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

September 23, 2022

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

FROM: Gregory H. Halnon, Member
Advisory Committee on Reactor Safeguards

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Date: 2022.09.23 16:07:59 -04'00'

SUBJECT: INPUT FOR ACRS REVIEW OF SHINE OPERATING LICENSE APPLICATION – SAFETY EVALUATION REPORT FOR CHAPTER 9, "AUXILIARY SYSTEMS," SECTION 9A.2.3, "FIRE PROTECTION SYSTEMS AND PROGRAMS"

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 (FSAR), for Chapter 9, Section 9a2.3, "Fire Protection Systems and programs." In addition, representatives from SHINE Medical Technologies, LLC (SHINE) met with the SHINE subcommittee on July 19-20, 2022, to discuss Fire Protection and Programs. The following is my recommended course of action concerning further review of this chapter and the staff's associated safety evaluation.

Background

The SHINE facility Fire Protection Plan (FPP) is comprised of the Fire Hazards Analysis (FHA), Safe Shutdown Analysis, Pre-Fire Plans, and Administrative Controls. The FPP conforms with Title 10 of the *Code of Federal Regulations* (10 CFR 50.48(a)) and Appendix A, Criterion 3. The plan description and associated evaluations are, for the most part, comprehensive and complete. The FPP has a traditional approach to fire safety with four elements of design/location, materials, fire detection and suppression, and firefighting systems effect on safety systems. In addition, the common defense-in-depth strategy of prevention, detection, and design for safe shutdown is employed.

The FHA separated the site into 25 discrete fire areas of analysis. Each area is discussed as to the fire safety considerations, combustible loading, and fire protection features (detection, suppression, passive). The Radiation Controlled Area (RCA) is specifically designed to limit, if not eliminate, the need for water suppression due to the risk of moderation of the low enriched uranium in the target solution. Fire suppression agents, primarily used in the RCA, include clean agents or inert gasses. Additionally, interface with operations and professional firefighters during firefighting activities is maintained to ensure no water is used inappropriately. Physical separation was able to be designed into the facility, greatly enhancing the fire risk margin. The description and analysis directly address the requirements in NUREG 1537, Parts 1 and 2.

SER Summary

The staff SER and associated Requests for Additional Information (RAIs) demonstrate a detailed review covering the most important aspects of fire scenarios (except as detailed below) and compliance with the requirements. In RAI 9-6, the staff probed the safe shutdown analysis, to ensure that the design and procedures are sufficient to provide for the safe shutdown of the SHINE facility in the event of fire. The key safe shutdown functions considered in the analysis include reactivity control, gas combustible gas control, target solution cooling and prevention of uncontrolled release of radioactive materials. The applicant stated there are no required safe shutdown functions that rely on only a single train. In the cases where multiple trains or divisional raceway routes are located in the same fire area, the specific shutdown separation criteria are considered in the analysis. Where these separation criteria could not be met, fire modeling was performed to determine that the redundant trains of equipment cannot be damaged by a single fire. Fire modeling was performed by using the Consolidated Model of Fire and Smoke Transport (CFAST) computational model.

In several other RAIs, the staff confirmed facility procedures, training, and design such that ignition control, combustible materials, fire ratings and features associated with suppression were adequate and appropriate for the systems. The conclusion of the SER affirmed reasonable assurance the FPP and associated analyses will not be adverse to common defense or health and safety of the public.

Based on the above determinations, the NRC staff found that the descriptions and discussions of the fire protection systems and programs are sufficient and meet the applicable regulatory requirements, guidance, and acceptance criteria, for the issuance of an operating license.

Concerns

I did not identify any specific deficiencies not meeting requirements of the review criteria although questions below could result in further discussion.

There are several areas where information is somewhat sparse and had to be explored during the subcommittee meeting.

1. The facility design basis includes the ability to withstand an aircraft impact from a reasonably sized airplane. The impact analysis shows no issue with impact to structural components of the facility. However, the FHA states the structural steel for the roof of the Main Production Facility is not fireproof, only covered in concrete. There is a lingering question of the consequences of the subsequent fire from aircraft fuel on the general area facility. The FHA does not address these consequences of this design basis event beyond the initial dynamic impact. Note this was also described as a concern for the Chapter 2 review.

2. Control of smoke and combustible gases was clearly described as being confined within the appropriate ventilation zones. However, there was no discussion on the ability or procedure for ejecting that smoke for re-entry activities and control of radioactive materials. During the subcommittee meeting, it was stated there are no pre-planned re-entry provisions or procedures. The re-entry plans would be developed ad hoc as part of the emergency plan implementation. Prudency dictates that some of the more radioactive areas with fire potentials should be assessed for safe smoke ejection.

3. There is no storage of fire water onsite. Hence, there is full dependence on the Janesville, WI city's municipal water system to supply all fire water needs. There is no mention of the reliability of this municipal system or the branch that feeds water to this area. Given the extreme weather where winter temperatures are routinely well below freezing, it seems that the reliability of the system should be known and assessed as adequate for ensuring the design criteria are met.

4. The FPP effectiveness beyond the incipient fire response by plant personnel depends largely on the use of offsite professional firefighters. The unique industrial processes, chemicals, materials, and hazards, both chemical and radiological, associated with the SHINE facility puts an added emphasis on the training of these non-SHINE personnel. The lack of involvement of Federal Emergency Management Administration in the All-Hazards planning process as well as the number of offsite personnel who may be trained adds a unique risk that is assumed by the local jurisdictions and licensee that is above what other nuclear facilities with onsite fire brigades realize. This also puts a tremendous importance on pre-fire plans pertaining to offsite professional firefighters, especially implementing the - training program for their use of the plan, establishing their protocols for interactions and clear communications with facility and operations personnel, and assuring maintenance of the documents. It was stated that fire exercises would be held every two years with the local fire department(s). This does not seem frequent enough given the importance placed on this key component of defense in depth. At least in the initial five years, it seems that annual exercises would be beneficial for better and timely familiarity with the facility and to validate the tactics assumed during the application phase of plant construction. In addition, SHINE training staff should consider providing a tour of the facility for key fire department professionals as part of their initial training program. Additionally, use of pictures, video technology, and other modern techniques for documenting spaces should be considered. This outreach and orientation experience would benefit both organizations.

5. There is presently no specifically dedicated fire marshal or staff position on the SHINE staff. During the subcommittee meeting, the SHINE staff expressed their intent to hire a fire protection engineer who would own the fire program under the Safety Analysis Manager. It was also stated they would rely on contract staff for technical issues and onsite general employee training for overall awareness during ongoing operations. Dedicated fire staff (full time or part time) provide ownership of the program and focus on fire prevention and response readiness. Given that a fire protection engineer is planned to be hired, it is expected this position will be the dedicated programmatic owner of all aspects of fire prevention and the readiness of both onsite and offsite responders. Without this position as the advocate for fire safety (much like a facility safety lead or corrective action program owner), a much higher management burden is placed on details of fire prevention and response. The implementing procedures and training program will be key to assuring a successful fire protection strategy.

6. In the response to RAI 9-6, the applicant stated that operators will be directed by procedure(s) and training to manually actuate the target solution vessel reactivity protection system (TRPS) and the engineered safety features actuation system (ESFAS) from the facility control room (assuming that TRPS or ESFAS had not already been actuated automatically). Some of these conditions that would require a manual trip are inability to control the fire, requiring off-site assistance or a degradation of facility control room habitability. For some conditions, a decision to trip is left to the discretion of the operator. These include loss of control or power to facility equipment causing erratic

7. indications, spurious equipment alarms and spurious operation of facility equipment. Timing of the trip actuation is difficult to determine under these conditions. This ambiguity could lead to a prolonged fire before a trip is initiated and the facility is put in safe shutdown (see bullet below). Again, the implementing procedures and training program will be key to assuring a successful safe shutdown strategy.

8. In some fire scenarios, the overall area heat-up due to the fire related heating ventilation and cooling system isolation, and the presence of the heat source in the specific area of concern, could reach equipment qualification temperature limits. This consideration may not be critical if the facility is put in a safe shutdown in a short period of time. In a case where there is a prolonged time to actuate a trip, the area heat up may prevent operation of the safety equipment required after actuation. For example, in Fire Area 2, the target solution off-gas system (TOGS) motor control center (MCC) hallway, even though the results from the CFAST computational model show that no potential fires are capable of damaging both divisions of TOGS MCCs, the general room heat up was not analyzed.

Recommendation

As lead reviewer for SHINE Chapter 9, Section 9a2.3, “Fire Protection Systems and Programs,” I recommend concerns/issues 1 through 7 above have further discussion and response at the appropriate opportunity.

References

1. U.S. Nuclear Regulatory Commission, “Fire Protection Systems and Programs,” Chapter 9, Section 9a.4.3, Staff Safety Evaluation Report, July 12, 2022 (ML22193A282).

2. SHINE Medical Technologies, LLC, Application for Operating License Supplement 14, Revision to Final Safety Analysis Report, Chapter 9, “Auxiliary Systems,” January 26, 2022 (ML22034A643).

3. SHINE Medical Technologies, LLC, Safe Shutdown Analysis, Revision 1, March 2022.

4. SHINE Medical Technologies, LLC, Response to Request for Additional Information, RAI 9-6, February 28, 2022 (ML22059A020).

5. U.S. Nuclear regulatory Commission, NUREG-1537, Part 1 and 2, “Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors,” February,1996.

6. U.S. Nuclear Regulatory Commission, “Fire Protection,” 10 CFR Part 48.

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