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

July 12, 2022

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

FROM: Vesna B. Dimitrijevic, Member Vesna Dimitrijevic
Advisory Committee on Reactor Safeguards

SUBJECT: INPUT FOR ACRS REVIEW OF SHINE OPERATING LICENSE - SAFETY EVALUATION FOR CHAPTER 8, "ELECTRICAL POWER SYSTEMS"

In response to the Subcommittee's request, I have reviewed the Nuclear Regulatory Commission (NRC) staff's safety evaluation report (SER) with no open items, and the associated section of the applicant's final safety analysis report, for Chapter 8, "Electrical Power Systems." The following is my recommended course of action concerning further review of this chapter and the staff's associated safety evaluation.

Background

Chapter 8 of the SER documents the staff's review of the Electrical Power System, which serves both the Irradiation Facility and the Radioisotope Production Facility. The system consists of Normal Electrical Power Supply System (NPSS) and Emergency Electrical Power Systems, which includes Uninterruptible Electrical Power Supply System (UPSS) and Standby Generator System (SGS).

The NPSS provides power for normal operation, and normal shutdown of the facility. It receives off-site power service from the local utility, through five separate transformer feeds. Portions of the NPSS, which are part of the emergency electrical power system, can also receive power from the SGS. The loads on the NPSS are not required for safe shutdown of the facility. Therefore, NPSS is classified as nonsafety-related, with exceptions of four redundant safety-related breakers whose safety function is to disconnect power to certain plant equipment that does not perform an active safety function.

Emergency electrical power is required to maintain safe reactor shutdown, to support operation of a required engineered safety feature, and to protect the public from releases of radioactivity. It consists of safety-related UPSS and nonsafety-related SGS.

The UPSS provides a safety-related source of power to equipment required to achieve and maintain safe shutdown and to prevent or mitigate the consequences of design basis events. The UPSS consists of a battery subsystem, inverters, bypass transformers, distribution panels,

and other distribution equipment necessary to feed safety-related alternating current (AC) and direct current (DC) loads and select nonsafety-related AC and DC loads. The UPSS is the only power source of the Emergency Electrical Power System that is classified as safety related.

The SGS consists of a natural gas-driven generator that automatically starts and provides power to a NPSS transfer bus. It provides a temporary source of nonsafety-related alternate power to the UPSS and selected loads for operational convenience and defense-in-depth. The SGS automatically starts upon a loss of off-site power (LOOP). It is not required to support safe shutdown of the SHINE facility.

SER Summary

The SER documents the staff's evaluation of the applicant's design for compliance with applicable regulations and standards. The NRC staff evaluated the descriptions and discussions of SHINE's electrical power system. The staff determined that the functional characteristics of the NPSS and the emergency power system provide reasonable assurance that the final design will conform to the design basis. The staff also finds that the applicant's use of specific codes and standards provides reasonable assurance that the electrical power system meets SHINE's plant specific Design Criteria 4, 27 and 28. The staff concluded that the NPSS provides reasonable assurance that in the event of a loss or interruption of electrical power, the facility can be safely shutdown; and that, in the event of a loss of the NPSS, the UPSS provides reasonable assurance the SHINE facility can be maintained in a safe shutdown condition.

Based on the above determinations, the NRC staff found that the descriptions and discussions of SHINE's electrical power system 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. The staff provided in-depth review. The application was well documented; some opportunities for improving completeness are suggested in the additional inputs by Member Charles Brown, below.

We had a concern, the same as the staff, about SHINE classifying the UPSS as safety related, but not as Class 1E electrical. The staff issued requests for additional information to SHINE requesting the Codes and Standards used for the design and the classification of the UPSS. From the requests for additional information responses it was determined that, while SHINE does not apply the full-scope of Class 1E standards, portions of Class 1E standards are applied to the design of the UPSS in order to satisfy applicable SHINE design criteria. The staff found that the use of specific portions of the IEEE codes and standards provide assurance that the UPSS has sufficient capacity and capability to perform its intended safety function.

An additional concern is connected with various time delays related to the facility responses to LOOP events: loss of the NPSS and transfer of power to the UPSS. For example, the Primary Closed Loop Cooling System (PCLS) pumps are not powered by the UPSS or SGS; therefore, given a LOOP, PCLS flow to the Target Solution Vessel (TSV) will be lost. Loss of PCLS flow starts a three-minute timer. If PCLS flow is not restored within the three-minute duration, TSV Reactivity Protection System will initiate an IU Cell Safety Actuation, resulting in the TSV dump valves opening and the target solution draining from the TSV to the TSV dump tank. We understand the purpose of this three-minute delay in protecting the plant availability. However,

without corresponding human factor analysis or operating procedures, we could not conclude that a PCLS flow could be restored in such short time, even given a short recovery of a LOOP. The applicant has provided the calculations showing that the target solution will not reach a boiling point within three minutes after a loss of an active cooling, so that the three-minute delay in transferring to a passive pool cooling does not present a safety issue. Our other concern was that any operator action in a short time could create conditions for a human error which, in this case, could lead to a further delay in in the TSV dump valves opening. The applicant confirmed that the bypassing a signal leading to the TSV dump valves opening would be very unlikely to occur by an operator. Based on the provided information and discussions, it can be concluded that the three-minute delay in draining the target solution from the TSV to the TSV dump tank, after a LOOP, does not present a safety concern.

Implications of various time delays are still worthy of further review, and could be a subject of a cross-cut focus area review or addressed in subsequent chapter reviews.

Recommendation

As lead reviewer for SHINE Chapter 8, I concur with the staff evaluation that descriptions and discussions of SHINE's electrical power system meet the applicable regulatory requirements and guidance, and acceptance criteria, and are sufficient for the issuance of an operating license.

No additional actions from the staff or applicant are needed to complete our review of Chapter 8. The second concern discussed above, will be addressed in the subsequent chapters or focused area review.

Additional Input from Member Charles Brown

Member Brown recommends the following additions to Chapter 8 should be considered:

- Revise Figures 8a2.1-1 and 8a2.2-1 to show that AC UPSS C is shown to be connected by interlocked either/or AC circuit breakers (or automatic bus transfer unit), not hard connected as shown, to ensure that the off-site AC power sources are not paralleled. This would provide consistency with the DC UPSS C detail provided in Ch 7, relative to the specific call out of auctioneered for the DC UPSS C.

- Revise Section 8a2.2 to state that natural gas for the SGS is supplied from an off-site utility service natural gas supplier. Currently Chapter 8 only refers to the SGS as being supplied by natural gas. It could be on-site or off-site. If on-site, there needs to be more definition of how much storage is needed to meet needs.

- Incorporate the definition of "safe shutdown configuration" unde LOOP conditions. In response to a question, the client has stated that the plant is in "walk away" safe shutdown once when on redundant DC battery backed up systems. There are 3-minute and 5-minute stripping of the loads, specified to support the overall 2-hour complete shutdown condition. This could be done by referencing the Tech Specs Definition section for "Safe Shutdown". This information should be co-located in the chapter in which it is used.

References

1. U. S. Nuclear Regulatory Commission, “Electrical Power Systems,” Chapter 8, Staff Safety Evaluation Report, April 28, 2022 (ML22118A762).

2. Final Safety Analysis Report, Chapter 8, Electrical Power Systems, January 26, 2022 (ML22034A622).

3. Shine Medical Technologies, LLC, Application for an Operating License Response to Request for Additional Information, July 2, 2021 (ML21183A128).

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