JT-60SA Newsletter

No. 53, 30 May 2014

Headline

Cryogenic system manufacturing right on track

Figure 1: ACB (left) and RCB (right), with the main heat exchanger block integrated, in the AL-AT workshop

The JT-60SA cryogenic system has an equivalent refrigeration capacity of about 9 kW at 4.5 K and is under manufacture/pre-assembly at the Air Liquide Advanced Technologies (AL-AT) plant in Sassenage, France, under contract to CEA. The main subsystems are the refrigeration cold box (RCB) and the auxiliary cold box (ACB) (Figure 1). The RCB houses heat exchanger blocks (Figure 2), valves and expansion turbines for the main refrigeration process. The ACB houses valves, a cold compressor and cryogenic circulators to precool and circulate the helium through the cryogenic circuits of JT-60SA as well as a large liquid helium bath to buffer heat load peaks.

Following the acceptance of AL-AT´s detailed design in December 2013, procurement and delivery of all components proceeded according to schedule and the two vacuum vessels for the RCB and the ACB were delivered in April 2014. These two vacuum vessels with 12 m length, 3.2 m diameter and a mass of 30 t were manufactured in Italy and transported by trucks passing the Alps through the Frejus Tunnel.

Integration of the components into the vacuum vessels (Figure 1) will continue until July 2014 followed by thorough works tests. In November 2014, RCB, ACB, cycle compressors, oil removal system, control system and other components will start their journey to Japan. On-site installation is due to start in April 2015 and acceptance tests of the complete cryogenic system should be finished by July 2016.

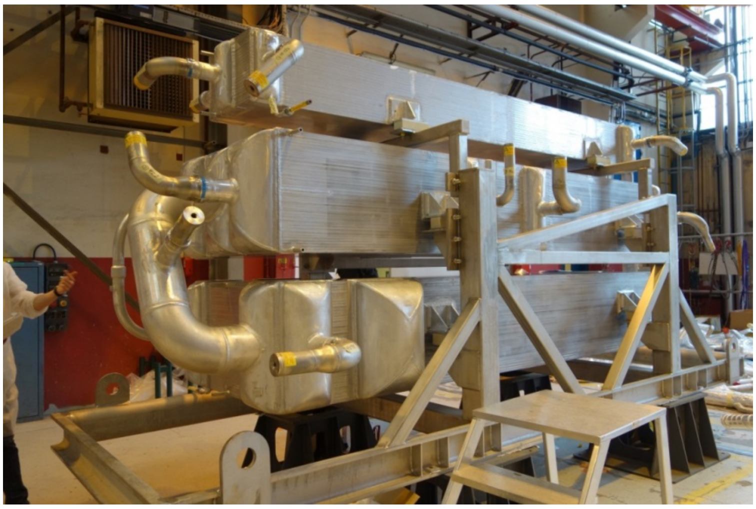
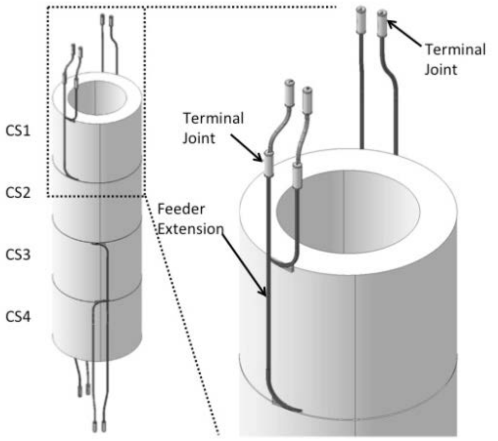


Figure 2: Main heat exchanger block

News

Low resistivity of terminal joint for CS achieved



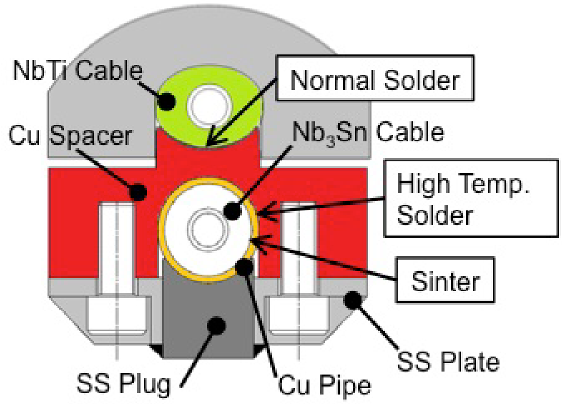


Figure 1: Terminal joint for CS

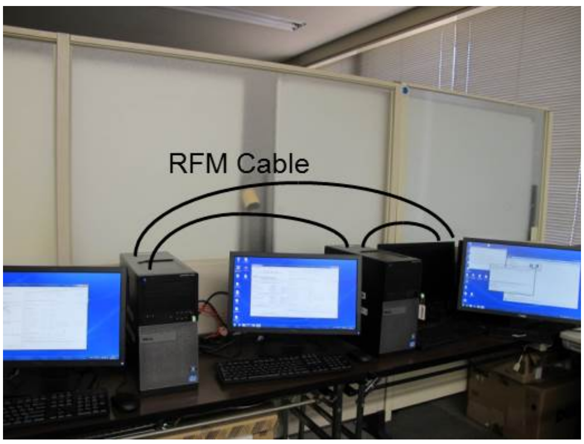
Figure 2: Cross section (as viewed from above)

The terminal joint of the central solenoid (CS) for JT-60SA (Figure 1) has been successfully developed to make a connection between the cable-in-conduit conductor using niobium-tin (Nb_3Sn) strand, which will be used in the CS manufacturing (Newsletter No. 45), and the niobium-titanium (NbTi) conductor, which will be used in the feeder that supplies the CS with electric current.

The aim of the improvement of the terminal joint was to make a sufficiently good sintered joint between the Nb_3Sn cable and the copper spacer in order to obtain a low contact resistance (less than 5 nΩ) (Figure 2). The structure of the copper spacer was therefore significantly improved, to maintain the diffusion bonded surface pressure of the copper, in the following way: (1) the Nb_3Sn cable was inserted into the copper pipe and heat treated with the pipe and Nb_3Sn cable swaged (at max. 650 ℃ for 19 hours), (2) the copper pipe was sintered and connected with the Nb_3Sn wire during the heat treatment, (3) the copper pipe and spacer were connected using high temperature solder (S50 with 238 ℃ solidus temperature and 241 ℃ liquidus temperature) not to melt the solder when connecting the NbTi conductor, and (4) the NbTi conductor was connected with the copper spacer using normal solder (H60A with 183 ℃ solidus temperature and 190 ℃ liquidus temperature). As a result, it was confirmed that a contact resistance value of 0.7 to 1.3 nΩ, which satisfies the requirement, was obtained in practice.

News

Development of power supply supervising computer completed



PS-SC system test using a dummy circuit

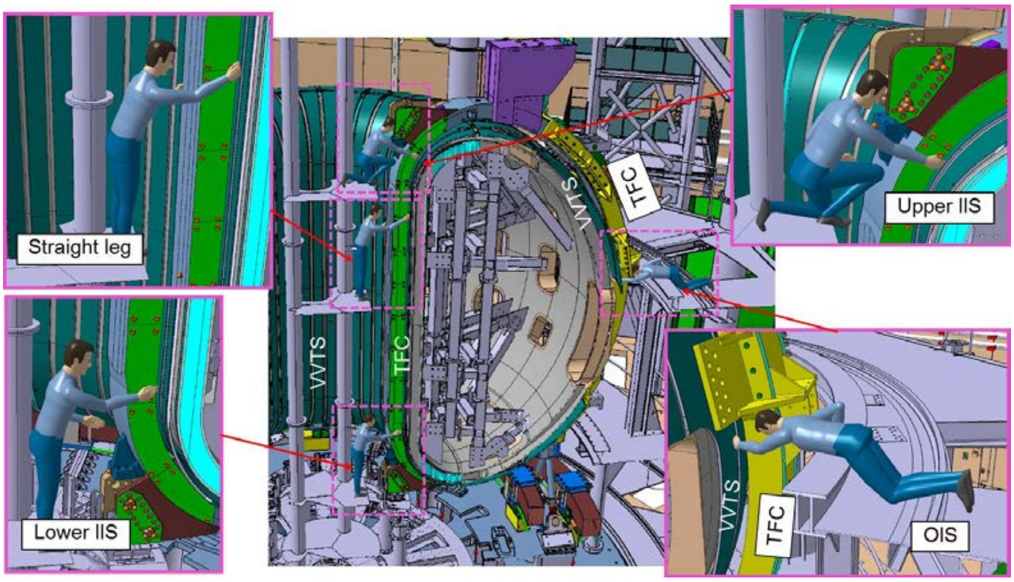
For the power supply manufacture for JT-60SA, the manufacture of the switching network unit for the central solenoid (SNU-CS) is being undertaken by Europe and the power supply supervising computer (PS-SC) system has been developed by JAEA.

For the PS-SC system development, a test was performed with a dummy circuit of the SNU-CS to confirm the signal interface between those systems using a reflective memory (RFM) cable. As a result, it was confirmed that the system successfully controlled the dummy circuit, which is nearly the same as that used for JT-60SA

Some parts of the system were delivered to Europe in the middle of May to be tested using the actual power supplies.

News

CAD simulation for TFC assembly adjustment

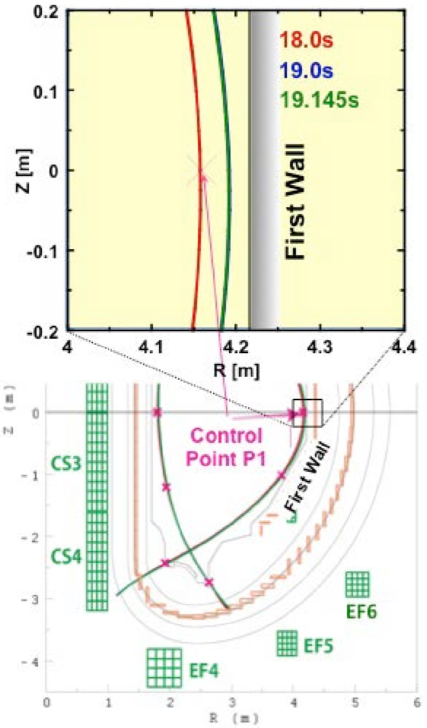


3D CAD simulation for gap measurement between TF coil and VVTS

Before the JT-60SA assembly, the gap control between devices and their precise spatial position are required to be checked in order to enhance the workability and safety of workers. To simulate the workability and safety, a virtual human body model called “human builder” has been used in the 3D CAD model (CATIA).

The workability and safety of the toroidal field (TF) coil assembly was simulated by inserting human builder into the JT-60SA 3D CAD model to check the gaps between the TF coil and the vacuum vessel thermal shield (VVTS). As a result of the simulation, it was confirmed that there were enough spaces for access to the straight legs, the upper and lower inner intercoil structures (IIS), and the outer intercoil structure (OIS), enabling workers to measure gaps (see figure).

MECS successfully developed for JT-60SA



Stable plasma discharge obtained within the voltage limit of the EF coil

The precise control of the plasma position is a key issue in safe and stable plasma operation. A magnetohydrodynamic equilibrium control simulator (MECS) has been developed in order to study the techniques of plasma equilibrium control for JT-60SA.

The MECS consists of a system controller, which decides the amount of electric current that needs to flow into the equilibrium field (EF) coil for plasma equilibrium, and a plasma simulator, which calculates the plasma equilibrium to be realised by internal plasma parameters such as EF coil current, plasma pressure and current profile.

The capacity of the power supply which applies the current to the coil is constrained in the actual JT-60SA device so that the output voltage and current do not exceed the limits. In order to achieve the same condition by simulation, a logic controller, which regulates the limits of the voltage and current in the same way as in the actual device, was introduced into the MECS.

As a result of the simulation, it was confirmed that, with a small time evolution of plasma pressure, the EF coil voltage fell within the limit and a stable plasma discharge could be obtained without the plasma surface striking the first wall (see figure).

With this development, the effects on the plasma control of the capacity of the power supply during the actual plasma discharge are now able to be verified.

Meetings

Design Review Meeting for SCMPS transformers design report

Figure 1: Screenshot of the DRM-MPS 18 videoconference

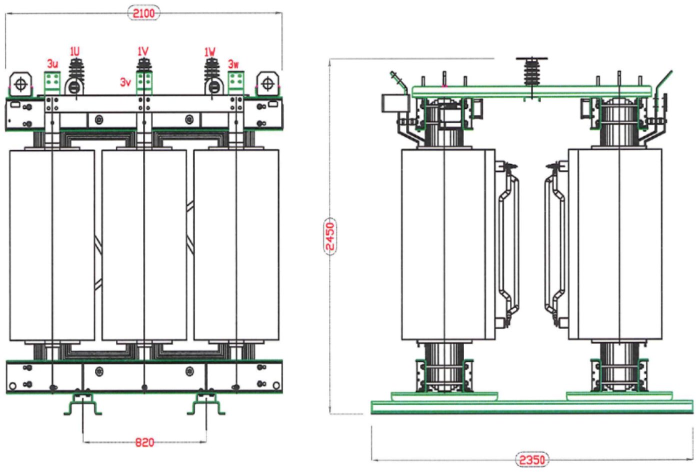


Figure 2: Layout of the FPPC transformer

The 18th Design Review Meeting on magnet power supply (DRM-MPS18) was held by videoconference on 19th March 2014 with the attendance of 20 experts from Germany (F4E Garching), Italy (ENEA, POSEICO-JEMA) and Japan (JAEA Naka) (Figure 1).

The purpose of the meeting was to agree on the transformer design report of the magnet power supply for the fast plasma position control (FPPC) coils (Figure 2) and part of the poloidal field coils. During this meeting, ENEA, F4E and JAEA made presentations of their comments on the draft report and the meeting attendees discussed mainly the transformer hot spot analysis, the mechanical stress analysis, the FPPC transformer pedestal, the voltage transducers, and the current vs. time relays.

At the end of the discussion ENEA, F4E and JAEA approved the document introducing in it all the requests.

Meetings

14th BA Steering Committee Meeting

On 10 April, the 14th Broader Approach Steering Committee (BASC) meeting was held at Rokkasho BA site in Aomori prefecture with attendance of representatives and experts from Europe and Japan. The 2013 Annual Reports and updated Project Plans for the three projects (IFMIF/EVEDA, IFERC and Satellite Tokamak Programme (STP)), submitted to the BASC, were discussed and approved.

As for the STP Project, the Project Leader (PL), S. Ishida, mentioned that the project was entering an exciting phase as it moved from manufacture of components to assembly thanks to the intensive collaboration between Europe and Japan. He reported the recent progress and near-future plan of the STP Project. Three equilibrium field coils had been put onto the cryostat base in the tokamak hall in January 2014. The assembly of the vacuum vessel would start in May and the quench protection circuit would be installed in September. The JT-60SA Research Plan had been updated in December 2013 with the cooperation of more than 330 researchers from 40 institutes in Europe and Japan. The Steering Committee expressed satisfaction with the progress of the STP Project. The PL also proposed an update of the Project Team including the appointment of H. Shirai as the STP Deputy Project Leader, prior to his appointment as the new PL as of 1 July 2014.

The next BA Steering Committee meeting will be held in Karlsruhe (Germany) on 4 November 2014.

Calendar

June 4-5, 2014
20th Technical Coordination Meeting (TCM-20)
Naka, Japan

June 23-27, 2014
41st European Physical Society Conference on Plasma Physics (EPS-CPP-41)
Berlin, Germany

September 26 - October 3, 2014
28th Symposium on Fusion Technology (SOFT-28)
San Sebastian, Spain

October 7, 2014
15th Meeting of the STP Project Committee (PC-15)
Naka, Japan

October 13-18, 2014
25th Fusion Energy Conference (FEC 2014)
Saint Petersburg, Russia

Contact Us

The JT-60SA Newsletter is released monthly by the JT-60SA Project Team.
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For more information please visit the website: http://www.jt60sa.org/