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अध्यक्ष एवं प्रबंध निदेशक

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(भारत सरकार का उद्यम)
(A Govt. of India Enterprise)

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**NUCLEAR POWER CORPORATION
OF INDIA LIMITED**

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PRESS RELEASE

An unprecedented natural event involving severe earthquake of magnitude 9.0 on the Richter scale, combined with a severe tsunami of about 14 meters height from mean sea level affected the northeast coast of Japan. Fukushima Daiichi nuclear power plant comprising of 6 reactors was affected by this calamity.

Fukushima Daiichi Units 1 to 3 were operating and units 4 to 6 were under maintenance outage during this event. The reactors at this location were of Boiling Water Reactor type. Following the earthquake, the operating reactors shut down automatically. The off site power i.e. power from the grid was lost due to earthquake and the on site power i.e. from the emergency diesel generators started automatically and reactor cooling was taking place as per design. However, the subsequent tsunami, submerged the emergency power sources rendering them unavailable. The plant lost all power supplies leading to "Station Black Out". Consequent to total loss of power, the core cooling got impaired. The water in the reactor gradually evaporated and escaped through relief systems, and eventually the fuel got uncovered. This resulted in overheating and initiated zirconium metal reaction with water, generating hydrogen gas. This gas escaped subsequently into the secondary containment building called the Reactor Building. Hydrogen explosion took place damaging part of reactor building roof in some of the units. In Unit 4, though the reactor did not contain fuel, the spent fuel stored in a water pool in the reactor

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building lost cooling and got overheated and resulted in a similar scenario of generation of hydrogen and explosion. Japanese authorities evacuated public from the surrounding area of 20 to 30 Km, as per the procedures.

NPCIL was closely monitoring the evolution of the event at Fukushima and getting information from International Agencies like, International Atomic Energy Agency (IAEA), World Association of Nuclear Operators, (WANO) Japan Atomic Industrial Forum (JAIF) and NPCIL representative posted at WANO Tokyo Centre.

Considering the severity of the incident, proactive action of constituting four task forces one each for different generations of designs of reactors was taken. Indian Nuclear Power Plants consist of two Boiling Water Reactors and eighteen Pressurized Heavy Water Reactors, with three types of designs.

Immediately guidelines have been sent by WANO in the form of Significant Operating Experience Report which highlights four aspects. These are, verifying the capability to mitigate conditions that result from beyond design basis, Verifying capability to mitigate Station Black Out conditions, Verifying the capability to mitigate internal and external flooding conditions, and walk down and inspection of important equipments to mitigate fire and flood events.

Detailed walk down of all the plants have been conducted by specially constituted teams at sites and preparedness has been ensured.

Atomic Energy Regulatory Board has also constituted a high level specialist committee, to study the implications of the incident at Fukushima to examine the need for enhancing the safety of Indian nuclear power plants.



The four task forces, based on the information available from the Fukushima Daiichi reactor incident, have studied the capability of the current reactors in India to handle similar extended loss of power scenarios . The results of the study was thoroughly reviewed and discussed with various experts and the top management in NPCIL .

The study highlights the following

Unlike Fukushima, TAPS 1&2 reactors are provided with a completely passive means of core cooling in the form of emergency condenser which does not require any motive power and cater to core cooling for a period of 6 hours. Provision for augmenting the water inventory in this condenser exists.

TAPS 1&2, boiling water reactors commenced operation in 1969. As a part of the regular safety review process, after the units completed 35 calendar years of operation, a revisit and thorough review was made on the performance and the health of the various equipment. The plants have been modernized and brought on par with the current requirements by doing number of modifications in the period 2004 - 2006.

Additionally, it has been recommended to inert the primary containment with nitrogen and provide advance alert mechanism for Tsunami.

The seismic capability of the structures has been found adequate for the seismic zone in which it is located. Tsunami at this coast can only be generated at the Makran fault near Karachi which is 900 Km away. The plant is found to be safe for the maximum height of tsunami that can be generated by the Makran fault. Additional shore protection measures are also being undertaken which will absorb considerable energy from the tsunami waves.



Water sources existing at the site in the form of emergency condenser, suppression pool and underground storage tank is adequate to cater to the cooling requirements for extended periods of more than 10 days.

For the first PHWR reactors at RAPS 1&2, flooding which can result from the upstream Gandhi Sagar dam break is the scenario considered and it is seen, on site power will be available.. A separate, Station Black Out Diesel generator is provided at a height of about 3 meters above flood level. Water resources available in several tanks at a higher elevation is adequate for the safety systems.

In the case of Madras Atomic Power Station, the finished floor levels of the buildings are higher than the maximum flood level postulated. This station had already handled the Indian Ocean Tsunami in December 2004 successfully and core cooling was maintained without any interruption. Further additional measures in the form of tsunami bunds have been constructed along the shore which will further reduce the intensity of tsunami. Tsunami Alert system is also available at this station. One of the diesel generators and two diesel driven fire fighting pumps are located at a height of about 3 meters from the flood level . The reservoirs at site which are at a higher elevation and at a considerable distance from the coast and the water contained in the various tanks and suppression pool will cater to the requirements for more than 10 days.

At all the Standardized PHWR type of reactors from Narora onwards, the seismic design is adequate to cater to all seismic events that can occur in the seismic zone in which the plants are located. There is also a margin of 1 to 4 meters above flood level postulated for the respective sites. The water inventory at these sites will also suffice



for meeting the requirements for a period of more than 10 days and in some cases upto even 30 days. The spent fuel pool water inventory is also assessed to be adequate for more than 10 days.

In fact the extended black out scenarios had been experienced during the turbine fire in NAPP 1 in 1993. The event was successfully handled to maintain adequate core cooling. The events at Three Mile Island, USA and Chernobyl, Ukraine (then Soviet Union) had brought out many learning points which were studied and incorporated in our reactors.

Though the above studies have indicated the capabilities exist to handle sever natural events, with a view to enhance the safety levels and build further defence in depth, the committees have come out with recommendations which are typically given below.

- Automatic reactor shutdown initiation on sensing seismic activity.
- Increasing the passive power source capacity for monitoring and control purposes, for longer durations.
- Provisions for hook up arrangements for adding cooling water inventory through external sources to all reactor cooling systems, and mobile diesel driven pumping units
- Augmentation of water inventory and the arrangement for transfer of water from the nearby sources, if required.
- Additional shore protection measures at Madras Atomic Power Station, and Tarapur Atomic Power Station, which are located on sea coasts.
- Additional hook up points for making up water to spent fuel pools at TAPS 1&2, RAPS 1&2, and MAPS 1&2.



The specialist committee constituted by AERB will also be submitting its report and NPCIL is committed to incorporate all the recommendations made by the committee. NPCIL proposes to take up implementation of the recommendation of its task forces immediately with requisite approvals from AERB, wherever applicable.

The event at Fukushima is still unfolding. As and when more details are available the recommendations will be revisited and additional measures deemed fit would be incorporated.



(S.K. Jain)

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