# Project Title

Multi-Phase Model Development to Assess RCIC System Capabilities under Severe Accident Conditions

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**Program**: RCIC Performance under Severe Accident Conditions: Multi-Phase Analysis (RC-7)

**ABSTRACT:**

The objective of this proposed project is to provide analysis methods for evaluation of the Reactor Core Isolation Cooling (RCIC) System performance under severe accident conditions. This proposed project will directly address the objectives described in Technical Work Scope Identifier RC-7 by developing physics-based models of the RCIC System and incorporating them into a multi-phase code for validation.

The RCIC System is a safety-related system that provides makeup water for core cooling of some Boiling Water Reactors (BWRs) with a Mark I containment. The RCIC System consists of a steam-driven turbine that powers a pump for providing water to the reactor pressure vessel. The turbine takes steam off of a main steam line and exhausts to the Suppression Pool. Although the RCIC System was designed for isolation events, the Fukushima Dai-ichi accidents demonstrated that the system can play an important role under accident conditions in removing core decay heat. The RCIC System is believed to have successfully removed decay heat for almost 70 hours in Unit 2. This duration greatly exceeds the 4 to 8-hour operation that the RCIC System is given credit for in US BWRs.

The greatest modeling needs for the RCIC System are with respect to the thermodynamics of the system performance under multi-phase flow conditions. This project will develop physics-based models of the RCIC System and implement and validate the models in a multi-phase reactor safety code.

The proposed path is to perform experimentally-backed CFD modeling; to select codes for the Design Basis Accident and Severe Accident aspect with due consideration to code limitations; to model the Design Basis Accident portion and the Severe Accident portion noting limitations and workarounds; and to recreate the Fukushima Dai-ichi Unit 2 accident.

The project will enable evaluation of the following two-phase thermodynamic aspects of the system:

- Turbine performance following ingestion of two-phase flow;
- Pump performance degradation due to:
  - Change in turbine performance
  - Suppression Pool heatup by turbine discharge
- Multi-dimensional temperature distribution in the Suppression Chamber
- Water carryover into the turbine;

Modeling will also consider operator actions and the RCIC turbine controller response.

The outcome/impact of the project will be as below:

- Increased knowledge of the RCIC System operational characteristics under accident conditions;
- Technically-defensible models of the RCIC System;
- Potentially, suggestions for modification of Severe Accident Management Guidelines (SAMGs);