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Progresses at CEA on EU DEMO reactor cryomagnetic system design activities and associated R&D

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The EU DEMO reactor is expected to be among the first applications of fusion for electricity generation in the near future and the design of its magnet system is of central importance as driving power plant performance, budget and production efficiency. In this purpose activities were led by CEA in the framework of EUROfusion to contribute to the EU DEMO magnet system design. It encompassed design activities (dimensioning and development of associated modelling tools) with R&D (design and tests of mock-ups).
The CEA design activity was mainly oriented towards Toroidal Field (TF) coils system to propose a conceptual option (pancake-wound, no radial plates) established with a semi-analytical CEA tool that considers the inter-dependent electromagnetic and mechanical behaviors. Then the proposed design is consolidated by detailed analyses:
- Thermo-hydraulics evaluation by coupling THEA, TRAPS and CAST3M softwares respectively for thermo-hydraulics, electromagnetic and thermal items. The outcomes obtained in normal and off-normal regimes are exposed and discussed in the paper.
- Mechanics evaluation with the most stressed zones identified and their criticity evaluated, in particular in the insulation zones. Design optimization is conducted on jacket corner radii and shape of the TF structures (casing and OIS). Finally analyses are led on the thermo-mechanic hotspot criterion.
Further to the TF system, the Poloidal Field (PF) coils and the Central Solenoid (CS) design were addressed by the same methodology, the outcomes will be expose and discussed.
Besides design activities, TF is also studied through manufacturing considerations with organization of the winding stations manufacturing.
The DEMO cryoplant design was also addressed considering the loads to be absorbed and its process structure. The CEA proposal and the factors of merit considered will be presented and discussed.
On another side, CEA also conducted R&D activities, mostly regarding the TF system with:
- Hydraulic tests at variable void fraction to explore its impact on helium friction.
- A full-scale TF conductor sample design and manufacture. The activity also included non-destructive examinations by tomography.
Finally perspectives will be discussed regarding dimensioning with tools developed at CEA and the R&D activities to be extended.

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