FERMI NATIONAL ACCELERATOR LABORATORY

ACCELERATOR SAFETY ENVELOPE

Fermilab Main Accelerator

Revision 15 March 15, 2024

Appendix A of the Safety Assessment Document

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Accelerator Safety Envelope

Fermilab Main Accelerator

Approval Page

Line Organization Review and Recommendation

This Appendix A Chapter 01 of the Fermi National Accelerator Laboratory (Fermilab) Safety Assessment Document (SAD), *Accelerator Safety Envelope – Fermilab Main Accelerator*, was prepared and reviewed by the staff of the Environment, Safety & Health Division (ESH) Accelerator Safety Department in conjunction with the Accelerator Directorate (AD) Line Management for each segment of the Fermilab Main Accelerator.

Signatures below indicate review of this Accelerator Safety Envelope (ASE), and recommendations that it be incorporated into the Appendices of the Fermilab SAD.

☐ _____
AD Associate Lab Director

☐ Madelyn Schmell
Accelerator Safety Department Head

☐ Madelyn Schmell
SAD Review Subcommittee Chair

Directorate & Fermi Site Office Final Approval

Final approval of this Accelerator Safety Envelope for the Fermilab Main Accelerator is granted by the Fermilab Director and the DOE Field Element Manager.

Director, Fermi National Accelerator Laboratory

DOE Field Element Manager, Fermi Site Office

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Revision History

Author	Rev. No.	Date	Description of Change

Maddie Schoell, Jessica Malo, and SAD Chapter Authors	15	March 15, 2024	• Inclusion of IRR #1c applicable Segments:
			  ○ P1-P2
			  ○ Muon Campus
			  ○ Switchyard
			  ○ Meson
			  ○ Neutrino
			• Updated Section 3 to incorporate Fencing as Passive Credited Control
			• In response to advance approval email "S07-A.1 ASE – Fermilab Main Accelerator" dated March 7, 2024, updated the Basis for Passive Shielding, RSIS, and Operating Parameters to reflect only the applicable basis for each segment of the accelerator
			• Updated Section 4 to include ODH Expert in addition to Cryo Coordinators/Facility Managers, to match titles within different Divisions/Directorates

Author	Rev. No.	Date	Description of Change
Maddie Schoell, Jessica Malo, and SAD Chapter Authors	14	March 2, 2024	• Inclusion of IRR #1b applicable Segments: ○ Booster ○ 8 GeV Line ○ Booster Neutrino Beam (BNB) ○ Main Injector ○ Recycler ○ Neutrinos from the Main Injector (NuMI) • In response to "Approval of the Fermi National Accelerator Laboratory Safety Assessment Document Appendix A.1 Accelerator Safety Envelope – Fermilab Main Accelerator, Revision 13, and Appendix B.2 Fermilab Unreviewed Safety Issue Process, Revision 0" dated January 11, 2024: ○ Additional details included related to calibration, maintenance and surveillance requirements. ○ Credited Control "Basis" language updated to exactly reflect the defined boundary conditions for the General Site and Public Areas ○ Updated the Accelerator Operating Parameter Credited Controls to include intensity and energy. • Updated Nominal Operating Intensity and Maximum Operating Intensity to align with updated "Basis" language. • In response to IRR #1b pre-start recommendation #2, Linac and 400 MeV Test Area (MTA) Accelerator Operating Parameter Credited Control values updated to accurately and consistently reflect the MCI analysis summarized in the SAD. • Per USI/RSI MTA-20240214, updated the CC Limits for 400 MeV Test Area (MTA) • Incorporation of Obvious and Operating Barriers as Passive Credited Control, ○ updated Section 3 to include Obvious and Operating Barriers to ensure only authorized access. ○ updated Section 4 to include ASE Violations related to the Obvious and Operating Barriers to ensure only authorized access. ○ Updated 400 MeV Test Area (MTA) Credited Controls to include Obvious and Operating Barriers to ensure only authorized access. • Inclusion of ASE violation related to Search & Secures. • Updated definitions to clarify nominal and maximum operation intensity

Author	Rev. No.	Date	Description of Change
Maddie Schoell	13	December 21, 2023	Following the revision of Department of Energy (DOE) Order 420.2C, *Safety of Accelerators*, to DOE O 420.2D and the FY23 PEMP Notable Goal 4, including comments and concerns noted in the memo "Request to Approve Fermilab's Accelerator Safety Envelope and Concurrence with Safety Assessment Documents for the Neutrino, Meson and Neutrino Switchyard 120 Experimental Areas Including SpinQuest" dated January 4, 2023 – major revisions were made to the ASE. • Separated ASEs for the Fermilab Main Accelerator from the FAST Accelerator, removing FAST from this ASE. • Major overhaul of outline of ASE, including general descriptions and information within Section 1 through Section 6 • Added Section 7 to specifically describe Credited Controls for each segment of the Fermilab Main Accelerator • Updated shielding assessment reference for the Neutrino Area. • Removed reference for Memo, "Accelerator Safety Envelope Limitations for Operating Areas" and included content from the memo within the ASE. Based on the "Phased Review Approach to Ensure Readiness to Operate Under DOE O 420.2D", select segments of the Fermilab Main Accelerator will be reviewed over the course of eight (8) reviews. Only applicable segments will be included in the current revision of the ASE. • IRR #1a applicable Segments: ○ Linac ○ 400 MeV Test Area (MTA)
Maddie Schoell	12	August 25, 2020	Updated "Area" column for MuCool Test Area to reflect new name, MeV Test Area (MTA). Updated shielding assessment references for MeV Test Area. Updated safety envelope beam intensities for MeV Test Area, and updated associated reference. Updated "ASE Violation Determination and Actions" section to clarify deficiency in credited control and ASE violations.

Author	Rev. No.	Date	Description of Change
Maddie Schoell	11	February 11, 2020	Updated shielding assessment references for the Muon Campus. Safety envelope beam intensities did not change. Updated "Area" column titles for Muon Campus areas for clarity.
John E. Anderson Jr.	10	November 12, 2019	Updated text for the "Control" section of the Operator Staffing section to reflect MCR responsibility for accelerator operations within the ASE beam intensity limits. Updated organizational name changes.
John E. Anderson Jr.	9	January 11, 2018	Removed Experimental ORC requirement from the ASE. Updated reference to the Routine Monitoring Program to reflect ESH Centralization. Clarified when shielding deficiencies would be an ASE violation.
John E. Anderson Jr.	8	August 28, 2017	Updated ASE energy limit for the Fermilab Accelerator Science and Technology (FAST) Facility.
John E. Anderson Jr.	7	March 3, 2017	Updated titles from ES&H reorganization, updated PPD ORC process to the FESHM ORC Process, and updated shielding assessment references for the Muon Campus and Booster accelerator areas. Safety envelope beam intensities did not change. Added Muon Campus 8 GeV beam on target intensity scaled from the 120 GeV intensity for clarity.
John E. Anderson Jr.	6	January 2, 2015	Added Safety Envelope beam intensity limits for the Advanced Superconducting Test Accelerator (ASTA) Injector. Changed Antiproton Source to Muon Campus. Updated references.
John E. Anderson Jr.	5	January 3, 2014	Updated ASE text to reflect recommendations from the Accelerator Readiness Review conducted October 1-3, 2013. Changes included moving numerical beam operating intensity limits from the ASE to a Division level document, scaling numerical beam safety envelope intensity limits to a 500 mrem accident condition, removing operating surveillance limits, and removing industrial hazards such as oxygen monitoring, cryogenic relief valve monitoring, and flammable gas system monitoring.

Author	Rev. No.	Date	Description of Change
John E. Anderson Jr.	4	April 25, 2013	Updated Department of Energy (DOE) DOE Order 420.2B, *Safety of Accelerator Facilities*, to DOE O 420.2C. Updated ASE text to reflect credible accident scenarios. Modified Operating and Safety Envelope beam parameters for the Main Injector, Recycler, and NuMI. Updated shielding assessment references for the revised Main Injector, Recycler, and NuMI shielding assessments. Updated Linac groundwater limit reference to new MARS calculations. Removed Operating and Safety Envelope beam parameters for Tevatron Circulating Beam, A0 and C0 Abort Absorbers, and the Pelletron; placing the areas in standby. Removed the Booster Radiation Damage Facility Operating and Safety Envelope beam parameters.
John E. Anderson Jr.	3	February 15, 2012	Added Operating and Safety Envelope beam intensity limits for the Neutrino Area.
John E. Anderson Jr.	2	March 21, 2011	Added Operating and Safety Envelope beam intensity limits for the HINS Linac at MDB.
John E. Anderson Jr.	1	January 20, 2011	Added Operating and Safety Envelope beam intensity limits for the MuCool Test Area.
John E. Anderson Jr.	0	December 10, 2009	Initial release of the laboratory-wide Accelerator Safety Envelope (ASE). The ASE is derived from the Safety Class Structures, Systems, or Components section of Fermilab Environment Safety and Health Manual (FESHM) Chapter 3010, *Significant and Reportable Occurrences*, and the Safety Envelope section of the existing Fermilab Safety Assessment Documents (SADs). This document supersedes and replaces the Safety Envelope section of the existing Fermilab SADs. Completed Safety Envelope calculations for the 8 GeV Line and MiniBooNE areas and revised Safety Envelope. Revised 8 GeV Line and MiniBooNE Operating limits to support future program needs based on post assessment documents.

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Table of Content

Section 1. Introduction and Scope

This document constitutes the integrated Accelerator Safety Envelope (ASE) for full power operation of all segments of the Fermilab Main Accelerator. It defines the Credited Controls that are established for all of the segments that make up the Fermilab Main Accelerator to assure that the level of risk to all workers, the public, and the environment is maintained at acceptable levels. This ASE is established in accordance with the DOE Order 420.2D, *Safety of Accelerators*, (DOE O 420.2D), and as flowed down through the Fermilab Environment, Safety and Health Manual (FESHM) including the Fermilab Radiological Control Manual (FRCM).

Section 2. Select Definitions and Acronyms

The following terms and/or acronyms are commonly used when discussing operation of the Fermilab Main Accelerator. Definitions that come directly from DOE O 420.2D, *Safety of Accelerators*, are noted with an asterisk (*), with further information on the interpretation and application of the definition for use at the Fermilab Main Accelerator in italics.

***Accelerator** A device and its components employing electrostatic or electromagnetic fields to impart kinetic energy to molecular, atomic, or sub-atomic particles and capable of creating a radiological area as defined by 10 CFR Part 835, Occupational Radiation Protection. Accelerator components include injectors, targets, beam dumps, detectors, experimental enclosures, accelerator enclosures, experimental areas, and experimental apparatus utilizing the accelerator. The accelerator also includes associated support and test facilities, equipment, systems, and utilities necessary to operate the accelerator or utilize the accelerated beam.

***Accelerator Facility** The accelerator, plant, buildings, structures, and equipment supporting the accelerator and its operations that are under direct control of the contractor

All facilities at Fermilab in some way contain components or conduct activities supporting an accelerator and its operations. As such, all facilities are described in the Safety Assessment Document (SAD).

***Accelerator Operations** Activities within the accelerator facility that, over the lifecycle of the facility, support 1) production or utilization of accelerator beams; 2) research and experimental activities utilizing accelerator beams; 3) handling, storage and analysis of accelerator induced radioactive components and materials within the accelerator facility boundary; 4) receipt, preparation, assembly, inspection, and installation of samples into the accelerator beam; or 5) removal, disassembly, handling, analysis, and storage for radioactive dose minimization to meet the definition of ALARA in 10 CFR Part 835, Occupational Radiation Protection, or transportation requirements, and packaging of samples after use in the

accelerator beam. Accelerator Operations excludes radioisotope processing activities that are not required to operate or maintain the accelerator.

***Accelerator Readiness Review (ARR)** A structured method for verifying that hardware, personnel, and procedures associated with commissioning or routine operations are ready to permit the activity to be undertaken safely.

***Accelerator Safety Envelope (ASE)** A documented set of verifiable physical and administrative requirements, bounding conditions, and credited controls that ensure safe operation and address accelerator specific hazards and risks.

Accelerator Safety Envelope Intensity Calculated intensity that, assuming a one (1) hour point source loss would produce a 100, 500, or 5000 mrem accident condition.

Accelerator Specific Hazard Hazards are classified as Accelerator Specific when their nature is uniquely defined by the configuration of the accelerator and they are not fully mitigated by Fermilab standard safety management programs. The passive, active engineered, and administrative mitigations which reduce accelerator specific hazards within Applicable Accelerator Facilities from unacceptable to acceptable risk are the Credited Controls

Applicable Accelerator Facility An Accelerator Facility further posted as an Exclusion Area.

***Commissioning** A phase of an accelerator facility operation that is typically used to conduct initial beam testing and/or verify design specifications. Commissioning periods may be tailored to the needs of each facility and there may be great variations in their duration, breadth, and formality, but in all cases, the activities will be bounded by an ASE and preceded by an ARR and DOE approval.

***Credited Control** Controls determined through the Safety Analysis to be essential for safe operation directly related to the protection of workers, the public, and the environment.

Credited Controls are implemented to mitigate Accelerator Specific Hazards within Applicable Accelerator Facilities to acceptable levels. For other facilities, controls to mitigate similar hazards are managed through programs and requirements specified in FESHM.

***DOE Element** First-tier organizations at DOE/NNSA HQ and in the field as listed in the Correspondence Style Guide, Office of the Executive Secretariat.

***DOE Field Element Manager** The manager having overall responsibility for a DOE field element including execution of oversight policy implementation. The Field Element Manager directs activities of DOE/NNSA field or site offices and has line accountability for all site program, project execution, and contract management.

The Fermilab Site Office (FSO) Manager is the DOE Field Element Manager.

***DOE Program Secretarial Officer (PSO)** An Assistant Secretary, Office Director, Head of Program Element, or NNSA Deputy Administrator to whom designated field offices directly report and who has overall landlord responsibilities for the assigned direct reporting elements.

Nominal Operating Intensity The intensity a given segment typically operates at, which is ~5% lower than the intensity identified by the machine and/or Project, supported by the Shielding Assessment, in order to accommodate potential fluctuation in beam intensity due to changes in efficiency.

Maximum Operating Intensity The maximum intensity a given segment is able to operate at. This value is used in the Maximum Credible Incident (MCI) analysis.

***Radiation** Ionizing radiation, including the accelerated particle beam and the radiation produced when the beam interacts with matter or changes direction. Radiation includes alpha particles, beta particles, gamma rays, X-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions.

***Radioisotope Processing** Chemical, thermal, or physical actions taken to separate, isolate, refine, or enrich specific isotopes of a chemical element.

***Residual Radioactivity** Radioactivity in structures, materials, soils, groundwater, and other media at a site resulting from the accelerator or accelerator operations.

***Reviewed Safety Issue** The outcome of the evaluation and determination phase of the USI Process.

***Risk** A quantitative or qualitative expression of possible harm, which considers both the probability that a hazard will cause harm and the amount of harm; or, alternatively, an estimate of the probability of occurrence of a hazard-related incident and the severity of the consequence associated with the incident.

Fermilab utilizes a qualitative risk assessment, following the methodology found in DOE-HDBK-1163-2020, Integration of Hazard Analyses.

***Safety Analysis** A documented process to systematically identify the hazards of a given operation; including a description and analyses of the adequacy of measures taken to eliminate, control, or mitigate the hazards and risks of normal operation; and identification and analyses of potential accidents and their associated risks.

***Safety Assessment Document (SAD)** A document containing the results of a Safety Analysis for an accelerator or accelerator facility pertinent to understanding the risks to workers, the public, and the environment of operating the accelerator.

***Unreviewed Safety Issue (USI)** An activity or discovered condition with accelerator specific hazards that have yet to be evaluated to determine if the activity or discovered condition introduces accelerator specific hazards that are not adequately addressed by the current SAD and approved ASE.

***USI Process** The process or methodology used to evaluate/review USIs to determine if the activity or discovered condition is adequately addressed by the current SAD and approved ASE.

Section 3. Description of Credited Controls

The Credited Controls identified in the ASE are a set of passive, active engineered, and administrative controls in use at the Fermilab Main Accelerator that define the bounding conditions and limitations for safe and environmentally sound operations. In accordance with FRCM Article 236, Fermilab utilizes Credited Passive and Active Engineered Controls whenever the maximum credible incident condition can exceed limits specified in Table 1.

Table 1. Acceptable Dose Levels Used in MCI Analysis.

Dose	Location	Potentially Exposed Individual
Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in **5 rem** in one hour in any area accessible by facility workers and co-located workers.	Inside service buildings or within Radiation Area fencing, where public cannot access	Facility Worker and/or Co-Located Worker
General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in **500 mrem** in one hour in areas to which the public is assumed to be excluded	Outside of enclosure/facility and surrounding shielding, in non-publicly accessible areas (beyond Obvious and Operating Barriers)	Members of the public if they access areas where they are not authorized

Public Area Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in **100 mrem** in one hour at Fermilab's site boundary AND/OR in any areas onsite in which the public is authorized.
• Batavia Road, Prairie Path (MBO), parking lots open to the public.
• All General Access Areas, including, but not limited to the following:
  ○ Wilson Hall
  ○ Ramsey Auditorium
  ○ Lederman Science Center
  ○ Building 327
	Outside of enclosure, in location where the public is invited	Maximally-exposed Off-Site Individual (a.k.a., a member of the public)

The Credited Controls listed in the ASE must be in place and functional for all operational areas. During periods of down time or maintenance when beam is not being delivered, Credited Controls may be

removed and managed under the Safety Configuration Management program to ensure they are replaced prior to resumption of operations.

For each Credited Control, the following is specified:

- **Applicability** – the condition in which the Credited Control is valid.
- **Basis** – description of the need for the Credited Control.
- **Credited Control** – specific elements that must be in place during beam operation. Beam operation to the affected area without required elements in place is an ASE violation.
- **Required Surveillance** – management and monitoring practices that must be performed to assure continued effectiveness of the Credited Control. Surveillances are to be carried out at the minimum specified interval. Beam operation to the affected area without the required surveillance being performed within the minimum specified interval is an ASE violation.
- **Response** – actions to be taken if there is a suspected deficiency, missing control, or other potential ASE violation for that particular Credited Control.

The Credited Controls are divided into three main categories: passive controls, active engineered controls, and administrative controls.

Passive

Passive Credited Controls are elements that are part of the physical design of the facility that require no action to function properly. These are fixed elements that take human intervention to remove. The types of Passive Credited Controls in use for the Fermilab Main Accelerator include:

- Shielding (i.e., Permanent/Structural, Labyrinths, Movable, Penetration Shielding)
- Fencing
- Obvious and Operating Barriers to ensure only authorized access (i.e., gate, bollard, Security Guard)

Acceptable methods for configuration of movable and/or penetration shielding include, but are not limited to: locked chains, Unistrut to block or inhibit movement, cover plates over penetration holes, etc.

Active Engineered

Active Engineered Credited Controls are systems designed to reduce the risks from accelerator operations to an acceptable level. The types of Active Engineered Credited Controls in use for the Fermilab Main Accelerator include:

- Radiation Safety Interlock System (RSIS)
- Oxygen Deficiency Hazard (ODH) Safety System

Radiation Safety Interlock System (RSIS)

Radiation Safety Interlock Systems (RSIS) are used to prevent injury, death, or serious over-exposure from beam-on radiation. The principal method employed by the RSIS is to establish and maintain

Exclusion Areas surrounding accelerator operating areas. Prior to accelerator operations, a Search and Secure is performed to establish the interlock system for the Exclusion Area(s). This Search and Secure ensures no personnel are remaining within the Exclusion Area(s) during accelerator operations. If there is a potential for personnel to inadvertently access the defined Exclusion Area, the RSIS is designed to inhibit accelerator operations in that area.

The RSIS may also include interlocked radiation monitors to supplement passive shielding Credited Controls. Specific radiation monitors are designated as Credited Controls in areas where passive shielding is insufficient to limit potential exposure in the maximum credible incident to less than limits specified in Table 1. If dose rates exceed specified levels, the RSIS is designed to inhibit accelerator operations in that area.

The RSIS utilize a modular redundant design where no single component failure will result in a loss of protection. To accomplish this, two separate fail-safe circuits are used to detect specific conditions. All circuits within the RSIS are designed in such a way that if a circuit fails, or specified input is lost, the failure would initiate a system shutdown resulting in a safe condition.

Oxygen Deficiency Hazard (ODH) Safety Systems

ODH Safety Systems are used to prevent injury or death from exposure to oxygen deficient environments. ODH Classifications are determined based on a quantitative risk assessment, further described in FESHM 4240. ODH Classifications are then used to determine required personnel training and qualification and other ODH control measures. ODH Safety Systems utilize various components (e.g., area oxygen monitors, vents, fan, etc.) to maintain the posted ODH Classification.

ODH Safety System component failures are taken into account in the initial ODH analysis, and surveillance requirements are determined based on the analysis. In the event of a known failure of an ODH Safety System component that is necessary to maintain the original ODH Classification, the area is evacuated and ODH Classification is updated as needed based on existing out-of-service policy or updated ODH analysis.

ODH Safety System components that are required to maintain the posted ODH Classification within an interlocked and/or posted Exclusion Areas will be identified as Credited Controls and summarized in this ASE.

Administrative

Administrative Credited Controls encompass the human interactions that define safe operations. These are the accelerator operating policies and procedures that are followed to ensure safe accelerator operations. The types of Administrative Credited Controls in use for the Fermilab Main Accelerator include:

- Operation Authorization Document
    - Must include the following information:
        - Segment Name

- Issue Date
- Mode(s) of Operation
- Operating Parameters (i.e., ASE Intensity Limit)
- Critical Device Controller (CDC)
- Critical Devices
- Exclusion Area(s)
- Credited Controls
  i. Shielding Requirements
  ii. Fencing Requirements
  iii. Location of Obvious and Operating Barriers to ensure only authorized access
  iv. RSIS Required Components and Inputs, including interlocked detectors
  v. ODH System Requirements
  vi. Staffing Requirements
  vii. Accelerator Operating Parameter
- May also include additional information beneficial to those operating the Fermilab Main Accelerator

- Staffing
- Accelerator Operating Parameter (i.e., ASE Intensity)

ASE Intensity Determination

The ASE Intensity Limit is determined as follows –

> The maximum credible intensity limit is determined based on how much beam can be produced and transported given design parameters and limitations of the accelerator or beamline and of upstream accelerators and beamlines. The maximum credible incident (MCI) is then determined as the worst case accident scenario where beam of the maximum credible intensity is not transported cleanly and may result in more than 100 mrem in an hour to a maximally-exposed offsite individual (MOI) in areas of the campus where the public is authorized, 500 mrem in an hour to an MOI in non-public areas of the campus, or 5 rem in an hour to a worker.

Obvious and Operating Barriers to Ensure Only Authorized Access

To permit entry to only authorized individuals into the area where the “General Site Basis” applies (see Figure 1). Obvious and Operating Barriers shall be established as Credited Controls at the following locations to permit only authorized access:

- Wilson Hall West
- Wilson Hall East
- Site 55

Figure 1. Location of Obvious and Operating Barriers.

These Obvious and Operating Barriers may use any of the following methods to satisfy the Credited Control function of ensuring entry is permitted to only authorized individuals:

- Gates & card reader
- Bollard
- Security Guard

During maintenance periods of the existing barrier which would remove or diminish functionality of the existing barrier, another approved method, listed above, shall be used.

Section 4. ASE Violation Determination and Actions

Determination

Performance degradation of any Credited Control that is required for safe operation of the associated accelerator segment that prevents satisfactory performance of its design function when it is required to be operable is a violation of the ASE. Credited Controls are required to be operable when an Operation Authorization Document for the associated accelerator segment is approved and the cognizant accelerator directorate Associated Laboratory Director (ALD) authorizes accelerator operation. The requirements for operability of Credited Controls when beam operations are authorized can be temporarily suspended by the Main Control Room Crew Chief and when the assigned Radiation Safety Officer applies configuration control locks on associated critical device power supplies.

> For Credited Controls that have additional overburden or Defense-in-Depth controls, it may not be immediately obvious if a deficiency is in the overburden or in the Credited Controls. In this case, it is not yet known if there even is a deficiency in Credited Controls constituting an ASE Violation. In these circumstances, the appropriate Line Organization and ESH Division Subject

Matter Experts (SMEs) will investigate to determine if Credited Controls were impacted. This determination shall be documented following the USI Process, as described in Section 6 of this ASE. If it is determined that Credited Controls were impacted, beam operations shall be terminated immediately and not resume until the Reviewed Safety Issue (RSI) is finalized. If beam operations were to resume without the Reviewed Safety Issue (RSI) being finalized, that would constitute an ASE Violation.

For ODH Safety System Credited Controls, in the event of a known failure of an ODH Safety System component that is necessary to maintain the original ODH Classification, and the Cryo Coordinator/ODH Expert/Facility Manager determine that there is a need to reclassify the area (as opposed to replacing components), the area is evacuated and ODH Classification is updated as needed based on existing out-of-service policy or updated ODH analysis. Reentry into the area, before the ODH Classification is updated, is limited to personnel approved by the Cryo Coordinator/ODH Expert/Facility Manager to perform work necessary for the ODH reclassification, any other access is a violation of the ASE.

Beam operation of the segment of the Fermilab Main Accelerator beyond the specified ASE Intensity Limit is a violation of the ASE.

Beam operation of the segment of the Fermilab Main Accelerator with required surveillance of a Credited Control not conducted within specified frequency, as defined for each segment in Section 7 of this ASE, is an ASE violation.

Beam operation of the segment of the Fermilab Main Accelerator without a valid Search & Secure being performed prior to operations is an ASE violation.

Un-authorized personnel found to have passed beyond an Obvious and Operating Barrier and remained within the area where the “General Site Basis” applies for a period of one (1) hour or longer after discovery during operation of applicable accelerator(s) and/or accelerator segment(s) and there is a potential to surpass the “General Site Basis” acceptable dose level of 500 mrem in an incident, there is an ASE violation.

Note: If individuals are escorted out within one (1) hour of discovery, this does not constitute an ASE violation.

Note: If the individuals are not escorted out within one (1) hour of discovery, an analysis shall be performed to determine if, based on actual operating parameters during the time the unauthorized individual(s) was/were present, there was a potential to surpass the “General Site Basis” acceptable dose level of 500 mrem in an incident. If the potential does not exist, this does not constitute an ASE violation. If the potential does exist, the USI Process shall be followed to determine if there was an ASE violation.

Note: applicable accelerator segments are not required to terminate operations.

Obvious and Operating Barriers not in place for a period of one (1) hour or longer following discovery during operation of applicable accelerator(s) and/or accelerator segment(s) is an ASE violation.

> Note: If original Obvious and Operating Barrier method is repaired/replaced OR another approved method is instituted within one (1) hour of discovery, this does not constitute an ASE violation.
>
> Note: If repairing/replacing original Obvious and Operating Barrier OR instituting another method within one (1) hour of discovery, and applicable accelerator segments are turned off within one (1) hour, this does not constitute an ASE violation. Accelerator operations may resume once Obvious and Operating Barrier back in place.
>
> Note: If repairing/replacing original Obvious and Operating Barrier OR instituting another method within one (1) hour of discovery, and applicable accelerator segments are not turned off, this does constitute an ASE violation. In this instance, beam operations to the applicable accelerator segments shall be terminated immediately and the USI Process shall be followed to obtain approvals to resume operations.

Questions regarding determination of an ASE violation shall be addressed to the Environment, Safety & Health (ESH) Division Accelerator Safety Department Head and the Accelerator Directorate (AD) Associate Lab Director.

Actions

If an unauthorized individual(s) is/are discovered to have passed beyond an Obvious and Operating Barrier, the following actions shall be taken:

- Individual(s) is/are escorted out of the area where the “General Site Basis” applies:
  - If the individual(s) is/are escorted out within one (1) hour of discovery, no ASE violation and no further actions required.
  - If the individual(s) is/are not escorted out within one (1) hour of discovery, an analysis shall be performed to determine if, based on actual operating parameters during the time the unauthorized individual(s) was/were present, there was potential to surpass the “General Site Basis” acceptable dose level of 500 mrem in an incident.
    - If no potential, no ASE violation and no further actions required.
    - If potential exists, follow the USI Process to determine ASE violation.
- Applicable accelerator segments are not required to be terminated.

If an Obvious and Operating Barrier is found to be not in place, the following actions shall be taken:

- Original Obvious and Operating Barrier method shall be repaired/replaced OR another approved method shall be instituted.
  - If complete within one (1) hour of discovery, no ASE violation and no further actions required.

  - If not able to be complete within one (1) hour of discovery, applicable accelerator segments may be turned off until the Obvious and Operating Barrier is repaired/replaced or another method is instituted. In this instance, no ASE violation exists and no further actions are required. Accelerator segments may resume operation once Obvious and Operating Barrier is back in place.
  - If not complete within one (1) hour of discovery, and applicable accelerator segments are not turned off, this does constitute an ASE violation. Beam operation to applicable segments shall be terminated immediately, and the USI Process shall be followed to obtain approvals prior to resuming operations.
- Assurance shall be made that unauthorized individuals did not pass through during the time the Obvious and Operating Barrier was not in place.

For all other ASE violations (as determined via the USI Process), beam operations to the affected segment of the Fermilab Main Accelerator shall be terminated immediately and put in a safe and stable configuration, and not resume until the circumstances of the event are reviewed and approval to resume operations is received. Non-affected segments of the Fermilab Main Accelerator may continue operations. The USI Process, as described in Section 6 of this ASE, will be used to analyze and document the circumstances of the ASE violation. Once the RSI has been finalized for the event causing the ASE violation, approval to resume operations to the affected segment of the Fermilab Main Accelerator will be issued by the DOE Field Element Manager.

Events determined to be ASE violations follow FESHM Chapter 3010 *Significant and Reportable Occurrences*, to provide the appropriate DOE notification and reporting.

Section 5. Configuration Management for Credited Controls

To ensure the integrity of the Credited Controls during accelerator operation, several methods of Configuration Management are in place.

- Excavation within the “Excavation Waiver Prohibited Zone” around the accelerator are required to go through the JULIE process. Part of the JULIE process includes ES&H Division Radiation Safety personnel review to determine if required shielding may be impacted.
- Required movable and penetration shielding is posted and/or locked and/or bolted in place where applicable.
- Components that are part of the Radiation Safety Interlock System (RSIS) are labeled.
- Surveillance is performed, as specified in Section 7.

If shielding is planned to be removed, the assigned Radiation Safety Officer (RSO) is responsible for ensuring the affected segment of the Fermilab Main Accelerator is locked off in a safe state, using RSO Configuration Control locks.

If any Credited Control is not in place, either planned or discovered, the assigned RSO is responsible for ensuring the affected segment of the Fermilab Main Accelerator is locked off in a safe state, using RSO Configuration Control locks.

Removal of Credited Controls (i.e., rescinding Operation Authorization Documents, removing shielding or fencing, etc.) during maintenance periods (when beam is not being delivered) is common, and the assigned RSO is responsible for ensuring the affected segment of the Fermilab Main Accelerator is locked off in a safe state, using RSO Configuration Control locks.

The ES&H Division Radiation Physics Operations and Accelerator Safety Departments utilize a Configuration Control Log to track instances of placing affected segment of the Fermilab Main Accelerator in a Configuration Controlled off state. This Log keeps track of reasons why the affected segment of the Fermilab Main Accelerator was locked off, what must be done prior to resuming operations, and confirmation that conditions are back in place and confirmed before operations are permitted to resume.

Section 6. Unreviewed Safety Issue (USI) Process

The Unreviewed Safety Issue (USI) Process is used to evaluate proposed activities/modifications and/or discovered conditions to ensure all hazards are adequately addressed in by the current SAD and approved ASE. The USI Process utilizes a USI Screening Form to determine if the proposed activity and/or discovered condition warrant further evaluation, and a USI Evaluation Form to determine if the proposed activity and/or discovered condition is a USI and what actions need to be taken. For discovered conditions, if the USI Screening Process determines that further USI Evaluation is needed, affected accelerator operations shall be stopped until the conclusion of the USI Process. At the conclusion of the USI Process, the review of the proposed activity/modification and/or discovered condition is classified as a Reviewed Safety Issue (RSI).

Proposed activities/modifications and/or discovered conditions at the Fermilab Main Accelerator are subject to the USI Process.

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Section 7. Summary of Credited Controls for All Segments of the Fermilab Main Accelerator Complex

Linac Credited Controls

Passive – Shielding

Applicability

During beam operations to the Linac segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
- Public Area Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 100 mrem in one hour at Fermilab's site boundary AND/OR in any areas onsite in which the public is authorized.
    - Batavia Road, Prairie Path (MBO), parking lots open to the public.
    - All General Access Areas, including, but not limited to the following:
        - Wilson Hall
        - Ramsey Auditorium
        - Lederman Science Center
        - Building 327

Credited Control

The following forms of passive shielding:

- Shielding between the interior surface of the enclosure walls and the surface of the berm up to 9.6 effective feet of dirt.
- The wall between the Linac enclosure and the Linac upper and lower gallery.
- The concrete block wall separating the Linac enclosure and the ITA experimental hall.
- Concrete shielding blocks that fill the utility and RF waveguide penetrations between the Linac enclosure and the lower Linac gallery.
- Poly beads that fill the upper waveguide penetrations for the 400 MeV Linac upgrade.

Required Surveillance In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.

Response Beam operation to the Linac will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Linac will not resume until approval is received from the AD Associate Lab Director (ALD) and the DOE Field Element Manager.

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability During beam operations to the Linac segment of the Fermilab Main Accelerator.

Basis To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
- Public Area Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 100 mrem in one hour at Fermilab's site boundary AND/OR in any areas onsite in which the public is authorized.
    - Batavia Road, Prairie Path (MBO), parking lots open to the public.
    - All General Access Areas, including, but not limited to the following:
        - Wilson Hall
        - Ramsey Auditorium
        - Lederman Science Center
        - Building 327

To ensure protection against dose to personnel inside the Linac's Exclusion Area(s) during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.

- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- Linac

Required components of the RSIS shall be specified in the Linac's Operation Authorization Document.

The following components of the Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

Radiation Safety System – Interlocked Radiation Monitors

Table 2. Linac Radiation Monitors Credited Controls

Type	Location	CC Limit (mrem/hr)
Chipmunk	A: Linac Enclosure Tank #1	1000
Chipmunk	B: Linac Gallery Tank #2	250
Chipmunk	C: Linac Gallery Tank #3	250
Chipmunk	D: Linac Gallery Tank #4	250
Chipmunk	E: Linac Gallery Tank #5	250
Chipmunk	F: Linac Gallery Tank #6	90
Chipmunk	G: Linac Gallery Tank #7	90
Chipmunk	H: Linac Gallery Tank #8	90
Chipmunk	I: Linac Gallery Tank #9	90
Scarecrow	J: Linac Enclosure Tank #3	175,000
Scarecrow	K: Linac Enclosure 400 MeV Labyrinth	10,000
Chipmunk	L: Booster Chute	90
Chipmunk	M: Linac Dump #1 Berm US	90
Chipmunk	N: Linac Dump #1 Berm DS	90
Chipmunk	O: Booster Tunnel Dump #1	90

Note that the radiation monitor trip levels may be set lower than the CC Limit for ALARA purposes or to ensure compliance with 10CFR835.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

In order to assure functionality of the instrument, area radiation monitors shall be maintained and calibrated on an interval no greater than fifteen (15) months.

Response	Beam operation to the Linac will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Linac will not resume until approval is received from the AD Associate Lab Director (ALD) and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability	During beam operations to the Linac segment of the Fermilab Main Accelerator.
Basis	To summarize the Credited Controls for safe operation of the Linac, and to provide explicit approval for operations of the Linac.
Credited Control	An approved Linac Beam Permit & Running Condition shall be issued prior to Linac beam operations.
Required Surveillance	In order to assure Operation Authorization Documents are maintained up-to-date, the Linac Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.
Response	Beam operation to the Linac will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Linac will not resume until approval is received from the AD Associate Lab Director (ALD) and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During beam operations to the Linac segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none

Response Beam operation to the Linac will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Linac will not resume until approval is received from the AD Associate Lab Director (ALD) and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameter

Applicability During beam operations to the Linac segment of the Fermilab Main Accelerator.

Basis To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
- Public Area Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 100 mrem in one hour at Fermilab's site boundary AND/OR in any areas onsite in which the public is authorized.
    - Batavia Road, Prairie Path (MBO), parking lots open to the public.
    - All General Access Areas, including, but not limited to the following:
        - Wilson Hall
        - Ramsey Auditorium
        - Lederman Science Center
        - Building 327

Credited Control The following intensity shall not be exceeded:

- 2.58e18 protons/hour at 116 MeV
- 4.98e18 protons/hr at 750 keV

Required Surveillance none

Response Beam operation to the Linac will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Linac will not resume until approval is received from the AD Associate Lab Director (ALD) and the DOE Field Element Manager.

400 MeV Test Area (MTA) Credited Controls

Passive – Shielding

Applicability

During beam operations to the MTA segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded.

Credited Control

The following forms of passive shielding:

- In areas with more than 17.2 effective feet of dirt shielding between the interior surface of the enclosure walls and the surface of the berm, 17.2 efd is credited
- In areas with less than 17.2 efd, all but 0.5 efd of the existing shielding is credited (allowing for 0.5 efd of defense in depth)
- Three (3) 3-inch gas manifold penetrations filled with poly beads
- Voids in the 20-inch vent penetration filled with poly beads
- Obsolete 10-inch cryo penetration filled with poly beads
- Obsolete 8-inch cryo penetration filled with poly beads
- Four (4) obsolete 4-inch cryo penetrations filled with poly beads
- 201 MHz 9-inch coaxial transmission line through MTA/Linac shield wall filled with sandbags
- 805 MHz 10x5 inch waveguide through MTA/Linac shield wall filled with sandbags
- 18x18 inch cable tray to Linac gallery filled with sandbags
- Berm penetration filled with sand and poly beads
- Beam pipe penetration voids filled with sand

Required Surveillance

In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.

Response

Beam operation to the MTA will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an

ASE violation is determined to have occurred, then beam operation to the MTA will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Obvious and Operating Barriers to Ensure only Authorized Access

Applicability	During beam operations to the MTA segment of the Fermilab Main Accelerator.
Basis	To permit entry to only authorized individuals into the area surrounding the MTA segment of the Fermilab Main Accelerator, where the "General Site Basis" applies.
Credited Control	Obvious and Operating Barriers to ensure only authorized access shall be established in the following locations: • Wilson Hall West • Wilson Hall East • Site 55
Required Surveillance	none

Response	If unauthorized individual(s) is/are discovered to have passed beyond an Obvious and Operating Barrier, the following actions shall be taken:
	• Individual(s) is/are escorted out of the area where the "General Site Basis" applies within one (1) hour of discovery
	• Applicable accelerator segments are not required to be terminated
	
	If an Obvious and Operating Barrier is found to be not in place, the following actions shall be taken:
	• Original Obvious and Operating Barrier method shall be repaired/replaced OR another approved method shall be instituted within one (1) hour of discovery
	  ○ Applicable accelerator segments are not required to be terminated,
	  ○ Applicable accelerator segments may be turned off if repair/replacement work and/or instituting another approved method is not able to be completed within one (1) hour of discovery. Applicable accelerator segments may resume operations once Obvious and Operating Barrier is back in place.
	• Assurance shall be made that unauthorized individuals did not pass through during the time the Obvious and Operating Barrier was not in place

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability

During beam operations to the MTA segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

To ensure protection against dose to personnel inside the MTA's Exclusion Areas during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- MTA

Required components of the RSIS shall be specified in the MTA's Operation Authorization Document.

The following components of the Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

Radiation Safety System – Interlocked Radiation Monitors

Table 3. MTA Radiation Monitors Credited Controls

Type	Location	CC Limit (mrem/hr)
Chipmunk	Linac High Ceiling	177
Chipmunk	Linac Ramp – top of berm upstream	165
Chipmunk	Linac Ramp – top of berm downstream	500
Chipmunk	Beam Stop Alcove – top of berm upstream of hatch	500
Chipmunk	MTA Upstream Stub – above UVB11 (SQA)	500
Chipmunk	MTA Hall – Ceiling Vent	500
Chipmunk	MTA Hall Mid-Hall	500
Chipmunk	MTA Hall "Front Porch"	500
Chipmunk	Pipe to Absorber	500
Chipmunk	MTA Counting House	5,000

Note that the radiation monitor trip levels may be set lower than the CC Limit for ALARA purposes or to ensure compliance with 10CFR835.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

In order to assure functionality of the instrument, area radiation monitors shall be maintained and calibrated on an interval no greater than fifteen (15) months.

Response

Beam operation to the MTA will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the MTA will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability

During beam operations to the MTA segment of the Fermilab Main Accelerator.

Basis

To summarize the Credited Controls for safe operation of the MTA, and to provide explicit approval for operations of the MTA.

Credited Control

An approved MTA Beam Permit & Running Condition shall be issued prior to MTA beam operations.

Required Surveillance

In order to assure Operation Authorization Documents are maintained up-to-date, the MTA Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.

Response	Beam operation to the MTA will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the MTA will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During beam operations to the MTA segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none
Response	Beam operation to the MTA will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the MTA will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During beam operations to the MTA segment of the Fermilab Main Accelerator.
Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.

- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
  -

Credited Control	The following intensity shall not be exceeded: 2.58e18 protons/hr at 400 MeV
Required Surveillance	none
Response	Beam operation to the MTA will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the MTA will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

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Booster Credited Controls

Passive – Shielding

Applicability	During beam operations to the Booster segment of the Fermilab Main Accelerator.
Basis	To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded ▪
Credited Control	The following forms of passive shielding: • Shielding between the interior surface of the enclosure to the surface of the berm is a minimum of 10.3 e.f.d. for the Booster Ring. The Booster/8 GeV Line section contained in the Booster segment has a minimum of 17.7 e.f.d. • At least 11 ft of Poly beads fill straight leg penetrations. • Booster/Transfer Hall connection concrete shielding blocks are in place. • 400 MeV Chute to Linac enclosure connection concrete shielding blocks and chute grate is in place. • Short 9 Labyrinth concrete shielding blocks are in place.
Required Surveillance	In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.
Response	Beam operation to the Booster will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the 8 GeV Line will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Obvious and Operating Barriers to Ensure only Authorized Access

Applicability	During beam operations to the Booster segment of the Fermilab Main Accelerator.

Basis	To permit entry to only authorized individuals into the area surrounding the MTA segment of the Fermilab Main Accelerator, where the "General Site Basis" applies.
Credited Control	Obvious and Operating Barriers to ensure only authorized access shall be established in the following locations: • Wilson Hall West • Wilson Hall East • Site 55
Required Surveillance	none

Response	If unauthorized individual(s) is/are discovered to have passed beyond an Obvious and Operating Barrier, the following actions shall be taken:
	• Individual(s) is/are escorted out of the area where the "General Site Basis" applies within one (1) hour of discovery
	• Applicable accelerator segments are not required to be terminated
	
	If an Obvious and Operating Barrier is found to be not in place, the following actions shall be taken:
	• Original Obvious and Operating Barrier method shall be repaired/replaced OR another approved method shall be instituted within one (1) hour of discovery
	  ○ Applicable accelerator segments are not required to be terminated,
	  ○ Applicable accelerator segments may be turned off if repair/replacement work and/or instituting another approved method is not able to be completed within one (1) hour of discovery. Applicable accelerator segments may resume operations once Obvious and Operating Barrier is back in place.
	• Assurance shall be made that unauthorized individuals did not pass through during the time the Obvious and Operating Barrier was not in place

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability	During beam operations to the Booster segment of the Fermilab Main Accelerator.
Basis	To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

To ensure protection against dose to personnel inside the Booster's Exclusion Area(s) during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- Booster
- 8 GeV Line

Required components of the RSIS shall be specified in the Booster's Operation Authorization Document.

The following components of the Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

Radiation Safety System – Interlocked Radiation Monitors

Table 4: Booster Radiation Monitors Credited Controls

Type	Location	CC Limit (nC)
TLM	BSTR TLM1 Per 23, 24, 1	10,000
TLM	BSTR TLM2 Per 2, 3, 4	10,000
TLM	BSTR TLM3 Per 5, 6	10,000
TLM	BSTR TLM4 Per 8, 9, 10	10,000

TLM	BSTR TLM5 Per 11, 12, 13	10,000
TLM	BSTR TLM6 Per 14, 15, 16	10,000
TLM	BSTR TLM7 Per 17, 18, 19	10,000
TLM	BSTR TLM8 Per 20, 21, 22	10,000
TLM	BSTR TLM3a Per 6, 7	10,000

Note that the radiation monitor trip levels may be set lower than the CC Limit for ALARA purposes or to ensure compliance with 10CFR835.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

In order to assure functionality of the instrument, area radiation monitors shall be maintained and calibrated on an interval no greater than fifteen (15) months.

Response

Beam operation to the Booster will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Booster will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability

During beam operations to the Booster segment of the Fermilab Main Accelerator.

Basis

To summarize the Credited Controls for safe operation of the Booster, and to provide explicit approval for operations of the Booster.

Credited Control

An approved Booster Beam Permit & Running Condition shall be issued prior to Booster beam operations.

Required Surveillance

In order to assure Operation Authorization Documents are maintained up-to-date, the Booster Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.

Response

Beam operation to the Booster will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Booster will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During beam operations to the Booster segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none
Response	Beam operation to the Booster will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Booster will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During beam operations to the Booster segment of the Fermilab Main Accelerator.
Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded ▪
Credited Control	The following intensity shall not be exceeded: 3.8e17 protons/hr at 8 GeV.

Required Surveillance	none
Response	Beam operation to the Booster will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Booster will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

8 GeV Line Credited Controls

Passive – Shielding

Applicability	During beam operations to the 8 GeV Line segment of the Fermilab Main Accelerator.
Basis	To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded ▪
Credited Control	The following forms of passive shielding: • 17.9 e.f.d. of the berm over the beamline
Required Surveillance	In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.
Response	Beam operation to the 8 GeV Line will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the 8 GeV Line will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Obvious and Operating Barriers to Ensure only Authorized Access

Applicability	During beam operations to the 8 GeV Line segment of the Fermilab Main Accelerator.

Basis	To permit entry to only authorized individuals into the area surrounding the 8-GeV Line segment of the Fermilab Main Accelerator, where the "General Site Basis" applies.
Credited Control	Obvious and Operating Barriers to ensure only authorized access shall be established in the following locations: • Wilson Hall West • Wilson Hall East • Site 55
Required Surveillance	none

Response	If unauthorized individual(s) is/are discovered to have passed beyond an Obvious and Operating Barrier, the following actions shall be taken:
	• Individual(s) is/are escorted out of the area where the "General Site Basis" applies within one (1) hour of discovery
	• Applicable accelerator segments are not required to be terminated
	
	If an Obvious and Operating Barrier is found to be not in place, the following actions shall be taken:
	• Original Obvious and Operating Barrier method shall be repaired/replaced OR another approved method shall be instituted within one (1) hour of discovery
	  ○ Applicable accelerator segments are not required to be terminated,
	  ○ Applicable accelerator segments may be turned off if repair/replacement work and/or instituting another approved method is not able to be completed within one (1) hour of discovery. Applicable accelerator segments may resume operations once Obvious and Operating Barrier is back in place.
	• Assurance shall be made that unauthorized individuals did not pass through during the time the Obvious and Operating Barrier was not in place

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability	During beam operations to the 8 GeV Line segment of the Fermilab Main Accelerator.
Basis	To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

To ensure protection against dose to personnel inside the 8 GeV Line's Exclusion Area(s) during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during applicable beam operation:

- 8 GeV Line
- Muon Transport-Mid
- MI-10
- MI12-A

Required components of the RSIS shall be specified in the 8 GeV Line's Operation Authorization Document.

The Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

Response	Beam operation to the 8 GeV Line will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the 8 GeV Line will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability	During beam operations to the 8 GeV Line segment of the Fermilab Main Accelerator.
Basis	To summarize the Credited Controls for safe operation of the 8 GeV Line, and to provide explicit approval for operations of the 8 GeV Line.
Credited Control	An approved 8 GeV Line Beam Permit & Running Condition shall be issued prior to 8 GeV Line beam operations.
Required Surveillance	In order to assure Operation Authorization Documents are maintained up-to-date, the 8 GeV Line Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.
Response	Beam operation to the 8 GeV Line will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the 8 GeV Line will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During beam operations to the 8 GeV Line segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none

Response	Beam operation to the 8 GeV Line will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the 8 GeV Line will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During beam operations to the 8 GeV Line segment of the Fermilab Main Accelerator.
Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded.
Credited Control	The following intensity shall not be exceeded: 3.78e17 protons/hr at 8 GeV.
Required Surveillance	none
Response	Beam operation to the 8 GeV Line will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the 8 GeV Line will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Booster Neutrino Beam (BNB) Credited Controls

Passive – Shielding

Applicability

During beam operations to the BNB segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
  - ▪

Credited Control

The following forms of passive shielding:

- Shielding between the buried beam carrier pipe and the surface of the berm up to 20.3 e.f.d.
- Shielding between the interior surface of the enclosure walls and the surface of the berm up to 17.9 effective feet of dirt except at the Manhole PMH-PVI-2.
- Shielding up to 16.4 e.f.d outside of the BNB enclosure at the Manhole PMH-PVI-2.
- Movable steel and concrete shielding blocks at the MI-12 Service Building location.
- The following penetrations require shielding as listed below. All other penetrations may not use shielding.

Table 5. Location of Credited Control Penetration Shielding for BNB.

Station (ft)	Description	Credited Control Shielding
569	Stripline Pens	3 feet of polyethylene beads (50% packing fraction)
688	90-degree Monitor	Several blocks of concrete (5.5 e.f.d.)

Required Surveillance

In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.

Response	Beam operation to the BNB will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the BNB will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Obvious and Operating Barriers to Ensure only Authorized Access

Applicability	During beam operations to the BNB segment of the Fermilab Main Accelerator.
Basis	To permit entry to only authorized individuals into the area surrounding the MTA segment of the Fermilab Main Accelerator, where the "General Site Basis" applies.
Credited Control	Obvious and Operating Barriers to ensure only authorized access shall be established in the following locations: • Wilson Hall West • Wilson Hall East • Site 55
Required Surveillance	none

Response	If unauthorized individual(s) is/are discovered to have passed beyond an Obvious and Operating Barrier, the following actions shall be taken:
	• Individual(s) is/are escorted out of the area where the "General Site Basis" applies within one (1) hour of discovery
	• Applicable accelerator segments are not required to be terminated
	
	If an Obvious and Operating Barrier is found to be not in place, the following actions shall be taken:
	• Original Obvious and Operating Barrier method shall be repaired/replaced OR another approved method shall be instituted within one (1) hour of discovery
	  ○ Applicable accelerator segments are not required to be terminated,
	  ○ Applicable accelerator segments may be turned off if repair/replacement work and/or instituting another approved method is not able to be completed within one (1) hour of discovery. Applicable accelerator segments may resume operations once Obvious and Operating Barrier is back in place.

- Assurance shall be made that unauthorized individuals did not pass through during the time the Obvious and Operating Barrier was not in place

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability

During beam operations to the BNB segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

To ensure protection against dose to personnel inside the BNB's Exclusion Area(s) during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- MI-12A
- MI-12B
- MI-13

Required components of the RSIS shall be specified in the BNB's Operation Authorization Document.

The following components of the Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

Radiation Safety System – Interlocked Radiation Monitors

Table 6. BNB Radiation Monitors Credited Controls

Radiation Detector Type	Location	CC Limit (mrem/hr)
Chipmunk	MiniBooNE Indian Creek Road	2.5

Note that the radiation monitor trip levels may be set lower than the CC Limit for ALARA purposes or to ensure compliance with 10CFR835.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

In order to assure functionality of the instrument, area radiation monitors shall be maintained and calibrated on an interval no greater than fifteen (15) months.

Response

Beam operation to the BNB will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the BNB will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability

During beam operations to the BNB segment of the Fermilab Main Accelerator.

Basis

To summarize the Credited Controls for safe operation of the BNB, and to provide explicit approval for operations of the BNB.

Credited Control

An approved BNB Beam Permit & Running Condition shall be issued prior to BNB beam operations.

Required Surveillance

In order to assure Operation Authorization Documents are maintained up-to-date, the BNB Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.

Response	Beam operation to the BNB will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the BNB will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During beam operations to the BNB segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none
Response	Beam operation to the BNB will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the BNB will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During beam operations to the BNB segment of the Fermilab Main Accelerator.
Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.

- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
  -

Credited Control	The following intensity shall not be exceeded: 3.78e17 protons/hr at 8 GeV.
Required Surveillance	none
Response	Beam operation to the BNB will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the BNB will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

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Main Injector Credited Controls

Passive – Shielding

Applicability	During beam operations to the Main Injector segment of the Fermilab Main Accelerator.
Basis	To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded ▪
Credited Control	The following forms of passive shielding: • 20.7 effective feet of dirt shielding between the interior surface of the enclosure walls and the surface of the berm. • The concrete blocks that separate the MI/RR enclosure from F0 enclosure along the P1 line and the decommissioned A1 line. • The concrete blocks that shield the MI31 service building from the decommissioned Pelletron beam line. • The steel and Poly that fill the site risers around the MI Ring. • The sand bags, poly beads, and poly blocks that fill the penetrations to the tunnel from the service buildings.
Required Surveillance	In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.
Response	Beam operation to the Main Injector will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Main Injector will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Obvious and Operating Barriers to Ensure only Authorized Access

Applicability	During beam operations to the Main Injector segment of the Fermilab Main Accelerator.

Basis	To permit entry to only authorized individuals into the area surrounding the MTA segment of the Fermilab Main Accelerator, where the "General Site Basis" applies.
Credited Control	Obvious and Operating Barriers to ensure only authorized access shall be established in the following locations: • Wilson Hall West • Wilson Hall East • Site 55
Required Surveillance	none

Response	If unauthorized individual(s) is/are discovered to have passed beyond an Obvious and Operating Barrier, the following actions shall be taken:
	• Individual(s) is/are escorted out of the area where the "General Site Basis" applies within one (1) hour of discovery
	• Applicable accelerator segments are not required to be terminated
	
	If an Obvious and Operating Barrier is found to be not in place, the following actions shall be taken:
	• Original Obvious and Operating Barrier method shall be repaired/replaced OR another approved method shall be instituted within one (1) hour of discovery
	  ○ Applicable accelerator segments are not required to be terminated,
	  ○ Applicable accelerator segments may be turned off if repair/replacement work and/or instituting another approved method is not able to be completed within one (1) hour of discovery. Applicable accelerator segments may resume operations once Obvious and Operating Barrier is back in place.
	• Assurance shall be made that unauthorized individuals did not pass through during the time the Obvious and Operating Barrier was not in place

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability	During beam operations to the Main Injector segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

-
- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
    -

To ensure protection against dose to personnel inside the Main Injector's Exclusion Area(s) during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- MI-20—MI-62
- TeV F Sector
- MI/TeV Crossovers

Required components of the RSIS shall be specified in the Main Injector's Operation Authorization Document.

The Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

Required Surveillance	In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.
Response	Beam operation to the Main Injector will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Main Injector will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability	During beam operations to the Main Injector segment of the Fermilab Main Accelerator.
Basis	To summarize the Credited Controls for safe operation of the Main Injector, and to provide explicit approval for operations of the Main Injector.
Credited Control	An approved Main Injector Beam Permit & Running Condition shall be issued prior to Main Injector beam operations.
Required Surveillance	In order to assure Operation Authorization Documents are maintained up-to-date, the Main Injector Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.
Response	Beam operation to the Main Injector will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Main Injector will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During beam operations to the Main Injector segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.

Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none
Response	Beam operation to the Main Injector will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Main Injector will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During beam operations to the Main Injector segment of the Fermilab Main Accelerator.
Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded. ▪
Credited Control	The following intensity shall not be exceeded: 2.83e17 protons/hr at 120 GeV.
Required Surveillance	none
Response	Beam operation to the Main Injector will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to

the Main Injector will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Recycler

Passive – Shielding

Applicability	During beam operations to the Recycler segment of the Fermilab Main Accelerator.
Basis	To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded. ▪
Credited Control	The following forms of passive shielding: • 20.7 effective feet of dirt shielding between the interior surface of the enclosure walls and the surface of the berm. • The concrete blocks that separate the MI/RR enclosure from F0 enclosure along the P1 line and the decommissioned A1 line. • The concrete blocks that shield the MI31 service building from the decommissioned Pelletron beam line. • The steel and Poly that fill the site risers around the MI Ring. • The sand bags, poly beads, and poly blocks that fill the penetrations to the tunnel from the service buildings.
Required Surveillance	In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.
Response	Beam operation to the Recycler will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Recycler will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Obvious and Operating Barriers to Ensure only Authorized Access

Applicability	During beam operations to the Recycler segment of the Fermilab Main Accelerator.

Basis	To permit entry to only authorized individuals into the area surrounding the MTA segment of the Fermilab Main Accelerator, where the "General Site Basis" applies.
Credited Control	Obvious and Operating Barriers to ensure only authorized access shall be established in the following locations: • Wilson Hall West • Wilson Hall East • Site 55
Required Surveillance	none

Response	If unauthorized individual(s) is/are discovered to have passed beyond an Obvious and Operating Barrier, the following actions shall be taken:
	• Individual(s) is/are escorted out of the area where the "General Site Basis" applies within one (1) hour of discovery
	• Applicable accelerator segments are not required to be terminated
	
	If an Obvious and Operating Barrier is found to be not in place, the following actions shall be taken:
	• Original Obvious and Operating Barrier method shall be repaired/replaced OR another approved method shall be instituted within one (1) hour of discovery
	  ○ Applicable accelerator segments are not required to be terminated,
	  ○ Applicable accelerator segments may be turned off if repair/replacement work and/or instituting another approved method is not able to be completed within one (1) hour of discovery. Applicable accelerator segments may resume operations once Obvious and Operating Barrier is back in place.
	• Assurance shall be made that unauthorized individuals did not pass through during the time the Obvious and Operating Barrier was not in place

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability	During beam operations to the Recycler segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded.
    - ▪

To ensure protection against dose to personnel inside the Recycler's Exclusion Area(s) during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- MI-20—MI-62
- TeV F Sector
- MI/TeV Crossovers

Required components of the RSIS shall be specified in the Recycler's Operation Authorization Document.

The Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

Required Surveillance	In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.
Response	Beam operation to the Recycler will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Recycler will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability	During beam operations to the Recycler segment of the Fermilab Main Accelerator.
Basis	To summarize the Credited Controls for safe operation of the Recycler, and to provide explicit approval for operations of the Recycler.
Credited Control	An approved Recycler Beam Permit & Running Condition shall be issued prior to Recycler beam operations.
Required Surveillance	In order to assure Operation Authorization Documents are maintained up-to-date, the Recycler Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.
Response	Beam operation to the Recycler will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Recycler will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During beam operations to the Recycler segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.

Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none
Response	Beam operation to the Recycler will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Recycler will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During beam operations to the Recycler segment of the Fermilab Main Accelerator.
Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded. ▪
Credited Control	The following intensity shall not be exceeded: 2.83e17 protons/hr at 8 GeV.
Required Surveillance	none
Response	Beam operation to the Recycler will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the

Recycler will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Neutrinos from the Main Injector (NuMI) Credited Controls – Full HEP Operations

Passive – Shielding

Applicability

During full HEP operations beam operations to the NuMI segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
  -

Credited Control

The following forms of passive shielding:

- 24.0 effective feet of dirt shielding between the interior surface of the enclosure walls and the surface of the berm.
- The shielding plug at the top of SR-1: 3 ft of iron 1 ft of concrete.
- The shielding plug at the top of SR-2: 2 ft of iron 1 ft of concrete.
- The concrete block wall separating the Target Hall enclosure and the MI-65 electronics room/bottom of the shaft.
- The removable concrete blocks on the top of the target shield pile.

Required Surveillance

In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.

Response

Beam operation to the NuMI will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the NuMI will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Obvious and Operating Barriers to Ensure only Authorized Access

Applicability

During full HEP beam operations to the NuMI segment of the Fermilab Main Accelerator.

Basis	To permit entry to only authorized individuals into the area surrounding the MTA segment of the Fermilab Main Accelerator, where the "General Site Basis" applies.
Credited Control	Obvious and Operating Barriers to ensure only authorized access shall be established in the following locations: • Wilson Hall West • Wilson Hall East • Site 55
Required Surveillance	none

Response	If unauthorized individual(s) is/are discovered to have passed beyond an Obvious and Operating Barrier, the following actions shall be taken:
	• Individual(s) is/are escorted out of the area where the "General Site Basis" applies within one (1) hour of discovery
	• Applicable accelerator segments are not required to be terminated
	
	If an Obvious and Operating Barrier is found to be not in place, the following actions shall be taken:
	• Original Obvious and Operating Barrier method shall be repaired/replaced OR another approved method shall be instituted within one (1) hour of discovery
	  ○ Applicable accelerator segments are not required to be terminated,
	  ○ Applicable accelerator segments may be turned off if repair/replacement work and/or instituting another approved method is not able to be completed within one (1) hour of discovery. Applicable accelerator segments may resume operations once Obvious and Operating Barrier is back in place.
	• Assurance shall be made that unauthorized individuals did not pass through during the time the Obvious and Operating Barrier was not in place

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability	During full HEP beam operations to the NuMI segment of the Fermilab Main Accelerator.
Basis	To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
    -

To ensure protection against dose to personnel inside the NuMI's Exclusion Area(s) enclosure during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- NuMI MI-65
- NuMI Decay Pipe Passageway
- NuMI MINOS Alcoves & Absorber Areas

Required components of the RSIS shall be specified in the NuMI's Operation Authorization Document.

The following components of the Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

<u>Radiation Safety System – Interlocked Radiation Monitors</u>

Table 7: NuMI Radiation Monitors Credited Controls

Type	Location	CC Limit (mrem/hr)
Chipmunk	MI65 PS room	5,000

Note that the radiation monitor trip levels may be set lower than the CC Limit for ALARA purposes or to ensure compliance with 10CFR835.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

In order to assure functionality of the instrument, area radiation monitors shall be maintained and calibrated on an interval no greater than fifteen (15) months.

Response

Beam operation to the NuMI will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the NuMI will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability

During full HEP beam operations to the NuMI segment of the Fermilab Main Accelerator.

Basis

To summarize the Credited Controls for safe operation of the NuMI, and to provide explicit approval for operations of the NuMI.

Credited Control

An approved NuMI Beam Permit & Running Condition for Full HEP Operations shall be issued prior to NuMI beam operations.

Required Surveillance

In order to assure Operation Authorization Documents are maintained up-to-date, the NuMI Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.

Response

Beam operation to the NuMI will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the NuMI will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During full HEP beam operations to the NuMI segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none
Response	Beam operation to the NuMI will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the NuMI will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During full HEP beam operations to the NuMI segment of the Fermilab Main Accelerator.
Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded ▪
Credited Control	The following intensity shall not be exceeded: 2.83e17 protons/hr at 120 GeV.

Required Surveillance	none
Response	Beam operation to the NuMI will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the NuMI will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Neutrinos from the Main Injector (NuMI) Credited Controls – Low Intensity Scans

Passive – Shielding

Applicability	During low intensity scan beam operations to the NuMI segment of the Fermilab Main Accelerator.
Basis	To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded ▪
Credited Control	The following forms of passive shielding: • 24.0 effective feet of dirt shielding between the interior surface of the enclosure walls and the surface of the berm. • The shielding plug at the top of SR-1: 3 ft of iron 1 ft of concrete. • The shielding plug at the top of SR-2: 2 ft of iron 1 ft of concrete. • The removable concrete blocks on the top of the target shield pile.
Required Surveillance	In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.
Response	Beam operation to the NuMI will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the NuMI will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Obvious and Operating Barriers to Ensure only Authorized Access

Applicability	During low intensity scan beam operations to the NuMI segment of the Fermilab Main Accelerator.
Basis	To permit entry to only authorized individuals into the area surrounding the MTA segment of the Fermilab Main Accelerator, where the “General Site Basis” applies.

Credited Control	Obvious and Operating Barriers to ensure only authorized access shall be established in the following locations: • Wilson Hall West • Wilson Hall East • Site 55
Required Surveillance	none

Response	If unauthorized individual(s) is/are discovered to have passed beyond an Obvious and Operating Barrier, the following actions shall be taken:
	• Individual(s) is/are escorted out of the area where the "General Site Basis" applies within one (1) hour of discovery
	• Applicable accelerator segments are not required to be terminated
	
	If an Obvious and Operating Barrier is found to be not in place, the following actions shall be taken:
	• Original Obvious and Operating Barrier method shall be repaired/replaced OR another approved method shall be instituted within one (1) hour of discovery
	  ○ Applicable accelerator segments are not required to be terminated,
	  ○ Applicable accelerator segments may be turned off if repair/replacement work and/or instituting another approved method is not able to be completed within one (1) hour of discovery. Applicable accelerator segments may resume operations once Obvious and Operating Barrier is back in place.
	• Assurance shall be made that unauthorized individuals did not pass through during the time the Obvious and Operating Barrier was not in place

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability	During low intensity scan beam operations to the NuMI segment of the Fermilab Main Accelerator.
Basis	To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.

- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
    -

To ensure protection against dose to personnel inside the NuMI's Exclusion Area(s) enclosure during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- NuMI MI-65
- NuMI Decay Pipe Passageway
- NuMI MINOS Alcoves & Absorber Areas

Required components of the RSIS shall be specified in the NuMI's Operation Authorization Document.

The following components of the Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

No Credited Radiation Monitors.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

Response

Beam operation to the NuMI will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the

NuMI will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability	During low intensity scan beam operations to the NuMI segment of the Fermilab Main Accelerator.
Basis	To summarize the Credited Controls for safe operation of the NuMI, and to provide explicit approval for operations of the NuMI.
Credited Control	An approved NuMI Beam Permit & Running Condition for Low Intensity Scans shall be issued prior to NuMI beam operations.
Required Surveillance	In order to assure Operation Authorization Documents are maintained up-to-date, the NuMI Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.
Response	Beam operation to the NuMI will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the NuMI will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During low intensity scan beam operations to the NuMI segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none
Response	Beam operation to the NuMI will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If

an ASE violation is determined to have occurred, then beam operation to the NuMI will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During low intensity scan beam operations to the NuMI segment of the Fermilab Main Accelerator.
Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded ▪
Credited Control	The following intensity shall not be exceeded: • 1.2e12 protons/pulse • 1 batch • 10-second timeline
Required Surveillance	none
Response	Beam operation to the NuMI will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the NuMI will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

P1 and P2 Beamlines Credited Controls

Passive – Shielding

Applicability During beam operations to the P1 and P2 Beamlines segment of the Fermilab Main Accelerator.

Basis To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

Credited Control The following forms of passive shielding:

- The following tables list the Credited e.f.d

Table 8: P1-P2 Beamline Longitudinal Credited Shielding.

Z-Range (ft) or (cell)	Credited Shielding (efd)
520-701	20.3
702-708	17.9
708-F0	17.9
F0	17.9
F0 – F13.5	17.9
F13.5 – F15	17.9
F15 Cryo Bldg	17.9
F15 – F18	17.9

Table 9: P1-P2 Beamline Transverse Credited Shielding.

Transverse Station (ft) or (cell)	Credited Shielding (efd)
MI 8400	20.3
MI 8450	20.3
MI 8475	20.3
MI 8569	17.9
707 8650	17.9
708 8725	17.9

708 8740	17.9
E48-4	17.9
E48-7	17.9
E49-7	17.9
E49-9	17.9
F00-5	17.9
17270	17.9
17450	17.9
17657	17.9
17683	17.9
17707	17.9
17910	17.9
18100	17.9

- The following penetrations require fill, as listed. All other penetrations may be unfilled.

Table 10: P1-P2 Penetration Credited Shielding.

Location or Enclosure	Cell or Z-Location (feet)	Fill
F13 Cryo 6 in	F13	sand
F13 Cryo 10 in	F13	sand
F15 Cryo 48"	F15	reduce area with sand fill

Required Surveillance In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.

Response Beam operation to the P1 and P2 Beamlines will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the P1 and P2 Beamlines will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Obvious and Operating Barriers to Ensure only Authorized Access

Applicability During beam operations to the P1 and P2 Beamlines segment of the Fermilab Main Accelerator.

Basis	To permit entry to only authorized individuals into the area surrounding the P1 and P2 Beamlines segment of the Fermilab Main Accelerator, where the "General Site Basis" applies.
Credited Control	Obvious and Operating Barriers to ensure only authorized access shall be established in the following locations: • Wilson Hall West • Wilson Hall East • Site 55
Required Surveillance	none

Response	If unauthorized individual(s) is/are discovered to have passed beyond an Obvious and Operating Barrier, the following actions shall be taken:
	• Individual(s) is/are escorted out of the area where the "General Site Basis" applies within one (1) hour of discovery
	• Applicable accelerator segments are not required to be terminated
	
	If an Obvious and Operating Barrier is found to be not in place, the following actions shall be taken:
	• Original Obvious and Operating Barrier method shall be repaired/replaced OR another approved method shall be instituted within one (1) hour of discovery
	  ○ Applicable accelerator segments are not required to be terminated,
	  ○ Applicable accelerator segments may be turned off if repair/replacement work and/or instituting another approved method is not able to be completed within one (1) hour of discovery. Applicable accelerator segments may resume operations once Obvious and Operating Barrier is back in place.
	• Assurance shall be made that unauthorized individuals did not pass through during the time the Obvious and Operating Barrier was not in place

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability	During beam operations to the P1 and P2 Beamlines segment of the Fermilab Main Accelerator.
Basis	To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

To ensure protection against dose to personnel inside the P1 and P2 Beamlines' Exclusion Area(s) enclosure during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- F Sector
- Muon Campus Pre-Target

Required components of the RSIS shall be specified in the P1 and P2 Beamlines' Operation Authorization Document.

The following components of the Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

<u>Radiation Safety System – Interlocked Repetition Rate Limiter</u>

- VH94 repetition rate for 120 GeV beam shall be limited to once per 55 seconds.

<u>Radiation Safety System – Interlocked Radiation Monitors</u>

Table 11: P1 and P2 Beamlines Radiation Monitors Credited Controls

Type	Location	CC Limit (mrem/hr)
Chipmunk	F15 Air Handler	440 mrem/hr

Note that the radiation monitor trip levels may be set lower than the CC Limit for ALARA purposes or to ensure compliance with 10CFR835.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

In order to assure functionality of the instrument, area radiation monitors shall be maintained and calibrated on an interval no greater than fifteen (15) months.

Response

Beam operation to the P1 and P2 Beamlines will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the P1 and P2 Beamlines will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability

During beam operations to the P1 and P2 Beamlines segment of the Fermilab Main Accelerator.

Basis

To summarize the Credited Controls for safe operation of the P1 and P2 Beamlines, and to provide explicit approval for operations of the P1 and P2 Beamlines.

Credited Control

An approved P1 and P2 Beamlines Beam Permit & Running Condition shall be issued prior to P1 and P2 Beamlines beam operations.

Required Surveillance

In order to assure Operation Authorization Documents are maintained up-to-date, the P1 and P2 Beamlines Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.

Response

Beam operation to the P1 and P2 Beamlines will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam

operation to the P1 and P2 Beamlines will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During low intensity scan beam operations to the P1 and P2 Beamlines segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none
Response	Beam operation to the P1 and P2 Beamlines will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the P1 and P2 Beamlines will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During beam operations to the P1 and P2 Beamlines segment of the Fermilab Main Accelerator.
Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could

potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

- ▪

Credited Control	The following intensity shall not be exceeded: • 2.75e15 protons/hr at 120 GeV • 3.78e17 protons/hr at 8 GeV
Required Surveillance	none
Response	Beam operation to the P1 and P2 Beamlines will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the P1 and P2 Beamlines will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Muon Campus Credited Controls

Passive – Shielding

Applicability

During beam operations to the Muon Campus segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
  -

Credited Control

The following forms of passive shielding:

<u>Permanent Shielding</u>

- In the area of the buried beam pipe between F17 in the Tevatron and the Pre-Target enclosure, 20.3 effective feet of dirt (efd) is credited.
- In the area of the Pre-Target and Pre-Vault enclosures, 17.9 efd of berm shielding is credited.
- Concrete shield blocks fill a magnet hatch between the AP0 service building and the Pre-Vault enclosure.
- In the area of the AP0 target vault, many concrete shielding blocks and steel shielding modules over the dump and target vault are credited.
- Concrete shield blocks fill a magnet hatch between the AP0 service building and the Transport enclosure.
- Along the M2 and M3 beamlines, excluding the short section under Indian Road, 11 efd of berm shielding is credited.
- Along the M3 line under Indian Road, 10 efd of shielding is credited.
- Under the Delivery Ring service buildings (AP-10, AP-30, and AP-50), 5 efd of shielding is credited.
- Over the Delivery Ring abort line, and over the Delivery Ring arcs, 10 efd of berm shielding is credited.
- In the Delivery Ring, there are 4 magnet drop hatches filled with concrete shielding blocks.
- In the AP-30 service building, there are 32 five inch penetrations that are filled with poly beads.

- In the AP-30 service building, there is an obsolete cryo trench with a penetration which is filled with poly beads and concrete.
- The Delivery Rings has stub rooms in the 20 and 40 sections that contain penetrations with 3 feet of sand for shielding.
- Over the M4 beamline through the Extraction and M4 enclosures, 15.1 efd of berm shielding is credited.
- Around the M5 beamline in the Extraction enclosure, there is a shield wall constructed of many concrete shield blocks.
- Around the M4 beamline in the M4 enclosure, there is a shield wall constructed of many concrete shield blocks.
- In the M4 enclosure, just upstream of the Diagnostic Absorber, there is a magnet hatch filled with concrete shield blocks.
- In the M4 beamline, upstream of the M4 shield wall, there are two beam stops that are locked in the closed position.
- There are 24 survey site risers throughout the Muon Campus that are filled with poly beads or sand.

Required Surveillance	In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.
Response	Beam operation to the Muon Campus will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Muon Campus will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Obvious and Operating Barriers to Ensure only Authorized Access

Applicability	During beam operations to the Muon Campus segment of the Fermilab Main Accelerator.
Basis	To permit entry to only authorized individuals into the area surrounding the Muon Campus segment of the Fermilab Main Accelerator, where the “General Site Basis” applies.
Credited Control	Obvious and Operating Barriers to ensure only authorized access shall be established in the following locations: • Wilson Hall West • Wilson Hall East • Site 55

Required Surveillance	none

Response	If unauthorized individual(s) is/are discovered to have passed beyond an Obvious and Operating Barrier, the following actions shall be taken:
	• Individual(s) is/are escorted out of the area where the "General Site Basis" applies within one (1) hour of discovery
	• Applicable accelerator segments are not required to be terminated
	
	If an Obvious and Operating Barrier is found to be not in place, the following actions shall be taken:
	• Original Obvious and Operating Barrier method shall be repaired/replaced OR another approved method shall be instituted within one (1) hour of discovery
	  ○ Applicable accelerator segments are not required to be terminated,
	  ○ Applicable accelerator segments may be turned off if repair/replacement work and/or instituting another approved method is not able to be completed within one (1) hour of discovery. Applicable accelerator segments may resume operations once Obvious and Operating Barrier is back in place.
	• Assurance shall be made that unauthorized individuals did not pass through during the time the Obvious and Operating Barrier was not in place

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability	During beam operations to the Muon Campus segment of the Fermilab Main Accelerator.
Basis	To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded ▪

To ensure protection against dose to personnel inside the Muon Campus's Exclusion Area(s) enclosure during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- Muon Campus Pre-Target
- Muon Campus Pre-Vault
- AP-0 Vault
- Muon Campus Transport US/DS
- Muon Campus Transport Mid
- Muon Campus Delivery Ring
- Muon Campus Extraction Enclosure & Stub
- Muon Campus M4 Enclosure **note: only required when operating to the Diagnostic Absorber*

Required components of the RSIS shall be specified in the Muon Campus's Operation Authorization Document.

The following components of the Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

<u>Radiation Safety System – Interlocked Radiation Monitors</u>

Table 12: Muon Campus Radiation Monitors Credited Controls

Type	Location	CC Limit (mrem/hr for Chipmunks)
Chipmunk	AP-10 North Door	500

Chipmunk	AP-10 Relay Rack A17R05	500
Chipmunk	AP-10 Relay Rack A16R07	500
Chipmunk	AP-10 Relay Rack A16R03	500
Chipmunk	AP-10 D:QS power supply	500
Chipmunk	AP-10 D:QD power supply	500
Chipmunk	AP-10 Relay Rack A14R03	500
Chipmunk	AP-10 Relay Rack A14R0Y	500
Chipmunk	AP-10 Control Room Southwest Door	500
Chipmunk	AP-10 Bay A13 South	500
Chipmunk	AP-10 Bay A12 North	500
Chipmunk	AP-10 Relay Rack A2R01	500
Chipmunk	AP-10 Southwest Rollup Door	500
Chipmunk	AP-10 South Door	500
Chipmunk	AP-30 South Door	500
Chipmunk	AP-30 South Rollup Door	500
Chipmunk	AP-30 D:H744 power supply	500
Chipmunk	AP-30 D:Q303 power supply	500
Chipmunk	AP-30 Relay Rack A35R07	500
Chipmunk	AP-30 Relay Rack A35R01	500
Chipmunk	AP-30 D:ISEP power supply	500

Chipmunk	AP-30 Relay Rack A35R03	500
Chipmunk	AP-30 Relay Rack A33R07	500
Chipmunk	AP-30 Relay Rack A33R01	500
Chipmunk	AP-30 D:ELAM power supply	500
Chipmunk	AP-30 D:V906 power supply	500
Chipmunk	AP-30 NE Rollup Door	500
Chipmunk	AP-30 North Door	500
Chipmunk	AP-50 West Door	500
Chipmunk	AP-50 Relay Rack A57R07	500
Chipmunk	AP-50 Relay Rack A57R01	500
Chipmunk	AP-50 Relay Rack A56R04	500
Chipmunk	AP-50 Relay Rack A55R08	500
Chipmunk	AP-50 Relay Rack A55R02	500
Chipmunk	AP-50 D:SEXV power supply	500
Chipmunk	AP-50 D:VA03 power supply	500
Chipmunk	AP-50 Relay Rack A53R07	500
Chipmunk	AP-50 Relay Rack A53R01	500
Chipmunk	AP-50 Abort Kicker power supply	500
Chipmunk	AP-50 D:ASEP	500

	power supply	
Chipmunk	AP-50 East Rollup Door	500
Chipmunk	AP-50 East Door	500
TLM	Upstream Transport enclosure	100,000 nC/min
TLM	Downstream Transport enclosure into Delivery Ring	100,000 nC/min
TLM	Delivery Ring 20 arc	100,000 nC/min
TLM	Delivery Ring 40 arc	100,000 nC/min
TLM	Delivery Ring 60 arc	100,000 nC/min
TLM	Delivery Ring abort line	100,000 nC/min

Note that the radiation monitor trip levels may be set lower than the CC Limit for ALARA purposes or to ensure compliance with 10CFR835.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

In order to assure functionality of the instrument, area radiation monitors shall be maintained and calibrated on an interval no greater than fifteen (15) months.

Response

Beam operation to the Muon Campus will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Muon Campus will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability

During beam operations to the Muon Campus segment of the Fermilab Main Accelerator.

Basis

To summarize the Credited Controls for safe operation of the Muon Campus, and to provide explicit approval for operations of the Muon Campus.

Credited Control	An approved Muon Campus Beam Permit & Running Condition shall be issued prior to Muon Campus beam operations.
Required Surveillance	In order to assure Operation Authorization Documents are maintained up-to-date, the Muon Campus Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.
Response	Beam operation to the Muon Campus will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Muon Campus will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During low intensity scan beam operations to the Muon Campus segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none
Response	Beam operation to the Muon Campus will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Muon Campus will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During beam operations to the Muon Campus segment of the Fermilab Main Accelerator.

Basis

To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
    -

Credited Control

The following intensities shall not be exceeded:

- 3.78e17 protons/hr at 8 GeV between F17 in the Tevatron and injection area in the Delivery Ring 30 straight section.
- 5.54e16 protons/hr at 8 GeV in the Delivery Ring downstream of the 30 straight section, or in the M4 beamline.
- 1.67e13 particles/hr at 3.1 GeV in the M5 line to the g-2 experiment

Required Surveillance

none

Response

Beam operation to the Muon Campus will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Muon Campus will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Switchyard (P3 to Switchyard Absorber) Credited Controls

Passive – Shielding

Applicability During beam operations to the Switchyard segment of the Fermilab Main Accelerator.

Basis To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
- Public Area Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 100 mrem in one hour at Fermilab's site boundary AND/OR in any areas onsite in which the public is authorized.
    - Batavia Road, Prairie Path (MBO), parking lots open to the public.
    - All General Access Areas, including, but not limited to the following:
        - Wilson Hall
        - Ramsey Auditorium
        - Lederman Science Center
        - Building 327

Credited Control The following forms of passive shielding:

<u>Permanent Shielding</u>

- Longitudinal range 17880-00360, 13.9 efd.
- Longitudinal range 00360-01520, 18.7 efd.

Three locations are exceptions:

- Station 20390, 5.5 efd
- Station 00124, 5.5 efd
- Station 00273, 5.5 efd

The following penetrations require fill, as listed. All other penetrations may be unfilled.

Table 13: P3-Switchyard Penetration Credited Shielding.

Location or Enclosure	Cell or Z-Location (feet)	Fill
F23 LCW S/R	18355	12" pipe filled with sand, two 3" LCW pipes unfilled

F25 Cryo 48"	18569	48" filled with sand, 12" 8" 5" and 3" penetrations within unfilled
F35 Cryo 48"	19368	48" filled with sand, 12" 8" 5" and 3" penetrations within unfilled
F45 Cryo 48"	20121	48" filled with sand, 12" 8" 5" and 3" penetrations within unfilled
A0 Cryo	20370	3' diameter pipe filled with sand, two 8" piped unfilled
A-0 Kicker Building (North)	0	3' of Poly Rods with 10% packing factor in three 7" penetrations
A-0 Kicker Building (North)	0	3' of Poly Rods with 10% packing factor in three 7" penetrations
A-0 Kicker Building (North)	0	3' of Poly Rods with 10% packing factor in three 7" penetrations
SY Encl. B Cryo Pen	745	sand
SY Encl. D: west pen to SSB	1640	2' poly beads
SY Encl. D: east pen to SSB	1640	2' poly beads

Required Surveillance In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.

Response Beam operation to the Switchyard will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Switchyard will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Fencing

Applicability During beam operations to the Switchyard segment of the Fermilab Main Accelerator.

Basis To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.

- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
- Public Area Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 100 mrem in one hour at Fermilab's site boundary AND/OR in any areas onsite in which the public is authorized.
    - Batavia Road, Prairie Path (MBO), parking lots open to the public.
    - All General Access Areas, including, but not limited to the following:
        - Wilson Hall
        - Ramsey Auditorium
        - Lederman Science Center
        - Building 327

Credited Control

The following fencing:

- The fencing immediately downstream of the Switchyard Dump.

Required fencing shall be specified in the Switchyard's Operation Authorization Document.

Required Surveillance

In order to assure the required fencing is in place, required fencing shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.

Response

Beam operation to the Switchyard will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Switchyard will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability

During beam operations to the Switchyard segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.

- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
- Public Area Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 100 mrem in one hour at Fermilab's site boundary AND/OR in any areas onsite in which the public is authorized.
    - Batavia Road, Prairie Path (MBO), parking lots open to the public.
    - All General Access Areas, including, but not limited to the following:
        - Wilson Hall
        - Ramsey Auditorium
        - Lederman Science Center
        - Building 327

To ensure protection against dose to personnel inside the Switchyard's Exclusion Area(s) enclosure during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- Transfer Hall
- Enclosure B
- Enclosure C, D, E
- G1 Stub

Required components of the RSIS shall be specified in the Switchyard's Operation Authorization Document.

The following components of the Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

Radiation Safety System – Interlocked Radiation Monitors

Table 14: P3-Switchyard Radiation Monitors Credited Controls

Type		Location	CC Limit
Chipmunk	20390	Transfer Hall	490 mrem/hour
Chipmunk	124	Transfer Gallery North Addition	24.5 mrem/hour
TLM1	273	WH-C-1 Manhole	3400 nC/min
Chipmunk	18569	F25 Cryo 48”	4810 mrem/hour
Chipmunk	19368	F35 Cryo 48”	4940 mrem/hour
Chipmunk	20121	F45 Cryo 48”Refrigerator Building	4950 mrem/hour
Chipmunk	0	A-0 Kicker Building (South)	4900 mrem/hour
Chipmunk	0	A-0 Kicker Building (Middle)	4900 mrem/hour
Chipmunk	0	A-0 Kicker Buiding (North)	4900 mrem/hour
TLM1	745	Enclosure B Cryo Penetration	3400 nC/min

Note that the radiation monitor trip levels may be set lower than the CC Limit for ALARA purposes or to ensure compliance with 10CFR835.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

In order to assure functionality of the instrument, area radiation monitors shall be maintained and calibrated on an interval no greater than fifteen (15) months.

Response

Beam operation to the Switchyard will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If

an ASE violation is determined to have occurred, then beam operation to the Switchyard will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability	During beam operations to the Switchyard segment of the Fermilab Main Accelerator.
Basis	To summarize the Credited Controls for safe operation of the Switchyard, and to provide explicit approval for operations of the Switchyard.
Credited Control	An approved Switchyard Beam Permit & Running Condition shall be issued prior to Switchyard beam operations.
Required Surveillance	In order to assure Operation Authorization Documents are maintained up-to-date, the Switchyard Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.
Response	Beam operation to the Switchyard will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Switchyard will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During low intensity scan beam operations to the Switchyard segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none

Response	Beam operation to the Switchyard will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Switchyard will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During beam operations to the Switchyard segment of the Fermilab Main Accelerator.

Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions:
	• Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
	• General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
	• Public Area Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 100 mrem in one hour at Fermilab's site boundary AND/OR in any areas onsite in which the public is authorized.
	  ○ Batavia Road, Prairie Path (MBO), parking lots open to the public.
	  ○ All General Access Areas, including, but not limited to the following:
	  ▪ Wilson Hall
	  ▪ Ramsey Auditorium
	  ▪ Lederman Science Center
	  ▪ Building 327

Credited Control	• The following intensity shall not be exceeded: 2.75e15 protons/hr at 120 GeV.
Required Surveillance	none
Response	Beam operation to the Switchyard will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If

an ASE violation is determined to have occurred, then beam operation to the Switchyard will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Meson Primary (MPrimary) Credited Controls

Passive – Shielding

Applicability During beam operations to the Meson Primary segment of the Fermilab Main Accelerator.

Basis To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

Credited Control The following forms of passive shielding:

- The following tables list the Credited e.f.d.

Table 15: MPrimary Longitudinal Credited Shielding.

Transverse Station (ft) or (cell)	Credited Shielding (efd)
1237-1335	16.3
1335-2308	18.7
2308-2350	13.9
2350-2370	18.7
2370-2413	13.9
2413-3005	18.7
3005-3350	15.5
3350-3967	14.7
3967-4340	15.3

- The following penetrations require fill, as listed. All other penetrations may be unfilled.

Table 16: MPrimary Credited Penetration Fill.

Location or Enclosure	Cell or Z-Location (feet)	Fill (efd or material)

M01	4010	13.1 shielding M01 train track hatch
M01	4128 (MS1)	2.65
M01	4144 (MS1)	2.65
M01	4158 (MS1)	2.65
M02	4350	Duct filled with 19.5 feet of sand
M02	4438 (MS2)	4.5 efd
M02	4467 (MS2)	4.5 efd
M02	4495 (MS2)	4.5 efd
M02	4550	Duct filled with 20 feet of sand
M03	4985	MCenter sight riser filled with 16.5 feet of sand
M04	5300	MCenter sight riser filled with 13 feet of sand
M05	5510	MCenter sight riser filled with 15.5 feet of sand

Required Surveillance In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.

Response Beam operation to the Meson Primary will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Meson Primary will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Fencing

Applicability During beam operations to the Meson Primary segment of the Fermilab Main Accelerator.

Basis To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

To ensure protection against dose to personnel outside the Meson Primary enclosures, but atop the berm within the Master Substation, during beam operations:

- Fencing is used to prohibit access

Credited Control

The following fencing must be in place during applicable beam operation:

- Radiation Area fencing within the Master Substation
- Radiation Area fencing surrounding the Meson Area Berm.

Required fencing shall be specified in the Meson Primary's Operation Authorization Document.

Required Surveillance

In order to assure that required fencing is in place, required fencing shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than fifteen (15) months.

Response

Beam operation to the Meson Primary will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Meson Primary will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability

During beam operations to the Meson Primary segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

To ensure protection against dose to personnel inside the Meson Primary's Exclusion Area(s) enclosure during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and

- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- F1
- F2
- F3
- M01
- M02
- M03
- M04
- M05

Required components of the RSIS shall be specified in the Meson Primary's Operation Authorization Document.

The following components of the Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

In order to assure functionality of the instrument, area radiation monitors shall be maintained and calibrated on an interval no greater than fifteen (15) months.

Response

Beam operation to the Meson Primary will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Meson Primary will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability	During beam operations to the Meson Primary segment of the Fermilab Main Accelerator.
Basis	To summarize the Credited Controls for safe operation of the Meson Primary, and to provide explicit approval for operations of the Meson Primary.
Credited Control	An approved Meson Primary Beam Permit & Running Condition shall be issued prior to Meson Primary beam operations.
Required Surveillance	In order to assure Operation Authorization Documents are maintained up-to-date, the Meson Primary Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.
Response	Beam operation to the Meson Primary will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Meson Primary will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During low intensity scan beam operations to the Meson Primary segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none
Response	Beam operation to the Meson Primary will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to

the Meson Primary will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During beam operations to the Meson Primary segment of the Fermilab Main Accelerator.
Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
Credited Control	The following intensity shall not be exceeded: 2.75e15 protons/hr at 120 GeV.
Required Surveillance	none
Response	Beam operation to the Meson Primary will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Meson Primary will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Meson Test (MTest) Credited Controls

Passive – Shielding

Applicability

During beam operations to the Meson Test segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

Credited Control

The following forms of passive shielding:

- The MT6 enclosure, constructed of 3'x3'x6.5' concrete shielding blocks
- The following tables list the Credited e.f.d.

Table 17: Meson Credited Shielding along the MTest Beamline - Longitudinal Sections

Transverse Station (ft) or (cell)	Credited Shielding (efd)
4340-4989	14.3
4989-4995	9
4995-5043	15
5043-5164	11.6
5164-5590	3.0
5590-5618	3.0

- The following penetrations require fill, as listed. All other penetrations may be unfilled.

Table 18: Meson Test Credited Penetration Fill.

Location or Enclosure	Cell or Z-Location (feet)	Fill (efd or material)
M03	5115	3' concrete at mouth of labyrinth

		and 3' hand stack at end of leg 1

Required Surveillance

In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.

Response

Beam operation to the Meson Test Area will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Meson Test will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability

During beam operations to the MTest segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

To ensure protection against dose to personnel inside the MTest's Exclusion Area(s) enclosure during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- MT6 Section 1
- MT6 Section 2

Required components of the RSIS shall be specified in the MTest's Operation Authorization Document.

The following components of the Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

MTest Primary Logic Chasis

- The MTest Primary Logic Chasis shall be configured to allow the transport of only the following through the MTest secondary beamline beyond the corresponding production target:
    - Secondary particles with central momentum in the range of 0 GeV/c to 30 GeV/c
    - Secondary particles with central momentum in the range of 32 GeV/c to 60 GeV/c

Secondary particles with central momentum up to 120 GeV/c

Radiation Safety System – Interlocked Radiation Monitors

Table 19: : MTest Radiation Monitors Credited Controls

Type	Location	CC Limit (mrem/hr)
Chipmunk	MT3 Cryo Labyrinth	95

Note that the radiation monitor trip levels may be set lower than the CC Limit for ALARA purposes or to ensure compliance with 10CFR835.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

In order to assure functionality of the instrument, area radiation monitors shall be maintained and calibrated on an interval no greater than fifteen (15) months.

Response	Beam operation to the MTest will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the MTest will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Active Engineered – Oxygen Deficiency Hazard (ODH) System

Applicability	During personnel access into Meson enclosure M02, M03, M04, and M05.
Basis	To ensure personnel are alerted to the presence of an oxygen deficient atmosphere, and to initiate personnel evacuation.
Credited Control	The following components of the ODH Safety System shall be in place, with no known loss of safety function, during personnel access into applicable areas: • Four (4) area/fixed oxygen monitors, two (2) high and two (2) low, in M03 • Four (4) area/fixed oxygen monitors, two (2) high and two (2) low, in M04 • One (1) horn and one (1) strobe in M03 • One (1) horn and one (1) strobe in M04
Required Surveillance	In order to assure functionality of the component, operation of all Credited ODH monitoring components shall be functionally tested at an interval no greater than twelve (12) months.
Response	Personnel access into MTest enclosures M02, M03, M04, and M05 shall be limited to the Cryo Coordinator/ODH Expert/Facility Manager or designee and those authorized to repair the system or reclassify the area. If an ASE violation is determined to have occurred, then beam operation to the MTest will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability	During beam operations to the MTest segment of the Fermilab Main Accelerator.
Basis	To summarize the Credited Controls for safe operation of the MTest, and to provide explicit approval for operations of the MTest.
Credited Control	An approved MTest Beam Permit & Running Condition shall be issued prior to MTest beam operations.

Required Surveillance	In order to assure Operation Authorization Documents are maintained up-to-date, the MTest Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.
Response	Beam operation to the MTest will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the MTest will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During low intensity scan beam operations to the MTest segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none
Response	Beam operation to the MTest will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the MTest will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During beam operations to the MTest segment of the Fermilab Main Accelerator.
Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

Credited Control	The following MPrimary beam intensity, sent to MTest, shall not be exceeded: 2.75e15 protons/hr at 120 GeV.
Required Surveillance	none
Response	Beam operation to the MTest will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the MTest will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Meson Center (MCenter) Credited Controls

Passive – Shielding

Applicability

During beam operations to the MCenter segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

Credited Control

The following forms of passive shielding:

- The following tables list the Credited e.f.d.

Table 20: Meson Credited Shielding along the MCenter Beamline - Longitudinal Sections

Transverse Station (ft) or (cell)	Credited Shielding (efd)
4340-5603	12.8
5603-5662	13.9
5662-5733	5.5
5733-5790	3.0
5790-5793	3.0
5793-5798	0.0

Required Surveillance

In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.

Response

Beam operation to the MCenter will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the MCenter will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Fencing

Applicability During beam operations to the Meson Center segment of the Fermilab Main Accelerator.

Basis To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

To ensure protection against dose to personnel outside the Meson Center enclosures during beam operations:

- Fencing is used to prohibit access

Credited Control The following fencing must be in place during applicable beam operation:

- Radiation Area fencing north of MC7, spanning Meson West (MW) and Meson Polarized (MP) beamlines

Required fencing shall be specified in the Meson Center's Operation Authorization Document.

Required Surveillance In order to assure that required fencing is in place, required fencing shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than fifteen (15) months.

Response Beam operation to the Meson Center will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the Meson Center will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability During beam operations to the MCenter segment of the Fermilab Main Accelerator.

Basis To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could

potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.

- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

To ensure protection against dose to personnel inside the MCenter's Exclusion Area(s) enclosure during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- MC6
- MC7
- MB7

Required components of the RSIS shall be specified in the MCenter's Operation Authorization Document.

The following components of the Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

<u>MCenter Primary Logic Chasis</u>

- The MCenter Primary Logic Chasis shall be configured to prevent MC6D from being energized above a current corresponding to the transport of 90 GeV particles.

<u>Radiation Safety System – Interlocked Radiation Monitors</u>

Table 21: Meson Center Radiation Monitors Credited Controls

Type	Location	CC Limit (mrem/hr)
Chipmunk	MDB MC6 US	19.7
Chipmunk	MDB MC6 Mid	28.2
Chipmunk	MDB MC6 DS	28.2
Chipmunk	MC6 Catwalk	440
Chipmunk	MC7 air gap, 6 ft below beamline	495

Note that the radiation monitor trip levels may be set lower than the CC Limit for ALARA purposes or to ensure compliance with 10CFR835.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

In order to assure functionality of the instrument, area radiation monitors shall be maintained and calibrated on an interval no greater than fifteen (15) months.

In order to assure functionality of the Logic Chasis, operation of the logic chasis shall be functionally tested at an interval no greater than fifteen (15) months.

Response

Beam operation to the MCenter will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the MCenter will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability

During beam operations to the MCenter segment of the Fermilab Main Accelerator.

Basis

To summarize the Credited Controls for safe operation of the MCenter, and to provide explicit approval for operations of the MCenter.

Credited Control	An approved MCenter Beam Permit & Running Condition shall be issued prior to MCenter beam operations.
Required Surveillance	In order to assure Operation Authorization Documents are maintained up-to-date, the Meson Center Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.
Response	Beam operation to the MCenter will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the MCenter will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During low intensity scan beam operations to the MCenter segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none
Response	Beam operation to the MCenter will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the MCenter will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During beam operations to the MCenter segment of the Fermilab Main Accelerator.

Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
Credited Control	The following MPrimary beam intensity, sent to MCenter, shall not be exceeded: 2.75e15 protons/hr at 120 GeV.
Required Surveillance	none
Response	Beam operation to MCenter will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the MCenter will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Neutrino Muon (NM) Credited Controls

Passive – Shielding

Applicability During beam operations to the NM segment of the Fermilab Main Accelerator.

Basis To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

Credited Control The following forms of passive shielding:

- The following tables list the Credited e.f.d.

Permanent Shielding

Table 22: Neutrino Muon Longitudinal Credited Shielding.

Transverse Station (ft) or (cell)	Credited Shielding (efd)
1520-1536	16.3
1536-1633	16.3
1633-1708	11.4
1708-1752	16.3
1752-2070	16.3
2070-2224	13.9
2224-2285	13.9
2285-2390	13.9
2390-2417	13.9
2417-2420	13.9
2420-2430	16.3
2430-2690	16.3
2690-2763	16.3
2763-3090	16.3
3090-3110	16.3

3110-3146	16.3
3146-3179	16.3

Required Surveillance In order to assure the required shielding is in place, required shielding shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than twelve (12) months.

Response Beam operation to the NM segment will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to the NM Segment will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Passive – Fencing

Applicability During beam operations to the Neutrino Muon segment of the Fermilab Main Accelerator.

Basis To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

To ensure protection against dose to personnel outside the Neutrino Muon enclosures, but atop the berm within the Master Substation, during beam operations:

- Fencing is used to prohibit access

Credited Control The following fencing must be in place during applicable beam operation:

- Radiation Area fencing surrounding the Neutrino Muon Berm.

Required fencing shall be specified in the Neutrino Muon's Operation Authorization Document.

Required Surveillance In order to assure that required fencing is in place, required fencing shall be verified in place against the listed Credited Controls in the ASE on an interval no greater than fifteen (15) months.

Response Beam operation to the Neutrino Muon will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE

violation is determined to have occurred, then beam operation to the Neutrino Muon will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Active Engineered – Radiation Safety Interlock System (RSIS)

Applicability

During beam operations to the NM Segment of the Fermilab Main Accelerator.

Basis

To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:

- Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers.
- General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded

To ensure protection against dose to personnel inside the NM Segment's Exclusion Area(s) enclosure during beam operations:

- Use of Search and Secure and interlock hardware to ensure personnel are not within the area and to establish the Exclusion Area(s) prior to beam operations, and
- Use of interlock hardware to maintain the Exclusion Area(s) and prevent inadvertent access during beam operations.
- A Search and Secure procedure must be carried out inside the Exclusion Area(s) prior to beam operations to ensure that all personnel are excluded. The Radiation Safety Interlock System (RSIS) must both ensure all personnel are cleared from exclusion areas prior to beam authorization and prevent entry into Exclusion Areas during beam operations.

Credited Control

The Radiation Safety Interlock System (RSIS) must prevent entry into the following Exclusion Area(s) during appliable beam operation:

- G2
- N01
- NM2
- NM3
- NM4

Required components of the RSIS shall be specified in NM's Operation Authorization Document.

The following components of the Radiation Safety Interlock System (RSIS) shall be in place, with no known loss of safety function, during applicable beam operations.

Radiation Safety System – Interlocked Radiation Monitors

Table 23: NM Segment Radiation Monitors Credited Controls

Type	Location	CC Limit (mrem/hr)
Chipmunk	G2 Cryo Penetration (z=2333')	495
Chipmunk	G2 Cryo Penetration (z=2337')	490
Chipmunk	NM3 Berm	500

Note that the radiation monitor trip levels may be set lower than the CC Limit for ALARA purposes or to ensure compliance with 10CFR835.

Required Surveillance

In order to assure functionality of the RSIS, operation of all access control interlock components shall be functionally tested at an interval no greater than fifteen (15) months.

In order to assure functionality of the instrument, area radiation monitors shall be maintained and calibrated on an interval no greater than fifteen (15) months.

Response

Beam operation to NM will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to NM will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Active Engineered – Oxygen Deficiency Hazard (ODH) System

Applicability

During personnel access into Neutrino Muon enclosure NM4.

Basis

To ensure personnel are alerted to the presence of an oxygen deficient atmosphere, and to initiate personnel evacuation.

Credited Control	The following components of the ODH Safety System shall be in place, with no known loss of safety function, during personnel access into applicable areas: • Two (2) area/fixed oxygen monitors (one high, one low), within NM4 • One (1) horn and one (1) strobe within NM4
Required Surveillance	In order to assure functionality of the component, operation of all Credited ODH monitoring components shall be functionally tested at an interval no greater than twelve (12) months.
Response	Personnel access into Neutrino Muon enclosure NM4 shall be limited to the Cryo Coordinator/ODH Expert/Facility Manager or designee and those authorized to repair the system or reclassify the area. If an ASE violation is determined to have occurred, then beam operation to the Neutrino segment will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.
Applicability	During personnel access into NM3 target cave.
Basis	To ensure personnel are alerted to the presence of an oxygen deficient atmosphere, and to initiate personnel evacuation.
Credited Control	The following components of the ODH Safety System shall be in place, with no known loss of safety function, during personnel access into applicable areas: • Two (2) area/fixed oxygen monitors (one high, one low), within NM3 • One (1) horn and one (1) strobe within NM3
Required Surveillance	In order to assure functionality of the component, operation of all Credited ODH monitoring components shall be functionally tested at an interval no greater than twelve (12) months.
Response	Personnel access into NM3 target cave shall be limited to the Cryo Coordinator/ODH Expert/Facility Manager or designee and those authorized to repair the system or reclassify the area. If an ASE violation is determined to have occurred, then beam operation to the Neutrino segment will not

resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Operation Authorization Document

Applicability	During beam operations to the NM segment of the Fermilab Main Accelerator.
Basis	To summarize the Credited Controls for safe operation of NM, and to provide explicit approval for operations of NM.
Credited Control	An approved NM Beam Permit & Running Condition shall be issued prior to NM beam operations.
Required Surveillance	In order to assure Operation Authorization Documents are maintained up-to-date, the NM Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.
Response	Beam operation to the NM Segment will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to NM will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Staffing

Applicability	During low intensity scan beam operations to the NM segment of the Fermilab Main Accelerator.
Basis	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
Credited Control	The following staffing shall be in place during applicable beam operation: • At least one member of the AD Operations Department who has achieved the rank of Operator II or higher shall be on duty and on site. • At least one member of the AD Operations Department shall be present in the Main Control Room (MCR). • These requirements could be satisfied by a single person.
Required Surveillance	none
Response	Beam operation to the NM Segment will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to

NM will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

Administrative – Accelerator Operating Parameters

Applicability	During beam operations to the NM segment of the Fermilab Main Accelerator.
Basis	To ensure operations within intensity used in the MCI analysis, and ensure accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard is mitigated to the following conditions: • Worker Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 5 rem in one hour in any area accessible by facility workers and co-located workers. • General Site Basis: Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in 500 mrem in one hour in areas to which the public is assumed to be excluded
Credited Control	The following intensity shall not be exceeded: 2.75e15 protons/hr 120 GeV.
Required Surveillance	none
Response	Beam operation to the NM segment will be terminated immediately once a USI Screening determines that a discovered condition warrants USI Evaluation. If an ASE violation is determined to have occurred, then beam operation to NM will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.