FBR-1 & 2 (IGCAR, India)

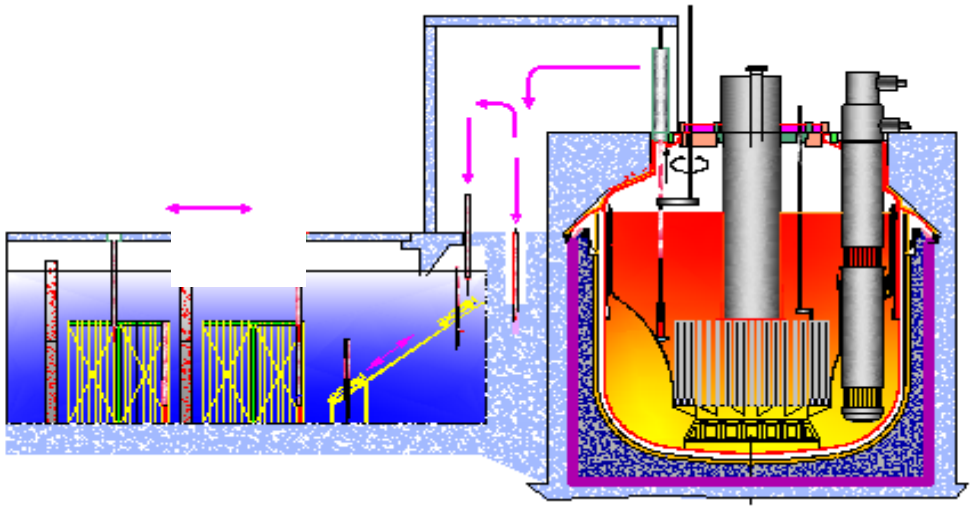

FIG. 6. Schematic representation of FBR-1 & 2

Full name:	*Fast Breeder Reactors 1 & 2*
Designer:	*India Gandhi Centre for Atomic Research*
Reactor type:	*Pool Type*
Electrical capacity:	*500 MWe*
Thermal capacity:	*1250 MWt*
Coolant	*Sodium*
Primary Circulation	*Forced*
System Pressure:	*0.11 MPa*
System Temperature:	*397 °C / 547°C (Reactor Inlet / Outlet)*
Fuel Material:	*MOX*
Fuel Cycle:	*8 Months*
No. of safety trains:	*6 independent trains (for Decay Heat Removal)*
Emergency safety systems:	*Active and Passive*
Residual heat removal systems:	*Active and Passive*
Design Life:	*60 Years*
Design status:	*Detailed Design*
Planned deployment/1st date of completion:	*2023 & 2024*
New/Distinguishing Features:	*Incorporates design features towards improved economy and enhanced safety. Innovative reactor assembly design with four primary pipes per sodium pump, shut down systems with advanced safety enhancing features, liquid poison based ultimate shut down system, twin unit design sharing non-safety systems such as the external fuel handling & storage system, core catcher capable of handling whole core melt etc.*

Introduction

The design of 500 MWe twin units Fast Breeder Reactors-1&2 (FBR-1&2) is a standardised one for serial construction. It incorporates the feedback experience gained from design, construction and safety review of 500 MWe Prototype Fast Breeder Reactor which is under construction presently, towards improved economy and enhanced safety. The reactor assembly design is engineered by incorporating many advanced design features resulting in 25% material savings and favouring manufacture & erection of integrated reactor assembly, as a single unit, thus leading to reduced construction time. Improvements are expected in the shut down systems, decay heat removal systems and the choice of materials for the permanent reactor assembly components and heat transport system. The layout incorporates a twin unit concept in which non-safety system especially the ex-vessel fuel handling system and fuel storage building are shared. Advanced core structural materials are employed aiming for higher burnup. FBR-1&2 design in general, and the design concepts in particular, would be the standardised options to be adopted for the MOX as well as future metal fuel reactors.

Description of the Nuclear System

The reactor is of pool type with 2 secondary sodium loops. The core consists of 2 fuel enrichment zones enveloped by blankets. Advanced shielding material of Ferro Boron is planned to be used for the bulk core radial shielding leading to reduction in the shielding thickness. Various shells in the primary vessel with optimised annular gaps along with reduced bulk radial shielding leads to a compact reactor block. Grid Plate with an innovative design permits forced flow only through the replaceable core subassemblies and the surrounding outer shielding assemblies are supported on raised spigots at the periphery of the grid plate. Two independent, redundant and diverse shut down systems having enriched B_4C absorber rods are employed, for the purpose of power regulation and safety. In addition, neutron poison systems based on either Li-6 or B_4C granules are deployed as a part of Ultimate Safety System. Primary sodium purification is carried out by in-vessel arrangement. For the roof slab, a new concept of dome shaped structure, which is supported on the reactor vault leading to the top structure being in compression, is expected to offer enhanced seismic safety margin.

Description of the Safety Concept

The safety features incorporated in FBR-1&2 are:

- Provision of four primary pipes per sodium pump offer higher safety margin for the Category 4 primary pipe rupture design basis event.
- In-vessel primary sodium purification is adopted to avoid the radioactive sodium being taken outside primary vessel.
- Stroke limiting device is added to the Control & Safety Rod, the primary shutdown system, to guard against inadvertent control rod withdrawal event.
- Temperature sensitive electromagnet is added to the Diverse Safety Rod, the secondary shutdown system, leading to enhanced safety.
- As an ultimate shutdown system, either liquid Li or B_4C granule based system is added to practically eliminate core disruptive accident.
- Three trains each of two diverse concepts (passive, active-passive) for decay heat removal are incorporated. Active-Passive systems are designed for $2/3^{rd}$ of their capacity by natural circulation
- Innovative multi-layer core catcher to handle whole core melt debris

Deployment Status and Planned Schedule

Detailed design of FBR-1&2 is in progress. Technology development of major reactor assembly components has been completed. Preliminary Safety Analysis Reports are under preparation, Design Safety Criteria are under review by regulatory agency and infrastructure development is in progress at site by the utility. FBR-1&2 are planned to be launched in 2023 and 2024 respectively.