

A comprehensive prototype development effort was conducted by Ultra Electronics that resulted in a proof-of-concept display interface module based on FPGA technology. The module drives a common 24-inch LCD display panel to provide real-time information and data-trending functionality (see Fig. 5).

The SDIS prototype displays have completed acceptance testing and will be delivered and installed in the NuScale main control room simulator in early 2019.

### System security aspects

Cybersecurity is an important consideration for any digital I&C system in a nuclear power plant. The NuScale I&C architecture is built on a defensive cybersecurity posture, with multiple layers of security. The systems that perform the most critical functions are located in the innermost security zones with the highest level of security protection. The licensing basis for the NuScale I&C design is 10 CFR Parts 50 and 52. The most critical I&C systems utilize a combination of both FPGA and analog technology to provide a system that contains inherent security features built into the fundamental system design.

### Licensing strategy

The path to licensing and regulatory approval of digital I&C systems in the Unit-

ed States has historically been difficult and uncertain. The process has traditionally required lengthy regulatory reviews and has created significant challenges for applicants, licensees, and the NRC staff.

The approach for the licensing and regulatory review of the NuScale I&C systems and the associated digital architecture departed from previous licensing applications, which were based on the Standard Review Plan (NUREG-0800). The SRP guidance is primarily suited for large light-water reactor technologies.

For the NuScale I&C design review, the NRC staff took an innovative approach by developing a design-specific review standard (DSRS), which is a paradigm shift. It provides a safety-focused review process that uses risk insights, considers the overall I&C architecture, and incorporates important lessons learned for future design reviews. The DSRS review guidance is structured around an integrated I&C design using digital technology, which is common in new and advanced reactor designs. It introduced the use of an integrated hazards analysis approach, which is a well-established safety engineering practice, to complement the traditional I&C design and analysis methods. This novel design-specific review approach is safety-focused, consolidating the applicable guidance in the SRP and providing a

consistent, comprehensive, and systematic method to address the safety and regulatory compliance of the I&C design in a unified framework.

By emphasizing fundamental I&C design principles, the NuScale I&C licensing application focused on demonstrating that the I&C architecture was intrinsically fail-safe and met all the applicable nuclear safety requirements. This is in contrast with past I&C licensing reviews that were performed on a system-by-system basis to demonstrate regulatory compliance and to determine that safety measures were adequate. The NuScale I&C licensing application included the necessary information to address all the significant aspects of the review in a unified manner through the fundamental design principle framework.

### References

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2. Arnholt, B. K., C. T. Williams, and M. Harrison, "Use of FPGAs for Real-Time Nuclear Power Display and Monitoring Applications," 11th International Workshop on Application of Field Programmable Gate Arrays in Nuclear Power Plants, October 8–12, 2018, Dallas, Texas. **N**



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