IFERC Newsletter

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Status of DEMO Design Activity

Highlights on Safety Studies

Task 5, which is carried out to ensure the safety of fusion JA&EU DEMO reactors, is composed of five sub-task activities; (Task 5-1) Radioactive Source Terms (RST) and energies, (Task 5-2) Initial events and accidental sequences, (Task 5-3) Mitigation systems for reference accident sequences, (Task 5-4) Waste characterization and management strategy, and (Task 5-5) Assessment of licensing constraints. Activities and achievements in 2022 are described below.

In Task 5-1, the source terms of DEMOs have been updated and comparative studies are ongoing. The PDP (Plasma-Driven Permeation) experiments of H/D mixed plasma was organized for the evaluation of the tritium retention in JA, and it was found that the diffusion coefficient in the W sample irradiated with iron ions (Fe2+) and neutrons was smaller than in the non-irradiated sample. For the Radioactive source terms and toxic materials, a working group in EU is reviewing all the work done, particularly for the tritium inventory map and for in-VV (Vacuum Vessel) dust in order to define the R&D necessary to narrow down the uncertainties of such inventories.

Regarding Task 5-2, an assessment of the impact of the PIEs (Postulated Initiating Events) on the environment was performed to consider the safety system for DEMOs. In JA, the vapor leakage to environment from ECH guard pipes was evaluated during in-VV LOCA (Loss Of Coolant Accident). The early dose was found to have a smaller effect than the dose target set for normal operation. In EU, many activities have been performed regarding safety analyses for DBA (Design Basis Accident) and DEC (Design Extension Conditions) scenarios and code qualifications. Fig-1 shows an example of the accident analyses.

As to Task 5-4, volume reduction of radioactive waste generated from the DEMOs was examined. In JA DEMO, a strategy for reducing the radwaste generated by the replacement of IVCs (In Vessel Components) was considered, and it was found that radwaste could be reduced to 60 % when a back-plate and divertor cassette with low neutron irradiation are reused and the T breeding materials are recycled as shown in Fig-2.

Safety regulations of existing facilities were analyzed in preparation for safety regulations for the DEMOs in Task 5-5. In JA, the safety regulatory framework related to the TRF (Tritium Removal Facility) at the CANDU reactor in Canada and JET in the UK was analyzed for the development of the proposed fusion reactor regulation in Japan. In the EU side, in the framework of developing a future Fusion Power Plant (FPP) including the step of a DEMO project, the Chair of the EUROfusion General Assembly proposed to set up a working group involving several nuclear safety experts in the fusion and fission fields to draw the principles of development of a new regulation tailored to the safety challenges of a fusion facility. Recommendations from the working group are being drafted.

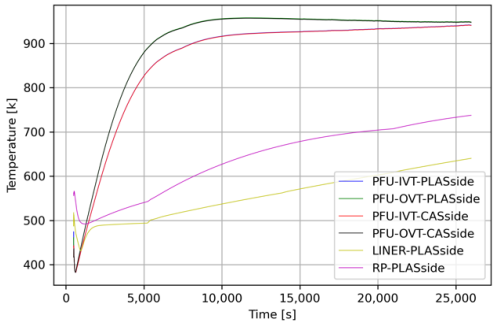

Fig-1: Divertor temperature transients following in-vessel LOCAs in the cassette and in the target – DEC accident (PFU: Plasma Facing Unit, IVT (OVT): Inner (Outer) Vertical Target, etc.)

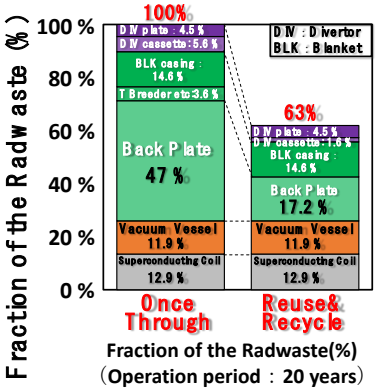

Fig-2: Effect of the volume reduction by reuse & recycle

(DEMO Design Task-5 TROs)