ELECTRA (KTH, Sweden)

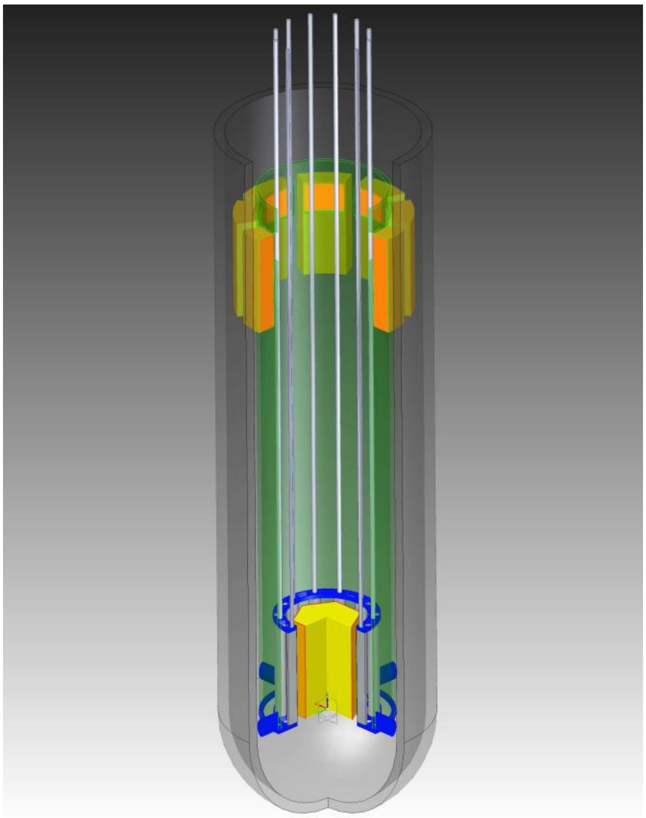

FIG. 24. A model of the primary system of ELECTRA

Full name:	*European Lead Cooled Training Reactor*
Designer:	*Royal Institute of Technology (KTH)*
Reactor type:	*Lead-cooled training Reactor*
Electrical capacity:	*Not foreseen*
Thermal capacity:	*0.5 MWth*
Coolant	*Lead*
Primary Circulation	*Natural*
System Pressure:	*< 0.1 MPa (primary), TBD (secondary)*
System Temperature:	*400÷500 °C*
Fuel Material:	*inert matrix (Pu,Zr)N*
Fuel Cycle:	*360 Months (with average availability of 50 %)*
No. of safety trains:	*TBD*
Emergency safety systems:	*hybrid*
Residual heat removal systems:	*Passive*
Design Life:	*30 Years (with average availability of 50 %)*
Design status:	*Concept*
Planned deployment/1st date of completion:	*Construction is planned to start in 2020 and completion in 2023*
New/Distinguishing Features:	*The use of inert matrix nitride fuel*

Introduction

The European Lead Cooled Training Reactor (ELECTRA) is a low power fast reactor intended for research, education, training and technology demonstration purposes. The reactor concept development is promoted by the Royal Institute of Technology, Uppsala University and Chalmers University of Technology (Sweden) since 2009, and leverages on the R&D performed over the last 15 years on nitride fuels, liquid lead cooling and advanced cladding materials.

Description of the Nuclear System

A very small core size (30×30 cm) is achieved thanks to the use of inert matrix (Pu,Zr)N fuel. The ensuing pressure drop is low enough to permit full heat removal by natural convection of the coolant during normal operation, with a steam generator (SG) elevation of approximately 2 m and a consequent vessel height of approximately 3 m. The high reactivity loss resulting from the use of fertile-free fuel is compensated by the rotation of 12 cylindrical drums with B_4C sections located outside the core.

The fuel for ELECTRA may derive from two different sources. The primary choice is to construct a small recycle facility in direct conjunction to the Swedish intermediate repository CLAB in Oskarshamn. With a capacity of 4 tons spent LWR fuel per year, such a facility could separate the required inventory of plutonium within two years. The second potential source for the fuel consists in 900 kg of separated PuO_2 owned by the Swedish utility OKG, which is presently residing in Sellafield. This material was supposed to be used for producing MOX to be burnt in the Oskarshamn power plant.

Concerning the cladding, a material with a high margin to failure is desired since ELECTRA is intended to be a facility with a special focus on research on fast reactor dynamics,. In addition, the estimated end-of-life dose to the cladding is less than 40 dpa. Therefore, the austenitic 15-15Ti steel is selected as the reference cladding material.

The choice of natural convection for heat removal in ELECTRA avoids the need for developing and qualifying materials for pump impellers. However, flow stability issues may arise. Consequently, the R&D programme for ELECTRA foresees the construction and operation of an electrically heated one-to-one scale mockup of the reactor.

Description of the Safety Concept

In Sweden, the Swedish Radiation Safety Authority (SSM) is the regulatory body monitoring all activities related to radiation protection and nuclear safety. For ELECTRA, prescription SSMFS 2008:17 (i.e., the Swedish radiation safety authority's regulation concerning the design and construction of nuclear power reactors) is of particular importance. No significant radiotoxic releases (> 1 mSv/year for the general public) are tolerated; hence, a list of anticipated and improbable events has to be dictated, and measures to handle them must be identified. Events of particular importance are those that could threat the integrity of the fuel and cladding, such as:

- change of core geometry during normal operation leading to reactivity and coolability variations;
- LOss of Coolant Accident (LOCA) or degraded coolability;
- Transient Over Power (TOP) leading to degradation of fuel and cladding tubes;
- loss of active residual heat removal.

Deployment Status and Planned Schedule

Preliminary discussions on the licensing procedure for ELECTRA have been conducted with SSM. The current legal framework is deemed to include sufficient provisions to carry out the licensing process, which includes submitting an environmental impact statement to the Environmental Court and a preliminary safety assessment report (PSAR) to SSM. According to the tentative time-plan for R&D, licensing, construction and operation of ELECTRA and its associated fuel cycle facilities, design and safety analyses will last till 2018, while licensing will take two more years, up to 2020. Pending availability of funding, construction may start in 2020, after which first criticality could be achieved in 2023.