

Project Title

High-Temperature Molten Salt Irradiation and Examination Facility for the Penn State Breazeale Reactor

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Research Reactor Upgrades
Infrastructure Support

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ABSTRACT:

The project objective is to build and install a permanent, high-temperature, molten salt neutron irradiation and post-irradiation analysis capability at the Penn State Breazeale Reactor (PSBR). This infrastructure improvement will provide a comprehensive national resource for neutron/radiation assisted corrosion, off-gas, and other applicable testing of candidate materials for molten salt reactors (MSRs) at the university research reactor scale.

While MSRs show tremendous promise as next generation nuclear power reactors, an area of considerable engineering challenge is the management of corrosion and other changes in reactor materials as they interact with the salts and with any water intrusion. Additionally, there are questions concerning the prevalence and chemical content off-gases from the salts. These challenges are exacerbated by the presence of radiation, particularly neutrons and gamma-rays. The MSR design community currently lacks a significant amount of fundamental data regarding radiation-influenced salt and materials properties. Therefore, neutron irradiation infrastructure for high-temperature MSR applications, along with post-irradiation examination capabilities, are essential to obtain the maximum amount of fundamental data for MSR modeling, development, and licensing efforts.

The proposed infrastructure improvements would contribute to the national need for the experimental determination of radiation induced MSR materials effects and fundamental data via a new Molten Salt Irradiation and Examination Facility. The proposed work on this new facility includes: (1) the design and construction of a heated, molten salt irradiation test apparatus, (2) the construction and installation of a permanent dry tube fixture in the PSBR pool for the test apparatus, and (3) the purchase and installation of a mass spectrometer in the PSBR hot cells to analyze gases from the irradiated salt experiments. The experimental design and safety analysis for the molten salt irradiation test apparatus and the new dry tube will be supported by a Research Assistantship via matching funds by the Penn State Ken and Mary Alice Lindquist Department of Nuclear Engineering. This significant contribution will be leveraged to utilize the proposed NEUP funding to the greatest effect, and to ensure that the apparatus that is ultimately designed is one that will be fully optimized, well-planned, and safe.

The impact of the proposed project will be a new university research reactor capability that will enable experiments essential to the development of MSRs, one of the key technologies for the future of nuclear power. The combination of irradiation and post-irradiation examination capabilities in one location will provide a comprehensive tool for data determination for the overall MSR development community.