DOE O 420.2D Phased Reviews: ARR #1 – Fermilab Main Accelerator

Accelerator Readiness Review

March 19-21, 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: ARR #1 – Fermilab Main Accelerator

This ARR is a full scope review of the Fermilab Main Accelerator to ensure compliance with the requirements in DOE O 420.2D. The segments and experimental areas that make up the Fermilab Main Accelerator include:

- Linac
- 400 MeV Test Area (MTA)
- Booster
- 8-GeV Line
- Booster Neutrino Beam (BNB)
    - MiniBooNE Detector
    - Short Baseline Neutrino Experimental Areas (SBND, MicroBooNE & ICARUS Experiments)
- Main Injector / Recycler
- Neutrinos from the Main Injector (NuMI)
    - NOvA Detector
    - Main Injector Neutrino Oscillation Search (MINOS) Hall Detectors
- P1-P2
- Muon Campus
- Switchyard
- Meson
    - Meson Experimental Area
- Neutrino
    - Neutrino Experimental Area

There have been no major changes to any of the accelerator segments of the Fermilab Main Accelerator. There have been no major changes to the experimental areas for BNB, NuMI, and Meson. As agreed upon by Fermilab and the Fermilab Site Office (FSO), resumption of accelerator operations to these segments and experimental areas are able to resume following their respective IRRs and closure of any pre-start findings. To date, Linac and MTA have resumed operations following IRR #1a and Director and FSO approval of ASE Revision 13. The Lab has closed out all pre-start recommendations from IRR #1b and is currently routing ASE Rev 14 for approvals, which will allow accelerator operations for Booster, 8-GeV, BNB, Main Injector, Recycler, and NuMI to resume in the coming days. The Lab is finalizing resolution to the pre-start recommendations from IRR #1c and anticipate routing of ASE Rev 15, for P1-P2, Muon Campus, Switchyard, Meson, and Neutrino, in the coming weeks.

The Neutrino Experimental Area was updated to include a new ammonia experimental target and surrounding shielding, but the beamline itself did not change. Accelerator operations of this segment will resume following the conclusion and closure of pre-start recommendations from this ARR #1.

This committee is asked to verify that the people, processes, and equipment in place to support continued safe operations of the Fermilab Main Accelerator are in compliance with the requirements of DOE O 420.2D. The committee is asked to present answers to the charge questions, and any findings (i.e., statements of fact based on what you were presented), comments (i.e., your opinions on the findings), noteworthy practices (i.e., elements you believe the Lab does well), opportunities for improvement (i.e., elements you believe are compliant but could be improved), and pre- and post-start recommendations (i.e., elements that must be addressed by the Lab to ensure compliance) at a closeout meeting with Fermilab's management. A final written report is requested within two weeks of the review.

Charge Questions

1. Do the updated Safety Assessment Document (SAD) Chapters and the Accelerator Safety Envelope (ASE) supporting Fermilab Main Accelerator Operations meet the requirements in DOE O420.2D?
2. Is the methodology for determining necessary Credited Controls based on the Maximum Credible Incident (MCI) analysis appropriate, and is it clear in our updated documentation?
3. Have our documents demonstrated that we have sufficient Credited Controls identified to ensure potential dose to the public is at or below acceptable levels?
4. Are the necessary Credited Controls in place to support safe operations of the Fermilab Main Accelerator?
5. Are the necessary program elements of DOE O 420.2d and the associated CRDs in place?
    - Clearly defined roles and responsibilities for accelerator activities including those for training and procedures.
    - A current listing/inventory of accelerators managed under this Order and exemptions or equivalencies to this Order.
    - A Safety Assessment Document (SAD)
    - A DOE approved Accelerator Safety Envelope (ASE)
    - A DOE approved Unreviewed Safety Issue (USI) Process; and
    - An Accelerator Readiness Review (ARR) process.
    - A Contractor Assurance System that maintains an internal assessment process
    - A Configuration Management Program that addresses accelerator safety
    - Credited controls and appropriate administrative processes related to accelerator safety (e.g., training, procedures, etc.)