TECHNICAL NOTE IN RELATION WITH
THE CRYOPUMPS MARKET SURVEY

Description of the ITER Torus and Cryostat Cryopump

Abstract

The experimental fusion reactor ITER will require between six and eight cryogenic vacuum pumps, which will evacuate the vacuum vessel in which the fusion reactions occur. Two additional pumps of the same design are used to evacuate the cryostat vessel. The build-to-print design of these pumps has recently been completed. A Call for Tender for the manufacturing of a prototype will be launched in fall 2011. This report describes the design of the Torus and Cryostat Cryopumps, as well as their procurement schedule and strategy.
1. INTRODUCTION

The ITER Torus and Cryostat Cryopumps (TCPs and CCPs) pump gases by adsorption on activated charcoal cooled to a temperature of about 4.5 K. ITER will require between six and eight TCPs and two CCPs.

The procurement of these series pumps is expected to start in 2014, and delivery is planned for 2017.

In order to be able to study the pump performance well ahead of time and to mitigate design risk, a 1:1 pre-production cryopump (PPC) will be manufactured. The corresponding Call for Tender will be published by F4E in fall 2011.

2. DESIGN OVERVIEW

The cryogenic circuit of the charcoal coated surface is cooled by a forced flow of supercritical Helium at a pressure of about 0.4 MPa and an inlet temperature of about 4.3 K. To minimize heat loads, the charcoal coated surfaces are surrounded by a thermal radiation shield cooled to about 90 K by forced flow cooling with gaseous helium at 1.8 MPa and an inlet temperature of 80 K.

The two cryogenic circuits are integrated in a stainless steel pump casing.

The pump diameter is approximately 1.8 m and the overall length of the pump is about 3.5 m.

To facilitate control of the pump speed, the pump is equipped with an inlet valve with a diameter of 800 mm and a valve stroke between 0 – 470 mm.

Metal gaskets are used in the valve seat.

The positioning of the valve head is effected with a pneumatic actuator operating at a pressure of 0.8 MPa.

The cryopump has an overall weight of 8 tons and operates with its axis in the horizontal direction.

Figure 1: The main components of the ITER TCP/CCP

(mod. QA-236 F4E_022GTTD)
3. PROCUREMENT STRATEGY AND SCOPE OF WORK

It is currently planned to place a contract with a company which has the capability to machine, assemble and inspect complex high-vacuum equipment (this includes the availability of clean facilities\(^1\), excellent welding & weld inspection capabilities, leak testing capabilities at ambient and LN temperature). The company will only be responsible for the manufacture of the PPC, and does not bear responsibility for the operational performance of the PPC.

The company which will be selected in the upcoming tender process is expected to perform the following:

- Contract management and Quality Assurance according to F4E standards (Quality Class 1, Third Party Inspection, etc)
- Procurement of raw materials
- Manufacturing and inspection of components according to a build-to-print drawing package supplied by F4E.

The main components to be manufactured and/or procured are:

- The cylindrical pump plug incl. sub flanges and Johnston couplings (4.2 tons SS 304)
- The front flange (1 ton, SS 316LN)
- Pump casing (Ø = 1560 mm, t = 10 mm, L = 2000 mm, SS 304)
- Non-hydroformed components of thermal shields (SS 304 sheets and pipes) incl. surface treatment (plasma spray coating)
- Internal piping and support structure (SS 304)
- Valve assembly incl. shaft and valve head (SS 316)
- Assembly of the cryopump (using the “free issue items” listed below) according to UHV standards and a technical specification provided by F4E. Welding and 100% weld inspection must be performed according to the ITER Vacuum Handbook.
- Planning and conduction of acceptance test (this includes alignment tests and related records, as well as pressure and leak tests (max. allowable leak rate of \(10^{-10}\) Pa·m\(^3\)/s) at ambient and LN temperature, possibly after cycling the cryogenic circuits between LN temperature and 470 K.
- Supply of “as built” drawings and related QA documentation
- Supply and delivery of handling and assembly tools
- Packing, insurance and transportation to Karlsruhe, Germany

\(^1\) Clean facilities are defined as a segregated clean area, access to which is limited to authorized, trained personnel wearing appropriate garment (hairnets, gloves, overalls and overshoes). The area must be properly maintained, and cleanliness must be monitored, including daily air quality checks. Entrances to the clean facilities must be equipped with sticky mats.
F4E will supply some or all of the following “free issue items”:

- All charcoal coated cryopanels, ready to be welded in place
- Blackened hydroformed components for the thermal shields
- The pneumatic valve actuator
- Bellows, slide bearing and metal seals for the valve assembly
- Electrical sensors incl. wiring and electrical feedthroughs

4. F4E MARKET SURVEY

To establish an optimum contract strategy, F4E needs to develop its understanding of the market with a comprehensive list of possible EU suppliers interested in the cryopumps manufacturing.

In the frame of the market survey, interested suppliers are invited to submit information.

Please fill in the attached market survey for your company.