Profile LFR-15

CLEAR-0

CHINA

GENERAL INFORMATION

NAME OF THE FACILITY	China Lead-based Zero Power Reactor
ACRONYM	CLEAR-0
COOLANT(S) OF THE FACILITY	None (solid LBE, etc.)
LOCATION (address):	China, Institute of Nuclear Energy Safety Technology, Chinese Academy of Sciences
OPERATOR	INEST
CONTACT PERSON (name, address, institute, function, telephone, email):	Chao Liu, FDS Team, No.350 Shushanhu Road, Hefei, Anhui, China, INEST, CAS, +86 551 65593681, contact@fds.org.cn;

STATUS OF THE FACILITY In operation

Start of operation (date): 2015

MAIN RESEARCH FIELD(S)

- ☑ Zero power facility for V&V and licensing purposes
- ☐ Design Basis Accidents (DBA) and Design Extended Conditions (DEC)
- ☐ Thermal-hydraulics
- ☐ Coolant chemistry
- ☐ Materials
- ☑ Systems and components
- ☑ Instrumentation & ISI&R

TECHNICAL DESCRIPTION

Description of the facility

The Chinese Academy of Sciences (CAS) launched an engineering project to develop ADS system for nuclear waste transmutation from 2011 and China LEAd-based Reactor (CLEAR) was selected as the reference reactor in CAS ADS project. In the first stage of CAS ADS project, a 10 MW lead-bismuth cooled research reactor named CLEAR-I coupled with a proton linac and heavy metal spallation target, will be designed and built.

CLEAR-I is the first lead-based reactor and ADS facility in China. In order to verify the physical design and control techniques of CLEAR-I, a zero power facility mimicking CLEAR-I, named China LEAd-based Zero Power Reactor (CLEAR-0) was designed.

CLEAR-0 was designed not only to meet the requirements of physics validation of CLEAR-I, but also with consideration of further researches on physics and control techniques. Therefore, there is quite a bit of flexibility in the structure of the cores, which comprise a lattice of standard assemblies and can simulate various cores by changing the materials loaded in standard assemblies. The container of the core is 3m in diameter and 1.65 m in height. Every standard assembly shell is hexagonal prisms structure in edge distance of 117.2 mm and height of 1.7 m. Meanwhile, it is remarkable that two reactor trip systems based on different mechanisms ensure that CLEAR-0 has excellent safety characteristics.

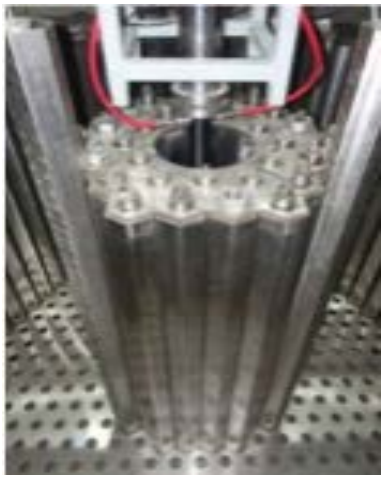
In order to perform reactor experiments also, the CLEAR-0 is coupling with an external neutron source and standard spectra reverse control modules, named neutron spectra reverse control facility. The neutron source called HINEG can provide steady D-T neutron with maximum neutron yield of 6.4 $\times 10^{12}$n/s and pulsed neutron yield of 10^{9} n/s. The external neutron source combined with control modules enable to produce specific neutron spectra, such as spectra in fusion reactor, advanced fission reactor and hybrid reactor etc.

After the construction of CLEAR-0, the first phase of experiments is for validation of CLEAR-I. The core will load UO_2 with ^{235}U enrichment of 19.75% and solid LBE. The core will be subcritical first and increase to critical step to step.

Acceptance of radioactive material

No

3D drawing/photo



Parameters table

Coolant inventory	~50 ton LBE
Power	Maximum Power is 10Wt
Test sections	
TS #1	*Characteristic dimensions* Dimensions of facility: Diameter:~5m; Height:~6m Dimensions of reactor core: Diameter:~3m; Height:~2m
	Static/dynamic experiment Experiments for development of ADS subcriticality measuring techniques (PNS, flux-to current ratio …); Subcritical Experiments for supporting license application of CLEAR-I operation in subcritical mode; Critical Experiments for supporting license application of CLEAR-I operation in critical mode.
	Temperature range in the test section (Delta T) Room temperature
	Operating pressure and design pressure Ordinary pressure
	Flow range (mass, velocity, etc.) N/C

Coolant chemistry measurement and control (active or not, measured parameters)	N/C
Instrumentation	Various nuclear detectors

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

- ✓ Sub-criticality measurement using Neutron Source Multiplication Method
- ✓ Specific neutron spectra modulation, such as fusion reactor, advanced fission reactor and hybrid reactor, etc.

PLANNED EXPERIMENTS (including time schedule)

- **2019.01-2019.12:**
  - ✓ To perform subcritical Experiment for supporting license application of CLEAR-I operation in subcritical mode
- **2020 – 2021**
  - ✓ To perform critical Experiment for supporting license application of CLEAR-I operation in critical mode

TRAINING ACTIVITIES

To be determined

REFERENCES (*specification of availability and language*)

Wu Y., Bai Y., Song Y., et al. Development strategy and conceptual design of China Lead-based Research Reactor. Annuals of Nuclear Energy, 2016, 87:511-516