Integrated Approach to Fluoride High Temperature Reactor (FHR) Technology and Licensing Challenges

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ABSTRACT:

The widespread deployment of FHR technology promises many benefits: improved safety through passive safety systems and proliferation-resistant waste forms; improved economics through higher operating temperatures and thus higher operating efficiency; and a diversification of the nation's energy portfolio by expanding the role of nuclear power beyond baseload electricity to meeting peaking electricity demand and supplying industrial process heat. Several challenges remain before this class of reactors can be deployed, mostly related to its technology readiness. Therefore, the vision of this integrated research project is to facilitate commercialization of FHRs, with a broader impact of supporting the development of other advanced reactors using cutting-edge technology.

The vision will be realized by following an integrated approach to address several key inter-related technology gaps associated with FHRs, thereby reducing technical uncertainties. These include challenges surrounding: tritium management, liquid salt coolant impurity removal and redox and corrosion control, advanced instrumentation under extreme conditions, qualification of alloys for structural applications, the design, fabrication, testing, demonstration, and modeling of novel heat exchangers, and verification and validation of neutronics and thermal hydraulics modeling and simulation tools in support of licensing. These were chosen to capitalize on the team members' areas of expertise, but also because those areas directly depend on and support each other, allowing research activities to be conducted synergistically, thus promoting effective and efficient use of resources while advancing FHR technologies. There exist many instances of synergy throughout the proposed work, upon which are elaborated within the proposal, but some examples include heat exchanger designs which support tritium management, the heat exchanger designs themselves requiring corrosion-resistant materials research, the materials research guided by data from advanced sensors and supporting reliable next-generation instrumentation technologies, the placement of which is informed by reconstruction algorithms and novel neutronics and thermal hydraulics methods to be validated. Many other instances appear, but these are given to illustrate the extent of integration which will ensure the success of this work.