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Progress of Qualification Testing for Full-Scale Plasma-Facing Unit Prototype of Full Tungsten ITER Divertor in Japan

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R&Ds for starting operation with a full- tungsten (W) ITER (INB-174) divertor have been enhanced by recommendation of the ITER council since 2011. Japan Atomic Energy Agency (JAEA) as Japanese Domestic Agency (JADA) and the ITER organization (IO) have been actively working on the development and demonstration on the full-W ITER divertor under the framework of the task agreement. JAEA is in charge of technology development and demonstration for manufacturing the Outer Vertical Target (OVT) together with Japanese industries. In 2013, as the first phase of the qualification program, JAEA demonstrated the armour heat sink bonding technology with small-scale mock-ups. A high heat flux (HHF) testing for the mock-ups was carried out in the ITER divertor test facility in Efremov Institute, Russia. JAEA succeeded in demonstrating the durability of the W monoblock joint to the Cu-alloy cooling tube against the heat load of 10 MW/m2 × 5000 cycles and 20 MW/m2 × 1000 cycles which are three times higher than a requirement (300 cycles). This result provided one of sufficient materials for the decision to start with the full-W ITER divertor in the baseline. Since 2014, as the second phase, the full-scale plasma-facing unit (PFU) prototypes have been manufactured to demonstrate the scale-up manufactural technology.
In this paper, JAEA reports progress of R&Ds on the full-scale PFU prototypes of a full- W ITER Divertor OVT. Under a framework of a W divertor qualification program, JAEA manufactured 7 full-scale PFUs as prototypes. Through the manufacturing, (i) all joint surfaces in four PFUs with a casting Cu interlayer successfully passed the ultrasonic testing and (ii) the surface profile in target part of PFUs stayed within a tolerance. (iii) Moreover JAEA succeeded in demonstrating a durability for the HHF testing of the repetitive heat load of 10 MW/m2 × 5000 cycles and 20 MW/m2 × 1000 cycles under close collaboration with the IO and the Efremov Institute. These results demonstrated the ability of Japanese industries to produce the PFU of full-W ITER divertor enough to meet the technical requirements.

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