JT-60SA Newsletter

No. 63, 31 March 2015

Headline

Works acceptance of gaseous helium storage vessels

Members of works acceptance team

Side view of one of the six vessels

Three completed vessels

JT-60SA is provided by Europe with a cryogenic system with a refrigeration capacity of 9 kW (eqv.) at 4.5 K. Before commissioning, and during occasional warm-up periods, the total 3.6 t helium inventory is stored in six pressure vessels. Each vessel has a length of 22 m, a diameter of 4 m, volume of 250 m^3 volume, and weight of about 73 t. As the vessels will store pure helium, the tightness and cleanliness requirements are quite demanding.

F4E awarded a contract to A. Silva Matos Metalomecanica SA (ASMM) (Portugal) for the supply of the vessels and their equipment, and their transport to Japan.

One of the vessels is also used to receive the cold helium (20 K) from the cryogenic system quench line, following a fast current discharge of the superconducting coils. F4E performed a fluid dynamic study of the impact of this event on the quench line and the vessel, and the results showed that the use of a special 18 m long helium diffuser system and of a thermal barrier connector at the quench line flange would avoid local chilling of the vessel wall below the minimum allowed temperature of the material, due to the ingress of the cold helium. The procurement of these components was added to the supply contract during the contract execution without impact on the delivery deadline.

On 5 February 2015, the final works acceptance of the six gaseous helium pressure vessels for the cryogenic system was successfully completed.

The F4E contract to ASMM has so far run on budget and on time with the earliest delivery date (two months ahead of the contractual date) being achieved, in spite of an already very stringent schedule. In less than nine months from the kick-off meeting, the detailed design, manufacturing and testing of these large components were completed according to the ASME VIII division 1 rules.

In order to meet the contractual milestones, F4E and ASMM worked in very close contact; problems have been swiftly solved with ad-hoc engineering solutions, and delays have been avoided, with tests performed by ASMM, with the assistance of F4E, overnight and on weekends.

The components will now be shipped to Hitachi port in Japan. The last difficult operation will be the road transport of the vessels to the Naka site and their installation on site, which is planned to be executed before the end of June 2015.

News

Electro-dynamic tests of SNU-CS by-pass switch

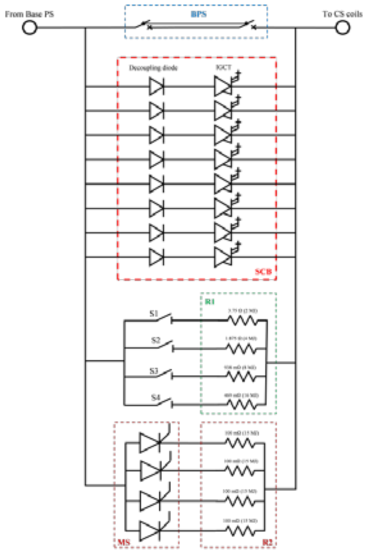


Figure 1: Final functional scheme of a CS SNU

Figure 2: Transportation of the BPS final cubicle to the SIEMENS SVEPPI test facilities

Figure 3: ENEA, OCEM, Microelettrica and SVEPPI technicians during the BPS tests

Figure 4: Detail of the SVEPPI switches and lines connected to the 220 kV substation

The JT-60SA central solenoid (CS) is divided into four superconducting modules. Each module is connected to an independent switching network unit (SNU) for plasma initiation. The four CS SNUs are procured by ENEA through a contract signed in October 2012 with the industrial supplier OCEM Energy Technology. The SNU detailed design was approved in July 2013.

The high performance of the CS SNUs is obtained by a hybrid (electromechanical-static) switch configuration. The coil current (with a nominal value up to ± 20 kA) is sustained for most of the operating time by an electromechanical by-pass switch (BPS). The operations of the electronic static circuit breaker (SCB) virtually hide the inadequate velocity and repeatability of the BPS and limit opening stresses and arc phenomena, improving the expected lifecycle and reliability. Furthermore, the global power losses are limited due to the negligible conduction losses of the BPS.

Figure 5: Set-up for the BPS electro-dynamic resistance test at 43 kA (A car shown in the photo shows the dimensions of the test area)

The BPS is based on a compact contactor by Microelettrica Scientifica with normally-open contacts and latching device allowing a bi-stable function. As the BPS reliability is relevant also for safety reasons, several levels of redundancy are implemented. The BPS can carry 23 kA for 250 s (every 1,800 s) in both directions, providing a large margin in case of overcurrent, plasma disruption or other fault conditions. The use of two groups of contacts in series, mounted on a single shaft, ensures a sufficient voltage for the SCB activation (Figure 1). Each group consists of four contacts in parallel and is operated by three independent coils (while two coils are sufficient to close the contacts). A mechanical latch prevents any unwanted opening (for example, due to voltage sags in the auxiliary power supply) and saves the auxiliary power during most of the working cycle.

BPSs based on the same design are employed also for other JT-60SA systems and functions, such as the superconducting magnet power supply (SCMPS) crow-bars and equilibrium field (EF) coil SNUs and boosters.

Considering the importance of the BPS, it was fundamental to verify its electro-dynamic resistance in case of currents far beyond the nominal value, also to avoid problems in case of fault. This test was successfully performed on the BPS enclosed in the JT-60SA final cubicle (Figures 2 and 3) at the SIEMENS SVEPPI laboratories in Scorzé (Italy). The test set-up is shown in Figures 4 and 5: in practice, the BPS was supplied directly from the 220 kV national grid.

The main tests consisted of applying to the closed BPS a sinusoidal current at 50 Hz with a peak value higher than 43 kA. This test current was applied six times for at least 110 ms. During the six shots the BPS was able to keep its closed status. After such tests, the BPS was correctly opened at the first attempt without showing damage or problems.

News

Splice plate welding between VV sectors

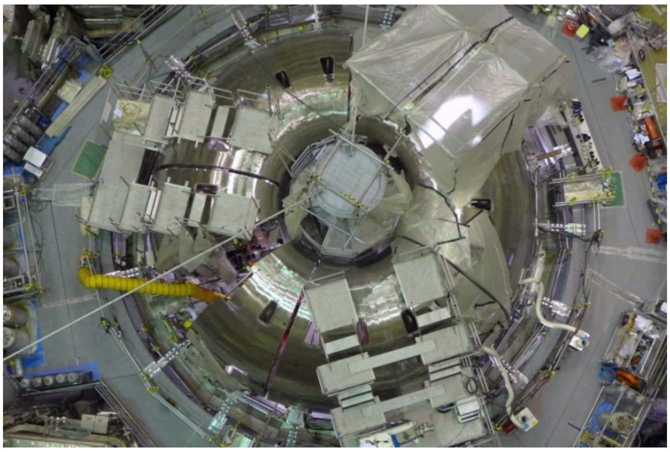


Figure 1: Splice plate welding in progress

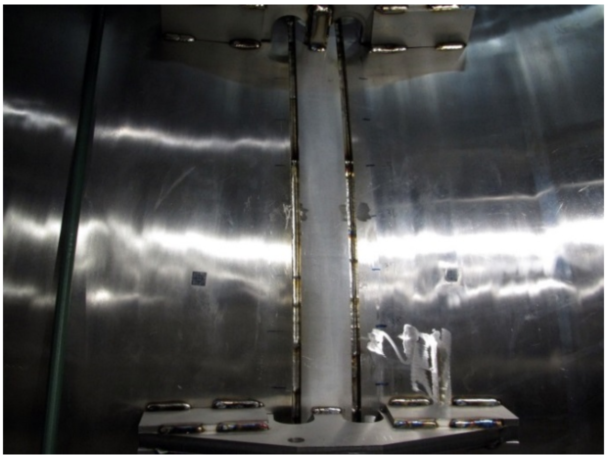


Figure 2: Close view of splice plate welding between VV-D02 and VV-D03

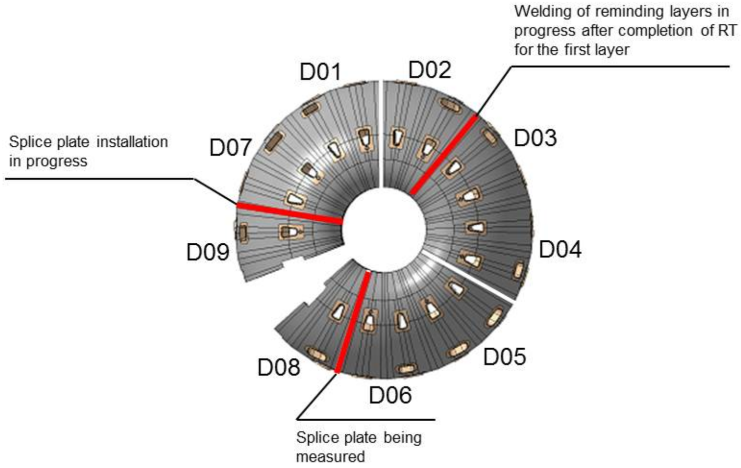


Figure 3: Current status of VV assembly

After completion of the direct joint welding of the three pairs of vacuum vessel (VV) 40° sectors, joint welding with splice plates between VV-D02 and VV-D03 has been started (Figure 1).

A splice plate is used as a margin adjustment in the gap between the VV sector pairs to accommodate edge shape and gaps which exceed the specified tolerances, and its thickness and material are the same as those of VV. To produce a successful joint weld in this situation, high skills are needed in the actual work since both edge alignment and welding shrinkage must be taken into account at the same time (Figure 2).

Currently radiographic testing (RT) has been performed on the first layer of the weld between VV-D02 and VV-D03, and completed with no problem, and the welding of the remaining layers is now in progress. In addition, the installation of the splice plates between VV-D07 and VV-D09, and the measurement of the splice plates installed between VV-D06 and VV-D08, are also in progress (Figure 3).

The welding work between VV-D01 and VV-D02, and VV-D04 and VV-D05 will be also performed using the same method in the near future.

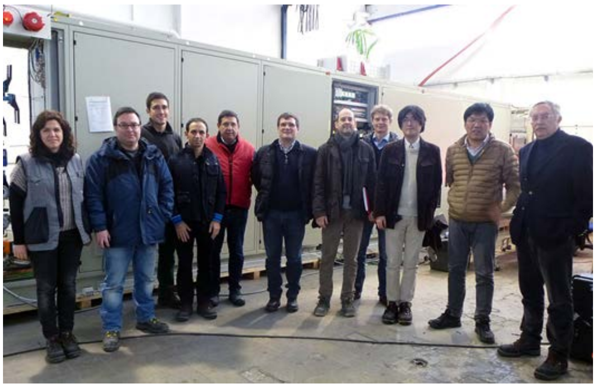
News

Successful FPPC power supplies acceptance tests

JEMA Laboratories, FPPC transformers connected to the test hall on the top left

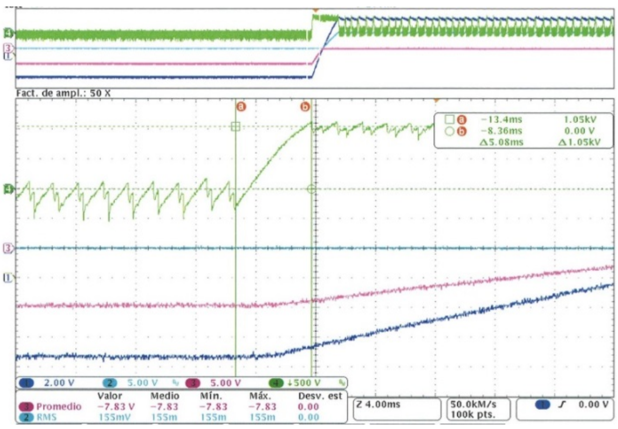
JEMA Laboratories, FPPC test hall, the rear view of FPPC converter connected to transformers

POSEICO – JEMA, in a joint venture, were awarded a contract by ENEA in August 2013 the contract for the procurement of eight power supplies (PS) and six transformers for part of the JT-60SA poloidal field coil PSs (including the central solenoid (CS)1, CS2, CS3, CS4, equilibrium field coil (EF)1 and EF6 PSs and the fast plasma position control (FPPC) PS). The FPPC converters' First Design Report was approved in July 2014, whereas the FPPC transformers were already manufactured and tested by then. The manufacturing process of FPPC converters was completed in November 2014 and in the meantime the characterisation process of FPPC converters started at JEMA Laboratories, focused on demonstrating the correctness of the choices made during the design phase. Thereafter two FPPC transformers were transferred by POSEICO to the JEMA Laboratories (San Sebastian, Spain) in order to test the FPPC converters.



JEMA Laboratories, the test hall

JEMA Laboratories, the FPPC converter tested



A screenshot of the oscilloscope during the FPPC type test with an open loop voltage step from - 1 kV to + 1 kV (rise time = 5 ms)

The acceptance tests were performed at JEMA Laboratories in February 2015 according to the International Electrotechnical Commission (IEC) 60146 standard. Witnesses at these tests were P. Zito, and V. Cocilovo (ENEA), L. Novello (F4E), K. Shimada and M. Matsukawa (JAEA), F. Fasce (POSEICO) and A. Dorronsoro, K. Celaya and D. Vian (JEMA). Acceptance tests were split into type and routine tests, according to the technical specification, the test procedure and the standard.

All tests gave positive results. Furthermore, the thermo-graphic camera did not highlight any critical hot spot. Also an additional type test was performed considering a step voltage signal reference at variable frequency from 1 Hz up to 50 Hz, in order to characterise the dynamic behaviour of the output voltage of the FPPC converter and its capability to follow fast variations of the plasma position. The tests performed pointed to good dynamic behaviour of the FPPC converter in open loop feed forward voltage control, for a reference voltage step from 0 to 1 kV, with the rise time of output voltage being just below 3 ms.

News

Manufacturing technique of pickup coil for quench detection established

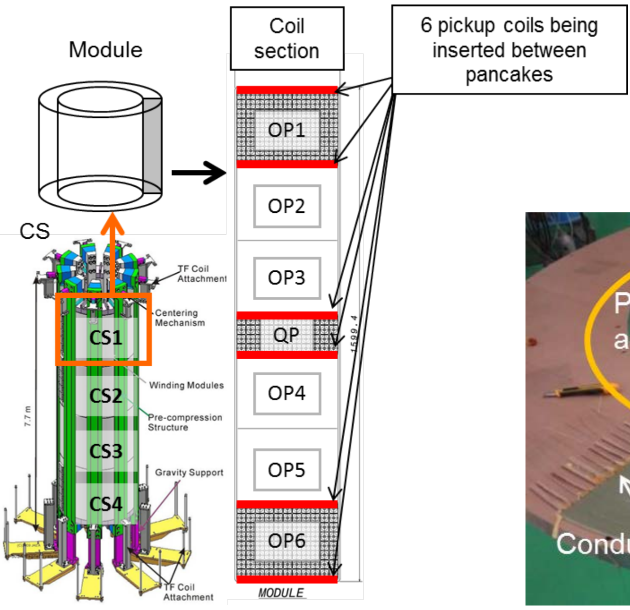


Figure 1: Schematic view of CS

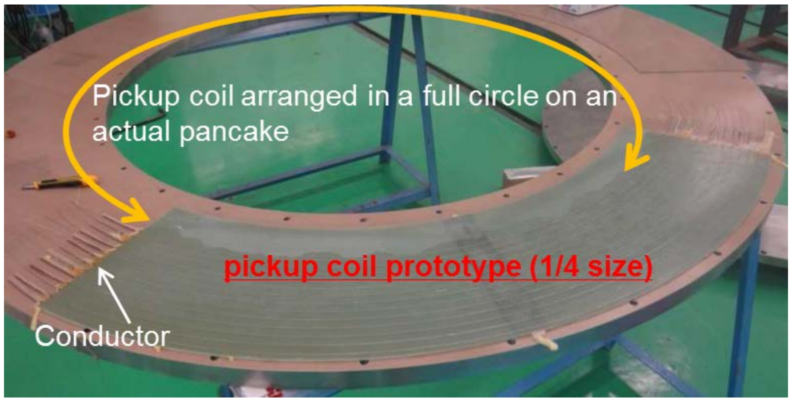


Figure 2: Pickup coil prototype

A pickup coil is a superconducting magnetic sensor for detecting a quench which would otherwise cause a temperature rise up to several hundred K in the magnet and would damage the magnet itself. Six disk-shaped pickup coils will be inserted between pancakes of the central solenoid (CS) module to sense the start of this event and help prevent magnet damage (Figure 1).

In quench detection with pickup coils, the magnetic field is captured by the pickup coils and the captured magnetic field is detected by a superconducting quantum interference device. Since the resistive voltage can then be measured with good accuracy by removing the inductive element induced by the coil signal, early quench detection is possible.

Recently, based on a detailed design, a pickup coil prototype was made one quarter of the actual size to verify its manufacturing properties, dimensional accuracy, permeability of resin, etc. (Figure 2). As a result, all the specified conditions were sufficiently satisfied to allow manufacture of the full-scale device to begin.

News

JT-60SA Research Plan version 3.2 issued


16 February 2015

JT-60SA

JT-60SA Research Plan

− Research Objectives and Strategy −

Version 3.2

2015, February

JT-60SA Research Unit

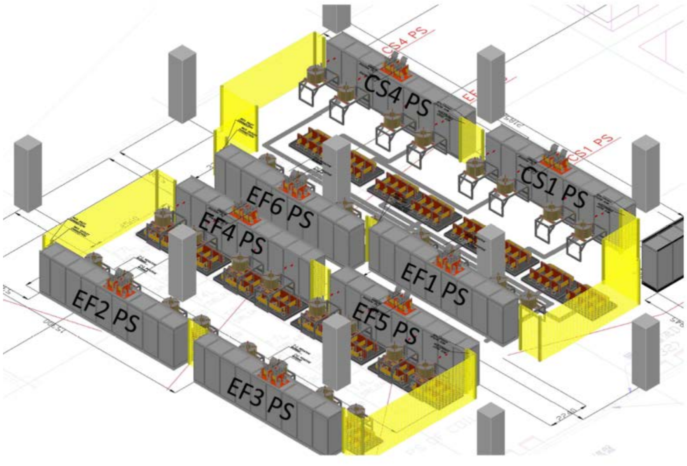
A new revision of the JT-60SA Research Plan version 3.2 (SARP ver. 3.2) was issued in February 2015, and published on the JT-60SA web site.

In the revised version, JT-60SA operation scenarios (the inductive H-mode scenario #2 and the hybrid scenario #4-2) have been simulated using validated codes and models.

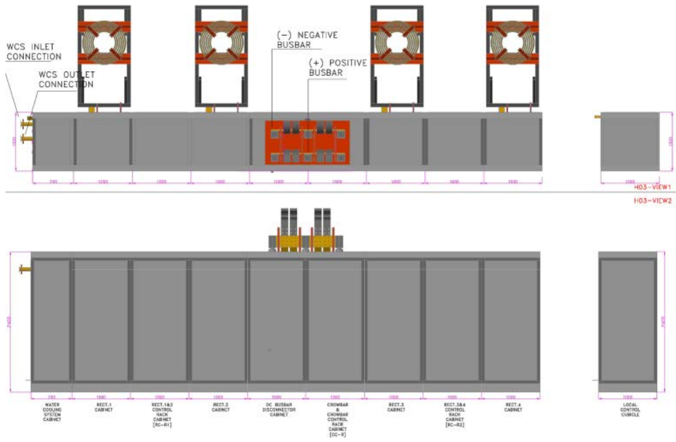
365 scientists, 157 from Japan (83 JAEA, 74 JA-Universities (15 institutes)), 203 from Europe (12 countries, 26 institutes), and 5 from the Project Team made a large contribution to the SARP as co-authors.

Meetings

DRMs for design phase completion on CS, EF and TF PS



Layout of the installation of EF1, EF2, EF3, EF4, EF5, EF6, CS1 and CS4 PS



Front and Top view of the converter cubicles

The design phase of the ac/dc converters for the superconducting magnets of JT-60SA has been completed, with the last design reports on the central solenoid (CS), equilibrium field (EF) coil and toroidal field (TF) coil power supply (PS) having been finalised and made ready for approval.

The converters that will supply the superconducting magnets of JT-60SA are procured by CEA and ENEA via two separate contracts with JEMA and POSEICO/JEMA respectively. The TF coil circuit is supplied by an ac/dc thyristor unidirectional converter rated for 25.7 kA in steady state and ± 80 V as no load voltage, while the poloidal circuits are supplied by ten ac/dc thyristor converters, almost all rated for ± 20 kA and ± 1 kV.

The design phase for superconducting magnet PSs started around the middle of 2013, and it took more than one year to complete it, as a number of converters with slightly different characteristics needed to be designed. To reduce the schedule impact, the design of the superconducting magnet power supplies (SCMPS) has been divided up into eight First Design Reports (FDRs), allowing the starting of the related manufacturing phase after the approval of each single document. During 2014, the different design reports related to the different magnet power supplies (MPS) have been prepared by the industrial suppliers and commented by all stakeholders. In particular, the final version of the FDRs on EF3 & EF4 PS and EF2 & EF5 PS were issued and validated in November 2014, while the final version of FDRs on EF1 & EF6 PS and CS PS and the FDR on TF PS, taking into account all the comments received during the design phase, were issued in January 2015.

Two Design Review Meetings (DRMs) were held on 4 and 5 February with the participation of the supplier, CEA, ENEA, F4E and JAEA experts to validate the design of TF PS and of EF1 & EF6 and CS PS respectively. The outcome of both DRMs was extremely positive, allowing the design of the converters to be validated.

Meanwhile, the procurement of critical components for the EF PS has been anticipated by the suppliers, and the assembly of the first EF PS units has already been started in the second half of 2014, in order to be ready for the first factory tests in the first half of 2015.

Calendar

April 20, 2015
Celebration of the delivery of the main components and start of their on-site installation by EU, and completion of the initial assembly of the vacuum vessel of the JT-60SA tokamak
Naka, Japan

April 21, 2015
16th Meeting of the BA Steering Committee (SC-16)
Naka, Japan

April 22 – 23, 2015
22nd Technical Coordination Meeting (TCM-22)
Naka, Japan

May 17 – 21, 2015
23rd International Conference on Nuclear Engineering (ICONE-23)
Chiba, Japan

May 31 – June 4, 2015
26th Symposium on Fusion Engineering (SOFE-26)
Austin, USA

Contact Us

The JT-60SA 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/