FESC
Florida Energy Systems Consortium

FESC Project Update: Due October 18, 2013

1. Project Description

Title: UFTR DIGITAL CONTROL SYSTEM UPGRADE FOR EDUCATION AND TRAINING OF ENGINEERS AND OPERATORS
PI: Kelly Jordan **Co-PI's: N/A**
Students (name/degree sought): Geoffrey Bickford, MS; Robert Beard, MS; Raymond Fortin, MS.; Ryan Kelley, Ph.D.
Description:
Budget: $ 45,000
Universities: University of Florida
External Collaborators: Indian River State College, Florida International University, Florida Power and Light, Duke Energy

2. Summary of Annual Progress (1 Page)

As nuclear power plants age, analog safety instrumentation obsolesces and becomes difficult to maintain. Adoption of advanced digital instrumentation and control (I&C) technologies in the nuclear sector has significantly lagged that of other industries. Utilities have been slow to implement these systems due to regulatory licensing uncertainty and a lack of internal expertise with new systems. As the previous generation of the nuclear workforce retires, the pool of available expertise in analog technology declines. The experience at Japan's Fukushima Power Station shows the need to continually modernize and augment reactor safety and operational systems.

The UFTR has undertaken an ambitious project to replace its 50-year old analog I&C systems with new, modern digital systems. Once modified, the facility will provide training and education for the future workforce as well as a demonstration platform in the area of advanced digital I&C for nuclear reactors. This effort ushers in a new focus on advanced digital I&C research, development, and testing, and greatly augments the existing Nuclear Engineering Program at UF. Further, the UFTR facility will offer training courses for other educational institutions in the state, such as Indian River State College, who provide the majority of nuclear technician education in Florida, as well as training for personnel from nuclear utilities and government agencies, including the Nuclear Regulatory Commission.

As part of the digital controls upgrade project, the UFTR has completed several major upgrades this year, including an NNSA-funded security system ($460k), a renovated HVAC system ($250k), a new stack exhaust monitor and high plume exhaust system funded by DOE ($212k).

FESC funding is being used to design, purchase, and install new control blade drive systems for the UFTR. We are working on a design with ITG in Jacksonville, using Siemens servo actuators and gear reduction boxes. The large gear reduction ration of 28000:1 (3600 rpm down to 0.125 rpm) presents a design challenge. We will have a design complete by December 2013 and ready for manufacture.

Two new partnerships have been formed in this reporting period: an industrial training partnership and an international research collaboration. A new partnership has been formed for nuclear training with FIU and IRSN as primary educational partners. The UFTR has linked up with the $3M-funded Regional Center for Nuclear Education and Training hosted at IRSN and Florida Power and Light / NextEra to develop an enhanced program for training of non-nuclear engineers in the nuclear industry.

The UFTR is also partnering with the Swiss Federal Institute of Technology, Lausanne (EPFL) and the CROCUS reactor to develop new methods for characterizing safety performance of research reactors. This collaboration has a financial commitment of $300k from EPFL to aquire new graduate students and postdoctoral scientists to work with UF in this area.

3. Funds leveraged/new partnerships created

UFTR – IRSN – FPL Workforce Development Partnership

Formed a partnership with Indian River State College and Florida Power and Light on NUCLEAR WORKFORCE DEVELOPMENT To ensure growth and sustainability of Florida's nuclear energy industry, there is a need to enhance Florida's nuclear careers. Training next generation nuclear workforce will provide the skillset needed to expand industry in the state of Florida, engagement at all levels of education (including the graduation of new engineers, technicians and outreach to K-12). Collaboration of Florida academic institutions and industrial partners is paramount to success. Both organizations have appointed representatives to the UFTR advisory board and committed funds for acquiring a nuclear plant simulator, should federal funding also become available.

UFTR – EPFL Research Reactor Safety Collaboration

The principal aim of the project is, in collaboration with the University of Florida and the University of Florida Training Reactor (UFTR) facility, to develop and validate a detailed coupled multiphysics models of the zero-power CROCUS reactor at EPFL and the UFTR, for the comprehensive analysis of the reactor behavior under transient (neutronic or thermal-hydraulic induced) conditions.

These two reactors differ significantly in the core design and thermal power output, but share unique heat transfer and flow characteristics (single-phase laminar flow in complex geometries with the possibility of mechancially entrained air bubbles). Validation experiments will be design to expand the validation domain of these existing models and computational codes and techniques. In this process, emphasis will be put to validate the coupled models developed and get confidence in their applicability for safety analysis.

EPFL will be principally responsible for the design and implementation of transient experiments to generate a database of reactor parameters, i.e. flow distribution, power profile and power evolution to be used to validate against code predictions. UF will focus on the generation of the coupled neutron kinetics and thermal-hydraulic models, including implementation of a TRACE/PARCS reactor simulator model, a PARET model, and development of full-field computational fluid dynamics models (using OpenFOAM) for refined thermalhydraulics physics treatments. In this subtask of the project, the aim is to verify by means of CFD the validity of TRACE predictions for atmospheric pressure water flow.

The work in this project will serve as a basis to develop two Ph.D.s, one at each University. The scientific understanding of these multiphysics domains will be expanded and the validation base of commonly-used calculation methods will be expanded to cover a new range of research reactor types. From a practical perspective, CROCUS and the UFTR will have fully validated reac-

tor dynamic and transient models for accident analysis. With these validated models, both facilities will have improved capabilities and flexibility for extended operations. CROCUS and the UFTR will be able to make future reactor modifications with reduced regulatory resistance. A feasibility analysis of future power uprates at these facilities will also result.