



IAEA FEC 2014

Contribution ID: 710

Type: Oral

Summary of the Test Results of ITER Conductors in SULTAN & Research, Development and Production of ITER Toroidal Field Conductors and Poloidal Field Cables in Russia

Monday 13 October 2014 17:40 (20 minutes)

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After completing the qualification tests of the ITER cable-in-conduit conductors (CICC), the series manufacture tests are running in the SULTAN test facility in Villigen, Switzerland, with target completion date in 2015. The key test for the conductor samples is the current sharing temperature, T_{cs} , at the nominal operating field and current, i.e. the maximum temperature at which the conductors operate before developing an electric field of $10 \mu\text{V/m}$. All the TF samples fulfilled the ITER requirement of $T_{cs} \geq 5.8 \text{ K}$ after 1000 load cycles. The T_{cs} results have a broad scattering among the suppliers, from 5.8 K up to 6.6 K.

The assembly of the Nb₃Sn based CICC samples (for TF and CS coils) is carried out at CRPP. The NbTi CICC samples (for PF, CC and bus bars) are assembled at the suppliers, with a U-bend replacing the bottom joint. The poor performance of some Main Busbar (MB) conductor samples, caused by poor sample assembly, triggered the effort to assemble a MB sample at CRPP with solder filled terminations and a bottom joint. The superior test results of the MB-CRPP sample, closely matching the performance assessment carried out using 3-D field distribution and n-index behaviour was a successful achievement of the last year of operation.

According to the Procurement Arrangement for the ITER coils, the winding companies must qualify the joint and termination manufacture by SULTAN samples. The first joint sample tested in SULTAN was a TF joint from EU, followed by a Correction Coil (CC) joint sample from China. Other joint samples are being assembled in USA (Central Solenoid), in Russia (PF1) and in China (PF6).

All the ITER coils use the "twin box" design for joints, except the Central Solenoid. At the first test in SULTAN of a twin-box TF joint sample in 2013, an unexpected resistance increase was observed after an accidental dump of the SULTAN field, causing a large field transient parallel to the joint contact surface, with large eddy currents and electromagnetic loads at the pressure-contact between strand bundle and copper plate of the twin box. The resistance requirement for the TF joint was still fulfilled after the dump. The impact of transient field on resistance and stability was investigated at an additional test campaign of the TF joint sample, with intentional dumps of the SULTAN field.

B

Russian Federation is the initiator and active participant in development and building of International Thermonuclear Experimental Reactor –ITER. The major element of ITER is its huge superconducting magnet. Special superconducting cables and conductors had to be developed to satisfy very strict demands for such conductors. A lot of Research and Development (R&D) works have been performed in Russia to create our own production of superconductors, cables and conductors. Russian Scientific R&D Cable Institute (known by Russian abbreviation as VNIIEP) has been participating in ITER project since 1993 both at the early stage of R&D and at the following stage of Engineering Design Activity (EDA). Tests of several short samples at Sultan test facility were crowned by successful testing of Toroidal Field (TF) and Poloidal Field (PF) insert coils performed in Japan in 2001 and 2008 correspondingly. After many R&D works now VNIIEP is actively implementing the final production and delivery stage of cables and conductors. By 2009 the new and modern technological complex has been accomplished to produce PF cables for both the Russian Federation (RF) and European parts and TF conductors for RF part. The complex includes several productions such as chemical technology line, cabling facility and jacketing line. In this review we present a short history of VNIIEP par-

ticipation in ITER and our current achievements, including some R&D results. The technology used and our production line are described in some details.

Country or International Organisation

Switzerland & Russian Federation

Paper Number

FIP/3-6Ra & FIP/3-6Rb

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Session Classification: ITER Technology