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Overview of the DEMO Design-Staged Approach in Europe

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This paper describes the status of the DEMO design activities performed in Europe and discusses the impact of some of the key requirements (such as electrical output, tritium self-sufficiency), the main constraints (e.g., those deriving from the tokamak-side and the Balance-of-Plant (BoP) / Power Conversion System (PCS)) on the systems design solutions and on the overall plant architecture. The paper focuses on the main DEMO technical / design integration issues, e.g., those where there are either gaps with ITER because of the inherent differences in the design approach and / or technologies adopted (e.g., protection of the first wall, possibly divertor configuration, tritium-fuel cycle, etc.), or because of the difference of plant requirements (e.g., tritium-breeding and extraction, thermal power extraction and conversion to electricity, remote maintenance schemes for high plant availability). The design of the breeding blanket and the selection of its coolant are examples that bear a strong impact on integration, maintenance, and safety because of the interfaces with all key nuclear systems (e.g., the BoP and PCS, tritium recovery and purification systems, etc.).
Work continues to be focused on the design of a pulsed baseline DEMO plant concept that integrates all the major DEMO sub-systems to understand integration risks and resolve design interface issues. Considerations are also given to a design based on latter-stage ITER scenario and able to operate in a short pulse mode (e.g., 1 hr) for nominal extrapolated performance (H98=1.0) and capable of moving to steady-state operation while maintaining the same fusion power and net electrical production in the case of a better confinement being feasible. However, this option requires a much higher confidence in physics extrapolation and highly reliable and efficient current-drive and control systems, which need to be deployed by day-1 and still need to be developed. The definition and analysis of the physics scenarios for the concept design and identification of the physics basis development needs are described elsewhere.
Incorporating lessons learned from the ITER design and construction, building of relationships with industry and embedding industry experience in the design are needed to ensure early attention is given to industrial feasibility, costs, nuclear safety and licensing aspects.

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