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ITER TOKAMAK VACUUM VESSEL THERMAL SHIELD ADDITIONAL NEUTRAL SHIELDING

CALL FOR NOMINATION
Ref. IO/CFN/14/11176/PMT
SUMMARY OF TECHNICAL SPECIFICATIONS

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1 Purpose

The purpose of this Build-to-Print Contract is to 1) procure the raw material, 2) perform necessary fabrication processes (cutting, machining, and polishing) 3) silver plating of the shielding plates and 4) packaging and delivery of the Additional Neutron Shielding (ANS) for the ITER Vacuum Vessel Thermal Shield (VVTS).

2 Background

The International Thermo-nuclear Experimental Reactor (ITER) is a large-scale scientific experiment with the goal of demonstrating that it is possible to produce commercial energy from fusion. A major component in the ITER Tokamak is the Thermal Shield (TS). The TS system will provide an effective optically opaque barrier for thermal loads being transferred from warm components to the superconducting coils and structures that operate at 4.5K. Thermal loads include: 1) thermal radiation and conduction during plasma operating state, 2) thermal radiation and conduction during Vacuum Vessel (VV) baking and 3) nuclear heating to the TF coils (which must not exceed 14kW). Estimates of the nuclear heating using models incorporating the latest information on vacuum vessel, blanket and diverter designs indicate that the heating could be as high as 21kW during a 500MW pulse. The addition of neutron absorbing material to the thermal shield will provide the necessary nuclear shielding to reduce the TF coil heating. The Additional Neutron Shielding (ANS) will be constructed of numerous plates, with gaps of 3-5mm between the plates. The total number of plates will reach approximately 720 pieces (plus spares) with the total approximate weight 8 metric tons. Each shielding plate will be attached to the inboard of the VVTS by two stud-bolts. A copper spacer will be inserted between the ANS and VVTS to improve the conduction cooling between the ANS and the TS panel and provide clearance to the TS cooling tubes.

3 Scope of Work

3.1 Scope of the Supply

The typical ANS assembly consists of neutron absorbing plates, copper spacers, threaded studs, hex nuts and washers, see Figure 3-1. The scope of basic supply includes the procurement and/or fabrication and delivery of the items listed in Table 3-1.

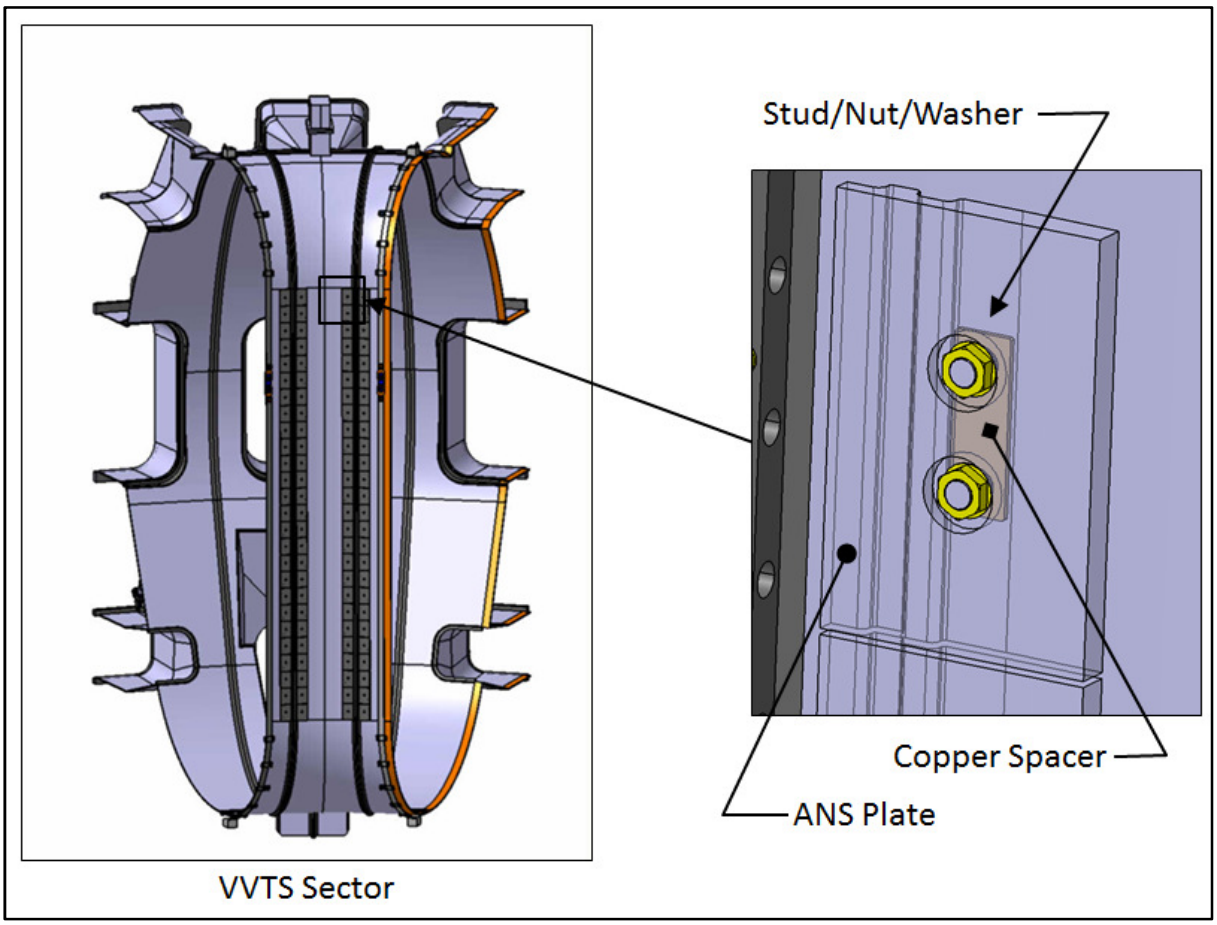

Figure 3-1: ANS Detail Assembly

Table 3-1: Supplied Items per 40° VVTS Inboard Sub-Assembly Sector

Item	Drawing/ Reference	Quality class	Safety class	Specific requirements class.*	Quantity/ 40° Sector
ANS Plate	033771/XX	1	*Not Applicable*	*Not Applicable*	*80*
Cu Spacer	033771/XX	1	*Not Applicable*	*Not Applicable*	*80*
Studs M20	033771/13	1	*Not Applicable*	*Not Applicable*	*160*
Washers	033771/14	1	*Not Applicable*	*Not Applicable*	*160*
Nuts M20	033771/15	1	*Not Applicable*	*Not Applicable*	*160*

**Nuclear pressure equipment, pressure equipment.*

3.2 Extent of the Supply

The following is a list of the general activities and tasks to be performed by the Supplier within the frame of the Supply Contract.

- Quality Control/Assurance
- Project Controls
- Procurement of raw material
- Manufacturing activities
- Packaging and Delivery

4 Manufacturing Requirements

4.1 Vacuum

Thermal Shield components function in a vacuum environment. Care must be taken in manufacturing processes to ensure no contaminants are introduced into surfaces which may be difficult to remove later and which might result in degraded vacuum performance.

4.2 Dimensional Inspection

At every important manufacturing stage, each ANS component shall be dimensionally inspected and the measurements documented. Results are to be compared with drawings. If necessary, remedial action is to be proposed to the IO prior to implementing a solution.

4.3 Material Requirements

The material shall be gadolinium inserted chromium-nickel stainless steel plate, 316NU-78 or equivalent material containing a minimum boron equivalent of 6.2%.

In general the material shall conform to ASME and ASTM standards. Before the start of production for full required quantity of material, a trial qualification program shall be performed with the goal of confirming the main requirements of the specification. The trial production of a limited quantity of plates (with equal thickness of production plates) shall be made and all the plates shall be qualified in accordance with qualification program agreed between Supplier and IO.

The qualification test to be performed shall include (at a minimum) chemical composition, Charpy impact, KIC and tensile testing. Testing shall be performed at room temperature and cryogenic temperature (~70-80K). The results of testing shall be documented in accordance with approved documentation requirements.

4.3 Special Processes Requirements

Silver Plating

A critical parameter for the successful operation of the ANS plates is emissivity. The chosen method of reducing the emissivity and therefor the heat load to the superconducting surfaces of the magnet structure is silver plating.

The candidate Suppliers shall have the experience to implement/oversee a silver plating program. The key processes of the silver coating are as follows:

1) Electrolysis cleaning removes contaminants other than oxide, hydroxide, and base metal from the surfaces of work pieces by placing the work pieces on the cathode.

2) Etching is the process used to remove oxide film, rust, scales or other forms of hydroxide from the surface of the work pieces.
3) Activation is the process of activating the surface by neutralizing the residual components and then removing any thin oxide film which may have appeared during the pretreatment process.
4) Nickel strike is the process of plating the material with nickel while removing the strong oxide film from the stainless steel.
5) Nickel plating is the process of forming an excellent, strong, and glossy plating layer by conducting nickel plating on the rough plating layer resulting from the nickel strike.
6) Silver plating is the process of forming a silver plating layer on the nickel plating layer.
7) Chromate treatment is the process of maintaining the original silver color from being affected by a contaminated environment or by fingerprints.

The supplier will be required to submit a detailed plating procedure to the IO for approval. A test of the silver plating process shall be performed prior to plating the full production quantity. The supplier shall have the experience and capability to implement a quality control program to check: thickness of plating, adhesion, porosity and emissivity.

5 Timetable

The tentative timetable is below. The final timetable with respect to delivery will be developed to coincide with VVTS deliveries.

Call for Nominations → December 2014
Call for Tender → February 2015
Contract Placement → May 2015
Batch #1 (sectors 5 & 6) estimated delivery → January 2016
Batch #2 (sectors 1, 2, 3 & 4) estimated delivery → April 2016
Batch #3 (sectors 7, 8 & 9) estimated delivery → January 2017

6 Experience Requirements

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

- Manufacturing capabilities:
  - understanding of the manufacturing requirements
  - experience with an appropriate procurement plan for material and associated inspection/testing
  - knowledge/experience of surface preparation/treatment and silver plating requirements and an appropriate execution plan
  - presence of required machining equipment
  - sufficient equipment and facility to meet the requirements as related to the scope of work (vacuum components, protection of silver plating, etc.)

- Experience with silver plating process and production of vacuum components

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.

7 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.