ARC Clean Technology, Inc.
Partnered with
Argonne National Laboratory

NE-24-32515 – Improvements to Passive Heat Removal Systems in SAS4A/SASSYS-1

YEAR AWARDED: 2024

TOTAL PROJECT VALUE: $150K ($30K ARC, $120,000 DOE)

STATUS: Completed

PRINCIPAL LAB INVESTIGATORS: Robert Iotti (ARC), Daniel O'Grady (Argonne)

DESCRIPTION: ARC Clean Technology, Inc., a company based in Washington, D.C., is currently developing the ARC-100 sodium-cooled fast reactor. Safe operation of a sodium-cooled fast reactor can be significantly aided by heat removal systems that do not rely on active power, but function using passive means. There are typically two types of systems utilized: the Reactor Vessel Auxiliary Cooling System (RVACS) and the Direct Reactor Auxiliary Cooling Systems (DRACS). When performing safety analysis, these systems must be considered as they impact steady state and transient behavior. On this project, ARC worked with Argonne National Laboratory (Argonne) to enhance the SAS4A/SASSYS-1 (SAS) safety analysis software's modeling capabilities for a generic RVACS model. These enhancements will enable ARC to have a better representation of the system's response during long-term cooling events

BENEFIT: The benefits of this project include the ability to operate at higher power levels through reduced conservatism. By improving the ability to represent passive decay heat removal during safety analysis, safety margins can be recovered. Recovered safety margins allow vendors to extend the operating envelope and improve economic competitiveness.

IMPACT: SAS4A/SASSYS-1 is a critical tool for assessing the safety of a pool-type Liquid Metal-cooled Reactor (LMR). While SAS4A/SASSYS-1 is not a design tool, its ability to efficiently capture the key phenomena of LMR allows vendors to iterate on different reactor designs in a cost-efficient manner. By improving the ability of SAS4A/SASSYS-1 to represent passive heat removal systems, vendors can further explore operating limits and improve economic competitiveness.

SIGNIFICANT CONCLUSIONS: The improvements made during this voucher were demonstrated using a fictional RVACS connected to the SAS4A/SASSYS-1 model of the Advanced Burner Test Reactor (ABTR). The ABTR demonstration highlighted how the recent improvements impact the reactor's long-term behavior and the overall safety margin. The extended functional form of the heat transfer coefficient between the structures and the air within the RVACS resulted in a higher heat transfer rate and air flow rate. A higher heat transfer rate reduced the peak cladding temperature by approximately 5 K. Furthermore, the ability to capture the heat transfer area under the guard vessel reduced the peak cladding temperate by approximately 20 K and allowed the reactor to cool down more rapidly than it would without considering this heat transfer pathway.

NEXT STEPS: End users of SAS4A/SASSYS-1 are encouraged to utilize the improvements made under this voucher when performing safety analysis. Further work is needed to validate the RVACS model within SAS4A/SASSYS-1. While some validation has been performed using tests conducted at Argonne in the 1960s, the experimental facility is not prototypic of current RVACS designs and the heat loss from the facility is difficult to fully quantify. Additional historical experiments are being investigated.