University of Florida Nuclear Training Reactor (UFTR) Digital Control System Upgrade for Education and Training of Engineers and Operators,

May 2012 Progress Report

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The UFTR is implementing the first ever fully digital control and safety system at a nuclear reactor in the United States. This is the key piece in a full renovation of the facility, which has been in operation since 1959. This upgrade will replace the analog system with a digital control system from Siemens Energy. This facility will provide for the training and education of the necessary workforce in the area of digital control and instrumentation for nuclear reactors. The upgrade ensures that the UFTR is on a footing to continue its research and education missions over the next decades.

As nuclear power plants age, analog safety technologies become harder to maintain. Adoption of digital technologies in the nuclear sector has significantly lagged that of other technological 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 us the need to continually modernize and augment reactor safety and operational systems.

The University of Florida has undertaken an ambitious project to replace its 50-year old protection and control system with a new, modern digital system. This project was conceived in 2008 and initiated in late 2011. All progress on design and implementation has taken place in the latest reporting period.

Once modified, the facility will provide training and education for the future workforce in the area of digital control and instrumentation for nuclear reactors. This effort ushers in a new focus on digital control and instrumentation, and augments the existing Nuclear Engineering Program at UF. Further, the UFTR facility will offer training courses for other educational institutions in the State, as well as training for personnel from nuclear utilities and government agencies, including the Nuclear Regulatory Commission.

The UFTR is upgrading its current analog control and protection systems, last refurbished in 1970, to encompass two independent digital systems, a protection system and a control system, both implemented using the T-3000 hardware from Siemens. This will be a first of its kind fully digital safety-and-control system that will become an operational testing and training platform for these technologies, helping shepherd future commercial nuclear power plants. Adoption and licensing in a training facility paves the way for acceptance in larger power reactors. The wider adoption of this technology further requires a trained base of operators and experts who are familiar with this new technology. The UFTR will be the most advanced training platform in an operating reactor environment. University of Florida students will have an unparalleled exposure to these technologies and an opportunity to graduate ready to help industry pursue and implement the next generation of digital facilities.

This project will contribute to safe operation of existing and future nuclear reactors by providing the means for training and education in the nuclear workforce needed to help the industrial transition to digital technologies. Because of the renewed interest in building new nuclear plants, and plans for life extension of existing plants, the utility industry has become interested in the use of digital safety and control systems. As a result, the Nuclear Regulatory Commission (NRC) has placed renewed effort on establishing new and updated regulation.

Funds leveraged/new partnerships created: We have obtained $167,000 in new federal funding for equipment at the UFTR relating to the upgrade from the Department of Energy. We have also progressed in discussions with Siemens Energy to provide a donation of controls equipment.

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System Design Details: Originally, UF was partnered with AREVA to supply both a reactor protection system and a reactor control system. The control system was to be supplied by subcontract by Siemens. After the dissolution of this agreement, UF approached Siemens about continuing with their portion of the partnership, and assumption of the AREVA deliverables. This was accepted in principle by Siemens management. Therefore the system design concept is based exclusively on Siemens equipment.

There are two important design decisions that are reflected in this concept, namely a choice of independent Control and Shutdown subsystems, and an implementation of an additional analog shutdown system using relay logic. These features reduce the engineering scope of the project by completely eliminating the legacy UFTR control system, and provide us with more control within the regulatory licensing process.

Combined vs. Separated Control and Shutdown systems: Implementing a combined system reduces hardware requirements, as only one application server is required. It is a simpler conceptual design, however, by combining the systems, all inputs, hardware, and software must be treated as a safety system. This implies that we must engineer the entire system to a System Integrity Level 3 (SIL 3, defined in IEEE 1012), imposing substantial engineering overhead on the implementation. Equally important is the preference expressed by the NRC in public meetings for a two, independent system solution. By making the systems independent, we may reduce the scope of software verification and validation (V&V) processes to the shutdown system alone.

Since we have chosen to implement separate shutdown and control systems, network isolation is needed to obtain full regulatory benefit. The entirety of the control system will functions as an analog input into safety system, which will provide complete digital isolation.

This system provides a regulatory hedge against adverse developments in the licensing process due to NRC discomfort with digital systems. It provides a simple, mechanical, fully analog shutdown capability to backstop the digital system. With this system, we retain the option to proceed with an install of the digital system via the 10CFR50.59 process. All safety trip functions would be covered by the analog relay system, rendering the digital system non-safety relevant. Retention of the 10CFR50.59 option is the mechanism for the UFTR to guarantee scheduling.

The reactor will not be recommissioned before install of digital control system. Once the legacy system is removed, we will have reached a point of no return – only with a successful digital upgrade will the reactor be restored. During the duration of the project, the reactor will not be available for operation.

Licensing strategy for the DCP: In November 2011, with the advice of the UFTR Advisory board, and due to feedback from the August 2011 NRC audit, it was decided to change licensing strategy away from power reactor space to research reactor space. This means that the UFTR will no longer pursue industrial-level certifications for the equipment. The equipment will be identical, however the level of QA testing and, for example, seismic qualification will be reduced. This is both a cost-saving measure and will streamline the licensing process with the NRC.

The NRC, up to now, has not had a formal process for licensing digital upgrades in research reactors. New draft regulation – an update to NUREG 1537 – is being written, which will formalize the process for approving these upgrades. The switch to a research reactor licensing strategy combined with better

definition of requirements from the regulatory agency will enhance our ability to make these upgrades with confidence that they will be accepted by the NRC.

20-year NRC Relicensing of the UFTR: NRC relicensing, a prerequisite for evaluation of the Digital Controls license amendment, was expected in December 2011. The relicensing has not yet occurred, and is now expected for the mid 2013. Outstanding issues relate to a reworking of the technical specifications for the reactor, a change in the way security procedures are regulated, and analysis of effluent monitoring methodology.

In May 2012, the UFTR was awarded a $180k infrastructure grant for gaseous effluent monitoring equipment from DOE. This money will resolve the licensing issue.