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सचिव, पञ्चनियम
एवं

निदेशक, सूचना एवं तकनीकी सेवाएं प्रभाग
एवं

निदेशक, औद्योगिक संयंत्र संरक्षा प्रभाग

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REPORT OF HIGH LEVEL AERB COMMITTEE ON SAFETY REVIEW OF INDIAN NUCLEAR POWER PLANTS AGAINST EXTERNAL EVENTS OF NATURAL ORIGIN

Atomic Energy Regulatory Board (AERB) constituted a committee on March 19, 2011 to review the safety of Indian Nuclear Power Plants (NPP) against external events of natural origin, in the light of the Fukushima accident. The committee has submitted its report on 31st August 2011.

The committee has observed that the design, operating practices and regulations followed in India have inherent strengths, particularly in case of pressurized heavy water reactors (PHWR) that account for 18 out of the 20 currently operational NPP units in India, to deal with the natural events and their consequences. The committee noted that NPCIL has already taken interim safety measures to enhance safety of the two older boiling water reactors (BWR) which are operational at Tarapur (TAPS-1&2) in light of the Fukushima accident. The measures include provisions for continuous reactor cooling under prolonged station black out (SBO), in which loss of both offsite and onsite power supplies is considered and preparatory work for inerting the containment with nitrogen to avoid hydrogen explosions as happened at Fukushima.



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Highlights of the committee's observations, conclusions and recommendations are given below.

- As per existing practice, it is a requirement that the key reactor operating personnel in India to be engineering graduates. They are licensed after induction training, rigorous qualifying tests and interviews and thus are in a better position to handle off-normal situation in the plant.
- All NPPs in India undergo Periodic Safety Reviews (PSR) following the procedure prescribed in AERB regulations. These reviews are done based on current safety standards. For older NPPs special safety reviews are carried out. A large number of safety upgrades have been implemented over the years in our NPPs, especially in the old units, based on the outcome of the various safety reviews mentioned above. The committee noted that these upgrades have substantially enhanced the safety of our NPPs including their capability to withstand natural events.
- The submarine faults capable of generating tsunamis are located at very large distances of more than 800km from the western coast and more than 1300 km on the eastern coast. Thus, unlike in the Fukushima case, the simultaneous occurrence of a strong earthquake and a tsunami at our NPPs, is not foreseen.
- The requirements for siting and design of NPPs with respect to postulated design basis natural events, as specified in AERB safety regulations, are found to be appropriate and sufficiently conservative. However, in the light of Fukushima experience it is considered prudent to further enhance this conservatism through better treatment of uncertainties in data and computational procedures.
- The Fukushima accident has shown that occasionally the magnitude of natural events can be higher than what is considered in design. It is therefore prudent to make additional design provisions such that at least

the basic safety functions for the NPPs are not impaired even under beyond design basis natural events (or extreme events). Towards this aim it is recommended that the parameters for each postulated extreme natural event be defined conservatively using the best available analytical methods. While design basis external events should govern the design of Structures, Systems and Components (SSCs), functionality of the most safety relevant SSCs should still be maintained under extreme events.

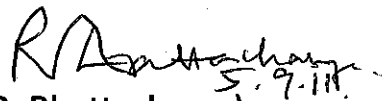
- A major lesson learned from the Fukushima experience is that capability to cool irradiated fuel in the reactor core and in the spent fuel storage facilities must remain available in the event of SBO as also in the face of beyond design basis natural events. In this connection, the committee noted that for the Indian NPPs, submergence of the fuel in the pool water is assured for a time period of at least one week under SBO, even with the most conservative assumptions on the quantum of decay heat from the stored fuel and without any credit for operator action.
- Design provisions exist in PHWRs to cool the reactor core, even under extended SBO. The efficacy of this design feature got amply demonstrated during the 17 hours long SBO caused by the turbine hall fire incident at Narora unit-1 in 1993. To further improve the capability to deal with extended SBO, the committee recommended that a reliable back-up provision should be made for addition of water to Primary Heat Transport System. Also operability of the fire water system should be ensured even during a flooding event.
- In the case of TAPS-1&2, core cooling under SBO can be maintained up to about 8 hours and thereafter provisions for make up of water to the emergency condenser is required. Some of the safety systems including class III power supply system in TAPS-1&2 would require upgrading to meet the currently revised flood level. A detailed study to identify the

design improvements to rectify the above deficiencies and the identified corrective actions must be completed at the earliest.

- After the 2004, Indian Ocean Tsunami, reassessment of flood level for Kalpakkam Site has been taken-up. This reassessment considers tsunami generated from a sub-sea earthquake caused by the Andaman-Nicobar-Sumatra fault and takes conservative account of the fault parameters and the directivity of tsunami propagation towards the Kalpakkam coast. The work done so far indicates that the maximum postulated flood level at Kalpakkam coast is likely to get revised upwards and consequently the corresponding design improvements for MAPS will have to be considered. The Prototype Fast Breeder Reactor at this site is likely to remain unaffected due to this revision as its grade level is sufficiently high. For all other coastal NPP locations there will be no change in the maximum postulated flood level.
- A beyond design basis external event may disable the facilities available at the NPP site for monitoring and control of important reactor parameters. It may also result in physical isolation of the site such that it may not be possible to receive outside help for a considerable period of time. Creation of an emergency facility at each NPP site which will remain functional under such conditions is therefore recommended.
- In spite of all the safety features provided, the extremely remote possibility of an accident leading to partial or total melting of fuel in the reactor core, called severe accident, due to unforeseen reasons should still be deterministically taken into consideration. In the area of severe accident management significant progress has been made in our country in the recent past in terms of analysis and R&D work. This should be expeditiously translated into design provisions together with related procedures for the operating as well as under construction NPPs.

The committee noted that even while its deliberations were in progress, NPCIL has proactively initiated work towards implementation of the recommendations of the committee and those from its own review and has drawn up an action plan for this work. It is also seen that pending implementation of permanent design improvements which require procurement of materials, components etc. and working out detailed engineering, some interim arrangements for meeting the intent of the recommendations have already been made.

This report will be reviewed in AERB in detail and AERB will pursue with NPCIL for implementation of the recommendations.


(R. Bhattacharya) 5.9.11