

2017-2019 10 CFR 835 Triennial Assessment Elements

April 30, 2020

M. Quinn, D. Cossairt, M. Schoell

General Overview

During this triennium, high energy physics and accelerator technology at Fermilab remain active and continue to adapt toward the intensity frontier. As such several new facilities were brought on line. The Long Baseline Neutrino Facility (LBNF), being designed to deliver neutrinos to the Deep Underground Neutrino Experiment (DUNE) continues to be one of the lab's main focuses. Additionally the Proton Improvement Program (PIP-II) is being developed to function as the lab's source of proton beam for future experiments. Fermilab operations during this period centered on the exploitation of the neutrino sector of particle physics in the form of both short baseline and long baseline experiments, the latter with "far" detectors located in Minnesota. Other experiments and R&D efforts also exploiting accelerated proton beams were also conducted. The development of the Muon Campus facilities, first for the Muon g-2 experiment and for the later Mu2e experiment, continued during this time. The most recent Fermilab Radiation Protection Program (RPP) was approved by the DOE FERMI Site Office on December 3, 2018. The current RPP is posted at: <https://esh-docdb.fnal.gov:440/cgi-bin/ShowDocument?docid=88>. No exemptions to the requirements of 10 CFR Part 835 have been requested by Fermilab and none are anticipated to be needed in the foreseeable future. The RPP was updated to incorporate changes being made to accommodate the evolving Fermilab research and operational program and also the "leased space" for the far detector of the DUNE experiment at the Sanford Underground Research Facility (SURF) in Lead, South Dakota. During the CY2017-CY2019 triennium, all elements of the Radiation Protection Program (RPP) implemented at Fermilab were reviewed as required by 10 CFR 835.102. The implementation of radiation protection requirements continues to be effective as judged by the radiation exposures received, reported annually on time and as required to the DOE Radiation Exposure Monitoring System (REMS), the ALARA efforts documented, and the limited number of non-compliances that warranted submission to the DOE NTS system. This 2017-2019 triennial report is the latest in a series of such triennial reports that are posted on the ESH&Q docdb at: <https://esh-docdb.fnal.gov:440/cgi-bin/ShowDocument?docid=1557>.

Specialized Efforts Carried Out During This Triennium

This section of the report summarizes many of the lab-wide efforts initiated, and mostly completed, during this triennium to improve the radiological protection performance of the Laboratory. Some of these efforts are intrinsically “ongoing” by their nature. While some of these initiatives are restricted to the management of keeping occupational radiation exposures ALARA under the auspices of the Radiation Protection Program, others are more general and also implement important aspects of the Laboratory’s Environment, Safety and Health Management System under the Fermilab Contractor Assurance System (CAS) program. At Fermilab, a holistic approach is taken in the ESH&Q program.

Revisions to the FRCM

All but one chapter of FRCM was revised during this triennium. These changes reflect program improvements in D&D, posting requirements, interface with the Accelerator Safety Order, radiation generating devices, environmental radiation protection, shielding assessments, controlled accesses to accelerator enclosures, radioactive material handling and transportation, training, and safety system testing among others.

Chapter 2, January 2018

Chapter 3, January 2019

Chapter 4, July 2018

Chapter 5, February 2017

Chapter 6, October 2017

Chapter 7, June 2017

Chapter 8, October 2018

Chapter 9, January 2018

Chapter 10, June 2017

Chapter 11, June 2017

Glossary, January 2018

Discussion of Doses Received

Doses to workers during this triennium continue to show a decade long trend of decreases. <https://esh-docdb.fnal.gov/cgi-bin/sso/RetrieveFile?docid=1641&filename=Collective-Dose-Q4-2019.pdf&version=37>. This trend demonstrates the ongoing ALARA efforts by line organization and ESH workers. It is especially impressive when compared with increasing beam powers, specifically in the Booster, the Main Injector, and delivered to the NuMI and BNB targets, especially. Beam powers have nearly doubled in this time.

Events Motivating Follow Up Investigations

During this triennium there were no identified no non-compliances reportable to DOE under the Noncompliance Tracking System (NTS).

Two informational level Occurrence Reporting System (ORPs) related to radiation protection were submitted this triennium. In one incident, a worker entered began performing work in a high radiation area without being authorized to perform the job. They had received permission to inspect the equipment, but not perform subsequent work. The worker then transported radioactive material in their personal vehicle, in violation of Fermilab policy. Work in all Accelerator Division enclosures was stood down and an all-hands meeting was called in order to set expectations for work performance. There were a multitude of corrective actions, including updating rad worker training, signage, and job planning responsibilities. [Link to HPI.](#)

In the other incident, a tote containing tritiated water leaked several ounces of water while it was being transported to the waste disposal facility. The leak appeared to have originated from the valve collar of the tote. The process for preparing totes was updated to include better ways of securing the totes inside the trailer, and caulking the valve collars to prevent against any leaks. [Link to HPI.](#)

Several incidents that produced unwanted outcomes related to radiation protection and were investigated using the HPI process. While these two events did not rise to the level of DOE reportability, the investigations motivated self-examination of program improvement.

In one, several activated shield blocks were delivered to an area of the lab that was not posted as a radioactive material area. Several changes were made to the material move request (MMR) system, including notifying the RSO group whenever radioactive material is to be moved. [Link to HPI.](#)

In another incident, a worker received a laceration on their hand while performing an ALARA job. While the radiological aspects of the job were appropriately addressed, the PPE worn for the work was inadequate. The hazard analysis template for the department was updated to include better guidance for PPE selection, and the ALARA spreadsheet was updated to make the work description clearer. [Link to HPI.](#)

In 2017, a worker was issued an enclosure reset key, normally used for resetting enclosure interlocks, instead of an enclosure enter key. While there were provided with safety system protection during the enclosure entrance, it was the incorrect key for the type of access they were making. Changes to both the keys and the keylogger system were made to prevent this type of incident from occurring again. [Link to HPI.](#)

In 2018, during a routine safety walkthrough of an enclosure, two workers were found without required PPE. An all hands message was sent out to the division to reiterate the necessity of following PPE and RWP requirements. The PPE requirement was reviewed and found to still be necessary, and a new electronic RWP system was analyzed (and implemented in 2020). [Link to HPI.](#)

In another incident, a subcontractor was escorted into a building by a Fermilab worker without having the appropriate dosimetry or signing the RWP. One issue was that this work involved effort by one division to take place in the physical space controlled by another. Several improvements

were made, including updating division procedures to include appropriate Division Safety Officers in such work, and clarifying HA and RWPs for the area in question. [Link to HPI.](#)

During a routine inspection of the MC1 experimental hall during an access period (HB-key, not Controlled Access), the ESH Coordinator discovered that 5 users were inside the hall without the required dosimetry badges. They were all part of the same group installing additional insulation on the storage ring magnet. The dosimetry requirement was stated in the HB-key access RWP and all 5 personnel (who are rad worker trained) had signed the RWP that morning, but the nominal leader of the group had concluded that dosimetry wasn't required, since he knew that the quads and kickers were not operating at that time. He informed the others of that conclusion when one individual asked about the dosimetry requirement. Following the discovery of the RWP violation, the DSO and RSO were contacted. Changes were made to the HB-key issuing procedure to require that the person issuing keys visually verify that everyone receiving a key is wearing their dosimetry badge. A sign was added to the access door reminding entrants of the requirement. [Link to HPI.](#)

In another incident, a radiological vacuum was found being used by a subcontractor for a non-radiological purpose. Workers for two different divisions were performing work that required a HEPA vacuum for silica control. The division where the work was being performed did not have a HEPA vacuum, so the workers for the other division went to the controlled location at Site 40 to check out a radiological vacuum. The vacuum was clean (non-contaminated), but was being used outside of a radiological area. The process for issuing rad vacuums was formalized, and work supervision in the affected division was updated and formalized to better define roles and responsibilities. [Link to HPI.](#)

In 2019, a dosimetry badge was issued to a minor without proper approval, in violation of Fermilab policy. The investigation revealed several shortcomings in the onboarding of minors, and an easily ignored warning from the computer system that allows dosimetry badges to be issued. The minor was contacted and the badge returned before they entered a radiation area. Several improvements to Fermilab processes were made, including the training system, to prevent minors from taking trainings such as radiological worker, and the dosimetry issuing system to prevent issuing badges to minors. [Link to HPI.](#)

During a repair to a sump pump in an enclosure near a posted contamination area, workers were found to have inadequate PPE for the potential of contamination. As workers returned to discuss continuing with the job, it was decided their hands and feet should be wiped down to remove any possible contamination. No contamination was detected on the workers. Improvements to posting, RWP implementation, training, communication and contamination measurement have been made, and efforts in this area are ongoing. [Link to HPI.](#)

External Assessments

DOELAP Onsite Assessment

This assessment was performed in July 2018. The resulting accreditation documents are <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=4825>. There were several findings and recommendations related to program documentation. The corresponding iTrack Review ID is #49366.

Safeguards and Security Audit

This was conducted in August 2019. The corresponding iTrack Review ID is #51526. The MC&A program was reviewed and received favorable comments. There was one recommendation to name specific Material Balance Area custodians.

Office of Enterprise Assessments Work Planning and Control Assessment

The U.S. Department of Energy (DOE) Office of Worker Safety and Health Assessments, within the independent Office of Enterprise Assessments (EA), conducted a work planning and control (WP&C) assessment at Fermilab in February 2019. The assessment report is at: <https://esh-docdb.fnal.gov/cgi-bin/sso/RetrieveFile?docid=5221>. The corresponding iTrack Review ID is #50867. Radiation protection work planning and control was part of the scope of the review. There were no findings or recommendations for the Radiological Control Organization.

Internal Assessments

Reviews of Shielding Assessments to Match Upgrades in Accelerator Operations and Delivery of Beam to New Facilities (Ongoing) The review of shielding assessments is an ongoing task assigned to the Shielding Assessment Review Panel (SARP) of the Radiation Safety Subcommittee of the Fermilab ES&H Committee and is connected to the requirements of FRCM Chapter 8 (see discussion of the entire subcommittee's activities below). The SARP maintains a Sharepoint™ Site containing all of the shielding assessments reviewed and recommended for approval since April 2011, including those performed during this triennium;

Booster 1/2017

IARC/A2D2 4/2017

FAST 300 MeV 8/2017

Main Injector 1500 kW 5/2018

Muon g-2 3/2017

NuMI-NoVA 1.2 MW 8/2018

P3 to Switchyard 10/2017

P3 to Swichyard/IERC 11/2019

PIP2IT 11/2019

All shielding assessments are currently up-to-date and consistent with the approved Fermilab Accelerator Safety Assessment Document (SAD) which in turn supports the current version of the DOE-FSO approved Fermilab Accelerator Safety Envelope (ASE). The SAD and ASE are found at: <https://esh-docdb.fnal.gov:440/cgi-bin/ShowDocument?docid=1066>.

Muon Campus g-2 Accelerator Readiness Review

This the first ARR for the newly repurposed Muon Campus. The review was performed in March 2017. The report can be found at: <https://esh-docdb.fnal.gov/cgi-bin/sso/RetrieveFile?docid=3495>. The corresponding iTrack Review ID is #47146. There were four pre-start recommendations, two post start recommendations and five noteworthy practices noted by the committee.

IOTA/FAST Electron Injector Accelerator Readiness Review

This ARR was performed in September 2017, and was the second of three reviews to be performed at the FAST facility. The review can be found at: <https://esh-docdb.fnal.gov/cgi-bin/sso/RetrieveFile?docid=3746>. The corresponding iTrack Review ID is #47687. There were three pre start recommendations, no post start recommendations, and four noteworthy practices identified.

Internal Assessment of Fermilab Dosimetry Program

This was performed in December 2017. It can be found at: <https://esh-docdb.fnal.gov/cgi-bin/sso/RetrieveFile?docid=4038>. The corresponding iTrack Review ID is #48367. The assessment team found that all technical aspects of the Dosimetry Program are adequate and functioning well. There were 13 program improvements identified and two noteworthy practices identified.

FRCM Chapter 4 Implementation Assessment

This self-assessment was conducted to review the contents of Chapter 4 (Radioactive Materials) of the Fermilab Radiation Control Manual (FRCM) against the actual field practices and determine if any gaps existed. The review was performed in April 2018. The report is located at <https://esh-docdb.fnal.gov/cgi-bin/sso/RetrieveFile?docid=4274>. The corresponding iTrack Review ID is #48609. There were no findings and four opportunities for improvement identified.

FAST/IOTA ARR

This was the third in a series of ARRs performed for the FAST/IOTA facility. This review was for beam injection into the IOTA storage ring. The review was performed in July 2018 and can

be found at <https://esh-docdb.fnal.gov/cgi-bin/sso/RetrieveFile?docid=4534>. The corresponding iTrack Review ID is #49126. There were 6 pre-start findings, 1 post-start finding, and three noteworthy practices identified.

Pyrophoric Metals Self-Assessment

The scope of this assessment was to identify metal materials of concern (i.e. metal materials that are either potentially pyrophoric under certain conditions or reactive with other materials), assess the adequacy of existing programmatic controls, conduct an inspection of the stored materials areas and understand the disposition strategies for materials identified as "no defined use." In addition, this assessment sought to confirm that materials of concern are all accounted for and managed at Fermilab. This was completed in April 2018. It is located at <https://esh-docdb.fnal.gov/cgi-bin/sso/RetrieveFile?docid=4235>. The corresponding iTrack Review ID is #48588. There was one non-conformance and 6 opportunities for Note: FESHM 6010 was revised in September 2019 to incorporate provisions pertaining to pyrophoric materials.

Source Use and Storage Self Assessment. May 2018. The report can be found at: <https://esh-docdb.fnal.gov/cgi-bin/sso/RetrieveFile?docid=4422>. The iTrack items are at: <https://www-esh.fnal.gov/pls/cert/iTrack.flist?rid=48948>. There were two instances of source users not signing the sign out sheets that were corrected in the course of the assessment. One opportunity for improvement and one noteworthy practice were identified.

High Dose Radioactive Material Storage

This was to review the strategy plan for the C0 long term storage facility for the highly radioactive items delivered to that facility and prepared there for reuse and or disposal, and was completed in September 2019. The report is located at: <https://esh-docdb.fnal.gov/cgi-bin/sso/ShowDocument?docid=5295>. There was one management concern, four recommendations, and three best practices identified. The corresponding iTrack Review ID is #51247.

ONGOING PROGRAM STRENGTHS

FESHCom and Its Subcommittees The Fermilab Environment, Safety, and Health Committee (FESHCom) and its subcommittees provide an integrated committee structure for coordinating the Laboratory's program in environment, safety, and quality. The monthly FESHCom meetings, with periodic presentations by the Chair of each of its subcommittees, are a venue for sharing information in a multidisciplinary manner. The Radiation Safety Subcommittee and related Tritium Task Force of this body continues to serve as a valuable forum for both technical experts and citizen members in promoting improvements to the Laboratory's program in radiation protection and thus comprises part of this internal assessment program. The monthly meetings of the Radiation Safety Subcommittee constitute an important part of program implementation, provide a forum for ongoing identification and resolution of problem areas, and give a connection to the overall Fermilab ES&H program. During this triennium, the Shielding Assessment Review Panel, Tritium Task Force, and Safety Assessment Document Review subcommittees have contributed directly to the radiation protection program. Also, many members of the Radiation Safety Subcommittee and the Environmental Protection Subcommittees continue to work together to identify and mitigate radiological problems at the Laboratory. FESHCom minutes, including the reports of its subcommittees are available at: <http://esh.fnal.gov/xms/Resources/FESHCom>. All subcommittee minutes are available to the entire Fermilab community. Those of the Radiation Safety Subcommittee are distributed to division/section/project heads.

Effectiveness of ALARA Efforts. The implementation of radiation protection requirements continues to be effective as judged by the radiation exposures received, reported annually on time and as required to the DOE REMS system, and the lack of significant noncompliances with radiation protection requirements or radiation-related environmental protection requirements. The efforts to maintain radiation doses ALARA is one that is carried out by many people at Fermilab as it cannot be accomplished by the radiation protection personnel alone. This group includes the staff of the Radiological Control Organization, including; engineers throughout the Laboratory, accelerator physicists, Accelerator Division leadership in planning for extensive shutdowns in which to effect improvements, the Accelerator Division Operations Group and many personnel of other Laboratory divisions. Partnerships with other groups in the ES&H Section are also very fruitful in achieving these objectives. Specific ALARA plans are documented and maintained by the Radiation Safety Officer(s) (RSOs) and/or the Radiological Control Technician(s) (RCTs) involved with the work.