PEACER (Seoul National University, Republic of Korea)

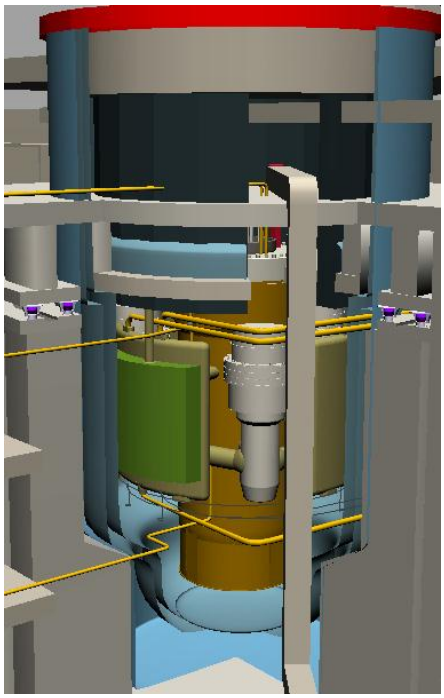

FIG. 20. 3D CAD Drawing of PEACER-300 MW(e)

Full name:	*Proliferation-resistant Environment-friendly Accident-tolerant Continuable and Economical Reactor*
Designer:	*Seoul National University*
Reactor type:	*Lead-bismuth cooled Reactor*
Electrical capacity:	*300 MWe*
Thermal capacity:	*850 MWth*
Coolant	*Pb-Bi (45-55% Wt.%) eutectic alloy*
Primary Circulation	*Forced*
System Pressure:	*0.1 MPa (primary) 8.0 MPa (secondary)*
System Temperature:	*300°C - 400 °C*
Fuel Material:	*U-TRU-Zr Alloy (58.04-31.07-10.88 Wt. %)*
Fuel Cycle:	*12 Months (Annual reload and in-house pyroprocess)*
No. of safety trains:	*1 train*
Emergency safety systems:	*Passive*
Residual heat removal systems:	*Passive*
Design Life:	*60 Years*
Design status:	*Conceptual Design*
New/Distinguishing Features:	*Reactor Vessel Air Cooling System (RVACS)*

Introduction

A group of researchers at the Seoul National University (SNU) conducted a feasibility study on accelerator-driven nuclear waste transmutation concept, in early 1990's. The Nuclear Materials Laboratory at SNU (SNUMAT) had carried out experimental investigations on Pb-Bi eutectic alloy as an alternative coolant to sodium for use in transmutation systems then under the consideration. Positive experimental verification of its stable physico-chemical properties of LBE enabled SNUMAT to initiate the development of the first dedicated transmutation fast reactor design cooled by LBE, designated in 1997 as Proliferation-resistant, Environment-friendly, Accident-tolerant, Continuable and Economical Reactors (PEACER).

The first PEACER design had a pancake-shaped fast reactor core with metallic fuels containing transuranic (TRU) elements extracted from LWR spent fuels by on-site pyrochemical partitioning processes under through multi-national controls. The upper core region of PEACER has thermalized neutrons for stabilization of long-lived fission products including technetium-99 and iodine-129. With a rated power of 550 MWe, the holt-leg coolant temperature of PEACER-550 was reduced to 400°C in order to ensure 60 year design life of structural materials including steam generator and 3 year life of fuel cladding material, even with well-known high corrosivity of LBE.

Description of the Nuclear System

The PEACER core design yields a support ratio of two (2), i.e. the amount of transuranic element (TRU) burnt in the transmutation core being twice the amount of TRU produced from a light water reactor core for the same electricity generation. The high support ratio goal could be achieved by using high diameter-to-height ratio for the PEACER core. Peripheral thermal traps are introduced to produce epithermal neutrons for the transmutation of long living fission products, including Tc-99, I-129, etc.

The second edition of PEACER was designed to have a rated power of 300 MWe. Each of three primary loops for PEACER-300 is equipped with a once-through steam generator and a centrifugal pump. Reactor inlet and outlet temperatures (300-400°C) are judiciously chosen with considerations on materials endurance, transient operability and thermal efficiency. By taking advantage of chemical stability of LBE, the balance of plant with standard superheated Rankine cycle is coupled to the primary coolant system through once-through steam generators that faciliate water flow inside tubes.

Description of the Safety Concept

Accident-tolerance requirement mandated the development of a RVACS. It is expected that RVACS will provide passive cooling capability for decay heat for PEACER-300. An innovative passive water cooling system for the reactor vessel outer wall has been introduced to allow for the system up-scaling from 300 MWe to large scale systems with passive safety. As LBE has high density, earthquake can exert severe load on structural components. Therefore seismic isolators are extensively employed for entire plant including pyrochemical partitioning facility. Three dimensional seismic isolators are applied for all the reactor systems, including the containment.

Deployment Status and Planned Schedule

PEACER has not been developed beyond the conceptual design or been built for any commercial system due to inadequate technical confidence. A scaled full-height test loop, HELIOS, has been operational since 2005 to this end. A small modular transmutation reactor named as PASCAR (Proliferation-resistant Accident-tolerant Self-supported Capsular and Assured Reactor) is being developed for demonstrating most design goals of PEACER.