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Manufacturing of the ITER tungsten divertor – prototyping/qualification and status of series production

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Fifty four Divertor Cassette Assemblies are to be manufactured to complete the toroidal ring of the full tungsten (W) ITER divertor. The Cassette Assembly consists of Outer Vertical Targets (OVT), Inner Vertical Targets (IVT), Dome and Cassette Body [1]. Three Domestic agencies (DAs) and their suppliers are involved in the procurement. The Japanese DA is in charge of OVT manufacturing, the European DA the IVT and the Cassette Body, with the Russian DA supplying the Dome. Following a successful prototype phase, all of the principal components are now in the series production phase.

The VT Plasma-facing Units (PFU) have adopted the W monoblock concept with swirl tape in straight parts [2] whereas those of Dome, which do not need to tolerate the highest stationary heat fluxes, use the flat tile concept on a hypervapotron heat sink [3]. The PFUs are mounted on the Steel Support Structure and welded to the coolant channels. Following several years of design consolidation, the procurement phase began by the qualification of manufacturing technologies to produce full-scale prototypes, delivering, for example, 2 m long PFUs of unprecedented size. During this process, strict requirements were imposed on qualification, manufacturing and inspection. The quality of W to heat sink joint, dimensional compliance and leak tightness, are the key requirements. Technical assessment on the requirements based on experience from the prototype manufacturing has been performed in view of the process optimization, such as tolerances, manufacturing strategy in machining, attachment and welding. Series production had been started in the qualified supplier sites.

The manufactured components are to be delivered to the integration site where the Divertor Cassette Assemblies will be in the final configuration. In parallel, integration of divertor mounted diagnostics where applicable will be performed. They are to be accepted only after a series of factory acceptance tests.

On delivery to the ITER site, the Divertor Cassette Assemblies will be installed through three lower ports into the vacuum vessel (VV) by divertor cassette movers. They will be inserted radially and then transported toroidally to the final position, where the cassettes are positioned and pre-loaded on the toroidal rails. Custom machining of the toroidal rail elements ensures the alignment requirements with respect to the Tokamak Assemblies Datum allowing for as-built VV dimensions.

This contribution will provide an overview of the ITER divertor procurement progress, technological solutions and return of experience from prototype manufacturing. The current plans Divertor Cassette integration and installation in the VV will also be described.

[1] M. Merola, et al., "Engineering challenges and development of the ITER Blanket System and Divertor" Fusion Eng. Des. 96–97, 2015, 34-41.

[2] T. Hirai, et al., "ITER divertor materials and manufacturing challenges", Fusion Eng. Des. 125 (2017) 250–255.

[3] T. Hirai, et al., "Hypervapotron Heat Sinks in ITER Plasma-Facing Components –Process Qualifications and Production Control toward Series Production"Fusion Eng. Des. 187 (2023) 113454 (6 pp).

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