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Test Strategy and Infrastructure for Breeding Blanket Development at KFE

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The development of breeding blankets is critical for the realization of fusion energy, as they are essential in fuel production and energy generation in fusion reactors. The pre-conceptual design for the K-DEMO blanket has commenced, with the HCCP (Helium-Cooled Ceramic Pebble) blanket concept adopted as the reference design following the KO-EU HCCP TBM project, while other potential design options are being explored. To support and validate these designs, studies have been conducted to derive the strategy and infrastructure necessary for breeding blanket development in Korea.

As part of such efforts, Korea Institute of Fusion Energy (KFE) performed a pre-conceptual study of the Korea Fusion Engineering Advanced Test Complex (KFEAT) which encompasses three primary facilities: the Integrated Breeding Test Facility, the Blanket System Test Facility, and the Fuel Cycle Pilot Facility. At the core of this proposal, the Integrated Breeding Test Facility is designed to perform component-level testing of breeding blankets for validation of overall performance under DEMO-relevant irradiation time and scenarios. It is based on a 40 MeV deuteron accelerator-driven system operating at up to 10 mA, capable of generating fusion-like neutrons. This enables neutron testing of blanket breeding units, potentially at one-to-one scale.

In the meantime, with the introduction of the "Strategy for Accelerating Fusion Energy Realization"in 2024, the development of key fusion technologies, including breeding blankets, is expected to gain further momentum. In alignment with this strategy, KFE has proposed a compact pilot device that will demonstrate steady-state operation and fusion-relevant performance in an industrially scalable form. Although the design requirements and key parameters of the device are still under discussion, it is envisaged that breeding blankets will be operated from early stage to supply tritium necessary for sustaining the fusion reaction.

While the development of the compact pilot device and supporting strategies is underway, the establishment of appropriate infrastructure for the qualification of breeding blankets remains a critical challenge. In this context, discussions are ongoing regarding how the compact pilot device and facilities such as KFEAT can be strategically aligned and utilized in a complementary manner, including the possibility of using the device as a volumetric neutron source. The outcome of these discussions is expected to shape Korea's long-term fusion roadmap and guide the development of breeding blankets.

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