Two-Phase Flow Facility for Dynamic Characterization of Thermal Hydraulics in Light Water Reactors

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ABSTRACT:
The objective of the proposed infrastructure enhancement is two-fold: (i) enable extraction of high quality single and two phase flow data to help advance experimental benchmarks for simulation efforts (e.g., RELAP-7 two phase flow models), and (ii) enrich the undergraduate and graduate educational experience at Texas A&M University. The facility itself represents a flow loop capable of single and two phase flow, and enables high spatial and temporal resolution of measurements in a neutronics coupled testbed. The local control of the heat input is a particular advantage for creating conditions analogous to important transient and steady state behavior in a reactor. The neutronics will be simulated real-time and coupled to the electrical heat generation of the test loop. The ~12 ft vertical test section will consist of 24 locally controlled heat sources for a 3 × 3 fuel rod array. The 216 cartridge heaters are capable of adding nearly 0.5 MW of thermal energy to the flowing coolant stream, allowing experimental studies across a wide range of steady state and transient conditions of importance to LWRs, both large scale as well as Small Modular Reactors. With local control of heating elements, volumetric heat generation profiles observed within commercial nuclear power plants (cosine-shaped, bottom-skewed, top-skewed, etc.) can be explored in great detail. The local void fraction and temperature will be fed into the neutronic simulations which are in turn coupled to the heat generation itself. With the ability to measure pertinent data in so many locations, the facility itself will serve to provide next generation high fidelity thermal hydraulic data in conjunction with the advanced modeling efforts that continue to gain traction. The PIs on this project possess the required experimental expertise in thermal hydraulics, representing a team capable of completing the tasks for successful design, construction, and implementation of this facility into both an educational and research setting. Expected outcomes include a student population better trained and versed in thermal hydraulics of nuclear power generation, and establishing the facility as a unique high fidelity two phase flow diagnostic resource.