



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS  
WASHINGTON, DC 20555 - 0001**

November 16, 2022

MEMORANDUM TO: Ronald Ballinger, Lead  
SHINE License Application Review Subcommittee  
Advisory Committee on Reactor Safeguards

FROM: Charles Brown, Member *Charles H. Brown, Jr.*  
Advisory Committee on Reactor Safeguards

SUBJECT: INPUT FOR ACRS REVIEW OF SHINE OPERATING LICENSE –  
SAFETY EVALUATION FOR CHAPTER 7, “INSTRUMENTATION  
AND CONTROL SYSTEMS”

In response to the Subcommittee’s request, I have reviewed the applicant’s final safety analysis report (FSAR), for Chapter 7, “Instrumentation and Control Systems,” and supporting Nuclear Regulatory Commission (NRC) staff’s safety evaluation report (SER) with no open items. In addition, representatives from SHINE Medical Technologies, LLC (SHINE), met with the SHINE subcommittee on July 19-20, 2022, to discuss safety related instrumentation and control systems and October 21, 2022, to discuss the non-safety related process integrated control system (PICS). This memo reflects my conclusions and recommended course of action on these subjects.

**Background**

SHINE FSAR Chapter 7 describes the Instrumentation & Control (I&C) systems, which provide the capability to monitor, control, and protect the facility systems manually and automatically during normal and accident conditions.

The SHINE facility is monitored and controlled through the PICS. The PICS performs the monitoring and control functions of the irradiation facility’s (IF’s) eight irradiation units (IUs) and at the facility level. This includes transferring target solution from one location to another, adjusting cooling systems, and the monitoring of temperature, pressure, level, and flow in various locations throughout the facility.

Each of the eight IUs has an independent Target Solution Vessel Reactivity Protection System (TRPS) and Neutron Flux Detection System (NFDS). PICS also controls certain systems in the Radioisotope Production Facility. The Engineered Safety Feature Actuation System (ESFAS) is provided for protective functions that are common to the entire facility. The radiation area monitoring system (RAMS) monitors radiation levels within the facility and emissions from the facility.

### **Safety-related Instrumentation and Control Systems (July 19-20, 2022, SHINE Subcommittee)**

SHINE FSAR Chapter 7 systems and topics addressed during this meeting include:

- The target solution vessel (TSV) reactivity protection system (TRPS)
- The engineered safety features actuation system (ESFAS)
- The highly integrated protection system (HIPS) platform implementing the TRPS and ESFAS
- The SHINE facility control room (FCR) control consoles and displays
- The radiation area monitoring systems (RAMS)
- The neutron flux detection system (NFDS).

This review focused on the overall I&C Design Criteria, the application of a three-channel adaptation of the approved HIPS for the TRPS and the ESFAS including the integration of the supporting NFDS and RAMS inputs to these systems.

The review demonstrated that the adaptation of the HIPS platform for the SHINE TRPS & ESFAS design incorporates the fundamental design principles of independence, redundancy, predictability & repeatability, diversity & defense-in-depth, and control of electronic access. Electronic control of access is ensured by specifying communication ports that are for communication outside of a HIPS chassis implement the one-way communication with hardware.

The SHINE FSAR provided both facility and specific system design criteria to be met for the safety related system design developments.

Finally, electronic control of access is satisfactorily controlled by the specifying that all data communication from the safety systems to the PICS is accomplished by uni-directional data diodes.

### **Process Integrated Control System (October 21, 2022, SHINE Subcommittee)**

The PICS is a non-safety related distributed digital control system that provides monitoring and control of the various processes throughout the SHINE facility. The PICS includes system controls, both automated and manual, and human system interfaces (HSIs) necessary to provide the operator interaction with the necessary process control mechanism. The HSIs are provided in the facility control room.

The principal functions of the PICS are to control and monitor facility systems and components. This includes systems and components within the IF. PICS also provides control and monitoring of the systems and components in the radioisotope production facility (RPF).

The functions of the PICS enable the operator to perform irradiation cycles, transfer target solution to and from the IU as well as throughout the RPF, and interface with the Tritium Purification System, processes in the supercell, waste handling operations, and the auxiliary systems.

In addition to the PICS, certain systems contain vendor-provided non-safety related control systems which interface with the PICS. These systems consist of the neutron driver assembly system (NDAS) controls, supercell controls, and various auxiliary system controls.

Similar to the safety-related systems, the SHINE FSAR provided both facility and specific system design criteria to be met for the PICS non-safety related system design developments.

Basically, these systems will be implemented with industrial control systems using the design criteria specified.

The overall PICS is by necessity complex and highly integrated and thus control of electronic access becomes critical. SHINE has delineated in the FSAR that:

The PICS and other vendor-provided non-safety related control systems do not allow remote access. Clearly defined remote access as the ability to access the components of the safety related systems and non-safety related systems and components such as operator workstations, main control board, PICS display cabinet, and other PICS controllers and cabinets from a location with less physical security.

The PICS and other vendor-provided non-safety related control systems include the capability to disable, through software or physical disconnection, unneeded networks, communication ports, and removable media drives, or provide engineered barriers.

The PICS and other vendor-provided non-safety related control systems do not use any wireless interface capabilities for control functions.

The PICS provides information to the facility data and communications system networks and equipment via a one-way data diode, such that no inputs can be provided to the PICS from off-site sources.

I conclude external electronic or wireless control of access is effectively prevented through their design specifications.

### **Conclusion**

I conclude that the safety systems and non-safety systems noted above and presented in these reviews meet the fundamental design principles for the safety systems and non-safety systems proposed for use in the SHINE facility and are satisfactory.

### **SER Summary**

NRC staff reaches the same conclusion and finds that the descriptions and discussions of the SHINE facility I&C systems and PICS are sufficient and meet the applicable regulatory requirements and guidance and acceptance criteria for the issuance of an operating license.

### **Concerns**

I did not identify any specific deficiencies in my review.

**Recommendation**

As lead reviewer for SHINE Chapter 7, "Instrumentation and Control Systems," I recommend we agree with the proposed I&C safety system designs and PICS designs presented in the SHINE FSAR and during SHINE Subcommittee meetings on July 19-20, 2022, and October 21, 2022.

**References**

1. U.S. NRC, "Instrumentation and Control Systems," Chapter 7, Staff Safety Evaluation Report, July 18, 2022 (ML22199A303).
2. U.S. NRC, "Instrumentation and Control Systems, Chapter 7, Section 7.4.3, Process Integrated Control System," Staff Safety Evaluation Report, October 20, 2022 (ML22292A310).
3. SHINE Technologies, LLC, Application for Operating License Supplement 14, Revision to Final Safety Analysis Report, Chapter 7, "Instrumentation and Control Systems," January 26, 2022 (ML22034A642).
4. SHINE Technologies, LLC. Final Safety Analysis Report, Chapter 7, Revision 2, "Instrumentation and Control Systems," August 31, 2022 (ML22249A136).
5. Advisory Committee on Reactor Safeguards, "Safety Evaluation of the NuScale Power, LLC Licensing Topical Report TR-1015-18653-P, Revision 1, 'Design of the Highly Integrated Protection System Platform'," April 24, 2017 (ML17108A433).
6. NuScale Power, LLC Submittal of the Approved Version of NuScale Topical Report TR-1015-18653, "Design of the Highly Integrated Protection System Platform," Revision 2, September 13, 2017 (ML17256A892).

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Package No: ML22319A197

Accession No: ML22319A217

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