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ITER ENCHANCED HEAT-FLUX FIRST WALL PANEL: CURRENT STATUS OF PROJECT AND PLANS *)

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The long cycle of manufacturing and testing of the full-scale prototype of the ITER Enchanced heat-flux First wall panel (FWP) was successfully completed. To achieve this result, a long way was covered from research experiments on small mock-ups, development and qualification of critical manufacturing technologies, design justification and, finally, manufacturing and testing of the full-scale prototype.

The Procurement Agreement signed between the ITER International Organization (IO) and the ITER Domestic Agency of the Russian Federation provides for the manufacture and delivery of 179 Enchanced heat-flux FWPs, which are among the most energy-intensive systems of the reactor. Completion of the full-scale prototype testing is one of the final steps to obtain permission to start manufacture the ITER FWPs.

The design of the FWP supplied by the Russian Federation has about 30 modifications (depending on the position of the panel in the reactor) and consists of a set of plasma-facing units (fingers) mounted on a supporting structure. The fingers are the most energy-intensive elements, have a multilayer composition of dissimilar metals, an advanced cooling system and provide a plasma-wall interface. The FWP design was verified by calculation methods and confirmed by experiments during development. In particular, the mock-ups with beryllium armour withstood 30,000 cycles of heat-flux tests with a surface thermal load at 4.7 MW/m^2 of absorbed power density, which is a record result.

All 40 fingers of the prototype successfully passed hydraulic tests with a water pressure of 7 MPa and vacuum tests with leak tightness control at a helium pressure of 4 MPa. 12 fingers successfully withstood 1000 cycles at 4.7 MW/m^2, which fully complies with the IO requirements. The full-scale prototype successfully passed acceptance hydraulic and vacuum tests. Hydraulic tests included tests at a pressure of 7 MPa with a holding time of 30 minutes, as well as tests in a flow mode with flow rate control in all parallel channels using the ultrasonic flow measurement method. The final stage - hot vacuum tests - consisted of cyclic loading of the prototype with helium pressure up to 4 MPa at room and elevated (250 ºC) temperatures. Deep outgassing and the use of non-evaporable gas hydrogen getters made it possible to ensure a background helium level of no worse than 10^{-11} Pa×m^3/s at 250 ºC and very high sensitivity in leak testing. Based on the results of the full-scale prototype program, a report was sent to the IO.

Before the completion of the full-scale prototype program, procedures for the delivery of raw materials for the manufacture of "serial" elements of the FWPs, as well as the manufacture of some semi-finished elements, have begun. Technological prototyping of the most complex units of various modifications of the FWP modules is underway.

The intention of the IO to change the FWP armour material from beryllium to tungsten forced an analysis of the suitability of the technologies developed for the FWP in the event of such a decision. The results of the analysis and the conducted initiative experimental work were positive and extremely encouraging and demonstrate the flexibility and high level of developments of JSC NIIEFA.

*) abstracts of this report in Russian