

DOE O 420.2D Phased Reviews: IRR #1c – Muon Campus, Switchyard, Meson and Meson Accelerator Segments, and Neutrino and Neutrino Experimental Areas Internal Readiness Review January 23-25, 2024

Charge

Background

Over the past several months, several updates have been made to the Fermilab accelerator safety documentation to align with new requirements in DOE O 420.2D, *Safety of Accelerators*, and address comments and recommendations provided by the Fermilab Site Office (FSO), the August 2023 Accelerator Readiness Review (ARR), and the September 2023 DOE Assist Visit. Fermilab will be conducting a series of reviews from November 2023 through March 2024 to ensure all aspects of accelerator safety are in place and meet the requirements and expectation to allow for safe operations of all accelerators under DOE O 420.2D.

In general, the following updates have been made:

- Fermilab SAD and ASE structure and layout has been updated,
- Incorporated updated methodology for analyzing non-accelerator specific hazards, generated a common risk matrix table in the SAD Appendix,
- Incorporated updated methodology for analyzing the Maximum Credible Incident (MCI) for the prompt ionizing radiation accelerator-specific hazard, and utilizing this methodology for determining Credited Controls,
- Identified Oxygen Deficiency Hazard (ODH) as an accelerator-specific hazard for applicable accelerator facilities,
- Incorporated ODH Controls, Radiation Monitors, and Search & Secure process as Credited Controls, and
- Developed an updated Unreviewed Safety Issue (USI) Program.

Fermilab had two accelerators operating under DOE O 420.2C. With the updated Order, three additional devices previously managed as Radiation Generating Devices (RGDs) will now be managed as accelerators. Each accelerator will conduct an Internal Readiness Review (IRR) that will focus on the updated Safety Assessment Document (SAD) Chapter and Accelerator Safety Envelope (ASE) specific to

that facility. Following the IRR, each accelerator will conduct an External Readiness Review (ARR) that will review all other aspects of accelerator safety required by DOE O 420.2D. Operations of several of the segments of the Fermilab Main Accelerator will resume following their respective IRRs. The full review schedule is as follows:

- IRR #1a – SAD/ASE Review for Fermilab Main Accelerator Common Chapters, Support Areas, and Linac & MTA Accelerator Segments
 - Linac & MTA Operations to follow IRR #1a.
- IRR #1b – SAD/ASE Review for Fermilab Main Accelerator Booster, 8 GeV, Booster Neutrino Beam (BNB), Main Injector, Recycler and Neutrinos from the Main Injector (NuMI) Accelerator Segments and the BNB & NuMI Experimental Areas
 - Booster, 8 GeV, Booster Neutrino Beam (BNB), Main Injector, Recycler and Neutrinos from the Main Injector (NuMI) operations to follow IRR #1b.
- IRR #1c – SAD/ASE Review for Fermilab Main Accelerator Muon Campus, Switchyard, Meson, and Neutrino Accelerator Segments and the Meson and Neutrino Experimental Areas
 - Muon Campus, Switchyard and Meson operations to follow IRR #1c.
- ARR #1 – Full ARR for the Fermilab Main Accelerator
 - Neutrino operations to follow IRR #1d and ARR #1.
- IRR #2 – SAD/ASE Review for the FAST Accelerator
- ARR #2 – Full ARR for the FAST Accelerator
- IRR #3 – SAD/ASE Review for the Test Stand Accelerators (CMTS1, PIP2IT, and VTS)
- ARR #3 – Full ARR for the Test Stand Accelerators (CMTS1, PIP2IT, and VTS)

Review Charge

This review is: IRR #1c – SAD/ASE Review for Fermilab Main Accelerator Muon Campus, Switchyard, Meson, and Neutrino Accelerator Segments and the Meson and Neutrino Experimental Areas

This IRR is a limited scope review focusing on the applicable SAD and ASE documents. This review will encompass the SAD Chapters that provide an overview of the Fermilab facilities and the SAD Chapters that address accelerator support facilities. The following is a list of applicable Chapters:

- SAD Section III – Fermilab Main Accelerator – Accelerator Segments
 - III-10 Muon Campus
 - III-12 Switchyard
 - III-13 Meson
 - III-14 Neutrino
- SAD Section IV – Fermilab Main Accelerator – Experimental Areas and Detectors
 - IV-3 Meson Switchyard 120 Experimental Areas
 - IV-9 Neutrino Switchyard 120 Experimental Areas

There have been no changes to the beamline or facility configuration for the Muon Campus, Switchyard and Meson Accelerator Segments, and only minor changes to the Neutrino Accelerator Segment (shortening of the very downstream end of the beam pipe).

Following the updated MCI analysis, additional radiation monitors have been identified as Credited Controls, however use of radiation monitors has been in place for previous operations. Additionally, an Engineered Credited Control will be added within the Radiation Safety Interlock System (RSIS) to limit the intensity. This has been used previously as a Defense-in-Depth, and will now become a Credited Control.

Following the inclusion of ODH as an accelerator-specific hazard within interlocked Exclusion Areas, components of the existing ODH Safety System within the Meson segment will become Credited Controls.

There has been no change to the facility configuration or management of experiments in the Meson Experimental Area.

Within the Neutrino Experimental Area, the target station and surrounding shielding have been updated to accommodate a new experiment, SpinQuest. The SpinQuest experiment will also introduce new hazards due to use of a frozen polarized ammonia target: use of ammonia and ODH. Use of ammonia, though unique, is handled as a non-accelerator specific hazard. The introduction of ODH will require Credited Controls, as it is within an interlocked Exclusion Area.

This committee is asked to review the updated documents noted above to verify they have addressed requirements in DOE O 420.2D and comments/recommendations from FSO, the August ARR, and the September DOE Assist visit. This committee is asked to verify that the SAD and ASE meets the requirements of DOE O 420.2D for the Muon Campus, Switchyard, Meson and Neutrino accelerator segments of the Fermilab Main Accelerator. This committee is also asked to verify that once the ASE has been approved by the Fermilab Site Office Manager, Muon Campus, Switchyard, and Meson segments of the Fermilab Main Accelerator are ready for operations under DOE O 420.2D. (Note that the Neutrino segment will not be resuming operations following this IRR.) The committee should present findings, comments, noteworthy practices, recommendations (specifically identifying any pre-start), and specific answers to the charge questions at a closeout meeting with Fermilab's management. A final written report is requested within two (2) weeks after the conclusion of the review.

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?
2. Is the methodology for determining the Maximum Credible Incident (MCI) clear in our updated documentation?
3. Are the Credited Controls, determined through the MCI, clear in our updated documentation?
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?
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?

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?
7. Are the procedures for handling and storage of the ammonia, within the Neutrino Experimental Area, on the path to be finalized and ready for ARR #1 for the Fermilab Main Accelerator in February?