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Design Considerations on the Standby Cooling System for the integrity of the CNS-IPA

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Due to the demand of the cold neutron flux in the neutron science and beam utilization technology, the cold neutron source (CNS) has been constructed and operating in the nuclear research reactor all over the world. The majority of the heat load removal scheme in the CNS is two-phase thermosiphon using the liquid hydrogen as a moderator. The CNS moderates thermal neutrons through a cryogenic moderator, liquid hydrogen, into cold neutrons with the generation of the nuclear heat load. The liquid hydrogen in a moderator cell is evaporated for the removal of the generated heat load from the neutron moderation and flows upward into a heat exchanger, where the hydrogen gas is liquefied by the cryogenic helium gas supplied from a helium refrigeration system. The liquefied hydrogen flows down to the moderator cell.

To keep the required liquid hydrogen stable in the moderator cell, the CNS consists of an in-pool assembly (IPA) connected with the hydrogen system to handle the required hydrogen gas, the vacuum system to create the thermal insulation, and the helium refrigeration system to provide the cooling capacity. If one of systems is running out of order, the operating research reactor shall be tripped because the integrity of the CNS-IPA is not secured under the full power operation of the reactor.

To prevent unscheduled reactor shutdown during a long time because the research reactor has been operating with the multi-purposes, the introduction of the standby cooling system (STS) can be a solution. In this presentation, the design considerations are considered how to design the STS satisfied with the following objectives: (a) to keep the moderator cell less than 350 K during the full power operation of the reactor under loss of the vacuum, loss of the cooling power, loss of common electrical power, or loss of instrument air cases; (b) to circulate smoothly helium gas in the STS circulation loop; (c) to re-start-up the reactor within 1 hour after its trip to avoid the Xenon build-up because more than certain concentration of Xenon makes that the reactor cannot start-up again; (d) to minimize the possibility of the hydrogen-oxygen reaction in the hydrogen boundary.

Keywords: Standby cooling system, Cold neutron source, In-pool assembly