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A Qualitative Study on the Reliability of TMSR500 Passive Cooling Design and Design Requirements Applicability

Almost all advanced reactor designs, including SMRs, rely on passive cooling features in the heat removal process. However, the reliability of the passive cooling system must be carefully evaluated due to the limitation of experimental data. Advanced reactor designs, specifically non-water cooled reactors, also face the challenge in terms of the existing safety design requirement applicability. In this paper, a qualitative study on the reliability of the TMSR500 passive cooling design has been performed. The applicability of the existing safety design requirements to the TMSR500 cooling design is also discussed here.

The reliability of the TMSR500 passive cooling system is studied qualitatively through four steps: 1) Identification of parameters affecting the operation; 2) Identification of key parameters which may cause the failure; 3) Root diagnosis to find deviation of key parameters for causing system failure (using fault trees); and 4) Evaluation of system reliability. The result of the study informs that the flow resistance especially which disturbs the access to the ultimate heat sink (environmental air), such as air intake and basement pipe outlet logging, becomes the key parameter in causing the system failures. The quantitative value of passive cooling system reliability can be achieved if the failure rate of each component is known.

For conservative analysis, the cooling capability estimation in the absence of passive air cooling is needed. Using simple analytical calculation supported by ORIGEN for decay heat calculation, the availability of basement water as the time function can be estimated conservatively.

The applicability of reactor coolant system design requirements, listed on Requirements 47 –52 of the IAEA Safety Standard No. SSR-2/1 (Rev. 1), to the TMSR500 cooling system design is also discussed here. Supported by the IAEA Safety Report Series No. 123, the identified gap will be more elaborated specifically on the TMSR cooling system design.

Country OR International Organization

Nuclear Energy Regulatory Agency (BAPETEN) - Indonesia

Email address

d.hidayanti@bapeten.go.id

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Author: SUKARNO, Diah Hidayanti (Nuclear Energy Regulatory Agency (BAPETEN) - Indonesia)

Presenter: SUKARNO, Diah Hidayanti (Nuclear Energy Regulatory Agency (BAPETEN) - Indonesia)

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