

ORNL Completes NUREG/CR-6842 Report on Digital I&C Systems

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To prepare for review of future reactors, the U.S. Nuclear Regulatory Commission (NRC) initiated this study to evaluate current practices and capture lessons learned. This study is intended to contribute to a determination of what assumptions or technical bases may need to be changed to prepare for licensing future reactors. This study was led by staff from ORNL’s Advanced Reactor Systems Group.

Findings from a study of experience with digital instrumentation and controls (I&C) technology in evolutionary nuclear power plants are presented. In particular, this study evaluated regulatory approaches employed by the international nuclear power community for licensing advanced I&C systems and identified lessons learned. The report (1) gives an overview of the modern I&C technologies employed at numerous evolutionary nuclear power plants, (2) identifies performance experience derived from those applications, (3) discusses regulatory processes employed and issues that have arisen, (4) captures lessons learned from performance and regulatory experience, (5) suggests anticipated issues that may arise from international near-term deployment of reactor concepts, and (6) offers conclusions and recommendations for potential activities to support advanced reactor licensing in the United States.

Experience with advanced I&C technologies at evolutionary nuclear power plants has shown that safety-related systems incorporating this technology can be developed and licensed for commercial nuclear power plants. However, licensing issues have arisen and some design and performance issues have been experienced. Many of these issues can be attributed to uncertainties regarding the safety significance of unique physical, functional, and performance characteristics introduced by this new technology. Existing requirements and regulatory guidance focus on current generation plants and have a tendency to be prescriptive with assumptions about particular design approaches.

The primary recommendation of this report is that the NRC should review current regulations. The NRC should review the appropriate regulatory guidance found in the NRC Standard Review Plan (NUREG-0800), regulatory guides (RGs), and branch technical positions (BTPs). As appropriate, the NRC should determine the need to revise its regulatory guidance (or determine whether rulemaking may be needed). Areas for review include the following:

- main control room design reviews
- human system interfaces
- displays and soft controls (RG 1.47)
- post-accident instrumentation (RG 1.97)
- alarms
- system isolation and cyber security
- system architecture
- network communications
- software common-cause failures

- redundancy, diversity, and defense in depth
- sensors
- information and data management
- software tools, including change control and security
- system reliability
- commercial off-the-shelf (COTS) systems

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