Proliferation-resistant, Accident-tolerant, Self-supported, Capsular Assured Reactor (PASCAR)

Il Soon Hwang, Myung Hyun Kim, Han Gyu Joo, Bong Yoo, Moo Hwan Kim, Seung Rok Oh, Kyung Woo Yi, Dong Yoon Han, Jun Lim, Hyo On Nam, Jae Hyun Cho, Keun Young Lee, Moo Hoon Bae, Sung Yeol Choi and Chang Hyo Kim

Nuclear Transmutation Energy Research Center of Korea (NUTRECK), Seoul National University

San 561-, Sillim-dong, Gwanak-gu, Seoul 151-742, Republic of Korea

hisline@snu.ac.kr

Based on PEACER (Proliferation-resistant, Environment-friendly, Accident-tolerant, Continual and Economical Reactor), a small proliferation-resistant transportable power capsules designated as PASCAR has been developed by capitalizing on outstanding natural circulation and chemically stability of lead-bismuth eutectic (LBE) coolant. PASCAR design employs an integral reactor capsule including a core of U-TRU-Zr-alloy fuel rods in open-square lattice and in-vessel steam generators with no pump. A capsule can deliver a reference thermal power of 100 MW cooled by LBE with a power conversion efficiency of 35%. The elimination of primary pump and the utilization of advanced structural materials as well as optimized hot-leg temperature self-supported for continual operations over 20 years with an initial loading of core with less 20% of fissile element concentration. The natural circulation capability leading to non-compromised accident-tolerance and the corrosion-resistance of materials to ensure up to 60 years of capsule design life are demonstrated with the help of HELIOS experiments and multi-dimensional computer simulations. To eliminate loss of coolant events, a double-wall reactor vessel has been employed, and the entire capsule is to be placed on a monolithic underground foundation through overhung supports with three dimensional seismic isolations. To cope with hypothetical core damage accidents, fully-passive and fail-safe designs are installed including double containments, buoyancy-driven second shutdown system, reactor vessel air cooling system, melting core distribution system and emergency battery power supply. At the end of its life, the core module with the inner reactor vessel will be replaced with a pristine unit while the spent module is cooled and transported to one of nearby multi-national fuel cycle centers in a lead-shielded cask for rebuilding. In addition to electricity generation, the modular power capsule can be used for local heating, hydrogen generation and desalination as well as research and demonstration of nuclear transmutation technology. Design descriptions and assessment findings on proliferation-resistance, accident-tolerance and economical viability of PASCAR as well as an integral demonstration concept with associated fuel cycle are presented.