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Plant Life Extension Program for Indian PHWR Power Plants - Actual Experience and Future Plans

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The Nuclear Power Corporation of India Limited (NPCIL) is responsible for design, construction and operation for all nuclear power plants in India. Currently, it has fourteen (14) reactor units under operation and another eight units are under various stages of planning and construction.

India has adopted Pressurised Heavy Water Reactors (PHWRs) for the initial phase of its nuclear power program. In the earlier PHWRs zircalloy-2 has been used as coolant tube material. Subsequent studies and experience have shown their life to be considerably lower (about 10 full power years) than originally estimated. This meant that reactors at Rajasthan-1&2 Madras-1&2 Narora-1&2 and Kakrapara-1 would require en-masse coolant channel replacement at least once in their lifetime. Subsequent reactors from Kakrapara-2 onwards would not need this en-masse coolant channel replacement as the coolant tube material has been upgraded to Zr 2.5% Nb.

En-masse coolant channel replacement and other life extension work have been carried out successfully in Rajasthan Unit-2 (RAPS-2). Madras unit-2 (MAPS-2) has been shutdown since January 2002 and preparatory work for en-masse coolant channel replacement and plant life extension is in progress. This paper discusses in brief the experience of RAPS-2 in carrying out the above jobs as well as the strategies being adopted for MAPS-2.

Since the coolant channel replacement work requires a plant outage of about 18 months, this opportunity is used to extend life of existing systems as well as upgradation work. This life extension and upgradation program is based on the results of detailed in service inspection, evaluation of performance of critical equipment, obsolescence and other strategic reasons. This paper discusses in detail some of the major areas of work done, for example introduction of supplementary control room, process control, computer based plant information and event analysis systems, provision of enhanced emergency core cooling system, inspection and replacement of heat exchangers and steam generators, and enhancement of emergency power supplies. It needs to be recognised that RAPS was built in the 1970s. Thus considerable upgrades have been done to meet latest safety requirements. Hence jobs like segregation of safety related power supplies and cables to meet more stringently groups and channel philosophy, installation of fire barriers and modernisation of fire detection system have also been carried out.

The paper discusses the tools developed including remote tooling, mock-ups done and special training given to ensure that the work is done safely in the shortest possible time and with the lowest man-rem consumption. For RAPS-2 results are compared with the original planned values and it will be noticed that considerable savings were achieved in man-rem, monetary expenditure and time taken for the job.

One significant aspect of the coolant channel replacement and upgradation work has been that all the work was done within the department of atomic energy. This included theoretical work, experimental studies, actual execution of the jobs and inspection and testing. The role of industry has been limited to supply of equipment. For MAPS outside agencies have been invited to participate in actual execution of the jobs at site. This has considerably changed the method of planning and execution of the jobs. For future reactors greater role of industry in development and actual site work is envisaged. The paper discusses the options being considered by NPCIL.

Plant life extension and upgradation of older plants throws up several issues related to safety regulatory criteria that the upgraded plant should meet. This paper discusses the methodology formed by the utility and regulatory authority to meet agreed criteria for safety. Also discussed are special areas of concern like configuration control, documentation, training and re-qualification of operations staff.

This paper concludes with a discussion of the strategies of plant life extension for future reactors where the emphasis will be on better and more automated tooling preparation, modular replacement, detailed planning, engineering, configuration control and management of outage.