ELFR (Ansaldo Nucleare, Europe/Italy)

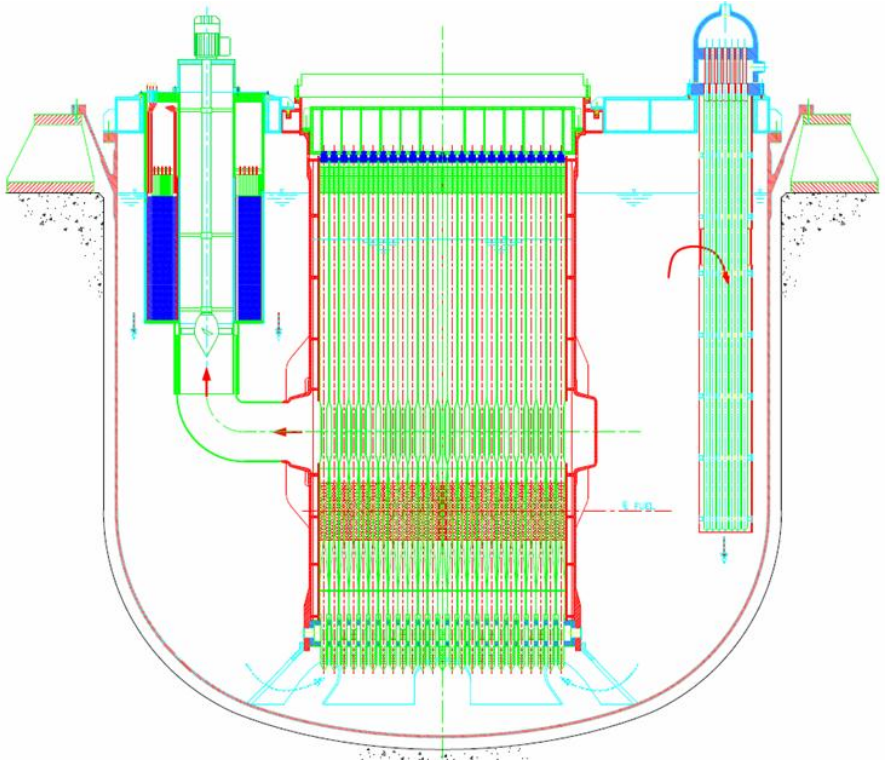

FIG. 19. ELFR primary system.

Full name:	*European Lead Fast Reactor*
Designer:	*Ansaldo Nucleare*
Reactor type:	*Lead-cooled Fast Reactor*
Electrical capacity:	*630 MWe*
Thermal capacity:	*1500 MWth*
Primary Coolant	*Lead*
Primary Circulation	*Forced*
Primary System Pressure:	*< 0.1MPa*
Primary System Temperature:	*400÷480 °C*
Secondary Coolant:	*Water/Superheated-Steam*
Secondary System Pressure:	*18 MPa*
Superheated Steam Temperature:	*450 °C*
Fuel Material:	*MOX*
Fuel Cycle /Residence time:	*30 Months /5 Years*
No. of safety trains:	*4 trains*
Emergency safety systems:	*No injection safety systems are needed*
Residual heat removal systems:	*2 DHR systems, 4 loops each - Passive*
Design Life:	*60 Years*
Design status:	*Conceptual Design*
Planned deployment/1st date of completion:	*2040 - 2050*
New/Distinguishing Features:	*First Of A Kind European LFR*

Introduction

The conceptual design of the European Lead Fast Reactor (ELFR) has been developed in the frame of the EU FP7 LEADER (Lead-cooled European Advanced Demonstration Reactor) Project. ELFR is a 1500 MWth pool system First Of A Kind (FOAK) of a future industrial size plant. The ELFR design complies with all GEN IV goals. ELFR has a closed fuel cycle (the so called adiabatic core). The nominal power is 1500 MWth and considering the net thermal efficiency of the selected superheated steam cycle the electric power capacity is about 630 MWe.

Description of the Nuclear System

The ELFR primary system is a pool-type configuration with all components removable. It presents a simple flow path and low pressure drop of the primary coolant allowing an efficient natural circulation. The primary coolant leaving from the core flows upward through the PP vertical duct, then radially through the SG, then to the cold plenum through perforated double-wall casing and from the cold plenum reaches the inlet of the core. The volume between the primary coolant free levels and the reactor roof is filled with Argon. The RV is cylindrical with a tori spherical bottom head and it is anchored to the reactor cavity from the top. A cone frustum, welded to the bottom head, provides the radial restraint of the Inner Vessel (IV). A steel liner covering the reactor pit constitutes the Safety vessel (SV). The volume between the RV and SV is such that, in case of RV leak, the primary coolant continues to cover the SG inlet maintaining the flow path. The IV has the main functions of core support and hot/cold plena separation. It is fixed to the cover by bolts and it is radially restrained at the bottom. The Core Support plate is mechanically connected to the IV with pins for easy removal/replacement. The core of a total power of 1500 MWth, is constituted by 427 hexagonal wrapped Fuel Assemblies (FAs) arranged in two zones of 157 (inner) FAs and 270 (outer) FAs with a different hollow pellet diameter, 12 CRs and 12 Safety Rods (SRs), surrounded by 132 Dummy Elements. Each FA extends above the lead free level and is long about 10 m. The FA consists of 169 fuel pins restrained by spacer grids. A Tungsten ballast in the upper part of the FA is used to overcome buoyancy forces. The ELFR is designed to have a closed fuel cycle (adiabatic core) with a conversion ratio of 1.07. The SG (spiral-type) and PP are integrated into a single vertical unit and placed vertically in the cold pool trough circular penetrations in the reactor roof. Eight SG/PP units are used in ELFR.

Description of the Safety Concept

ELFR is equipped with two diverse, redundant and separate shutdown systems: the first system, that has also the control function, is made of absorber rods passively inserted by buoyancy from the bottom of the core; the second system is made of absorbers rods passively inserted by pneumatic system (using depressurization) from the top of the core. The Decay Heat Removal (DHR) system consists of two diverse, passive, redundant and independent systems: the first system is composed of four Isolation Condenser systems (ICs) connected to four out of eight SGs secondary side; the second system is composed of four ICs connected to four Dip Coolers located in the cold pool. Three out of four ICs of each system are sufficient to remove the decay heat power. Both systems are passive, with actively actuated valves, equipped with redundant and locally stored energy sources. 2D seismic isolators are installed below the reactor building to cut the horizontal seismic loads.

Deployment Status and Planned Schedule

The ELFR is in the conceptual design phase. Demonstration of the LFR technology is on-going and the operation of a FOAK industrial-scale ELFR is foreseen around 2040-2050. The achievement of this target is strictly connected to the realization of the ALFRED demonstrator around 2025.