Abstract

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Safety and availability are prime factors for nuclear power plant operation. Safe operation requires a well-built backup of safety systems for investment, environment and public protection. This backup system is maintained with the use of active and passive safety systems in the form of engineered safety features. Traditionally, active safety systems have been utilized for quenching accidental conditions. These systems are associated with proper and timely operator actions, which is some time misleading. Now a days, passive safety systems are becoming more popular due to their dependence on forces of nature for operation and actuation. Passive operations include, under gravity flow, natural recirculation of fluid and nitrogen gas pressure. For such type of systems, only certain conditions are met and the passive operation is started automatically. Therefore, world nuclear community has started using passive safety systems in the present nuclear power plant technology for simplicity in operation, maintenance and safety enhancement.

This thesis concentrates on the augmentation of passive safety features in small scale pressurized water reactor design. The research was started with the study and simulation of a small scale reference power plant. The scope of simulation includes safety systems including necessary nuclear and conventional island systems. The individual process systems and related electrical systems are simulated and integrated within the frame work of their respective instrumentation and control to form a standalone simulated model for a reference power plant. Using this model, design basis accident has been created

and the response of the safety systems together with related primary systems has been observed. Satisfactory results have been experienced in this regard.

The research was extended by designing and simulating a passive safety injection system. This proposed system consists of many passive components and functions in absence of an existing safety injection system for mitigating loss of coolant accidental condition. The use of proposed passive system has been suggested only for intermediate type pipe breaks because for small breaks, the depressurization is slow and only high pressure charging system is utilized whereas for larger breaks, the depressurization is very fast and low pressure safety injection system is actuated rapidly. Therefore, in a simulation test run this proposed system has been tested and verified for intermediate coolant loss accident. It has been found that the response of the proposed passive system is satisfactory and it keeps all necessary safety parameters within range. Through this research, it is concluded that the proposed passive system could be a potential candidate for handling intermediate type breaks representing loss of coolant accidents in small scale pressurized water reactors. For other accidental conditions of the plant like steam generator tubes rupture and steam line break, the use of conventional way of management has been suggested.

Keywords: Advance NPP, Passive safety, Analysis, LOCA, Reliability