TerraPower
partnered with
Argonne National Laboratory

NE-19-18709, Improvements to SAS4A Severe Accident Modeling Capabilities to Support Licensing and Commercialization of TerraPower's Traveling Wave Reactors

YEARS AWARDED: 2019

TOTAL PROJECT VALUE: $480k (DOE: $370k, TerraPower: $110k)

STATUS: Completed

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DESCRIPTION: Since the mid-1980s, Argonne National Laboratory has developed the SAS4A/SASSYS-1 computer code for thermal, hydraulic, and safety analysis of power and flow transients in liquid-metal-cooled nuclear reactors (LMRs). Under this voucher, TerraPower and ANL sought to develop additional capabilities within the SAS4A code to analyze a range of postulated severe accidents that might lead to coolant boiling and/or fuel failure. An updated version of SAS4A/SASSYS-1 including these severe accident modeling capabilities allows TerraPower to more accurately and credibly model the accident events. This extended modeling capability is necessary for the design, licensing and commercialization of the Traveling Wave Reactor (TWR) the company is proposing to develop.

BENEFIT: Through knowledge encapsulated in SAS4A/SASSYS-1, ANL continues to develop greater understanding of the behavior of the various LMR systems, structures, and components during off-normal events and how it affects overall system performance, safety, and feasibility. In addition to extending and improving the Post-Failure Metal Fuel module LEVITATE-M and the sodium boiling module of SAS4A, the extension of the SAS4A documentation and verification test coverage offers improvements that allow TerraPower to meet the requirements of modern software development engineering process practices.

IMPACT: A major challenge for the TWR technology that TerraPower seeks to commercialize is the need for a modernized regulatory infrastructure. To address this, the Nuclear Regulatory Commission (NRC) has engaged with the Licensing Modernization Project (LMP) to look at its proposed technology-inclusive, risk-informed and performance-based licensing framework. The LMP relies on probabilistic risk assessments to make risk-informed selection of Licensing Basis Events (LBEs) based on their frequency and estimated consequences. Implementing this regulatory framework will require advanced reactor companies like TerraPower to demonstrate the ability to model any plant LBEs that could progress to core damage.

SIGNIFICANT CONCLUSIONS: The addition of the new inter-assembly heat transfer model and the axial heat transfer model to the post-failure fuel relocation module LEVITATE_M adds important new capabilities for the accurate simulation of severe accidents and safety analysis. The post-failure inter-assembly heat transfer (IAHT) model is important, as the results of initial simulations presented in this section of the report show that the IAHT can prevent the assembly wall failure and potential failure propagation to neighboring assemblies during a severe ULOF accident.

NEXT STEPS: The preliminary findings from this voucher-supported effort show that the failure of the assembly wall does not necessarily lead to the failure of the neighboring assemblies, also that accident termination with limited core damage is still possible. The current model is only the first step towards extended post-assembly-failure simulations with SAS4A.