

Hydromine
partnered with
Pacific Northwest National Laboratory

NE-20.1-21392, On-Line Lead/Water heat Exchanger Sensor/System Feasibility

YEAR AWARDED: 2020

TOTAL PROJECT VALUE: \$500k (DOE: \$400k, Kairos: \$100k)

STATUS: Completed

PRINCIPAL LAB INVESTIGATORS: Bill Glass (PNNL), Luciano Cinotti (Hydromine)

DESCRIPTION: Hydromine, Inc., a U.S. company, is developing two projects: the LFR-AS-200, a 200-MW lead-cooled fast reactor for power station production, and the LFR-TL-X, a micro reactor intended for deployment in remote sites and on merchant ships for propulsion. Like many reactor systems, the heat exchanger tubes are the most susceptible regions for corrosion and leakage. Because of its unique, self-contained cooling system, traditional inspections and repairs using robotics will be expensive or impractical. On-line structural health corrosion monitoring (OLSHM) is preferable for the detection of tube degradation that could result in leaks and mixing of heat exchanger fluids. Under this GAIN voucher, the aim was to leverage PNNL's experience with high temperature ultrasound to demonstrate feasibility for OLSHM of the Hydromine lead-cooled reactor heat exchanger for cracks and corrosion.

BENEFIT: Hydromine recognizes the difficulty and expense of shutting down and flushing the lead-cooled reactor for inspection and maintenance. OLSHM of the most susceptible components could support extended periods of operation and limit shutdowns for inspection and repair/maintenance to "for cause" rather than based on arbitrarily chosen inspection intervals.

IMPACT: In central power stations it is possible to inspect the components once removed from containment, but this imposes significant cost and radiation exposure burdens. For the LFR-TL-X, which has only one SG, removal for in-service inspection is practically impossible, plus this could reduce reactor lifetime and complicate licensing. A reliable OLSHM for steam generator tubes could solve this issue for deployment of micro LFRs. More importantly, continuous monitoring offers an additional safety margin.

SIGNIFICANT CONCLUSIONS: The PNNL demonstrated OLSHM system feasibility was encouraging but there is more work to do. Generally, the work showed that flaws of interest were detectable on 3-m and 30-m tubing at room temperature. The high temperature adhesives failed but pressure coupling of the transducers worked for more than 1 week in argon and air environments and up to 550°C. The planned lead wetting test was not performed due to resource limitations.

NEXT STEPS: Hydromine was acquired by Newcleo in 2021.