PROTON AREA

SECTION III CHAPTER 15 OF THE FERMILAB SAD

Revision 0 month dd, yyyy

This Chapter of the Fermilab Safety Assessment Document (SAD) contains a summary of the results of the Safety Analysis for the Proton Area of the Fermi Main Accelerator that are pertinent to understanding the risks to the workers, the public, and the environment due to its operation.

SAD Chapter Review

This Section III, Chapter 15 of the Fermi National Accelerator Laboratory (Fermilab) Safety Assessment Document (SAD), *Proton Area*, was prepared and reviewed by the staff of the Accelerator Directorate, Beams Division, External Beams Delivery Department in conjunction with the Environment, Safety & Health Division (ESH) Accelerator Safety Department.

Signatures below indicate review of this Chapter, and recommendation that it be approved and incorporated into the Fermilab SAD.

☐ ______________________________________
Line Organization Owner

☐ ______________________________________
Accelerator Safety Department Head

☐ ______________________________________
SAD Review Subcommittee Chair

☐

Revision History

Printed versions of this Chapter of the Fermilab Safety Assessment Document (SAD) may not be the currently approved revision. The current revision of this Chapter can be found on ESH DocDB #1066 along with all other current revisions of all Chapters of the Fermilab SAD.

Author	Rev. No.	Date	Description of Change
Paul Allcorn	0	August 7, 2023	• Initial issue of the Proton Area SAD Chapter

Table of Contents

Acronyms and Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
ACNET	Accelerator Control Network System
AD	Accelerator Directorate
AHJ	Authority Having Jurisdiction
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
APS-TD	Applied Physics and Superconducting Technology Directorate
ARA	Airborne Radioactivity Area
ASE	Accelerator Safety Envelope
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASO	Accelerator Safety Order, referring to DOE O 420.2D *Safety of Accelerators*
^{7}Be	Beryllium-7
BLM	Beam Loss Monitor
BNB	Booster Neutrino Beam
BPM	Beam Position Monitor
BY	Boneyard
CA	Controlled Area
CA	Contamination Area
CAS	Contractor Assurance System
CC	Credited Control
CCL	Coupled Cavity Linac
CDC	Critical Device Controller
CERN	European Organization for Nuclear Research
CFM	Cubic Feet per Minute
CFR	Code of Federal Regulations (United States)
Ci	Curie
CLW	Co-Located Worker (the worker in the vicinity of the work but not actively participating)
cm	centimeter
CPB	Cryogenics Plant Building
CSO	Chief Safety Officer
CUB	Central Utility Building
CW	Continuous Wave
CX	Categorically Excluded
D&D	Decontamination and Decommissioning
DA	Diagnostic Absorber
DAE	Department of Atomic Energy India

DCS	Derived Concentration Standard
DocDB	Document Database
DOE	Department of Energy
DOT	Department of Transportation
DR	Delivery Ring
DSO	Division Safety Officer
DSS	Division Safety Specialist
DTL	Drift Tube Linac
DUNE	Deep Underground Neutrino Experiment
EA	Environmental Assessment
EA	Exclusion Area
EAV	Exhaust Air Vent
EENF	Environmental Evaluation Notification Form
EMS	Environmental Management System
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
ES&H	Environment, Safety and Health
Fermilab	Fermi National Accelerator Laboratory, see also FNAL
FESHCom	Fermilab ES&H Committee
FESHM	Fermilab Environment, Safety and Health Manual
FHS	Fire Hazard Subcommittee
FIRUS	Fire Incident Reporting Utility System
FNAL	Fermi National Accelerator Laboratory, see also Fermilab
FODO	Focus-Defocus
FONSI	Finding of No Significant Impact
FQAM	Fermilab Quality Assurance Manual
FRA	Fermi Research Alliance
FRCM	Fermilab Radiological Control Manual
FSO	Fermilab Site Office
FW	Facility Worker (the worker actively performing the work)
GERT	General Employee Radiation Training
GeV	Giga-electron Volt
^{3}H	Tritium
HA	Hazard Analysis
HAR	Hazard Analysis Report
HCA	High Contamination Area
HCTT	Hazard Control Technology Team
HEP	High Energy Physics
HFD	Hold for Decay

HLCF	High Level Calibration Facility
HPR	Highly Protected Risk
Hr	Hour
HRA	High Radiation Area
HSSD	High Sensitivity Air Sampling Detection
HVAC	Heating, Ventilation, and Air Conditioning
HWSF	Hazardous Waste Storage Facility
Hz	Hertz
IB	Industrial Building
IBC	International Building Code
ICW	Industrial Cooling Water
IEPA	Illinois Environmental Protection Agency
IEEE	Institute of Electrical and Electronics Engineers
INFN	Istituto Nazionale di Fisica Nucleare
IMPACT	Integrated Management Planning and Control Tool
IPCB	Illinois Pollution Control Board
IQA	Integrated Quality Assurance
ISD	Infrastructure Services Division
ISM	Integrated Safety Management
ITNA	Individual Training Needs Assessment
KeV	kilo-electron volt
kg	kilo-grams
kW	kilo-watt
LBNF	Long Baseline Neutrino Facility
LCW	Low Conductivity Water
LHC	Harge Hadron Collider
LLCF	Low Level Calibration Facility
LLWCP	Low Level Waste Certification Program
LLWHF	Low Level Waste Handling Facility
LOTO	Lockout/Tagout
LPM	Laser Profile Monitor
LSND	Liquid Scintillator Neutrino Detector
LSO	Laser Safety Officer
m	meter
mA	milli-amp
MABAS	Mutual Aid Box Alarm System
MARS	Monte Carlo Shielding Computer Code
MC	Meson Center
MC&A	Materials Control and Accountability

MCR	Main Control Room
MEBT	Medium Energy Beam Transport
MEI	Maximally Exposed Individual
MeV	Mega-electron volt
MI	Main Injector
MINOS	Main Injector Neutrino Oscillation Search
MMR	Material Move Request
MOI	Maximally-Exposed Offsite Individual *(Note: due to the Fermilab Batavia Site being open to the public, the location of the MOI is taken to be the location closest to the accelerator that is accessible to members of the public.)*
MP	Meson Polarized
mrad	milli-radian
mrem	milli-rem
mrem/hr	milli-rem per hour
MT	Meson Test
MTA	400 MeV Test Area
MTF	Magnet Test Facility
^{22}Na	Sodium-22
NC	Neutrino Center
NE	Neutrino East
NEC	National Electrical Code
NEPA	National Environmental Policy Act
NESHAPS	National Emissions Standards for Hazardous Air Pollutants
NFPA	National Fire Protection Association
NM	Neutrino Muon
NMR	Nuclear Material Representative
NOvA	Neutrino Off-axis Electron Neutrino (ve) Appearance
NPH	Natural Phenomena Hazard
NRTL	Nationally Recognized Testing Laboratory
NIF	Neutron Irradiation Facility
NTSB	Neutrino Target Service Building, see also TSB
NuMI	Neutrinos at the Main Injector
NW	Neutrino West
ODH	Oxygen Deficiency Hazard
ORC	Operational Readiness Clearance
OSHA	Occupational Safety and Health Administration
pCi	pico-Curie
pCi/mL	pico-Curie per milliliter
PE	Professional Engineer

PIN	Personal Identification Number
PIP	Proton Improvement Plan
PIP-II	Proton Improvement Plan - II
PHAR	Preliminary Hazards Analysis Report
PPD	Particle Physics Directorate
PPE	Personnel Protective Equipment
QA	Quality Assurance
QAM	Quality Assurance Manual
RA	Radiation Area
RAF	Radionuclide Analysis Facility
RAW	Radioactive Water
RCT	Radiological Control Technician
RF	Radio-Frequency
RFQ	Radio-Frequency Quadrupole
RIL	RFQ Injector Line
RMA	Radioactive Material Area
RMS	Root Mean Square
RPCF	Radiation Physics Calibration Facility
RPE	Radiation Physics Engineering Department
RPO	Radiation Physics Operations Department
RRM	Repetition Rate Monitor
RSI	Reviewed Safety Issue
RSIS	Radiation Safety Interlock System
RSO	Radiation Safety Officer
RWP	Radiological Work Permit
SA	Shielding Assessment
SAA	Satellite Accumulation Areas
SAD	Safety Assessment Document
SCF	Standard Cubic Feet
SCFH	Standard Cubic Feet per Hour
SEWS	Site-Wide Emergency Warning System
SNS	Spallation Neutron Source
SR	Survey Riser
SRF	Superconducting Radio-Frequency
SRSO	Senior Radiation Safety Officer
SSB	Switchyard Service Building
SSP	Site Security Plan
SWIC	Segmented Wire Ionization Chambers
TLM	Total Loss Monitor

TLVs	Threshold Limit Values
TPC	Time Projection Chamber
TPES	Target Pile Evaporator Stack
TPL	Tagged Photon Lab
TSB	Target Service Building, see also NTSB
TSCA	Toxic Substances Control Act
TSW	Technical Scope of Work
T&I	Test and Instrumentation
UPB	Utility Plant Building
UPS	Uninterruptible Power Supply
USI	Unreviewed Safety Issue
VCTF	Vertical Cavity Test Facility
VHRA	Very High Radiation Area
VMS	Village Machine Shop
VMTF	Vertical Magnet Test Facility
VTS	Vertical Test Stand
WSHP	Worker Safety and Health Program
μs	micro-second

III-15. Proton Area

III-15.1. Introduction

This Section III, Chapter 15 of the Fermi National Accelerator Laboratory (Fermilab) Safety Assessment Document (SAD), covers the Proton Area segment for the Fermilab Main Accelerator (Accelerator Segment).

III-15.1.1 Purpose/Function

The service buildings, experimental halls, and associated support buildings have been repurposed; the tunnels will be decommissioned as resources allow.

III-15.1.2 Current Status

The Proton Line is currently Non-Operational.

III-15.1.3 Description

The Proton Area encompasses the tunnels, service buildings, experimental halls, and other structures which had been associated with the experimental programs in that area. Although the original proton beamline started in Switchyard Enclosure B, the beamline has since been disconnected and decommissioned. For the purposes of this SAD Chapter, the Proton Area begins at the interface of Switchyard Enclosures E and J and continues to the ends of the Proton East (PE), Proton Center (PC), Proton West (PW) and Wide Band beamline enclosures.

III-15.1.4 Location

The Proton Area for the Fermilab Main Accelerator is located on the Fermilab site in Batavia, IL.

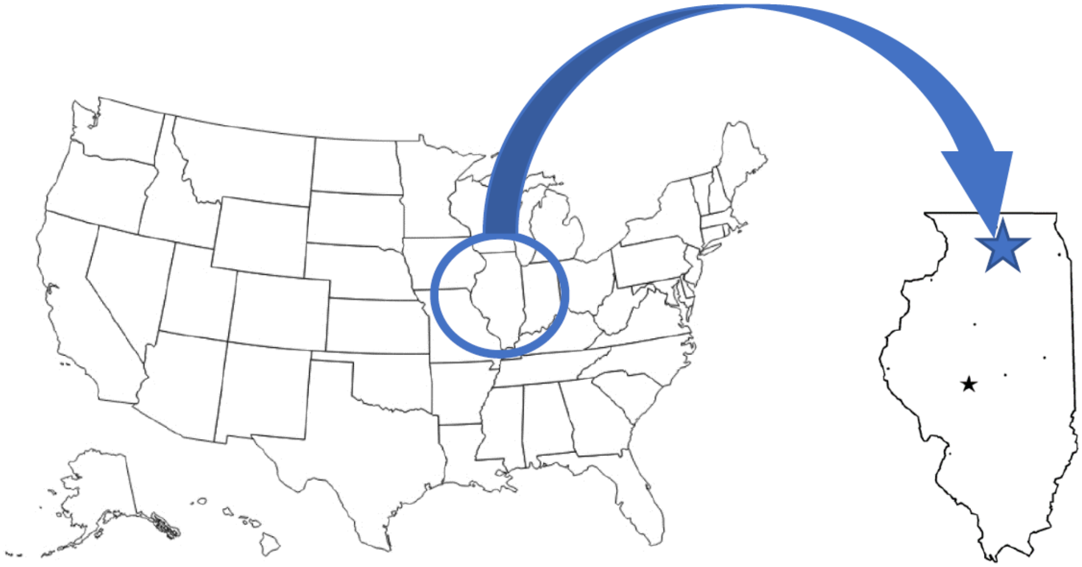

Figure 1. Regional view showing the location of the Fermilab site in Batavia, IL.

The following aerial photograph shows the location of the Proton Beam Line in relationship to the Fermilab site.

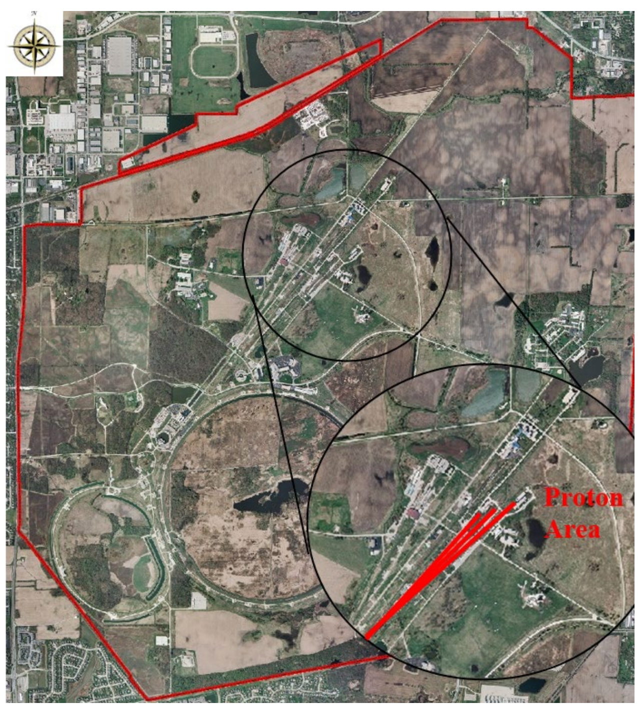

Figure 2. Aerial view of the Fermilab site, indicating the location of the Proton area .

III-15.1.5 Management Organization

Management of the individual areas is shown in the figure below.

The Accelerator buildings are managed by Accelerator Directorate, Beams Division, External Beam Delivery Department.

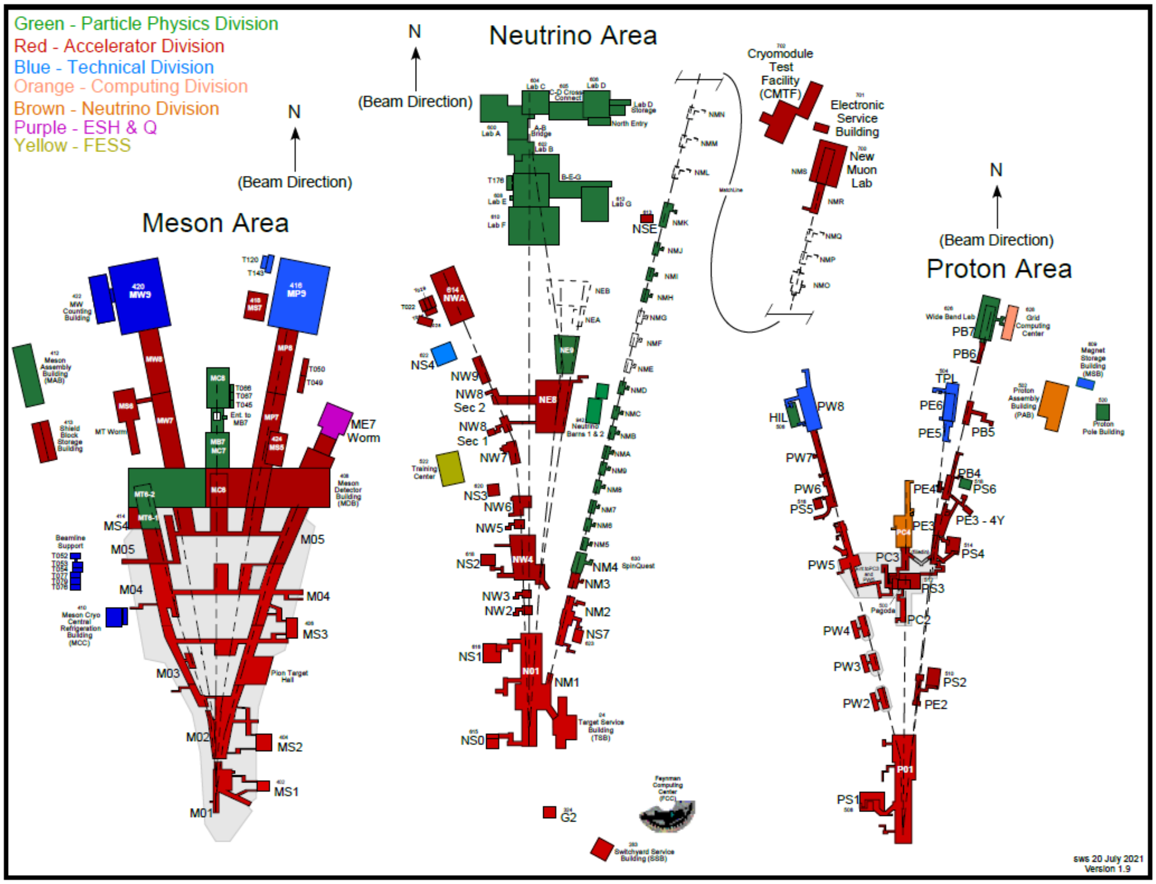

Figure 3. Management Ownership of the Switchyard Beamlines, including Proton Area.

III-15.1.6 Operating Modes

N/A

III-15.1.7 Inventory of Hazards

The following table lists all of the identified hazards found in the Proton Area enclosure and support buildings. Section III-15.10 *Appendix – Risk Matrices* describes the baseline risk (i.e., unmitigated risk), any preventative controls and/or mitigative controls in place to reduce the risk, and residual risk (i.e., mitigated risk) for facility worker, co-located worker and Maximally Exposed Offsite Individual (MOI) (i.e., members of the public). A summary of these controls is described within Section III-15.2 *Safety Assessment.*

Prompt ionizing, Oxygen Deficiency Hazards due to cryogenic systems within accelerator enclosures, and fluorinert byproducts due to use of fluorinert that is subject to particle beam have been identified as accelerator specific hazards, and as such their controls are identified as Credited Controls. The analysis of these hazards and their Credited Controls will be discussed within this SAD Chapter, and their Credited Controls summarized in the Accelerator Safety Envelope for the Fermilab Main Accelerator. Accelerator specific controls are identified as **purple/bold** throughout this Chapter.

All other hazards present in the Proton Area are safely managed by other DOE approved applicable safety and health programs and/or processes, and their analyses have been performed according to applicable DOE requirements as flowed down through the Fermilab Environment, Safety and Health Manual (FESHM). These hazards are considered to be Standard Industrial Hazards (SIH), and their analysis will be summarized in this SAD Chapter.

Table 1. Hazard Inventory for Proton Area.

Radiological		**Toxic Materials**	
☐	**Prompt Ionizing Radiation**	☒	Lead
☒	Residual Activation	☒	Beryllium
☒	Groundwater Activation	☐	**Fluorinert & Its Byproducts**
☐	Surface Water Activation	☐	Liquid Scintillator Oil
☐	Radioactive Water (RAW) Systems	☐	Pseudocumene
☐	Air Activation	☐	Ammonia
☐	Closed Loop Air Cooling	☐	Nanoparticle Exposures
☐	Soil Interactions	**Flammables and Combustibles**	
☒	Radioactive Waste	☒	Combustible Materials (e.g., cables, wood cribbing, etc.)
☒	Contamination	☒	Flammable Materials (e.g., flammable gas, cleaning materials, etc.)
☐	Beryllium-7	**Electrical Energy**	
☐	Radioactive Sources	☐	Stored Energy Exposure
☐	Nuclear Material	☒	High Voltage Exposure
☐	Radiation Generating Devices (RGDs)	☒	Low Voltage, High Current Exposure
☐	Non-Ionizing Radiation Hazards	**Kinetic Energy**	
Thermal Energy		☒	Power Tools
☐	Bakeouts	☒	Pumps and Motors
☐	Hot Work	☐	Motion Tables
☐	**Cryogenics**	☒	Mobile Shielding
Potential Energy		**Magnetic Fields**	
☒	Crane Operations	☐	Fringe Fields
☐	Compressed Gasses	**Other Hazards**	
☐	Vacuum/Pressure Vessels/Piping	☒	Confined Spaces
☐	Vacuum Pumps	☐	Noise
☒	Material Handling	☐	Silica
Access & Egress		☒	Ergonomics
☒	Life Safety Egress	☐	Asbestos

III-15.2. Safety Assessment

All hazards for the Proton Area of the Fermilab Main Accelerator are summarized in this section, with additional details of the analyses for accelerator specific hazards.

III-15.2.1 Radiological Hazards

The Proton Area presents radiological hazards in the form of residual activation, groundwater activation, radioactive waste, and contamination. These hazards with controls that comply with the Fermilab Radiological Control Manual (FRCM)[1].

III-15.2.1.1 Prompt Ionizing Radiation

Prompt ionizing radiation is not an identified hazard. The Tevatron is non-operational.

III-15.2.1.2 Residual Activation

Residual radiation due to past activation of beam line components remains. Residual radiation can give rise to radiation exposures to personnel during accesses to the beam enclosures for repair, maintenance, decommissioning and inspection activities.

In most situations, general RWPs for accesses will suffice. A job-specific RWP and/or an ALARA ("as-low-as-reasonably-achievable") plan will be required for work on any highly activated or contaminated equipment per Fermilab Radiological Control Manual (FRCM) requirements. These tasks will be supervised by members of the Radiological Control Organization under the direction of the assigned Radiation Safety Officer (RSO).

The Radiation Survey, dated August 11, 2002, indicates that the highest residual dose rate is 3 mrem/hr at 1 foot. This is located at the PB4 target pile.

Assuming 2000 hours of exposure, the dose received would be 6,000 mrem (6 rem) at 1 foot. This is the baseline dose (consequence) assumed for workers (W) and co-located workers (CW). This value is scored as a medium consequence (M).

Assuming 8670 hours of exposure, the received dose would be 26,280 mrem (26 rem) at 1 foot. This is the baseline dose (consequence) assumed for a maximally exposed individual (MOI). Public access to the PB4 enclosure is excluded by locked doors and locked gates beyond the doors, making MOI access beyond-extremely-unlikely (BEU) as the baseline likelihood. This results in baseline risk IV.

Because the tunnels are inaccessible to the public, credit may be taken for the tunnel walls and overburden. Using the tenth-layer-value for concrete (0.8717 m), a calculation indicated that the 12 inch-thick concrete walls, provide sufficient shielding to attenuate the yearly (8760 hour) dose to 12 rem. This mitigative measure reduces the residual risk to medium (M), lowering the overall residual risk score to IV.

III-15.2.1.3 Groundwater Activation

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.1.4 Surface Water Activation

N/A.

III-15.2.1.5 Radioactive Water (RAW) Systems

N/A.

III-15.2.1.6 Air Activation

N/A

III-15.2.1.7 Closed Loop Air Cooling

N/A

III-15.2.1.8 Soil Interactions

N/A.

III-15.2.1.9 Radioactive Waste

Radioactive waste produced in the course of the Proton Area operations will be managed within the established Radiological Protection Program (RPP) and as prescribed in the Fermilab Radiological Control Manual (FRCM).

Radioactive waste is a standard radiological hazard that is managed within the established Radiological Protection Program (RPP) and as prescribed in the Fermilab Radiological Control Manual (FRCM). Waste minimization is an objective of the equipment design and operational procedures. Although production of radioactive material is not an operational function of the Proton Area beam loss and, in the case of some beam diagnostics devices, intentional interception of the beam will result in activation of beam line elements. Reuse of activated items will be carried out when feasible. Activated items that cannot be reused will be disposed of as radioactive waste in accordance with the FRCM requirements.

The Proton Area is non-operational; radioactive waste is not being generated.

III-15.2.1.10 Contamination

The radiation survey conducted August 11, 2002, found no accessible contamination. Beam has not been transported since then. This reduces the baseline likelihood to “beyond extremely unlikely”; baseline consequence is “negligible”. The mitigative measures, “frisk upon exit” and “survey material”, remain in place. Before work is conducted, additional preventative and mitigative measures will be determined through a job-specific hazard analysis.

III-15.2.1.11 Beryllium-7

N/A.

III-15.2.1.12 Radioactive Sources

N/A.

III-15.2.1.13 Nuclear Material

N/A.

III-15.2.1.14 Radiation Generating Devices (RGDs)

N/A.

III-15.2.1.15 Non-Ionizing Radiation Hazards

N/A.

III-15.2.2 Toxic Materials

III-15.2.2.1 Lead

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.2.2 Beryllium

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.2.3 Fluorinert & Its Byproducts

N/A.

III-15.2.2.4 Liquid Scintillator Oil

N/A.

III-15.2.2.5 Pseudocumene

N/A.

III-15.2.2.6 Ammonia

N/A.

III-15.2.2.7 Nanoparticle Exposures

N/A.

III-15.2.3 Flammables and Combustibles

III-15.2.3.1 Combustible Materials

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.3.2 Flammable Materials

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.4 Electrical Energy

The AD DSO has applied administrative locks on the power supplies to limit the ability to send power into the tunnel.

III-15.2.4.1 Stored Energy Exposure

N/A.

III-15.2.4.2 High Voltage Exposure

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.4.3 Low Voltage, High Current Exposure

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.5 Thermal Energy

Hazards associated with thermal energy are not present in the Proton Area. The Proton Area is non-operational.

III-15.2.5.1 Bakeouts

N/A.

III-15.2.5.2 Hot Work

N/A.

III-15.2.5.3 Cryogenics

N/A.

III-15.2.6 Kinetic Energy

Hazards associated with kinetic energy include the use of power tools, and motors and pumps. "Mobile Shielding" is no longer "shielding", per se, as the Proton Area is non-operational. However, the hazards associated with moving the items remain.

III-15.2.6.1 Power Tools

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.6.2 Pumps and Motors

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.6.3 Motion Tables

N/A.

III-15.2.6.4 Mobile Shielding

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.7 Potential Energy

Hazards associated with potential energy include crane operation.

III-15.2.7.1 Crane Operations

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.7.2 Compressed Gasses

N/A.

III-15.2.7.3 Vacuum/Pressure Vessels/Piping

N/A.

III-15.2.7.4 Vacuum Pumps

N/A.

III-15.2.7.5 Material Handling

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.8 Magnetic Fields

The Proton Area is non-operational. Powered magnets have been de-energized; permanent magnets are not present.

III-15.2.8.1 Fringe Fields

N/A.

III-15.2.9 Other Hazards

Routine operations are limited to maintenance, such as sump pump repair/replacement.

III-15.2.9.1 Confined Spaces

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.9.2 Noise

N/A.

III-15.2.9.3 Silica

N/A.

III-15.2.9.4 Ergonomics

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.9.5 Asbestos

N/A.

III-15.2.9.6 Working at Heights

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.10 Access & Egress

III-15.2.10.1 Life Safety Egress

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.11 Environmental

III-15.2.11.1 Hazard to Air

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.11.2 Hazard to Water

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.2.11.3 Hazard to Soil

This hazard has been evaluated within the common Risk Matrix table included in SAD Section I Chapter 04 *Safety Analysis.* Work in the Proton Area involving this hazard implements the controls specified in the common Risk Matrix table. No unique controls are in use.

III-15.3. Summary of Hazards to Members of the Public

Public access to the buildings is restricted by locked doors. In addition, access to the tunnel is further restricted by locked gates.

III-15.4. Summary of Credited Controls

The Proton Area is non-operational and thus does not require any passive, active engineered, or administrative controls that rise to the level of a Credited Control needing inclusion in the Accelerator Safety Envelope.

III-15.4.1 Passive Credited Controls

The Proton Area is non-operational. There are no passive credited controls.

III-15.4.1.1 Shielding

N/A.

III-15.4.1.1.1 Permanent Shielding Including Labyrinths

N/A.

III-15.4.1.1.2 Movable Shielding

N/A.

III-15.4.1.1.3 Penetration Shielding

N/A.

III-15.4.1.2 Fencing

N/A.

III-15.4.1.2.1 Radiation Area Fencing

N/A.

III-15.4.1.2.2 Controlled Area Fencing

N/A.

III-15.4.2 Active Engineered Credited Controls

The Proton Area is non-operational. There are no active engineered credited controls.

III-15.4.2.1 Radiation Safety Interlock System

N/A.

III-15.4.2.2 ODH Safety System

N/A.

III-15.4.3 Administrative Credited Controls

The Proton Area is non-operational. There are no administrative credited controls.

III-15.4.3.1 Operation Authorization Document

N/A.

III-15.4.3.2 Staffing

N/A.

III-15.4.3.3 Accelerator Operating Parameters

N/A.

III-15.5. Defense-in-Depth Controls

Service building doors are locked. Tunnel access gates are locked, and the key must be obtained from the Main Control Room.

As discussed in III-15.2.1.2 (Residual Activation), the 12 inch-thick concrete walls of the PB4 enclosure reduce the MOI risk to IV. The surrounding soil is considered defense-in-depth.

III-15.6. Machine Protection Controls

The Proton Area is non-operational; there are no machine protection controls.

III-15.7. Decommissioning

DOE Field Element Manager approval shall be obtained prior to the start of any decommissioning activities for the Proton Area.

III-15.8. Summary and Conclusion

III-15.9. References

[1] Fermilab Radiological Control Manual

III-15.10. Appendix – Risk Matrices

Risk Assessment methodology was developed based on the methodology described in DOE-HDBK-1163-2020. Hazards and their potential events are evaluated for likelihood and potential consequence assuming no controls in place, which results in a baseline risk. A baseline risk (i.e., an unmitigated risk) value of III and IV does not require further controls based on the Handbook. Events with a baseline risk value of I or II do require prevention and/or mitigation measures to be established in order to reduce the risk value to an acceptable level of III or IV. Generally, preventive controls are applied prior to a loss event, reflecting a likelihood reduction, and mitigative controls are applied after a loss event, reflecting a consequence reduction. For each control put in place, likelihood or consequence can have a single “bin drop”, resulting in a new residual risk (i.e., a mitigated risk). This risk assessment process is repeated for each hazard for Facility Workers (FW), Co-Located Workers (CLW), and Maximally-Exposed Offsite Individual (MOI). At the conclusion of the risk assessments, controls that are in place for the identified accelerator specific hazards are identified as Credited Controls and further summarized in Section III-15.4 of this Chapter.