal Shield
- Various Magnet Systems
- The Cryostat
- The Vacuum Vessel Pressure Suppression System
- The Blanket and Divertor Systems

The VVPSS as shown in Figure 1.0 limits the VV internal pressure to 0.15 MPa in the case of Loss of Coolant Accident or other pressurizing accidents. This is a nuclear safety function as a large internal pressure could lead to a breach of the primary confinement boundary of the machine.

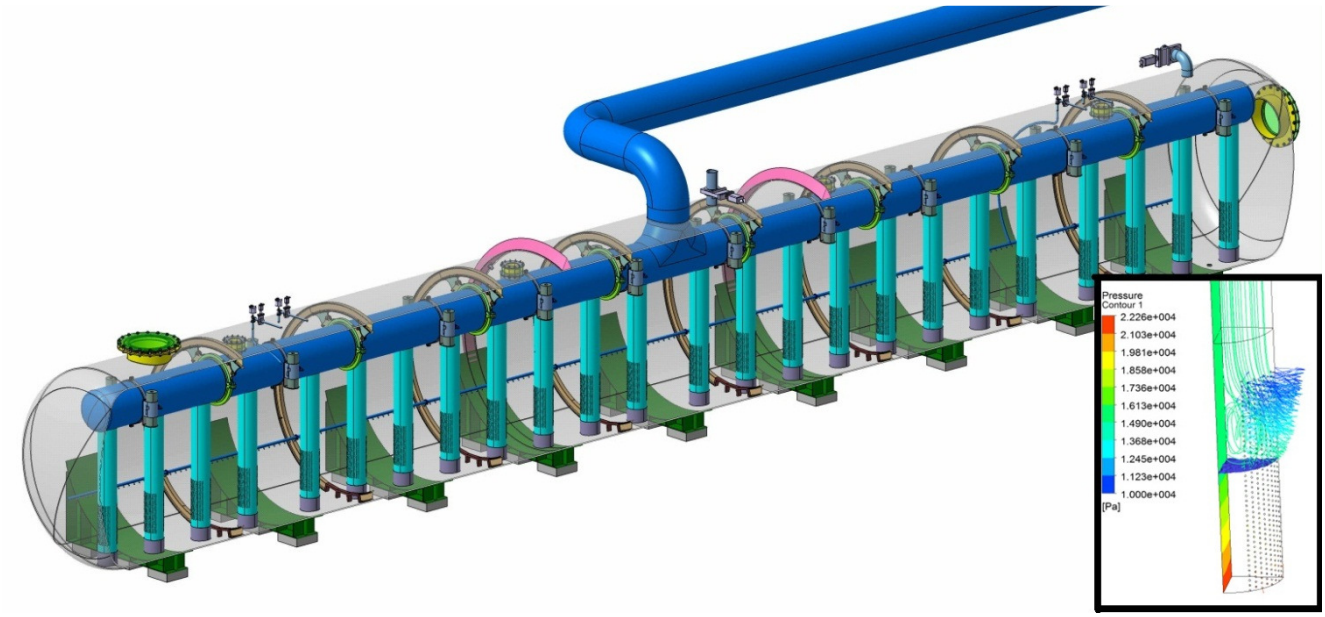

Figure 1.0 Vacuum Vessel Pressure Suppression System (inset – sparger)

The large cylindrical tank of ~46 m length and 6.0 m diameter is half full or water used as the suppression pool to condense the steam resulting from the most adverse in-vessel coolant leak. The tank contains 24 vertical sparger tubes, perforated with 10mm holes, to distribute the steam and hot gas in the tank for efficient condensation and cooling.

Due to the unique thermal-hydraulic conditions in which the VVPSS shall operate, characterized by saturated or superheated steam condensed at very low, sub-atmospheric pressures, a comprehensive verification is required for licensing approval of this safety system.

Scope of work

The objective of this work is to perform verification experiments for the ITER steam condenser and propose an experimental program that will enable the qualification and licensing of the design.
The selection of the testing apparatus shall be justified as well as any scaling proposed. A full scale test of one or more spargers is the preferred solution to assess interactions between adjacent spargers. This work includes the design, construction and operation of the testing apparatus.

It is expected that this component verification process will assess the condensation phenomena under prototypical ITER VVPSS thermal-hydraulic conditions. This included super-heated steam (~150C) and a pressure in the space above the water in the suppression pool of ~ 4.2 kPa.(abs.) Multiple tests shall be performed at various pressures, temperatures and flow rates to assess the performance over a wide range of conditions.

This program should give sufficient experimental data for a detailed understanding of bubble condensation efficiency at VVPSS prototypical conditions. Previous scaled experimental studies and analytical studies have contributed to the condensation efficiency correlations used in the safety code analysis for system design. ITER will provide reports of previous studies to the winning bidder at the onset of the contract.

Experience and data from Boiling Water Reactors shall be referenced where applicable to validate the design of the distribution system and the ability to effectively cool and condense.

Selection criteria

Companies to be invited to tender will be selected based on the following criteria:

• *Organisation ability*: The Tenderer must prove how the competences have been integrated in the past in relevant projects. Experience in nuclear plant or in fusion experimental plants is required.

The facility mechanical requirements are:

- Steam generation capability of ~3 kg/sec for periods sufficient to establish operation;
- Sufficient heating and cooling systems to maintain operating conditions during testing;
- Vacuum Pumping system to maintain 4.2kPa (abs.);
- Control Room or I&C capabilities to capture and analyze high-speed data and video;
- On-site capabilities for small repairs and modifications;
- Established Safety System.

• *Relevant experience and technical and engineering capability*: The Tenderer must prove to be able to provide in an organised way the competences specified in the Scope of Work above. The professional engineering services and competences to be provided are:

- Previous experience with Suppression System nuclear verification experiments;
- Design and Analysis of system components;
- Fabrication, Installation and commissioning of the large experimental apparatus;
- Thermal hydraulic expertise sufficient to justify scaling for nuclear verification;
- Analysis experience with RELAP and MELCOR for pre-test and post-test analysis;
- CAD (Specialized in Mechanical Engineering - preferably CATIA)
- High quality report writing appropriate to be submitted to licensing authorities;
- Support capability for Licensing discussions

During the tendering process the Supplier will also have to provide evidence of:

- *QA system*: The Tenderer shall have and maintain a valid ISO 9000 certification and shall have the duty to verify and document the equivalent quality level of all its subcontractors and consultants.

- *Verification Experience*: The Tenderer shall provide explanation of previous experiences with verification studies for suppression systems.

- *Professional Software*: The Tenderer shall provide a list of the professional software available and used, e.g. for structural (static, dynamic, seismic), thermal-hydraulic (RELAP, MELCOR) and thermo-mechanical analyses, electromagnetic analyses, CATIA V5 CAD software etc.

• *Language ability*: The language used at ITER is English. A fluent professional level is required (spoken and written English).

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. ITER Organization may choose to visit customer references and may also use other sources of information.

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.

Timetable

The tentative timetable for this work is as follows:

Call for Nomination	**July-Aug. 2014**
Qualification of Companies	**Sept. 2014**
Tender Submission	**Oct. 2014**
Contract Placement	**Nov-Dec. 2014**
Completion of Contract	**June 2016**