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**PF1 COIL MANUFACTURING, TESTING AND SUPPLY FOR THE ITER PROJECT <sup>\*)</sup>**<sup>1</sup>Ustinov A.L., <sup>2</sup>Bursikov A.S., <sup>3</sup>Vadaturskiy V.V., <sup>2</sup>Mednikov A.A., <sup>1</sup>Krasilnikov A.V.,  
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The ITER superconducting electromagnet system (EMS) consists of the Central Solenoid, 18 Toroidal Field (TF), 6 Poloidal Field (PF) and 18 Correction Coils. The design and approaches to the manufacture of the PF coils were developed by the ITER Organization (IO). Winding was produced from Nb-Ti cable-in conduit conductors with circulation cooling. The power jacket of the square conductors was made of 316LN austenitic stainless steel. The PF2 – PF5 coils were manufactured and supplied by the ITER European Domestic Agency (F4E). For their manufacture the B55 Building with a set of manufacturing equipment was constructed on the ITER construction site in France. The PF6 coil was produced in China.

The Russian Federation was responsible for manufacturing and supply of the PF1 coil. The Procurement Arrangement with the IO was signed in March of 2011. The quality requirements included the qualification of used materials, procedures and personnel supported by manufacturing and testing of a large number of samples and mock-ups, as well as the tests of critical units and PF1 coil assembly. Along with the non-destructive examination methods such as ultrasonic, X-ray, leak tightness tests, etc., the destructive examination techniques were applied for the qualification samples of the welded joints and insulation after vacuum-pressure impregnation (VPI).

The PF1 coil consists of 8 double pancakes produced by two-in-hand winding [1]. Each pancake includes 2 winding lengths of the winding superconductor 400 m each. 16 lengths were used in total. For the integrated procedure qualification, the pancake sample was manufactured from the conductors with copper wire cables. The conductors were produced by the cooperative efforts of Russian and European companies.

The helium inlets were welded in the middle of each winding length for the cryogenic support of the coil. The multilayer turn insulation of the pancakes made from fiberglass and polyimide tapes was applied during the winding. The pancake winding and insulation were carried out in a class-8 clean room. The pancake insulation was reinforced by the VPI with hot-setting epoxy resin. The impregnated pancakes were stacked and sandwiched with the fiberglass layers. The multilayer ground insulation from glass tape was applied on the pancake stack. To join into the winding, the pancake inlets were equipped with the end structures – boxes with covers made from copper-stainless steel bimetal plate. The stripped terminals of the superconducting cables of each pancake were sealed into the boxes and formed the semi-contacts which leak tightness was provided by welding of the covers. The helium cooling circuit pipes were hermetically welded in the boxes. The semi-contacts of the adjacent pancakes were integrated in low-resistance electrical contacts. The PF1 coil comprises in total 8 inner-pancake and 7 outer-pancake electrical contacts as well as 2 terminal semi-contacts for the connection to supply feeders. The inlet and outlet helium pipes of the contacts through the high-voltage breaks were integrated in inlet and outlet manifolds. The ground insulation of the PF1 winding was reinforced by the VPI with hot-setting epoxy resin. The high-voltage strength of the winding was qualified using the Paschen curve tests.

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**References**

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- [2]. Yury Ilin et al., Completion and Factory Acceptance Test of ITER PF1 Coil – MT-28 conference

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<sup>\*)</sup> [abstracts of this report in Russian](#)