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Experimental testing of a large scale water-cooled RCCS: observations and considerations for passive decay heat removal

The Natural convection Shutdown heat removal Test Facility (NSTF) is a large-scale test facility constructed at Argonne built to generate validation data for passive decay heat removal systems of advanced reactors. Reflecting key features of a $\frac{1}{2}$ scale, water-based, Reactor Cavity Cooling System, the facility and testing program has been on-going since 2018. Over 60 test cases, performed over a wide range of operating conditions, have been completed to study behavior and assess heat removal performance.

A majority of the test cases were performed at saturation temperatures with natural circulation driven boiling flow, the operational and fluid state most prototypic to a full-scale reactor. The characteristics of natural circulation phenomena and two-phase flow can trigger complex thermal hydraulic behaviors, some of which induce unstable flow mechanisms and degraded system performance.

The following paper summarizes some of the major observations and findings related to performance and stability. Specific topics include the role of inventory level on RCCS behavior, impact of changes in channel and steam discharge loss coefficients, and consequences of flow blockages. Additionally, a discussion will be included on potential impacts of boiling induced vibrations on structural components, along with recommendations for design features that may improve system stability.

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