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How Tokamak Interface Requirements are Driving the Design of TBM Systems in ITER towards Breeding Blanket Design in DEMO

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The Test Blanket Module (TBM) Program in ITER provides breeder units and related systems with all relevant technologies to test and validate design concepts of tritium breeding blankets for a power-producing reactor, specifically DEMO. Three ports are allocated to the ITER Members (IM's) participating to the TBM Program and 6 Test Blanket Systems (TBS) are going to be installed and tested during ITER plasma operational phase. The port #16 has been assigned to the European IM hosting two types of TBM: a Helium Cooled Lithium-Lead and a Helium Cooled Pebble-Bed. Each of them belongs to the corresponding TBS which includes as well its own He cooling and Tritium extraction/recovery systems. The TBS concern energy relevant systems in terms of thermodynamic and Tritium fuel cycles and they qualify not only the TBM Program, but ensure also the fulfilment and completeness of the scientific mission of the ITER Project itself in view of the next generation of fusion reactors. The paper, taking into account the return of experience (RoX) gained in developing the two EU TBS, summarises and discusses how, for the first time out of a mock-up based laboratory scale testing, the integration aspects and requirements impact and drive the design and the construction of this type of energy (power-production) systems in view of DEMO. Technological and fabrication solutions adopted for the EU TBS and their integration in ITER with more than 25 ITER interfacing systems implied a RoX gained on requirement management related to regulatory and licensing processes (TBS are under ESP/ESPN). Safety demonstration strategy, radioprotection and radwaste requirements are discussed on a system engineering basis, highlighting what applicable to DEMO. This effort is a key part of the scientific mission of the TBM Program in ITER, providing to DEMO the maximum information on the TBS as technological objects operating in a real fusion reactor environment. The activity includes the RoX of the design, construction, installation, commissioning, operation, inspection and post-test analyses, covering the complete consultation cycle with an Agreed Notified Body and license oversight and endorsement by the French Nuclear Regulator. The integration of the safety demonstration for relevant tritium breeding blankets in DEMO is a key milestone along the pathway toward the future fusion power plant reactor.

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Author: Dr FERRARI, Marco (Fusion for Energy)

Co-authors: Dr VAN DER LAAN, Jaap (IO Organization); Dr BOCCACCINI, Lorenzo Virgilio (EUROfusion, Karlsruhe Institute of Technology); Dr GIANCARLI, Luciano (IO Organization); Dr POITEVIN, Yves (Fusion for

Energy)

Presenter: Dr FERRARI, Marco (Fusion for Energy)

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