JT-60SA Newsletter

No. 117, November 2021

Headline

Change at the helm of the JT-60SA project

Former PL, M. Hanada (left) and new PL, H. Shirai (right)

The Project Leader (PL) of the Satellite Tokamak Programme (STP) Project has been changed from Masaya Hanada to Hiroshi Shirai, after the appointment by the Broader Approach Steering Committee (BASC) on 27 August 2021, because Hanada-san has left for Rokkasho site due to internal personnel reallocation in QST. He said, “At present, JT-60SA is facing difficulties due to the equilibrium field (EF) 1 incident. I am sorry that I cannot continue the repairs of EF1 and the work for the integrated commissioning (IC) with the first plasma next year.”

From 2017, he was engaged in the JT-60SA project, with the main mission to complete the JT-60SA construction, and to control the project schedule. The construction itself was completed in 2020, after encountering difficulty with the central solenoid (CS) insertion, solved in a strong collaboration between Europe and Japan. In July 2020, he was appointed PL. In the final stage of the IC in March 2021, the EF1 feeder incident occurred, which the Integrated Project Team (IPT) is tackling with external experts again in a strong collaborative effort. He strongly believes the IPT can overcome the EF1 incident and realise the first plasma next autumn as scheduled.

He said, “Please deepen mutual trust for the success of the JT-60SA project. If needed, I will support the JT-60SA project from the Rokkasho site.”

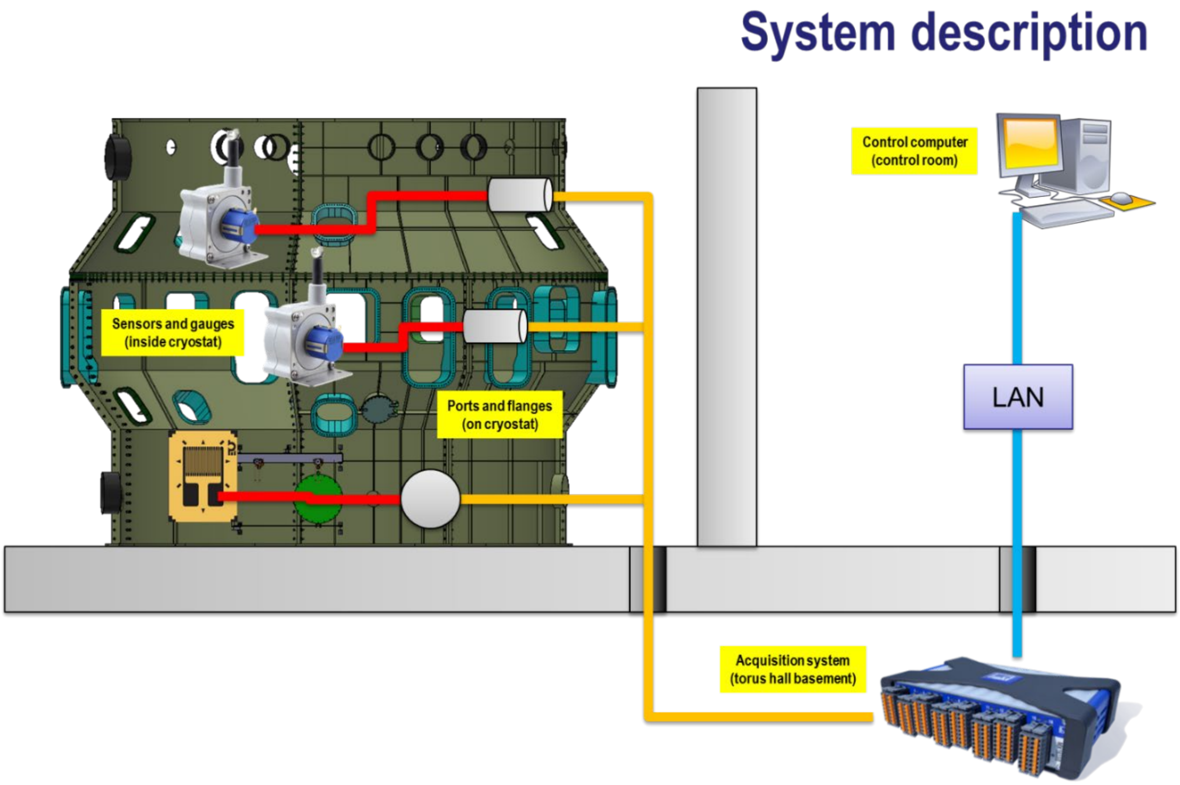
For the new PL, Hiroshi Shirai, this is the second time he has taken the role of the STP PL. His first term was from July 2014 to April 2018, when components and systems of JT-60SA were manufactured both in European and Japanese factories, transported to Naka site one after another and put together inside and outside the tokamak building. Near the end of his term, he accepted two toroidal field (TF) coils specially sent by air using an Antonov 125. After he entrusted his duty as the PL to Yutaka Kamada, he re-entered into ITER business. First he took the role of the vice-chair of the Management Advisory Committee (MAC) of the ITER Council. Now he is the chair of the MAC.

His re-appointment as STP PL might be a bit unexpected. But he is so glad that he comes back to join the Project Team and can be a help to the JT-60SA project again. He said, “Indeed JT-60SA is now having a tough time. But both European and Japanese people are now working strenuously to get the project back on the right track. On the basis of the powerful and excellent work of Hanada-san so far, I will do my best to strongly support and proceed with the project.”

News

Displacement and stress monitoring system

The Displacement and Stress Monitoring System for the JT-60SA TF coils has the purpose of collecting, recording and making available to the user the radial and toroidal displacements of the toroidal field (TF) coils and the strains and stresses of their gravity support (GS) legs. The procurement of the instrumentation is part of a Procurement Arrangement (PA) under the responsibility of F4E.



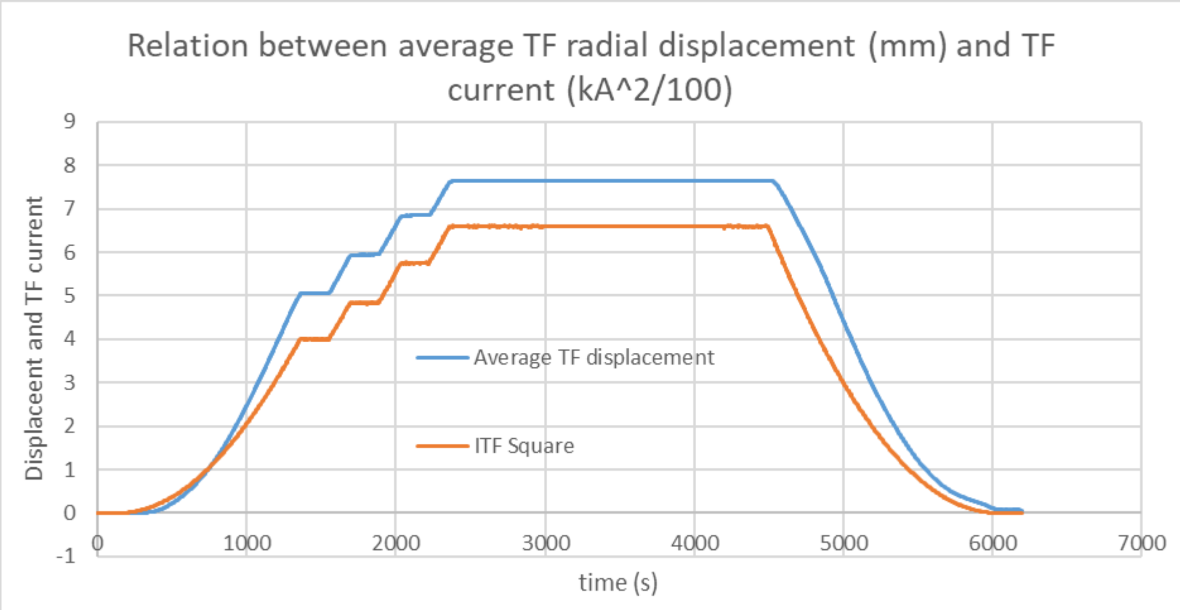
System Overview

The Displacement and Stress Monitoring System for the JT-60SA TF coils is made of:

- 39 potentiometric position transducers, which are connected to the outside of the cryostat, and to the TF coil. Each transducer is installed in a cryostat port, which is welded on the external face of the cryostat vessel body.
- 144 strain gauge (SG) half bridges, to measure the axial strain/stress of the 36 GS legs of the TF magnet. On each GS leg there are four half bridges, each made of two 350 ohm film strain gauges, for a total of 288 strain gauges elements.
- An integrated acquisition system, capable of recording the signals from the sensors with a frequency of at least 10 kHz (strain gauges) and 100 Hz (potentiometers), and capable of working continuously, to monitor and record unexpected events 24 hours a day,
- All the cabling and installation materials, required to connect the sensors with the acquisition system, including electrical vacuum feedthroughs, port stubs and port flanges.

F4E took also the responsibility of installing the instrumentation and routing all cables to the data acquisition station (DAS). QST has the responsibility for transferring the data into the JT-60SA data server and control system.

The commissioning and confirmation of the appropriate functioning of the mechanical monitoring system from the SGs and displacement sensors were performed during TF coil energisation tests in 2 March 2021. The next picture shows a comparison between the measured average radial displacement of the TF coil and the square of the TF coil current. The two curves follow the same behaviour, and the maximum radial displacement is close (slightly smaller) than the expected value from analytical calculation.



Monitoring of the radial displacement of the TF coils at the equatorial plane with respect to the TF coil current

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News

PA for massive gas injection system

The Procurement Arrangement (PA) for the Supply of the Massive Gas Injection System (MGI) system was signed between QST and F4E in May 2021. The design of the system, followed by the procurement, assembly and testing of the hardware, will be carried out under the responsibility of the Max-Planck-Institute for Plasma Physics (IPP) in Germany. The system will be installed in the JT-60SA tokamak as a tool for plasma disruption mitigation experiments, which is considered a high priority both for JT-60SA and for future tokamaks, because uncontrolled disruption events can cause significant damage to the machine.

The system is based on a similar installation on the ASDEX Upgrade machine (at IPP), which has been scaled up to the required size for JT-60SA. The system includes two MGI valves, both mounted behind the upper oblique stabilising plates (Figure 1), one in port section P09, the other in port section P18. A gas preparation station (Figure 2), complete with mixing valves, safety valves and a suitable air supply, will be located remotely, below the torus hall. The system will be controlled by a programmable logic controller (PLC), which will communicate with the tokamak control and data acquisition system.

Most of the work on the system to date has been on the preparation of the design and the associated paperwork for the approval of the system in accordance with the High Pressure Gas Law in Japan. Finite-element analysis has been completed by IPP demonstrating that the design is sound, and many discussions have been held between QST and Ibaraki Prefecture, the culmination of which is a design file, which has recently been submitted for formal approval by the prefecture. Approval for the system is expected in October 2021, after which the procurement and assembly can proceed.

It is expected that the hardware will be delivered to Naka in the second half of 2022.

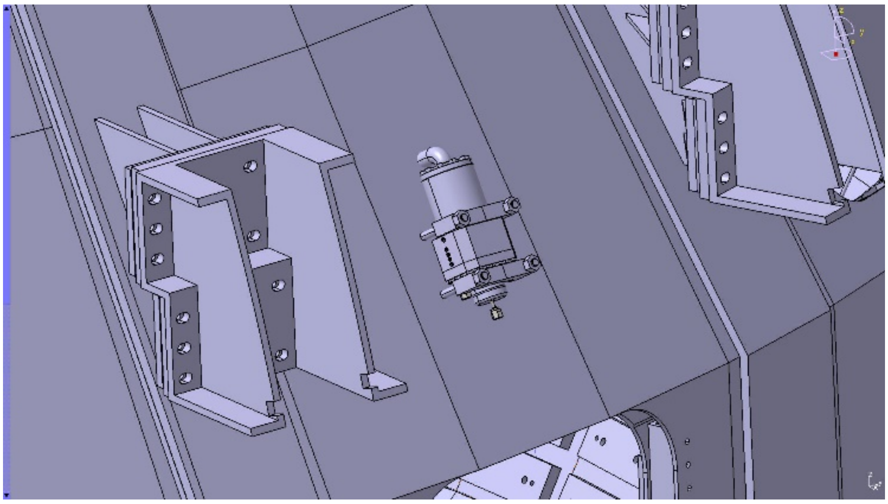


Figure 1: MGI valve mounted behind the stabilising plate

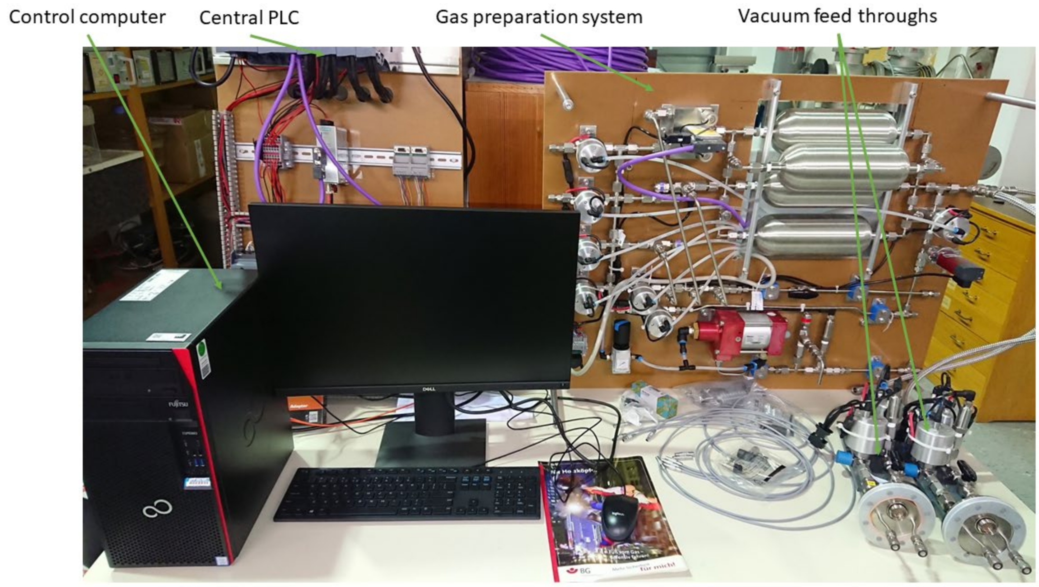


Figure 2: Current lab setup of the JT-60SA MGI system

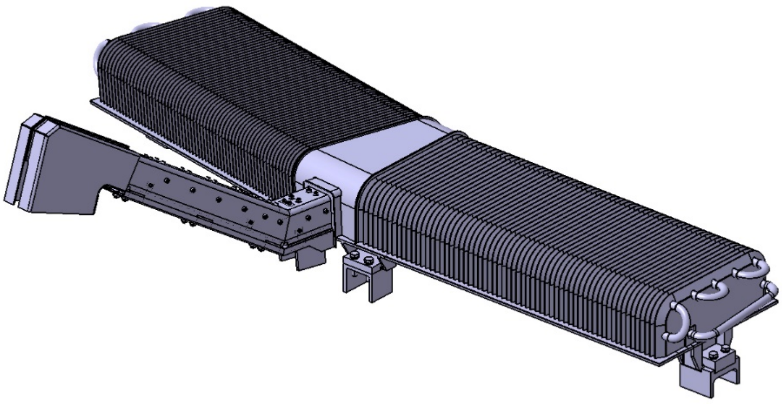
News

Progress in construction of divertor cryopumps

During JT-60SA plasma operation, some fuel gas is continuously exhausted by diverting the edge plasma to the divertor cassettes. There, the hot ionised particles are neutralized, cooled down, and pumped off by cryopumps.

F4E, with support from the Karlsruhe Institute of Technology (KIT) under a EUROfusion grant, will provide nine divertor cryopumps and one spare, to be installed during the maintenance enhancement phase I. The cryopumps are mounted inside the vacuum vessel (VV) underneath the divertor cassettes. Each pump unit (Figure) is composed of four charcoal-coated steel panels, enclosed by two cold base plates and two chevron type radiation baffles to reduce the heat input from the hot divertor and the VV. While the baffles are maintained at about 80 K by helium gas, the panels are cooled by supercritical helium at a temperature of 3.7 K. At such low temperatures, the charcoal adsorbs the gas particles, including helium very efficiently. In order to release the adsorbed gases again from the panels after plasma operation, they will be regenerated overnight at elevated temperatures of about 100 K. Regeneration is assisted by electrical heaters and monitored by temperature sensors.

The baffles must be transparent to the gas particles but block thermal heat radiation and 110 GHz stray radiation from the electron cyclotron resonance (ECR) heating. For this reason, the baffles will be blackened by a special absorbing layer (see below).



CAD model of one divertor cryopump unit with shielded coolant connections

In order to fit into the limited space between the VV and the divertor cassettes, the divertor cryopumps are extremely compact. KIT provided the preliminary design and performed the necessary structural and thermal analyses to issue the technical specification. The cryopanels and the base plate are actively cooled components, the cooling channels of which are made by hydroforming at high pressure. Blackening of the baffles is achieved by a plasma spraying technique using a powder mixture of aluminium oxide and titanium oxide. Qualification of the coating and blackening processes benefit from similar techniques used for the ITER cryopumps.

As part of the Procurement Arrangement with QST, F4E launched a European Call for Tender, ultimately awarding the manufacturing contract to Research Instruments (RI), Germany, in January 2021. RI has developed the design, adapting it to their tooling capabilities such that it is now suitable for manufacture. During weekly meetings, F4E and KIT closely follow the progress and agree on manufacturing aspects and all interfaces with the supplier and with QST. The supports between the VV and the divertor cryopumps, which need to be installed in advance, are ready for delivery to QST, in agreement with the schedule.

News

PA signed for tokamak device upgrade components

Port flanges, extentions of the common stage, and ports and boundary boxes, will be installed to upgrade the JT-60SA tokamak device to increase the capacity of the device performance. Implementation of this Procurement Arrangement (PA) started in 20 July 2021 and will be completed by 31 December 2024.

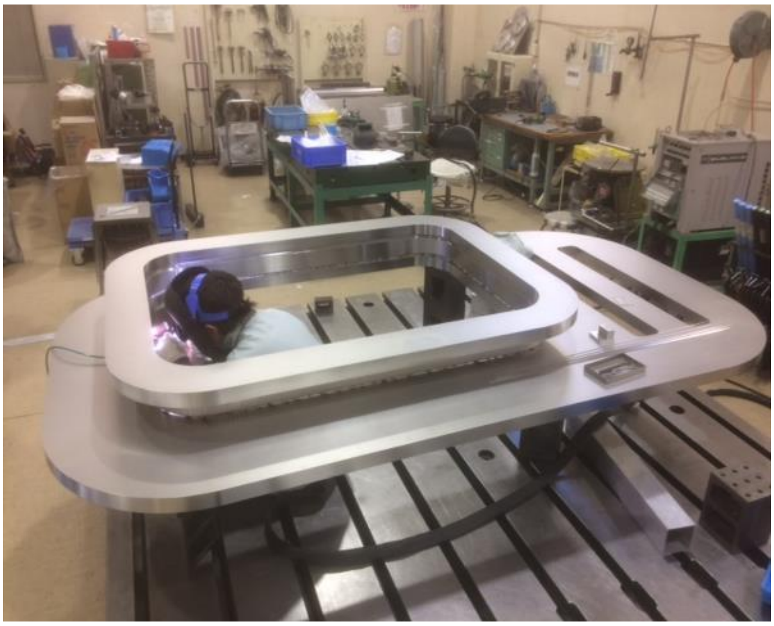
Two types of port flanges will be manufactured: conversion flanges (for port sections P-02, P-06, P-08 and P-09) and local closure flanges (for P-02, P-08 #1, P-08 #2 and P-09). Manufacturing will be carried out by Komiyama Electron Corp.

The upper stage and extended regions of the P05 and P10 common stage will be manufactured with the type 304 stainless steel, and assembled with antirust treatment high tension bolts. Interface plates will be installed between the stage floor and each equipment item. Manufacturing will be carried out by the NAT Corporation.

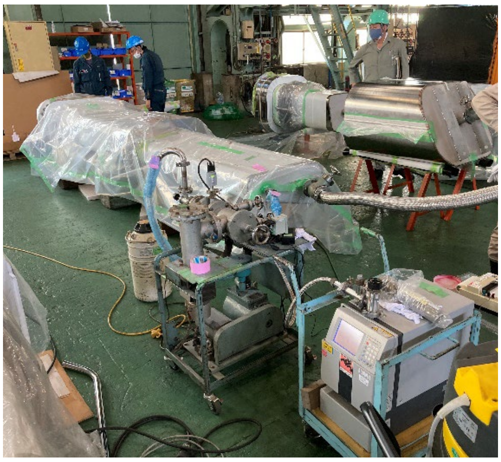
There are 55 port penetrations out of 73 bores to the inside vacuum vessel (VV). The upper and lower vertical port bores located in odd sectors, totalling 18 ports, will be utilised for the penetrations of the plasma diagnostics, heating device, etc. 28 port penetrations have already been installed and the remaining 27 port penetrations will be manufactured by this PA. The vacuum boundary box structures will be installed along with the cooling water pipes for divertors and the first wall, and will be manufactured by this PA. Manufacturing will be carried out by Kimura Chemical plants Co., Ltd.

Preparation work for the port installation, such as removal of the closure plates and flanges, and manholes, will also be performed by this PA. The work will be carried out by Kurihalant Co., Ltd.

It is expected that all of the components will be delivered to QST by the end of November 2023.



Conversion flange P02 under manufacture at Komiyama Electron Corp



Upper vertical port of the VV side welded to bellows

Upper vertical port assembled with extended structure to the cryostat, being leak-tested with helium

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Meeting

36th Technical Coordination Meeting via videoconference

TCM-36 via videoconference

The 36th Technical Coordination Meeting (TCM-36) of experts from Europe and Japan was held by videoconference on 23–25 June 2021. A total of 107 experts attended the meeting: 45 from the European Home Team (HT) and Institute, 46 from the Japanese HT and Institute, 11 from the ITER Organization and 5 from the Project Team.

At the beginning of the plenary session, M. Hanada, Project Leader (PL), presented an opening talk as an introduction to TCM-36. The PL expressed his thanks to all the participants, especially from the ITER Organization. He explained the progress in the overall schedule towards the restart of the Integrated Commissioning (IC). S. Ide, Japanese Deputy Project Manager, presented a summary of the first operation phase of JT-60SA. Cool-down of the superconducting coils and others in the cryostat had been completed, and the transition into the superconducting state was confirmed for all the coils. Coil energisation tests took place and electron cyclotron range of frequency (ECRF) plasma at 2.25 T (toroidal field (TF) current of 25.7 kA) was successfully produced. However, as S. Moriyama reported, an "equilibrium field (EF)1 incident" then occurred. The root cause of the EF1 incident was due to insufficient insulation at the quench detection wire conductor exit and the use of inappropriate material for the insulation sheath of the quench detection wire. Quality management had failed to spot the inappropriate insulation either by checking documents or visual inspection.

In the meeting, preparations towards the restart of the Integrated Commissioning (IC) and improvements following the EF1 incident were presented, including the plan and schedule for inspection, repair and testing. Also, the present status and plans were reported for the tokamak device, cryoplant and magnet system, power supply system, diagnostics system, control system and data access. The replacement plan for data analysis and the experiment database servers was also introduced.

Despite the enforced delay in operation, planned enhancements could still proceed with their procurement, and in some cases installation could be carried out during the present outage, saving time later. Machine enhancement items were presented including in-vessel components (resistive wall mode control coil, first wall and heat sink, water cooling pipes, beam protection plate, divertor cassettes, upper first wall, divertor cryopump and pellet launching system), heating and current drive systems (ECRF system, ECRF waveguides and neutral beam injector (NBI)), power supply systems (resistive wall mode control coil, power supply, error field control coil power supply, 1st and 2nd ECRF power supply) and diagnostic systems (such as Thomson scattering and the VUV divertor spectrometer). Further enhancement hardware was also explained for the actively cooled divertor, phase contrast imaging (PCI), fast ion loss detector (FILD), fast ion D alpha (FIDA) detector, X-ray imaging crystal spectrometer (XICS) and Doppler reflectometry and possible new diagnostics.

The configuration control models, Plant Integration Document (PID) updating status, and updates of the action list were reported and summarised.

Finally, the PL announced that the next TCM (TCM-37) would be held in December 2021.

Meeting

30th STP Project Committee Meeting

Discussions during 30th STP Committee Meeting

The 30th Meeting of the Satellite Tokamak Programme Project Committee (STP-PC) was held on 15 October 2021. A total of 24 participants joined the meeting by videoconference. There were 6 members from the Project Committee, the Project Leader (PL), 6 experts from the Project Team, and 11 experts from the European and Japanese Home Teams (HTs).

In this meeting the PL, the European Project Manager and the Japanese Deputy Project Manager (DPM), reported on the progress of the STP project and the equilibrium field (EF) 1 incident.

The STP-PC expressed satisfaction with preparation and improvement for the restart of Integrated Commissioning (IC) as well as the achievements and the progress in both European and Japanese procurements since the last STP-PC Meeting. These include the progress of repair work of feeder joint insulation, reinforcement of insulation of high temperature superconductor current leads (HTS CL) and replacement of insulated quench detection (QD) wires, and repair of the damaged AC grounding switch in the EF1 base power supply. The STP-PC appreciated the completion of the Procurement Arrangements (PA) for the Resistive Wall Mode Control Coil Power Supply System, for External personnel for JT-60SA operation and maintenance in FY 2020 and for Installation and commissioning of the Displacement and Stress Monitoring System for the JT-60SA TF coils.

The STP-PC took note of the report by the Japanese DPM on the coil-feeder system insulation enhancement, and expressed satisfaction with clarifying the causes of the EF1 incident and necessary repairs to prevent reoccurrence of a similar incident. The STP-PC took note of the risk mitigation actions described for the specific issue of the central solenoid (CS) feeder and QD wires, and encouraged these activities to continue. The STP-PC commended the strenuous and continuous efforts of the Japanese HT for the on-site repair work to meet the restart of the IC and the continuous commitment of the European HT in support.

The STP-PC recommended the “Update of Project Plan” and “Work Programme 2022” for approval by the Broader Approach Steering Committee (BASC). The STP-PC took note of the schedule on the restart of the IC in February 2022 to be continued up to the end of September 2022, when the remaining coil energisation tests and plasma operation would be implemented.

The STP-PC decided that the next STP-PC meeting (PC-31) would be held on 15 March 2022.

Calendar

1-3 December 2021
37th Technical Coordination Meeting (TCM-37)
Videoconference

12−16 December 2021
Pulsed Power Conference & Symposium on Fusion Engineering (2021 PPC & SOFE)
CO, USA

16 December 2021
28th Meeting of the BA Steering Committee (SC-28)
Padua, Italy

15 March 2022
31st Meeting of the STP Project Committee (PC-31)
Naka, Japan

17–22 April 2022
15th International Symposium on Fusion Nuclear Technology (ISFNT-15)
Hefei, China

Contact Us

The JT-60 Newsletter is released by the JT-60SA Project Team.

Suggestions and comments are welcome and can be sent to newsletter@jt60sa.org.