DOE O 420.2D, IRR #1c

Closeout Report of the IRR Committee

February 25, 2024

Executive Summary

At the request of Marc Clay, Deputy COO of the Fermi National Accelerator Laboratory (Appendix A), an Internal Readiness Review (IRR) was conducted January 23-25, 2024 at Fermilab. The Review team members are identified in Appendix B. The Review process included evaluating documentation, presentations by Fermilab staff, discussions with Fermilab staff, and tours of the facilities. The results of the Review Team's evaluation were provided to Fermilab Management and the Fermi Site Office in a closeout briefing on January 25, 2024.

A further discussion of the Team Findings, Comments, Recommendations, and Opportunities for Improvement, plus Noteworthy Practices, is included in this report.

The Team found that the documents provided were much improved over the initial evaluation of the materials performed in August, 2023. The documents, with only a few exceptions noticed in this Report, are in compliance with DOE Order 420.2D and with the Accelerator Safety Order Guide.

When the Pre-Start Recommendations are closed, it is the consensus of this Review Team that the facilities evaluated in this Review are ready to safely return to routine operations.

Findings

The wrought-iron fence surrounding the master electrical substation is an effective Credited Control. Signage should be evaluated to ensure requirements for content and spacing are met.

SpinQuest will be using a target made from polarized solid ammonia in the form of beads. The ammonia is kept under liquid nitrogen to stop sublimation. Weekly target changes are anticipated during operations. Spent targets will be returned to the University of Virginia for additional studies.

At some locations, an interlocked radiation monitor that is credited with promptly shutting off the Accelerator segment in the event of a serious incident to prevent exceeding dose limits in the Accelerator Safety Envelope (ASE) to the public and co-located workers is also used to ensure compliance with DOE dose limits to workers, which are far lower than the Incident limits. This practice is common among DOE Accelerators, but the Operator's response to an alarm must rapidly evaluate the radiation level that caused the instrument response to assess the potential ASE implications of the interlocked radiation monitor's action.

Comments

Labeling of Credited Controls is still in progress in a number of locations visited in the tours. Proper labeling is vital for Work Control and to ensure that Credited Control systems are not modified or damaged during maintenance and modifications. Some locations are easy to access and just need to be done when time and personnel are available. Other harder to access areas will need work plans and HAs (Hazard Awareness) in IMPACT to be completed. For example, some locations (such as penetrations located behind clustered beam pipes) may need ladders or lifts to access. For those areas currently inaccessible, more thought and planning will be required.

The Repetition Rate Monitor (RRM) deserves a Figure showing the location of the RRM in the ARR Presentation. This device is a Credited Control, and serves an important role to ensure that the beam operates within established limits without requiring Operator actions. Identifying the location and settings for the RMM in the presentation will assist the Review Team in understanding this important device.

When any Hazard is “checked” in a Plenary presentation, the location and use of the hazard should be briefly mentioned in the presentation. This practice will ensure that each identified Non-Accelerator Specific Hazard (NASH) is noted and discussed as appropriate, in the presentations. This Team recognizes the important balance between the information provided in a Review and the duration of presentations, so if discussing each NASH topic would excessively increase the length of the Plenary presentations, perhaps consider a brief summary presentation on the general NASH issues, and have special hazards included in the facility-specific presentations. To facilitate the review process, use the same order for hazards in all presentations, SADs, and risk tables..

The logical flow of the SAD and ASE for the Switchyard segment is not apparent. An additional segment for P1 and P2 exclusively would make the SAD and the ASE flow more logical and easier to follow. Ensure that the Figures clearly support the discussion.

SpinQuest will be using a target made from polarized solid ammonia in the form of beads. The target is loaded into a target insert stick in the NF4 hall and then transported into the NM3 target cave, with a maximum of 28.9 grams of ammonia. Weekly target changes are expected during operations. The spent targets are sent back to the University of Virginia for additional studies. Test runs have been accomplished using HDPE beads. Ten grams of material was received in December of 2023. Training has been developed for the SpinQuest team, with records kept in the form of a daily training log. Ammonia monitors have been installed with alarm points set at 25 ppm.

Taking “baby steps” with regards to the loading/ handling of the ammonia target is commendable and should continue. A number of procedures have been developed, and the team understands there is more work to be done. Fermilab Fire Department has collaborated on the development of the procedures.

The use of escape packs requires constant training to assure competence, and may provide a false sense of security. Workers involved should practice with the escape packs under duress, to determine the difference in air capacity (calm worker vs stressed worker). Consideration should be given to simply evacuating the space.

While procedures have been developed to assure that the ventilation system is locked “on”, there is not an alarm system to alert workers in case of a failure. Depending on workers to notice that the ventilation has stopped while they are concentrating on the task of working with the target is not optimal. Workers may be too involved in target loading

and not notice when something goes wrong. Scenario practice should include these types of failures.

Care needs to be taken when shipping the target, as it may be classified as a hazardous and radioactive material. Some shipping companies may not understand what they are handling, causing delays. Developing a relationship with the carrier that will handle the shipments to ensure a smooth process would be prudent.

Recommendations

Pre-Start #1: Label all Credited Controls in the tunnels and work areas prior to beginning operations.

Pre-Start #2: Complete the MCI analyses for segments lacking detailed mitigated exposure calculations and ensure that Credited Controls are consistent with the results.

Post-Start #1: Prior to the ARR, develop visuals for each presentation that clearly display the mitigated doses from the MCI at these segments, and the areas currently considered to be accessible to the public.

Post-Start #2: Consider creating an additional SAD segment for P1 and P2 exclusively, which will make the SAD and ASE flow more logically.

Post-Start #3: Prior to the ARR, determine the best Review process for evaluating proposed “post beam” activities and experiments, including the USI process. Present this proposal to the ARR Team in a session at the conclusion of the Accelerator ARR for their evaluation.

Noteworthy Practices

The Repetition Rate Monitor (RRM) is an effective Engineered Control for beam limits.

Practice on the Ammonia handling processes and engagement of the Fire Department and other organizations is an excellent undertaking.

Charge Questions

1.Have the Safety Assessment Document (SAD) Chapters and the Accelerator Safety Envelope (ASE) supporting the Muon Campus, Switchyard, Meson, and Neutrino Accelerator Segments and the Meson Experimental Area and Neutrino Experimental Area Operations (as noted in the list of applicable Chapters in the Charge) been updated to meet the requirements in DOE O 420.2D and address the recommendations from FSO, the ARR review team, and the DOE Assist team? Yes, pending completion of Pre-Start Recommendations

2. Is the methodology for determining the Maximum Credible Incident (MCI) clear in our updated documentation? Conditional Yes, following competition of Pre-Start Recommendations.

3. Are the Credited Controls, determined through the MCI, clear in our updated documentation? Yes, following completion of Pre-Start Recommendations

4. Have the performance elements for active engineered Credited Controls applicable to Fermilab Main Accelerator Muon Campus, Switchyard, Meson, and Neutrino Accelerator Segments been appropriately detailed into their respective SAD Chapters and flowed down into the Fermilab Main Accelerator ASE? Yes

5. Have our documents demonstrated that we have sufficient Credited Controls in place to ensure potential dose to the public is at or below acceptable levels? Yes

The following questions are specific to Neutrino and Neutrino Experimental Areas only:

6. Are the required hardware controls in place for presence of ammonia within the Neutrino Experimental Area? Yes

7. Are the procedures for handling and storage of the ammonia, within the Neutrino Experimental Area, on the path to be finalized and ready

Commented [JW1]: Recommend something here about the conditional--"See Prestart #2," or something like that.

Commented [MIG2R1]: Agree with John on this to give an actionable item

for ARR #1 for the Fermilab Main Accelerator in February? Conditional Yes; progress is impressive, but a concentrated effort involving Fermi and UVA organizations will be required to have the procedures fully vetted and staff trained.

Appendix A

Marc Clay letter (PDF)

Appendix B

Review Team

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Will Motto	ANL
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Observers

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