India is planning to construct 600 MWe Fast Breeder Reactors beyond Prototype Fast Breeder Reactor (PFBR). The design of these reactors is being augmented from that of PFBR both in terms of economics and safety. The safety criteria for the next generation of FBRs are being evolved taking into account the worldwide trend. This paper briefs the significantly new criteria pertinent to the shutdown systems in the currently evolving safety criteria. According to the evolving criteria the plant shall be designed such that it can be brought into a controlled state from any accident scenario and the containment function can be maintained so that significant radioactive releases would be practically eliminated. This requires identification of design extension conditions in which accidents that are more severe than DBAs or those involve additional failures are to be addressed. This paper briefs about the design extension conditions that would be addressed by shutdown systems and the philosophy adopted to finalize the configuration of shutdown of system for future SFR so as to practically eliminate significant radioactive release to public.

Passive shutdown devices under development for future FBRs
R.Vijayashree

India is planning to construct 600 MWe Fast Breeder Reactors beyond Prototype Fast Breeder Reactor (PFBR). PFBR has two independent fast acting shutdown systems. The absorber rods of the first system are called as control and Safety Rod (CSR) and that of the second system are called as Diverse Safety Rods. Future FBRs will also have two fast acting diverse and independent shutdown systems with few significant augmentations. For the first shutdown system in addition to CSR, in few core locations hydraulically suspended absorber rods (HSAR) are planned to be provided. In order to reduce the consequences due to inadvertent withdrawal of Control and Safety Rod, it is proposed to introduce a stroke limiting devise for the CSRs that are used for power control also. Temperature sensitive magnetic switch that would switch of the current to the electromagnet holding the DSR is planned to be provided as a passive shutdown feature to the second shutdown system. Further special core subassemblies to be inserted in the reactor core at suitable locations are being developed. Different versions of these devices are being developed mainly to take care of design extension conditions where the first two active systems are assumed to have failed. These devices are being designed such that beyond the failure of the two shutdown systems on further rise in outlet temperature of these assemblies, poison would get injected in to the active core zone. This paper briefs about the above mentioned various passive shutdown features/devices under development.

vi. Korea, Republic of

Design Study for Passive Shutdown System of the PGSFR
J. H. Lee, KAERI

There have been no experiences of implementing a passive shutdown system in operating or operated SFRs around the world. However, new SFRs are considered to adopt a self-actuated shutdown system (SASS) in the future to provide an alternate means of passively shutting down the reactor.

The Prototype Gen-IV SFR (PGSFR) developed by KAERI also adopts this system for the same reason. This passive shutdown design concept is combined with a group of secondary control rod drive mechanisms (SCRDM). The system automatically releases the control rod assembly (CRA) around the set temperature, and then drops the CRA by gravity without any external control signals and any actuating power in an emergency of the reactor.

This paper describes the parametric design study of a passive shutdown system, which consists of a thermal expansion device, an electromagnet, and a secondary control rod assembly head. The conceptual design values of each component are also suggested. Parametric calculations are performed to check the suitability of the performance requirements of the thermal expansion device and electromagnets.

The thermal expansion difference is calculated in the range of 1.7 ~ 2.6 mm for the 2.86 m long expansion device of the PGSFR, an additional design study to trigger off the CRA by utilizing the limited length is ongoing.

The electromagnetic forces on the CRA with a 1 mm air gap are in the range of ~ 300 N. Thus, the thermal expansion difference of the thermal expansion device to trigger off the CRA shall be controlled within 1 mm at the setting temperature. Design feasibility tests using the several test mockups of the thermal expansion device as a passive concept of the PGSFR are being performed.

vii. Romania

ALFRED Demonstrator – Safety Rods System
D. Gugiu, INR

The main goal of the ALFRED project is to play the role of a demonstrator for the European concept of a LFR, able to prove the safety and reliability in all operating conditions through the use of some simple engineering solutions while reducing to the largest possible extent the uncertainties related to all development stages: design, construction and operation.

The ALFRED core has been designed taking into account in a comprehensive approach the main goals to be achieved, the safety performances required as well as the main technological constraints that should be fulfilled.

In this context and taking into account the topic of the meeting, the presentation is focused on the safety rod system that has been successfully adapted from the CDT-MYRRHA project.

The SRs targeted performances and their worth will be briefly presented.

Moreover, some results of the preliminary safety analysis will be provided with a focus on the most representative DBA and DEC events, as well as conclusions regarding the safety performances.

viii. Russian Federation

Passive Safety Components for Lead-Cooled Reactor Facilities
M.K. Sarkulov, NIKIET