U.S. DEPARTMENT OF ENERGY
NUCLEAR ENERGY RESEARCH INITIATIVE
ABSTRACT

PI: **Michael Corradini** **Proposal No.: 99-0233**

Institution: **University of Wisconsin-Madison**

Collaborators: **Argonne National Laboratory**

Title: **Interfacial Transport Phenomena and Stability in Molten Metal-Water Systems**

Mixing of high-temperature liquid metal and water arises in a variety of applications involving innovative nuclear reactor concepts. The goal of this work is to determine the envelope of operating conditions, which yields optimal energy transfer between molten metal and water with maximum stability. This is to be done by providing experimental data and supporting analyses on such interfacial transport phenomena using prototypic molten metal-water systems with innovative instrumentation under a range of relevant operating conditions. Our research objectives will be to: 1] Design and operate experimental apparatuses, which will investigate liquid metal-water interactions under prototypical flow conditions; 2] Measure the integral behavior of such interactions to determine the flow regime behavior for a range of conditions and the stability of these flow regimes for prototypic conditions; 3] Measure the interfacial mass and heat transfer behavior to ascertain steam and water volume fractions, interfacial area concentrations and heat transfer coefficients; 4] Determine the envelope of operating conditions which yields an optimum in energy transfer between molten metal and water with maximum flow stability. Such fundamental data are needed for studies of innovative nuclear reactor concepts involving heat transport systems with direct contact between molten metals and water.

The proposed project consists of three specific tasks for Wisconsin and Argonne collaboration:

1) Measurements of flow regime behavior of water injected into molten metal, including the stability of the flow;
2) Real-time X-ray imaging of the multiphase structure of vaporizing water drops or jets in a molten metal under similar conditions and improved X-ray technology used for two-dimensional experiments;
3) Analytical modelling of the interfacial transport phenomena in these molten metal-water multiphase systems, incorporating the results of the two experimental tasks, and making this tool available to other researchers.

Each task will involve a unique collaboration between the university and laboratory teams. This team effort is possible since the laboratories in which the work is to be performed are in relatively close proximity and the research investigators have worked together in the past on specific research projects related to liquid metal and water heat transfer phenomena.

With this research approach we will be able to better qualitatively understand and quantitatively measure, flow regimes for the metal-water-steam system under varied flow conditions, flow regime transitions, mapping of flow conditions that provide maximum flow stability, determination of heat transfer coefficients for varied conditions, and geometric effects on flow regimes, stability and heat transfer performance.