DOE O 420.2D, IRR #1b

Closeout Report of the IRR Committee

January 19, 1024

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 9-11, 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 11, 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 materials presented were significantly improved since the August 2023 ARR. The documents are more consistent between facilities, and the documents' outline was more effective at presenting the material in a useful manner.

Using a consistent template for the documents and the presentations is effective and very helpful to Reviewers and to Fermilab staff. Having consistent outlines allowed for a quick and effective comparison of key points between the various facilities, as well as presenting the conclusions in a similar manner.

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 Analyses) 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.

In the presentations and documentation, there was a lack of consistency regarding soil activation. There is a difference in the level of detail between the Soil Interactions sections of different SAD chapters, which can appear inconsistent to the reader. Additionally, in the Booster analysis, information on the potential for soil activation was missing altogether. “Soil Interactions” was not checked in the inventory of hazards in Section III-4.1.7 of the Booster SAD, and Section III-4.2.1.8 (Soil Interactions) was marked “N/A”. No reasoning is provided as to why this was omitted from the Booster analysis. This was also the case for the Booster PowerPoint presentation. A slide was provided later to give some additional detail on the Booster soil study samples, explaining that soil study samples contain traces of 3H and 22Na, but MARS Simulations and sump water monitoring indicated negligible levels. More consistent soil activation information between chapters,

and providing this information for the Booster, would improve clarity for the reader.

In the documents and presentations, at times it was difficult for the Review Team to understand how operating the facility within the parameters presented in the ASE would ensure that results of the Maximum Credible Incident analysis were applicable to the actual incident that might challenge the ASE limits. A brief but focused discussion on how the machine limits identified in the ASE will ensure that the impacts of the mitigated MCI are acceptable would be helpful to the reader of the document and to the Operations staff.

In some of the Safety Assessment Documents, the Operating Modes section (III-x.1.6) for a segment often includes a discussion of activities in upstream or downstream segments that are not immediately adjacent to the segment covered in the SAD chapter. This can be confusing to the reader. For example, in the Booster SAD, the discussion of HEP mode references the Muon area, 120 GeV Fixed Target HEP, and the Neutrino program. These are all downstream of the 8 GeV Line, and don't appear to impact Booster operations. (In addition, referencing 120 GeV activities is a potential source of confusion when the Booster is limited to 8 GeV.) The BNB SAD Chapter mentions only the Booster as its source of 8 GeV protons, omitting explicit mention of the 8 GeV Line. The description of beam transfer from the Booster to BNB via MI-8 suggests that the earlier version of the SAD was written before the 8 GeV Line had its own SAD Chapter, and much of the Operating Modes section was unchanged. The same is true of the Main Injector/Recycler Ring SAD Chapter, which also still refers to the 8 GeV Line as MI-8. In addition, the MI/RR SAD Chapter includes a reference to beam passing from MI-8 to BNB, which doesn't have any bearing on MI/RR operating modes. Focusing the SAD Chapter discussions on the Segment, and only the immediately adjacent upstream and downstream segments, would be helpful for clarity.

The removal of highly-activated components, such a horns and associated equipment in the NuMI Target Hall are conducted remotely, and the activated articles will be placed in a cask before being lifted to the surface for transport to an appropriate location. The committee highlighted the presentation during the risk matrix table for the NuMI Crane Operations and the committee also visited the NuMI underground Target Hall. It was described in the presentation that these hazards were evaluated to be common Risk Matrix table entries, however it was presented that NuMI involves remote handling activities of highly activated target equipment (50 R/hr unshielded, 400 mrem/hr within shielded coffin). As a unique Non-Accelerator Specific Hazard (NASH) within the NuMI SAD Chapter, it is recommended to give more explanation beyond referring to the common NASH Risk Matrix table (within the SAD Appendix C). Some minor details should be added to the Chapter such as the specific work planning and controls covered within other Laboratory safety programs. This should bring clarity to identifying and acknowledging the inherent risk of moving such activated components.

Recommendations

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

Pre-Start #2: Ensure that the ASE Accelerator Operating Parameter Credited Control value(s) accurately reflect the MCI analysis summarized in the SAD.

Pre-Start #3: Complete MCI analysis for each segment prior to beginning operations.

Post-Start #1: Ensure SAD Chapters accurately document soil activation hazard, or discuss why it is not applicable.

Post-Start #2: Clarify how the MCI parameters are presented/discussed in the SAD Chapters.

Post-Start #3: Discuss NuMI remote handling activities as a unique Non-Accelerator Specific Hazard (NASH) within the NuMI SAD Chapter rather than referring to the common NASH Risk Matrix table (within SAD Appendix C).

Post-Start #4: Rectify identified typos and suggested wording edits.

Opportunities for Improvement

Consider limiting discussions within the SAD Chapters to that segment and only the immediately upstream and downstream segments.

Ensure numbers in the calculations are accurate (considering rounding and significant figures).

Clarify that LOTO procedures are to be reviewed and updated annually, not ALL procedures.

Noteworthy Practices

The use of AI to locate the source of beam loss or a drift in the beam position should be very helpful in hot spots before a team provides a rad survey, and could be useful targeting and prioritizing maintenance activities.

Fermilab has developed training for staff that will screen proposed actions and as-found conditions for potential USIs. This is a good start, and a way to integrate the USI process in work planning activities.

Response to Charge Questions

1. Have the Safety Assessment Document (SAD) Chapters and the Accelerator Safety Envelope (ASE) supporting Booster, 8 GeV, Booster Neutrino Beam (BNB), Main Injector, Recycler and Neutrinos from the Main Injector (NuMI) 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? YES pending completion of pre-start recommendations
3. Are the Credited Controls, determined through the MCI, clear in our updated documentation? YES
4. Have the performance elements for active engineered Credited Controls applicable to Booster, 8 GeV, Booster Neutrino Beam (BNB), Main Injector, Recycler, and Neutrinos from the Main Injector (NuMI) (RSIS and radiation monitors) 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

Appendix A

Marc Clay letter (PDF)

Appendix B

Review Team

Michael Geelhoed	FNAL
Carrie McGivern	FNAL
Will Motto	ANL
John Woodford	ANL
Frank Kornegay	SNS (retired), chair

Observers

Rachel Madiar	FSO
Joe Cracco	BHSO