Experimental measurements of fission product retention in liquid sodium

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Program: RC-3 Experimental Investigation of Radioisotope retention capability of liquid metal coolants (Sodium and Lead)

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ABSTRACT:

Liquid metal fast breeder reactors (LMFBRs) are leading candidates for the next phase of commercial nuclear reactor deployment. However, to license and operate a commercial liquid cooled nuclear power plant, it is vital to ensure its safe operation. The two primary types of metal coolants being considered are sodium and lead. There have been several key technology gaps identified for LMFBRs with a major issue being the understanding of radioisotope retention in the liquid metal coolants, specifically sodium and lead. While much work has been conducted to analyze isotope retention in light water reactors, less has been done to characterize retention phenomenon in LMFBR type environments. The metal-fuel pool-type sodium-cooled fast reactor (SFR) configuration is a leading candidate for LMFBR deployment and thus will be the focus of this proposal.

Overall Project Objectives:

1. **Perform a detailed review of the available literature documenting the existing data on the solubility of fission and metallic components in sodium** (this information will be used in pool injection studies). Data documented in Argonne reports ANL-ART-3, ANL-ART-38, and ANL-ART49, will be utilized as a starting point for this objective. Any anticipated gaps in this solubility data will be explored experimentally in small pool experiments within a glove box.

2. **Conduct a series of experiments to obtain high fidelity data on radionuclide retention in liquid sodium for gases, aerosols, and solid particles.** To achieve this, X-Ray imaging of gas bubbles, sodium pool sampling at different elevations and time in a sodium column, and gas mass spectroscopy will be implemented into the experimental system. To reduce the error and develop robust techniques, a preliminary water facility identical to the experimental sodium facility will be used to help validate the preparation and release of gases, aerosols, and particles into the fluid column.

3. **Perform comparisons between experimental data and the results from computational tools such as the Integral Fast Reactor (IFR) Pool Scrubbing Code and thermodynamic equilibrium chemistry models such as HSC.** The results of the comparisons will be used to inform the experiments and to provide recommendations for future code development efforts.

4. **Train several students in aspects related to the SFR technology**. This includes working with sodium by conducting the experiments and developing a better understanding of relevant SFR source term phenomena.