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OPTIMIZED DESIGN OF THE REACTOR PROTECTION SYSTEM FOR SMART

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ABSTRACT

SMART (System-integrated Modular Advanced Reactor) is an integral type pressurized water reactor which has an integral reactor coolant system configuration that eliminates the involvement of large pipes for the connection of the major components. The top-tier requirements for SMART design are the enhancement of safety and the improvement of economics and commercial competitiveness. For the safety enhancement, SMART has the design characteristics of adopting the inherent and passive safety, simplified safety system, and advanced MMIS (Man-Machine Interface System). For the economic enhancement, SMART has the design characteristics of applying the system simplification and the component modularization. According to the top-tier requirements, SMART MMIS include the followings: 1) to meet all current regulatory and industry requirements; 2) to improve plant safety and availability; 3) to improve the cost effectiveness of nuclear power generation.

This research introduces an optimized design of the RPS (Reactor Protection System) for SMART. For the safety and economic enhancement, RPS adopts the proven technologies from the conventional nuclear power plant and the simplified design including SCOPS (SMART COre Protection System) as a processor module in the RPS. RPS performs the reactor trip function and the ESF (Engineered Safety Features) initiation function. RPS provides an emergency shutdown of the reactor to protect the core and reactor coolant system pressure boundary. SCOPS, located in the RPS cabinet, generates DNBR and LPD trip and pre-trip signals, as well as CWP (CRA withdrawal prohibit) output signals to the RPS. The RPS will use these and other inputs to automatically actuate a reactor trip whenever the safety parameters exceed a predefined value in at least two of the four redundant RPS channels.

The RPS and SCOPS for SMART are designed with the proven safety grade platform based on PLC (Programmable Logic Controller) of the conventional nuclear power plant. RPS includes bistable processor, coincidence processor, interface and test processor, maintenance and test panel, and SCOPS processor. For the simplified design, we changed the number of processors for bistable and coincidence from two or three processors to one processor, respectively. In the conventional plant, core protection system is an independent system which consists of four processors, but SCOPS is composed of one processor and included in the RPS cabinet as a sub component. Through our optimized design of the RPS for SMART, the number of cabinets can be reduced about 60% than the conventional design and we are expecting that the response time between RPS and SCOPS could be decreased by our integrated design through safety data link. Consequently, our optimized design could contribute to the safety and economic enhancement of SMART MMIS design.