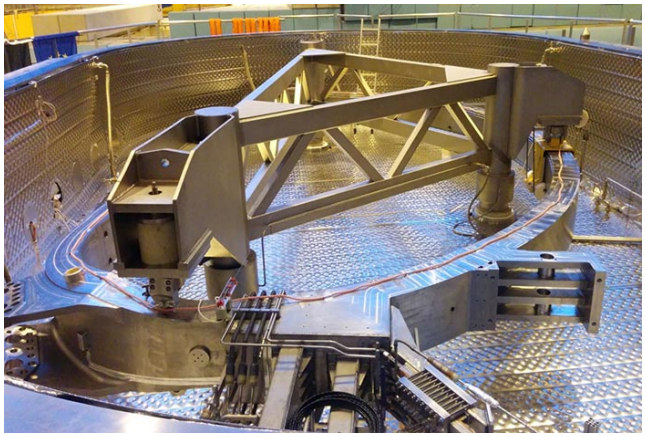
JT-60SA Newsletter

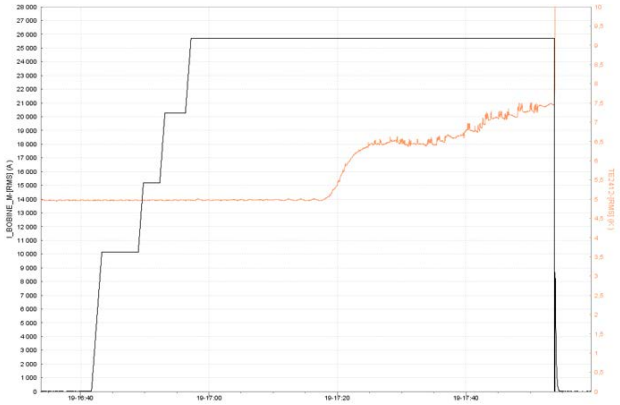
No. 75, 31 March 2016

Headline

First TF coil cold test succeeds



First TF coil in the TFCTF cryostat in Saclay



Current at 25.7 kA and quench test by temperature increase up to 7.46 K

The first JT-60SA toroidal field (TF) coil, manufactured by General Electric (formerly Alstom) under the responsibility of CEA Cadarache, was inserted into the cryostat of the TF coil cold test facility (TFCTF) at CEA Saclay at the beginning of January 2016. The coil was then cooled down at an average rate of about 1.5 K/h until it reached a temperature of 5 K. At this temperature, the coil became superconductive for the first time in its life…

The current test phase of the TF coil cold test then took place on 17 February 2016. The coil was first energised for several hours at 25.7 kA, which is its nominal operating current in the JT-60SA tokamak, and the test finished with a normal fast discharge. In a second phase, the coil was energised again, and the inlet temperature of the coil was increased slowly in order to check its temperature margin against a quench. A temperature of about 7.46 K was recorded just before the beginning of the quench. Once the quench was detected by the magnet safety system, with a threshold of 100 mV/100 ms, a fast discharge was triggered to the dump resistor with a time constant of 10 s. At the same time, the safety relief valves were opened to evacuate the helium in the coil and avoid too much pressure rise.

On 26 February, the coil was energised for the last time at 25.7 kA to check that the quench had not induced any damage, and was then discharged slowly through the power supply (PS). This successful result of the final test demonstrated that the first JT-60SA TF coil achieved all the performance requirements at nominal conditions of temperature and current.

At the beginning of March, the coil was removed from the cryostat and prepared for assembly with the outer intercoil structure (OIS), prior to its packaging for shipment to Japan.

News

VVTS assembly starts

Figure 1: Assembly of the first 20° VVTS is underway

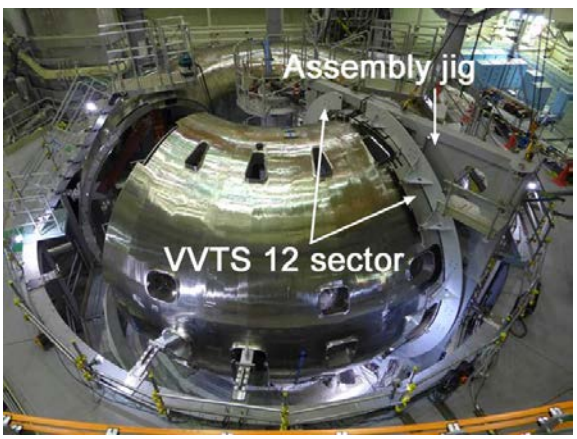


Figure 2: First 20° sector (No.12) was installed

On 15 February 2016, 3 vacuum vessel thermal shield (VVTS) sets, which together form a 60° sector, were delivered to the JAEA Naka site and stored in the assembly hall. Based on the scenario verified with 2 prototypes in January, the assembly of the production VVTS started in the torus hall (Figure 1).

The first 20° sector (No.12) was successfully mounted around the vacuum vessel (VV) in February (Figure 2). The second 20° sector is currently being assembled. All of the VVTSs, except one around the 20° VV gap, will be installed by July 2016.

News

Factory tests of EF2 - 5 PSs completed

Figure 1: Participants in the EF3 PS factory tests

Figure 2: In the remote control room during the EF3 PS tests

Figure 3: Testing the overvoltage protection of the EF4 PS crowbar

Figure 4: Reactors set for the test to prove the new dc reactor design (new larger reactor in front and the originals in back)

The EF2 - 5 superconducting magnet power supplies (PSs), together with the TF PS, are procured by CEA through a contract with Jema Energy S.A. (JEMA), signed in 2013.

After the approval of the first design report, the manufacturing of the ac-dc converters for the PSs of the equilibrium field (EF) superconducting coils EF2, EF3, EF4 and EF5 was completed by JEMA during 2015, and the related factory tests were successfully completed in February 2016.

The EF3 and EF4 PSs are thyristor converters rated at ±20 kA and ±836 V, while the EF2 and EF5 PSs are rated at +10/-20 kA and ±836 V. The 4 converters are designed to operate with a duty cycle of 220s/1800s.

A modular design has been applied to the converters, employing 2 types of basic bridges: a unidirectional bridge with a rated current of 5 kA, composed of 6 thyristors, and a bidirectional bridge with a rated current of ± 5kA, composed of 12 thyristors connected in a back-to-back scheme. The EF3 and EF4 converters are composed of 4 bidirectional bridges connected in parallel, while the EF2 and EF5 converters are composed of 2 bidirectional bridges and 2 unidirectional ones.

A bidirectional crowbar is connected to the output of each converter to protect the converter in case of a fault. In fact, the crowbar allows short-circuiting of the converter output, providing a low impedance reclosing path for the coil current. To be

quick enough, the crowbar is composed of a static part and a mechanical switch. As it is a safety relevant component, it has been designed to assure high reliability and seismic resistance.

During the power tests performed at JEMA premises in July (Figure 1 and 2) and November 2015, and more recently in January (Figure 3) and February 2016, all the key aspects of the design have been positively verified: nominal current and nominal voltage tests were successfully performed, crowbar operation at the nominal current was verified, seismic design of the crowbar was proved by means of seismic vibration tests, and control performance was proved to be adequate and reliable in any operation condition.

Some minor problems, related to the thermal design of dc reactors and the voltage control in open loop, were detected during the tests performed in 2015. Both issues were investigated and fixed by JEMA: new dc reactors were designed and manufactured, and a new voltage control scheme has been applied. Both modifications were successfully verified during the final tests on the EF4 PS, performed in January and February 2016 (Figure 4).

The next step is the factory test of TF PSs, which are planned in March 2016, before shipment of all components to Japan.

News

CS SNUs ready for shipment to Japan

Figure 1: 52 crates at the OCEM premises


Figure 2: Cubicles covered with moisture-proof bags before packing in the wooden crates


Figure 3: Static circuit breaker stacks removed from the cubicle for shipment (yellow items are shock detectors)


Figure 4: ENEA and OCEM personnel by the by-pass switch crates, showing how tall the crates are

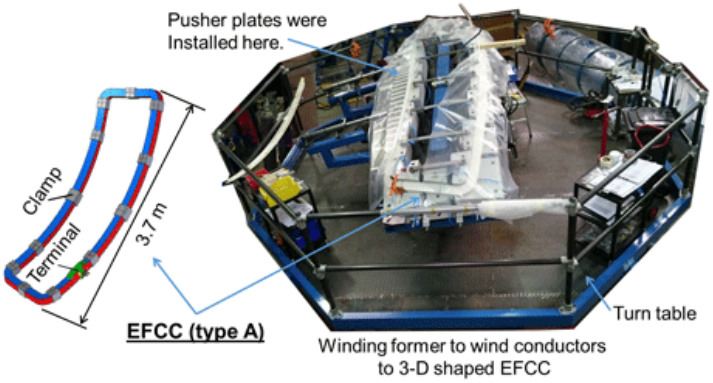
Four sets of the switching network units (SNUs), being procured by ENEA for the JT-60SA central solenoid (CS), were successfully tested and made ready for shipment to Japan.

The detailed design of the SNUs was approved by the JT-60SA Project Leader (PL) in July 2013. The first SNU (full-scale prototype) was successfully tested, at full current (20 kA) and full voltage (5 kV), at ENEA Frascati facilities in September 2014. Those 4 SNUs together with their local control cubicle were tested in October 2015 in a configuration similar to the final installation in the JT-60SA rectifier building at the JAEA Naka site. Many other tests were performed on SNU critical components through 2013, 2014 and 2015 (for example, see article in Newsletter No. 63). Most of these tests were attended by ENEA, F4E and JAEA representatives.

Since all of the tests on the CS SNUs have already been completed successfully, now the SNUs can be shipped to Japan. All of the SNU elements were packed in 52 wooden crates at the premises of OCEM Energy Technology S.r.L (OCEM), the Italian industrial supplier (Figure 1). The packing included several systems to ensure a safe marine and land transportation. In particular more than 200 shock detectors were applied to the cubicles and crates (Figure 3). The crates will travel from the OCEM premises, through the ports of La Spezia (Italy) and Yokohama (Japan), to the Naka site in 2016. The exact delivery date is now being adjusted for settlement among the JT-60SA partners, taking all of the ongoing activities into account.

News

Progress of EFCC fabrication at TESLA



Eighteen Error Field Correction Coils (EFCCs) will be installed in the VV of the JT-60SA device to correct error fields caused by misalignment of the superconducting coils and so forth. The EFCCs are being manufactured by Tesla Engineering Limited (TESLA) in the United Kingdom, under a contract concluded by JAEA in November 2014.

On 16 and 17 February 2016, D. Tsuru from JAEA visited TESLA to have technical discussions and to confirm the status of EFCC manufacturing. The manufacturing process of EFCCs consists of winding, vacuum impregnation, and assembly. He viewed the ongoing winding process of the first EFCC, which had already been started in February 2016, and various tools and jigs for other processes. A specially designed winding former, including a turntable and a biaxial seesaw mechanism to accommodate the 3-D shape of the EFCC, was in use for the winding process. He had some fruitful discussions concerning technical issues and other items during his visit as well.

TESLA will continue EFCC manufacturing. All of the EFCCs will be delivered to the JAEA Naka site by March 2017.

Meeting

MIIFED – IBF 2016

On 8 - 11 February 2016, the Monaco-ITER International Fusion Energy Days (MIIFED) combined with the ITER Business Forum (IBF) was held with 556 participants from 285 companies/institutes and 26 countries. This conference was opened by the welcome addresses of Dr. Bernard BIGOT, Director General of ITER Organization, and H.S.H. Prince Albert II of Monaco.

On the first day, a keynote session was held with the main theme being the importance of international collaboration to promote progress in challenging areas of science and technology. The session included reports of the activities by CERN, ITER, SKA Telescope, the International Linear Collider, JT-60SA, and F4E. From the JT-60SA project, Y. Kamada, the Project Manager of JA Home Team, presented on ”International collaboration among research organizations and industry in JT-60SA construction”. Introducing some examples of procurement and assembly for the JT-60SA, he emphasized, ”the collaboration between Europe and Japan including industries is close and tight. All the members of the EU and JA Integrated Project Team (IPT) are sharing the same and clear target. With an effective communication amongst them, they have overcome many problems and implemented the project efficiently”. The status of the project and spirit of the JT-60SA IPT earned applause from the audience.

Meeting

TCM-24 held in Naka

The 24th Technical Coordination Meeting (TCM-24) was held on 24 and 25 February 2016 at JAEA Naka Fusion Institute. A total of 79 experts attended the meeting in person or via videoconference: 34 from the EU Home Team (France, Germany, Italy and Spain), 33 from the JA Home Team, 6 from the Project Team, and 6 invited from Spain and Japan.

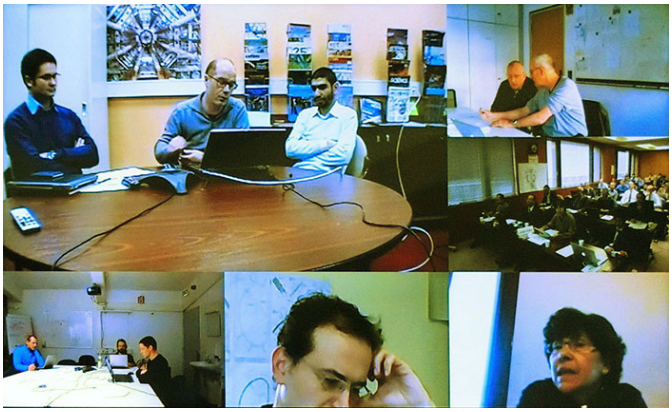
At the beginning of the meeting, H. Shirai, the PL of the Satellite Tokamak Programme, made an opening presentation, in which he explained the results of the Broader Approach Steering Committee held in December (BASC-17), the Work Programme 2016, the overall project progress, and so forth, and expressed satisfaction with the successful achievements and steady progress in both EU and JA procurements, in particular, the delivery of the TF coils and outer intercoil structure to the TFCTF in Saclay.

During the meeting, the status and actions in the following areas were reported and discussed: manufacturing of TF, EF and CS coils, lower port thermal shield, in-vessel components, high temperature superconductor current leads, cryostat and PS

systems, assembly of the VV and VVTS, development of the supervisory control system and data acquisition system, commissioning of the cryogenic system, and overall assembly, integrated commissioning and initial operation of the JT-60SA device.

In the last session of the meeting, the winners of the "JT-60SA Newsletter Award", who were the top 3 contributors to JT-60SA Newsletter articles in 2014 - 2015, were announced. The first prize was given to K. Masaki of JAEA, and the second prize to L. Novello of F4E, and the third prize to M. Wanner of F4E. In addition, E. Di Pietro, the EU Deputy Project Manager, filled a pupil in the blank second eye of a Daruma doll expressing his thanks to the quench protection circuit team of Consorzio RFX for their accomplishment of the procurement arrangement. (Traditionally, when Japanese start a big project, they often paint only one eye of a Daruma doll praying for success, and complete the other eye in celebration of its accomplishment.)

The PL finally announced that the next meeting, TCM-25, would be held in Avilés, Spain on 6 - 7 July 2016, and the TCM-26 would be held in Naka, Japan on 9 - 10 November 2016.



Calendar

22 April 2016
18th Meeting of the BA Steering Committee (SC-18)
Rokkasho, Japan

30 May – 3 June 2016
22nd International Conference on Plasma Surface Interactions in Controlled Fusion Devices (PSI 2016)
Rome, Italy

4 – 8 July 2016
43rd European Physics Society Conference on Plasma Physics (EPS 2016)
Leuven, Belgium

6 – 7 July 2016
25th Technical Coordination Meeting (TCM-25)
Avilés, Spain

5 – 9 September 2016
29th Symposium on Fusion Technology (SOFT 2016)
(Prague, Czech Republic)

Contact Us

The JT-60 Newsletter is released monthly by the JT-60SA Project Team.
Suggestions and comments are welcome and can be sent to newsletter@jt60sa.org.

For more information, please visit the website: http://www.jt60sa.org/.