CLEAR-I (INEST, China)

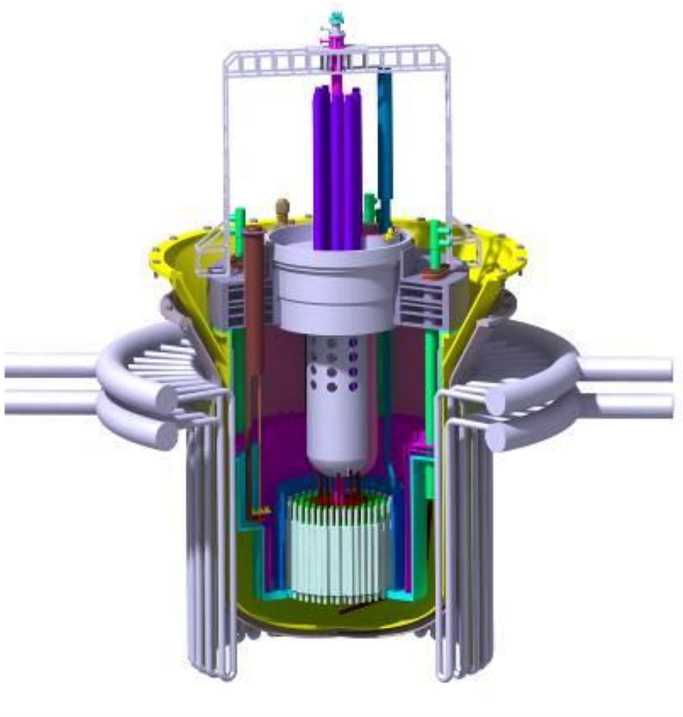

FIG. 16. View of the core of CLEAR-I

Full name:	*China LEAd-based Research Reactor*
Designer:	*Institute of Nuclear Energy Safety Technology, Chinese Academy of Sciences*
Reactor type:	*Heavy Liquid metal-cooled Reactor*
Thermal capacity:	*10 MWth*
Coolant	*Lead Bismuth Eutectic*
Primary Circulation	*Natural*
System Pressure:	*0.05 MPa*
System Temperature:	*260°C -390 °C*
Fuel Material:	*UO_2*
Fuel Cycle:	*120 Months/10 Years*
Emergency safety systems:	*Passive*
Residual heat removal systems:	*Passive*
Design Life:	*30 Years*
Design status:	*Preliminary Engineering Design*
Planned deployment/1st date of completion:	*2023*
New/Distinguishing Features:	*Dual-mode operation: Lead-bismuth cooled reactor and ADS*

Introduction

The Chinese Academy of Sciences (CAS) launched an engineering project to develop ADS system and lead-based fast reactors named China LEAd-based Reactor (CLEAR) series.

For the first phase, a 10MWth lead-bismuth cooled research reactor (CLEAR-I) will be developed by the Institute of Nuclear Energy Safety Technology (INEST).

CLEAR-I was designed to be operated at two modes: critical operation for heavy liquid metal fast reactor technology test and accelerator driven subcritical operation for ADS system.

Description of the Nuclear System

In the reference parameters design of CLEAR-I, pool-type configuration is selected, where the reactor vessel is placed inside a safety vessel. The thermal power is 10MW and no electric power is generated. Lead-bismuth (LBE) is adopted as primary coolant and UO_2 with ^{235}U enrichment 19.75% is chosen as the first loading fuel, MOX fuel is alternative. Hexagonal wrapped fuel assemblies are used in a hexagonal lattice core, which cladding material is SS316Ti and structure material is SS316L. In critical operation mode, the core consists of 76 fuel assemblies, 60 reflector assemblies and 48 shielding assemblies, while in sub-critical operation mode, a part of fuel assemblies will be replaced with reflector assemblies and the K_{eff} will be 0.98

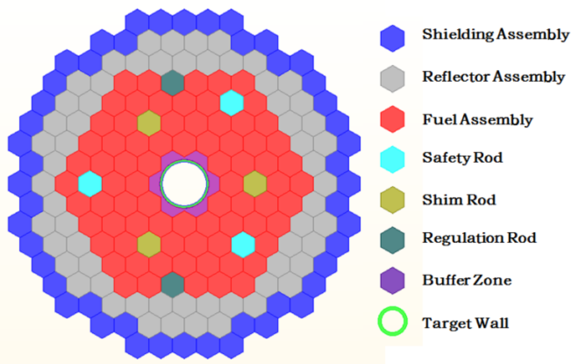

FIG. 17. Scheme of CLEAR-I core

Description of the Safety Concept

Considering the characteristic of low power density of reactor and large expansion coefficient of lead-bismuth, the primary cooling system is designed to rely on natural circulation entirely, which improves safety characteristics of the reactor. The operation temperature and coolant velocity is designed relatively low, which can reduce the corrosion-erosion effect effectively. A Reactor Vessel Air Cooling System (RVACS) is incorporated in CLEAR-I to remove the decay heat in emergency. The RVACS is designed to be consisted of tens of tubes installed outside the reactor guard vessel to cool the reactor by thermal radiation. The heat removal by the RVACS is continued by means of natural circulation of air. Double-wall containment system concept is used in the design. Main radioactive nuclides are contained and shielded by the internal containing chambers with ventilation system. The integrity of the structure was protected by the external airtight building.

Deployment Status and Planned Schedule

The conceptual designs of CLEAR-I have been performed, preliminary engineering design are underway. Multi-functional large-scaled lead-bismuth experimental loops KYLIN-II for material test, thermal-hydraulics test and safety test will be constructed before the end of 2013.

The design of pre-research platform of key reactor components including control rod drive system, refuelling mechanism and the reactor simulator has been accomplished, construction will be carried out in 2013 .The Highly Intensified D-T Neutron Generator HINEG for neutron experiment and software validation will be finished constructing by INEST about 2014.

At this point, the analysis of typical accidents and the compilation of Preliminary Safety Analysis Report are in progress. CLEAR-I will be operational around 2023.