



# FERMI NATIONAL ACCELERATOR LABORATORY

## ACCELERATOR SAFETY ENVELOPE

### Fermilab Main Accelerator

Revision 15 January 22, 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

\_\_\_\_\_  
Accelerator Safety Department Head

\_\_\_\_\_  
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 Jess Malo	15	January 22, 2024	<ul style="list-style-type: none"> <li>• Inclusion of IRR #1c applicable Segments:               <ul style="list-style-type: none"> <li>○ Muon Campus</li> <li>○ Switchyard</li> <li>○ Meson</li> <li>○ Neutrino</li> </ul> </li> <li>• Inclusion of fencing as Credited Control</li> <li>• Inclusion of engineered controls within the Radiation Safety Interlock System (RSIS) to limit intensity</li> </ul>
Maddie Schoell	14	January 8, 2024	<ul style="list-style-type: none"> <li>• Inclusion of IRR #1b applicable Segments:               <ul style="list-style-type: none"> <li>○ Booster</li> <li>○ 8 GeV Line</li> <li>○ Booster Neutrino Beam (BNB)</li> <li>○ Main Injector</li> <li>○ Recycler</li> <li>○ Neutrinos from the Main Injector (NuMI)</li> </ul> </li> <li>• 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:               <ul style="list-style-type: none"> <li>○ Additional details included related to calibration, maintenance and surveillance requirements.</li> <li>○ Credited Control “Basis” language updated to exactly reflect the defined boundary conditions for the General Site and Public Areas</li> <li>○ Updated the Accelerator Operating Parameter Credited Controls to include intensity and energy.</li> </ul> </li> <li>• In response to IRR #1b pre-start recommendation #2, Linac and MTA Accelerator Operating Parameter Credited Control values updated to accurately and consistently reflect the MCI analysis summarized in the SAD.</li> </ul>

Author	Rev. No.	Date	Description of Change
Maddie Schoell	13	December 21, 2023	<p>Following the revision of Department of Energy (DOE) Order 420.2C, <i>Safety of Accelerators</i>, 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.</p> <ul style="list-style-type: none"> <li>• Separated ASEs for the Fermilab Main Accelerator from the FAST Accelerator, removing FAST from this ASE.</li> <li>• Major overhaul of outline of ASE, including general descriptions and information within Section 1 through Section 6</li> <li>• Added 0 to specifically describe Credited Controls for each segment of the Fermilab Main Accelerator</li> <li>• Updated shielding assessment reference for the Neutrino Area.</li> <li>• Removed reference for Memo, “Accelerator Safety Envelope Limitations for Operating Areas” and included content from the memo within the ASE.</li> </ul> <p>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.</p> <ul style="list-style-type: none"> <li>• IRR #1a applicable Segments: <ul style="list-style-type: none"> <li>○ Linac</li> <li>○ 400 MeV Test Area (MTA)</li> </ul> </li> </ul>
Maddie Schoell	12	August 25, 2020	<p>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.</p> <p>Updated “ASE Violation Determination and Actions” section to clarify deficiency in credited control and ASE violations.</p>

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, <i>Safety of Accelerator Facilities</i> , 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	<p>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, <i>Significant and Reportable Occurrences</i>, 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.</p> <p>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.</p>



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## 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
<b>Worker Basis:</b> Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in <b>5 rem</b> in one hour in any area accessible by facility workers and co-located workers.	Inside service buildings, where public cannot access	Facility Worker and/or Co-located Worker
<b>General Site Basis:</b> Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in <b>500 mrem</b> 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	Members of the public if they access areas where they are not authorized
<p><b>Public Area Basis:</b> Mitigated consequence of any credible postulated accident scenario at maximum operating intensity that could potentially result in <b>100 mrem</b> in one hour at Fermilab’s site boundary AND/OR in any areas onsite in which the public is authorized.</p> <ul style="list-style-type: none"> <li>• Batavia Road, Prairie Path (MBO), parking lots open to the public.</li> <li>• All General Access Areas, including, but not limited to the following:               <ul style="list-style-type: none"> <li>○ Wilson Hall</li> <li>○ Ramsey Auditorium</li> <li>○ Lederman Science Center</li> <li>○ Building 327</li> </ul> </li> </ul>	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

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 principle 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 may also include additional engineered controls to limit the intensity below the maximum possible of the machine.

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. RSIS Required Components and Inputs, including interlocked detectors
  - iii. ODH System Requirements
  - iv. Staffing Requirements
  - v. 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.

#### 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/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/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 0 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.

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

In the event that the ASE is violated (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 0.

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 applicable 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

**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
- 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:

- 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.

#### *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
- 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 MTA’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:

- 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	50
Chipmunk	Linac Ramp – top of berm upstream	50
Chipmunk	Linac Ramp – top of berm downstream	50
Chipmunk	Beam Stop Alcove – top of berm upstream of hatch	50
Chipmunk	MTA Upstream Stub – above UVB11 (SQA)	50
Chipmunk	MTA Hall – Ceiling Vent	50
Chipmunk	MTA Hall Mid-Hall	50
Chipmunk	MTA Hall “Front Porch”	50
Chipmunk	Pipe to Absorber	50
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.

<b>Required Surveillance</b>	<p>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.</p> <p>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.</p>
<b>Response</b>	<p>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.</p>

#### *Administrative – Operation Authorization Document*

<b>Applicability</b>	<p>During beam operations to the MTA segment of the Fermilab Main Accelerator.</p>
<b>Basis</b>	<p>To summarize the Credited Controls for safe operation of the MTA, and to provide explicit approval for operations of the MTA.</p>
<b>Credited Control</b>	<p>An approved MTA Beam Permit &amp; Running Condition shall be issued prior to MTA beam operations.</p>
<b>Required Surveillance</b>	<p>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.</p>
<b>Response</b>	<p>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.</p>

#### *Administrative – Staffing*

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



<b>Credited Control</b>	<p>The following staffing shall be in place during applicable beam operation:</p> <ul style="list-style-type: none"><li>• 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.</li><li>• At least one member of the AD Operations Department shall be present in the Main Control Room (MCR).</li><li>• These requirements could be satisfied by a single person.</li></ul>
<b>Required Surveillance</b>	none
<b>Response</b>	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*

<b>Applicability</b>	During beam operations to the MTA segment of the Fermilab Main Accelerator.
<b>Basis</b>	<p>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:</p> <ul style="list-style-type: none"><li>• 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.</li><li>• 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</li><li>• 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.<ul style="list-style-type: none"><li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li><li>○ All General Access Areas, including, but not limited to the following:<ul style="list-style-type: none"><li>▪ Wilson Hall</li><li>▪ Ramsey Auditorium</li></ul></li></ul></li></ul>

- Lederman Science Center
- Building 327

<b>Credited Control</b>	The following intensity shall not be exceeded: 2.58e18 protons/hr
<b>Required Surveillance</b>	none
<b>Response</b>	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.

Booster Credited Controls

*Passive – Shielding*

<b>Applicability</b>	During beam operations to the Booster segment of the Fermilab Main Accelerator.
<b>Basis</b>	<p>To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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</li> <li>• 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.             <ul style="list-style-type: none"> <li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li> <li>○ All General Access Areas, including, but not limited to the following:                 <ul style="list-style-type: none"> <li>▪ Wilson Hall</li> <li>▪ Ramsey Auditorium</li> <li>▪ Lederman Science Center</li> <li>▪ Building 327</li> </ul> </li> </ul> </li> </ul>
<b>Credited Control</b>	<p>The following forms of passive shielding:</p> <ul style="list-style-type: none"> <li>• Shielding between the interior surface of the enclosure to the surface of the berm is a minimum of 12.5 effective feet of dirt.</li> <li>• At least 12 ft of Poly beads fill selected penetrations.</li> <li>• Booster/Transfer Hall (Main Ring) connection concrete shielding blocks are in place.</li> <li>• 400 MeV Chute to Linac enclosure connection concrete shielding blocks are in place.</li> <li>• S9/L10 Labyrinth concrete shielding blocks are in place.</li> </ul>
<b>Required Surveillance</b>	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.

*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
- 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 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 applicable 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
Chipmunk	Booster East Fan Room (Short 12)	490 mrem/hr
Chipmunk	Booster Crossover at CUB (Short 19)	490 mrem/hr
Chipmunk	Booster/Line W Gal Intersect (Long 22)	235 mrem/hr
Chipmunk	Booster Per 1 Exit Stairwell (Short 1)	490 mrem/hr
Chipmunk	MI-8 Line in WBT (12’ US of Buttress)	39 mrem/hr
Chipmunk	MI-8 Line on Berm (WBT)	490 mrem/hr
TLM	BSTR TLM1 Per 23, 24, 1	10000nC/min
TLM	BSTR TLM2 Per 2, 3, 4	10000nC/min
TLM	BSTR TLM3 Per 5, 6	10000nC/min
TLM	BSTR TLM4 Per 8, 9, 10	10000nC/min
TLM	BSTR TLM5 Per 11, 12, 13	10000nC/min
TLM	BSTR TLM6 Per 14, 15, 16	10000nC/min
TLM	BSTR TLM7 Per 17, 18, 19	10000nC/min
TLM	BSTR TLM8 Per 20, 21, 22	10000nC/min
TLM	BSTR TLM3a Per 6, 7	10000nC/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.

<b>Required Surveillance</b>	<p>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.</p> <p>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.</p>
<b>Response</b>	<p>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.</p>

#### *Administrative – Operation Authorization Document*

<b>Applicability</b>	<p>During beam operations to the Booster segment of the Fermilab Main Accelerator.</p>
<b>Basis</b>	<p>To summarize the Credited Controls for safe operation of the Booster, and to provide explicit approval for operations of the Booster.</p>
<b>Credited Control</b>	<p>An approved Booster Beam Permit &amp; Running Condition shall be issued prior to Booster beam operations.</p>
<b>Required Surveillance</b>	<p>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.</p>
<b>Response</b>	<p>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.</p>

#### *Administrative – Staffing*

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

<b>Credited Control</b>	<p>The following staffing shall be in place during applicable beam operation:</p> <ul style="list-style-type: none"><li>• 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.</li><li>• At least one member of the AD Operations Department shall be present in the Main Control Room (MCR).</li><li>• These requirements could be satisfied by a single person.</li></ul>
<b>Required Surveillance</b>	none
<b>Response</b>	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*

<b>Applicability</b>	During beam operations to the Booster segment of the Fermilab Main Accelerator.
<b>Basis</b>	<p>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:</p> <ul style="list-style-type: none"><li>• 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.</li><li>• 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</li><li>• 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.<ul style="list-style-type: none"><li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li><li>○ All General Access Areas, including, but not limited to the following:<ul style="list-style-type: none"><li>▪ Wilson Hall</li><li>▪ Ramsey Auditorium</li></ul></li></ul></li></ul>

- Lederman Science Center
- Building 327

<b>Credited Control</b>	The following intensity shall not be exceeded: $3.8e17$ protons/hr
<b>Required Surveillance</b>	none
<b>Response</b>	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*

<b>Applicability</b>	During beam operations to the 8 GeV Line segment of the Fermilab Main Accelerator.
<b>Basis</b>	<p>To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:</p> <ul style="list-style-type: none"><li>• 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.</li><li>• 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</li><li>• 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.<ul style="list-style-type: none"><li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li><li>○ All General Access Areas, including, but not limited to the following:<ul style="list-style-type: none"><li>▪ Wilson Hall</li><li>▪ Ramsey Auditorium</li><li>▪ Lederman Science Center</li><li>▪ Building 327</li></ul></li></ul></li></ul>
<b>Credited Control</b>	<p>The following forms of passive shielding:</p> <ul style="list-style-type: none"><li>• 17.9 e.f.d. of the berm over the beamline</li></ul>
<b>Required Surveillance</b>	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.
<b>Response</b>	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.

*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
- 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 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
- 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

<b>Credited Control</b>	The following intensity shall not be exceeded: 3.78e17 protons/hr
<b>Required Surveillance</b>	none
<b>Response</b>	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.

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Booster Neutrino Beam (BNB) Credited Controls

*Passive – Shielding*

<b>Applicability</b>	During beam operations to the BNB segment of the Fermilab Main Accelerator.
<b>Basis</b>	<p>To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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</li> <li>• 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.             <ul style="list-style-type: none"> <li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li> <li>○ All General Access Areas, including, but not limited to the following:                 <ul style="list-style-type: none"> <li>▪ Wilson Hall</li> <li>▪ Ramsey Auditorium</li> <li>▪ Lederman Science Center</li> <li>▪ Building 327</li> </ul> </li> </ul> </li> </ul>
<b>Credited Control</b>	<p>The following forms of passive shielding:</p> <ul style="list-style-type: none"> <li>• Shielding between the buried beam carrier pipe and the surface of the berm up to 20.3 e.f.d.</li> <li>• 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.</li> <li>• Shielding up to 15.9 e.f.d outside of the BNB enclosure at the Manhole PMH-PVI-2 (allows for 0.5 e.f.d. of defense -in -depth) shielding).</li> <li>• Movable steel and concrete shielding blocks in the MI-12 Service Building access shaft.</li> </ul>
<b>Required Surveillance</b>	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.

*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
- 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 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 applicable 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 5. BNB Radiation Monitors Credited Controls*

Radiation Detector Type	Location	CC Limit (mrem/hr)
Chipmunk	MiniBooNE Indian Creek Road	2.5
Chipmunk	MI-12B Stripline Penetrations	150

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
- 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: 3.78e17 protons/hr

**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.

Main Injector Credited Controls

*Passive – Shielding*

<b>Applicability</b>	During beam operations to the Main Injector segment of the Fermilab Main Accelerator.
<b>Basis</b>	<p>To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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</li> <li>• 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.             <ul style="list-style-type: none"> <li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li> <li>○ All General Access Areas, including, but not limited to the following:                 <ul style="list-style-type: none"> <li>▪ Wilson Hall</li> <li>▪ Ramsey Auditorium</li> <li>▪ Lederman Science Center</li> <li>▪ Building 327</li> </ul> </li> </ul> </li> </ul>
<b>Credited Control</b>	<p>The following forms of passive shielding:</p> <ul style="list-style-type: none"> <li>• 20.7 effective feet of dirt shielding between the interior surface of the enclosure walls and the surface of the berm.</li> <li>• The concrete blocks that separate the MI/RR enclosure from F0 enclosure along the P1 line and the decommissioned A1 line.</li> <li>• The concrete blocks that shield the MI31 service building from the decommissioned Pelletron beam line.</li> <li>• The steel and Poly that fill the site risers around the MI Ring.</li> <li>• The sand bags, poly beads, and poly blocks that fill the penetrations to the tunnel from the service buildings.</li> </ul>
<b>Required Surveillance</b>	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.

*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
- 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 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 applicable 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.

<b>Credited Control</b>	An approved Main Injector Beam Permit & Running Condition shall be issued prior to Main Injector beam operations.
<b>Required Surveillance</b>	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.
<b>Response</b>	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*

<b>Applicability</b>	During beam operations to the Main Injector segment of the Fermilab Main Accelerator.
<b>Basis</b>	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
<b>Credited Control</b>	<p>The following staffing shall be in place during applicable beam operation:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• At least one member of the AD Operations Department shall be present in the Main Control Room (MCR).</li> <li>• These requirements could be satisfied by a single person.</li> </ul>
<b>Required Surveillance</b>	none
<b>Response</b>	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*

<b>Applicability</b>	During beam operations to the Main Injector segment of the Fermilab Main Accelerator.
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**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: 2.83e17 protons/hr

**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.

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Recycler Credited Controls

*Passive – Shielding*

<b>Applicability</b>	During beam operations to the Recycler segment of the Fermilab Main Accelerator.
<b>Basis</b>	<p>To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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</li> <li>• 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.             <ul style="list-style-type: none"> <li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li> <li>○ All General Access Areas, including, but not limited to the following:                 <ul style="list-style-type: none"> <li>▪ Wilson Hall</li> <li>▪ Ramsey Auditorium</li> <li>▪ Lederman Science Center</li> <li>▪ Building 327</li> </ul> </li> </ul> </li> </ul>
<b>Credited Control</b>	<p>The following forms of passive shielding:</p> <ul style="list-style-type: none"> <li>• 20.7 effective feet of dirt shielding between the interior surface of the enclosure walls and the surface of the berm.</li> <li>• The concrete blocks that separate the MI/RR enclosure from F0 enclosure along the P1 line and the decommissioned A1 line.</li> <li>• The concrete blocks that shield the MI31 service building from the decommissioned Pelletron beam line.</li> <li>• The steel and Poly that fill the site risers around the MI Ring.</li> <li>• The sand bags, poly beads, and poly blocks that fill the penetrations to the tunnel from the service buildings.</li> </ul>
<b>Required Surveillance</b>	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.

*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
- 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 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 applicable 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.

<b>Credited Control</b>	An approved Recycler Beam Permit & Running Condition shall be issued prior to Recycler beam operations.
<b>Required Surveillance</b>	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.
<b>Response</b>	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*

<b>Applicability</b>	During beam operations to the Recycler segment of the Fermilab Main Accelerator.
<b>Basis</b>	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
<b>Credited Control</b>	The following staffing shall be in place during applicable beam operation: <ul style="list-style-type: none"><li>• 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.</li><li>• At least one member of the AD Operations Department shall be present in the Main Control Room (MCR).</li><li>• These requirements could be satisfied by a single person.</li></ul>
<b>Required Surveillance</b>	none
<b>Response</b>	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*

<b>Applicability</b>	During beam operations to the Recycler segment of the Fermilab Main Accelerator.
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<b>Basis</b>	<p>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:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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</li> <li>• 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.             <ul style="list-style-type: none"> <li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li> <li>○ All General Access Areas, including, but not limited to the following:                 <ul style="list-style-type: none"> <li>▪ Wilson Hall</li> <li>▪ Ramsey Auditorium</li> <li>▪ Lederman Science Center</li> <li>▪ Building 327</li> </ul> </li> </ul> </li> </ul>
<b>Credited Control</b>	The following intensity shall not be exceeded: 2.83e17 protons/hr
<b>Required Surveillance</b>	none
<b>Response</b>	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.

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Neutrinos from the Main Injector (NuMI) Credited Controls

*Passive – Shielding*

**Applicability** During 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
- 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:

- 24.0 effective feet of dirt shielding between the interior surface of the enclosure walls and the surface of the beam.
- 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.

**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.

*Active Engineered – Radiation Safety Interlock System (RSIS)***Applicability**

During 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
- 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 NuMI’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:

- 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.

Radiation Safety System – Interlocked Radiation Monitors

*Table 6: NuMI Radiation Monitors Credited Controls*

Type		Location	CC Limit (mrem/hr)
Chipmunk	MI65 PS room		5000

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 beam operations to the NuMI segment of the Fermilab Main Accelerator.

<b>Basis</b>	To summarize the Credited Controls for safe operation of the NuMI, and to provide explicit approval for operations of the NuMI.
<b>Credited Control</b>	An approved NuMI Beam Permit & Running Condition shall be issued prior to NuMI beam operations.
<b>Required Surveillance</b>	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.
<b>Response</b>	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*

<b>Applicability</b>	During beam operations to the NuMI segment of the Fermilab Main Accelerator.
<b>Basis</b>	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
<b>Credited Control</b>	<p>The following staffing shall be in place during applicable beam operation:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• At least one member of the AD Operations Department shall be present in the Main Control Room (MCR).</li> <li>• These requirements could be satisfied by a single person.</li> </ul>
<b>Required Surveillance</b>	none
<b>Response</b>	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*

<b>Applicability</b>	During beam operations to the NuMI segment of the Fermilab Main Accelerator.
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<b>Basis</b>	<p>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:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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</li> <li>• 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.             <ul style="list-style-type: none"> <li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li> <li>○ All General Access Areas, including, but not limited to the following:                 <ul style="list-style-type: none"> <li>▪ Wilson Hall</li> <li>▪ Ramsey Auditorium</li> <li>▪ Lederman Science Center</li> <li>▪ Building 327</li> </ul> </li> </ul> </li> </ul>
<b>Credited Control</b>	The following intensity shall not be exceeded: 2.83e17 protons/hr
<b>Required Surveillance</b>	none
<b>Response</b>	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.

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Switchyard: P1-P2 Credited Controls

*Passive – Shielding*

**Applicability** During beam operations to the P1-P2 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:

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

*Table 7. 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 8. P1-P2 Beamline Transverse Credited Shielding.*

<b>Transverse Station (ft) or (cell)</b>	<b>Credited Shielding (efd)</b>
<b>MI 8400</b>	20.3
<b>MI 8450</b>	20.3
<b>MI 8475</b>	20.3
<b>MI 8569</b>	17.9
<b>707 8650</b>	17.9
<b>708 8725</b>	17.9
<b>708 8740</b>	17.9
<b>E48-4</b>	17.9
<b>E48-7</b>	17.9
<b>E49-7</b>	17.9
<b>E49-9</b>	17.9
<b>F00-5</b>	17.9
<b>17270</b>	17.9
<b>17450</b>	17.9
<b>17657</b>	17.9
<b>17683</b>	17.9
<b>17707</b>	17.9
<b>17910</b>	17.9
<b>18100</b>	17.9



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

Table 9. 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-P2 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-P2 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 P1-P2 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 P1-P2’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:

- F Sector
- Muon Campus Pre-Target

Required components of the RSIS shall be specified in the P1-P2’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 10: P1-P2 Radiation Monitors Credited Controls*

Type		Location	CC Limit
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.

<b>Required Surveillance</b>	<p>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.</p> <p>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.</p>
<b>Response</b>	<p>Beam operation to the P1-P2 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-P2 will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.</p>

#### *Administrative – Operation Authorization Document*

<b>Applicability</b>	<p>During beam operations to the P1-P2 segment of the Fermilab Main Accelerator.</p>
<b>Basis</b>	<p>To summarize the Credited Controls for safe operation of the P1-P2, and to provide explicit approval for operations of the P1-P2.</p>
<b>Credited Control</b>	<p>An approved P1-P2 Beam Permit &amp; Running Condition shall be issued prior to P1-P2 beam operations.</p>
<b>Required Surveillance</b>	<p>In order to assure Operation Authorization Documents are maintained up-to-date, the P1-P2 Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.</p>
<b>Response</b>	<p>Beam operation to the P1-P2 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-P2 will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.</p>

#### *Administrative – Staffing*

<b>Applicability</b>	<p>During beam operations to the P1-P2 segment of the Fermilab Main Accelerator.</p>
<b>Basis</b>	<p>To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.</p>

<b>Credited Control</b>	<p>The following staffing shall be in place during applicable beam operation:</p> <ul style="list-style-type: none"><li>• 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.</li><li>• At least one member of the AD Operations Department shall be present in the Main Control Room (MCR).</li><li>• These requirements could be satisfied by a single person.</li></ul>
<b>Required Surveillance</b>	none
<b>Response</b>	Beam operation to the P1-P2 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-P2 will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

#### *Administrative – Accelerator Operating Parameters*

<b>Applicability</b>	During beam operations to the P1-P2 segment of the Fermilab Main Accelerator.
<b>Basis</b>	<p>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:</p> <ul style="list-style-type: none"><li>• 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.</li><li>• 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</li><li>• 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.<ul style="list-style-type: none"><li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li><li>○ All General Access Areas, including, but not limited to the following:<ul style="list-style-type: none"><li>▪ Wilson Hall</li><li>▪ Ramsey Auditorium</li></ul></li></ul></li></ul>

- Lederman Science Center
- Building 327

<b>Credited Control</b>	The following intensity shall not be exceeded: <ul style="list-style-type: none"><li>• 2.75e15 protons/hr at 120 GeV</li><li>• 3.78e17 protons/hr at 8 GeV</li></ul>
<b>Required Surveillance</b>	none
<b>Response</b>	Beam operation to the P1-P2 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-P2 will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

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## Muon Campus Credited Controls

*Passive – Shielding*

<b>Applicability</b>	During beam operations to the Muon Campus segment of the Fermilab Main Accelerator.
<b>Basis</b>	<p>To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:</p> <ul style="list-style-type: none"><li>• 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.</li><li>• 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</li><li>• 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.<ul style="list-style-type: none"><li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li><li>○ All General Access Areas, including, but not limited to the following:<ul style="list-style-type: none"><li>▪ Wilson Hall</li><li>▪ Ramsey Auditorium</li><li>▪ Lederman Science Center</li><li>▪ Building 327</li></ul></li></ul></li></ul>
<b>Credited Control</b>	<p>The following forms of passive shielding:</p> <p><u>Permanent Shielding</u></p> <ul style="list-style-type: none"><li>• 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.</li><li>• In the area of the Pre-Target and Pre-Vault enclosures, 17.9 efd of berm shielding is credited.</li><li>• Concrete shield blocks fill a magnet hatch between the APO service building and the Pre-Vault enclosure.</li><li>• In the area of the APO target vault, many concrete shielding blocks and steel shielding modules over the dump and target vault are credited.</li><li>• Concrete shield blocks fill a magnet hatch between the APO service building and the Transport enclosure.</li><li>• Along the M2 and M3 beamlines, excluding the short section under Indian Road, 11 efd of berm shielding is credited.</li></ul>

- 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 23 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.

*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
- 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 Muon Campus’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:

- 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.

## Radiation Safety System – Interlocked Radiation Monitors

Table 11: 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 power supply	500
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 beam operations to the Muon Campus segment of the Fermilab Main Accelerator.

<b>Basis</b>	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
<b>Credited Control</b>	The following staffing shall be in place during applicable beam operation: <ul style="list-style-type: none"><li>• 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.</li><li>• At least one member of the AD Operations Department shall be present in the Main Control Room (MCR).</li><li>• These requirements could be satisfied by a single person.</li></ul>
<b>Required Surveillance</b>	none
<b>Response</b>	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*

<b>Applicability</b>	During beam operations to the Muon Campus segment of the Fermilab Main Accelerator.
<b>Basis</b>	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: <ul style="list-style-type: none"><li>• 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.</li><li>• 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</li><li>• 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.<ul style="list-style-type: none"><li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li><li>○ All General Access Areas, including, but not limited to the following:</li></ul></li></ul>

- Wilson Hall
- Ramsey Auditorium
- Lederman Science Center
- Building 327

<b>Credited Control</b>	The following intensities shall not be exceeded: <ul style="list-style-type: none"><li>• 3.78e17 protons/hr at 8 GeV between F17 in the Tevatron and injection area in the Delivery Ring 30 straight section.</li><li>• 5.54e16 protons/hr at 8 GeV in the Delivery Ring downstream of the 30 straight section, or in the M4 beamline.</li><li>• 1.67e13 particles/hr at 3.1 GeV in the M5 line to the g-2 experiment</li></ul>
<b>Required Surveillance</b>	none
<b>Response</b>	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 (P3-Switchyard) Credited Controls

*Passive – Shielding*

**Applicability** During beam operations to the P3-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:

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

*Table 12. P3-Switchyard Longitudinal Credited Shielding.*

<b>Transverse Station (ft) or (cell)</b>	<b>Credited Shielding (efd)</b>
<b>17880-18550</b>	13.9
<b>18550-18600</b>	13.9
<b>18600-19332</b>	13.9
<b>19332-19345</b>	13.9
<b>19345-19815</b>	13.9
<b>19815-19867</b>	13.9
<b>19867-20114</b>	13.9
<b>20114-20128</b>	13.9
<b>20128-20313</b>	13.9
<b>20313-20370</b>	13.9
<b>20370-20376</b>	13.9
<b>20376-00130</b>	13.9
<b>130-175</b>	13.9
<b>175-215</b>	13.9
<b>215-265</b>	13.9
<b>265-360</b>	13.9
<b>360-740</b>	18.7
<b>740-750</b>	18.7
<b>750-807</b>	18.7
<b>807-920</b>	18.7
<b>920-1250</b>	18.7
<b>1250-1265</b>	18.7
<b>1265-1290</b>	18.7
<b>1290-1333</b>	18.7
<b>1333-1495</b>	18.7
<b>1495-1520</b>	16.3



Table 13. P3-Switchyard Transverse Credited Shielding.

Transverse Station (ft) or (cell)	Credited Shielding (efd)	Transverse Station (ft) or (cell)	Credited Shielding (efd)
17910	13.9	175	13.9
18100	13.9	184	13.9
18302	13.9	200	13.9
18355	13.9	236	13.9
18410	13.9	251	13.9
18535	13.9	260	13.9
18569	13.9	273	5.5
18605	13.9	300	13.9
18695	13.9	385	18.7
18753	13.9	400	18.7
18811	13.9	438	18.7
19050	13.9	500	18.7
19317	13.9	600	18.7
19342	13.9	700	18.7
19367	13.9	800	18.7
19650	13.9	814	18.7
19750	13.9	900	18.7
19842	13.9	948	18.7
19925	13.9	986	10.2
20098	13.9	1000	18.7
20122	13.9	1100	18.7
20148	13.9	1200	18.7
20390	5.5	1280	18.7
0	13.9	1330	18.7
85	13.9	1510	16.3
124	5.5		

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

Table 14. 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
Transfer Gallery	0	3' of Poly Rods with 10% packing factor in three 7" penetrations
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 P3-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 P3-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 P3-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 P3-Switchyard’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:

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

Required components of the RSIS shall be specified in the P3-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 Repetition Rate Limiter

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

Radiation Safety System – Interlocked Radiation Monitors

Table 15: P3-Switchyard Radiation Monitors Credited Controls

Type	Location	CC Limit
Chipmunk	A-0 Ramp	490 mrem/hr
Chipmunk	Transfer Gallery North Addition	24.5 mrem/hr
Chipmunk	Transfer Gallery North Addition	24.5 mrem/hr
TLM	Enclosure B	14,641 nC/min
TLM	Enclosure C	74,460 nC/min
Chipmunk	F2 Refrigerator Building	4,810 mrem/hr
Chipmunk	F3 Refrigerator Building	4,940 mrem/hr
Chipmunk	F4 Refrigerator Building	4,940 mrem/hr
Chipmunk	A-0 Kicker Building (South)	4,900 mrem/hr
Chipmunk	A-0 Kicker Building (Middle)	4,900 mrem/hr
Chipmunk	A-0 Kicker Building (North)	4,900 mrem/hr
Chipmunk	Enclosure B Cryo Penetration	95 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.

In order to assure functionality of the repetition rate limiter, operation of the repetition rate limiter shall be functionally tested at an interval no greater than fifteen (15) months.

**Response**

Beam operation to the P3-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 P3-Switchyard will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

*Administrative – Operation Authorization Document*

<b>Applicability</b>	During beam operations to the P3-Switchyard segment of the Fermilab Main Accelerator.
<b>Basis</b>	To summarize the Credited Controls for safe operation of the P3-Switchyard, and to provide explicit approval for operations of the P3-Switchyard.
<b>Credited Control</b>	An approved P3-Switchyard Beam Permit & Running Condition shall be issued prior to P3-Switchyard beam operations.
<b>Required Surveillance</b>	In order to assure Operation Authorization Documents are maintained up-to-date, the P3-Switchyard Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.
<b>Response</b>	Beam operation to the P3-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 P3-Switchyard will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

*Administrative – Staffing*

<b>Applicability</b>	During beam operations to the P3-Switchyard segment of the Fermilab Main Accelerator.
<b>Basis</b>	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
<b>Credited Control</b>	The following staffing shall be in place during applicable beam operation: <ul style="list-style-type: none"> <li>• 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.</li> <li>• At least one member of the AD Operations Department shall be present in the Main Control Room (MCR).</li> <li>• These requirements could be satisfied by a single person.</li> </ul>
<b>Required Surveillance</b>	none

**Response** Beam operation to the P3-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 P3-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 P3-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 P3-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 P3-Switchyard will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

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## Meson: Meson Primary (MPrimary) Credited Controls

*Passive – Shielding*

**Applicability** During beam operations to the MPrimary 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:

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

*Table 16. MPrimary Longitudinal Credited Shielding.*

<b>Transverse Station (ft) or (cell)</b>	<b>Credited Shielding (efd)</b>
<b>1237-1335</b>	16.3
<b>1335-1615</b>	18.7
<b>1615-1635</b>	16.3
<b>1635-2058</b>	16.3
<b>2058-2130</b>	16.3
<b>2130-2308</b>	16.3
<b>2308-2350</b>	13.9
<b>2350-2370</b>	16.3
<b>2370-2413</b>	13.9
<b>2413-2480</b>	16.3
<b>2480-2850</b>	16.3
<b>2850-2950</b>	16.3
<b>2950-3005</b>	16.3
<b>3005-3350</b>	15.5
<b>3350-3475</b>	16.3
<b>3475-3558</b>	16.3
<b>3558-3950</b>	16.3
<b>3950-3967</b>	16.3
<b>3967-4003</b>	13.9
<b>4003-4062</b>	13.9
<b>4062-4160</b>	13.9
<b>4160-4300</b>	13.9
<b>4300-4340</b>	16.3

Table 17. MPrimary Transverse Credited Shielding.

Transverse Station (ft) or (cell)	Credited Shielding (efd)	Transverse Station (ft) or (cell)	Credited Shielding (efd)
M001280	16.3	ME13400	16.3
M001330	16.3	ME13450	16.3
M001500	13.9	ME13500	16.3
M001600	13.9	ME13550	16.3
M001620	13.9	ME13552	16.3
M001640	13.9	ME13600	16.3
M002050	13.9	ME13650	16.3
M002100	13.9	ME13700	16.3
M002200	16.3	ME13750	16.3
M002340	13.9	ME13800	16.3
M002360	13.9	ME13850	16.3
M002400	16.3	ME13900	16.3
M002600	16.3	ME13950	16.3
M002750	16.3	ME13975	13.9
M002950	13.9	ME14000	13.9
M003200	15.05	ME14035	13.9
ME13353	16.3	ME14050	13.9

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

Table 18. 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

**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 MPrimary 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 MPrimary 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 MPrimary 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 outside the Switchyard 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

Required fencing shall be specified in the MPrimary’s Operation Authorization Document.

<b>Required Surveillance</b>	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.
<b>Response</b>	Beam operation to the MPrimary 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 MPrimary 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)*

<b>Applicability</b>	During beam operations to the MPrimary segment of the Fermilab Main Accelerator.
<b>Basis</b>	<p>To mitigate the accumulated dose from a Maximum Credible Incident (MCI) for a radiological hazard to the following conditions:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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</li> <li>• 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.             <ul style="list-style-type: none"> <li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li> <li>○ All General Access Areas, including, but not limited to the following:                 <ul style="list-style-type: none"> <li>▪ Wilson Hall</li> <li>▪ Ramsey Auditorium</li> <li>▪ Lederman Science Center</li> <li>▪ Building 327</li> </ul> </li> </ul> </li> </ul> <p>To ensure protection against dose to personnel inside the MPrimary’s Exclusion Area(s) during beam operations:</p> <ul style="list-style-type: none"> <li>• 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</li> </ul>

- 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:

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

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

**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 MPrimary 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 MPrimary 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 MPrimary segment of the Fermilab Main Accelerator.

<b>Basis</b>	To summarize the Credited Controls for safe operation of the MPrimary, and to provide explicit approval for operations of the MPrimary.
<b>Credited Control</b>	An approved MPrimary Beam Permit & Running Condition shall be issued prior to MPrimary beam operations.
<b>Required Surveillance</b>	In order to assure Operation Authorization Documents are maintained up-to-date, the MPrimary Beam Permit and Running Condition shall be verified on an interval no greater than twelve (12) months.
<b>Response</b>	Beam operation to the MPrimary 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 MPrimary will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

*Administrative – Staffing*

<b>Applicability</b>	During beam operations to the MPrimary segment of the Fermilab Main Accelerator.
<b>Basis</b>	To ensure accelerator operations are disabled and initiate an immediate response in the event of a determined ASE violation.
<b>Credited Control</b>	<p>The following staffing shall be in place during applicable beam operation:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• At least one member of the AD Operations Department shall be present in the Main Control Room (MCR).</li> <li>• These requirements could be satisfied by a single person.</li> </ul>
<b>Required Surveillance</b>	none
<b>Response</b>	Beam operation to the MPrimary 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 MPrimary will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

*Administrative – Accelerator Operating Parameters*

<b>Applicability</b>	During beam operations to the MPrimary segment of the Fermilab Main Accelerator.
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<b>Basis</b>	<p>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:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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</li> <li>• 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.             <ul style="list-style-type: none"> <li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li> <li>○ All General Access Areas, including, but not limited to the following:                 <ul style="list-style-type: none"> <li>▪ Wilson Hall</li> <li>▪ Ramsey Auditorium</li> <li>▪ Lederman Science Center</li> <li>▪ Building 327</li> </ul> </li> </ul> </li> </ul>
<b>Credited Control</b>	The following intensity shall not be exceeded: 2.75e15 protons/hr at 120 GeV.
<b>Required Surveillance</b>	none
<b>Response</b>	Beam operation to the MPrimary 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 MPrimary will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.



## Meson: Meson Test (MTest) Credited Controls

*Passive – Shielding***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
- 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:

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

*Table 19. Meson Credited Shielding along the MTest Beamline - Longitudinal Sections.*

<b>Transverse Station (ft) or (cell)</b>	<b>Credited Shielding (efd)</b>
4340-4605	13.9
4605-4710	16.3
4710-4716	13.9
4716-4841	16.3
4841-4889	11.4
4889-4989	16.3
4989-4995	11.4
4995-5043	16.3
5043-5164	11.6
5164-5590	3.0
5590-5618	3.0

*Table 20. Meson Credited Shielding along the MTest Beamline - Transverse Sections.*

<b>Transverse Station (ft) or (cell)</b>	<b>Credited Shielding (efd)</b>
ME24250	13.9
ME24375	13.9
MC24480	13.9
MC24540	13.9
MC24550	13.9
MC34775	16.3
MC34973	16.3
MC34985	11.4
ME35003	16.3
ME35005	16.3
MC35025	16.3
MC35065	5.5
MC45297	3.0
MC55520	3.0

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

Table 21. Meson 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 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 – 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
- 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 MTest'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:

- 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 22: MTest Radiation Monitors Credited Controls

Type	Location	CC Limit (mrem/hr)
Chipmunk	MT3 Cryo Labyrinth	360

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 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:

- One (1) area/fixed oxygen monitor of four (4) available
- One (1) horn and one (1) strobe for each enclosure

**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 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 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.

<b>Credited Control</b>	<p>The following staffing shall be in place during applicable beam operation:</p> <ul style="list-style-type: none"><li>• 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.</li><li>• At least one member of the AD Operations Department shall be present in the Main Control Room (MCR).</li><li>• These requirements could be satisfied by a single person.</li></ul>
<b>Required Surveillance</b>	none
<b>Response</b>	<p>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.</p>

#### *Administrative – Accelerator Operating Parameters*

<b>Applicability</b>	During beam operations to the MTest segment of the Fermilab Main Accelerator.
<b>Basis</b>	<p>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:</p> <ul style="list-style-type: none"><li>• 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.</li><li>• 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</li><li>• 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.<ul style="list-style-type: none"><li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li><li>○ All General Access Areas, including, but not limited to the following:<ul style="list-style-type: none"><li>▪ Wilson Hall</li></ul></li></ul></li></ul>

- Ramsey Auditorium
- Lederman Science Center
- Building 327

**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: 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
- 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:

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

*Table 23. Meson Credited Shielding along the MCenter Beamline - Longitudinal Sections*

<b>Transverse Station (ft) or (cell)</b>	<b>Credited Shielding (efd)</b>
4340-4566	13.9
4566-4656	13.9
4656-4709	13.9
4709-4936	16.3
4936-4986	13.9
4986-5297	16.3
5297-5353	11.4
5353-5518	16.3
5518-5603	13.9
5603-5662	13.9
5662-5733	5.5
5733-5790	3.0
5790-5793	3.0
5793-5798	0.0

Table 24. Meson Credited Shielding along the MCenter Beamline - Transverse Sections.

Transverse Station (ft) or (cell)	Credited Shielding (efd)	Transverse Station (ft) or (cell)	Credited Shielding (efd)
ME24250	13.9	MC65734-W	3.0
MC24540	13.9	MC65735-W	3.0
MC24550	13.9	MC65739-W	3.0
MC34985	13.9	MC65741-E	3.0
ME35003	13.9	MC65742-W	3.0
ME35005	13.9	MC65743-W	3.0
MC65655	13.9	MC65747-W	3.0
MC65662-E	13.9	MC65749-E	3.0
MC65662-W	13.9	MC65750-W	3.0
MC65664-E	13.9	MC65754-W	3.0
MC65670-W	13.9	MC65755-W	3.0
MC65673-W	13.9	MC65757-W	3.0
MC65679-W	13.9	MC65759-E	3.0
MC65682-W	13.9	MC65759-W	3.0
MC65685-W	13.2	MC65765-W	3.0
MC65701-W	13.9	MC65767-E	3.0
MC65715-W	5.5	MC65775-E	3.0
MC65719-W	32.0	MC65788-E	3.0
MC65722-W	5.5	MC65790-W	3.0
MC65728-W	3.0	MC65791-E	3.0
MC65733-E	3.0		

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

Table 25. Meson Credited Penetration Fill.

Location or Enclosure	Cell or Z-Location (feet)	Fill (efd or material)
M02	4350	Sand
M02	4550	Sand
M03	4985	Sand
M04	5300	Sand
M05	5510	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 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.

*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
- 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 MCenter'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:

- 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.

#### MCenter Primary Logic Chasis

- 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.

Radiation Safety System – Interlocked Radiation Monitors

Table 26: 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	4870
Chipmunk	One ft outside MC7	480
Chipmunk	On Lowest MC7 Roof	440

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.

*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:

- One (1) area/fixed oxygen monitor of four (4) available
- One (1) horn and one (1) strobe for each enclosure

**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 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 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 MCenter 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 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.

<b>Credited Control</b>	<p>The following staffing shall be in place during applicable beam operation:</p> <ul style="list-style-type: none"><li>• 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.</li><li>• At least one member of the AD Operations Department shall be present in the Main Control Room (MCR).</li><li>• These requirements could be satisfied by a single person.</li></ul>
<b>Required Surveillance</b>	none
<b>Response</b>	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*

<b>Applicability</b>	During beam operations to the MCenter segment of the Fermilab Main Accelerator.
<b>Basis</b>	<p>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:</p> <ul style="list-style-type: none"><li>• 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.</li><li>• 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</li><li>• 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.<ul style="list-style-type: none"><li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li><li>○ All General Access Areas, including, but not limited to the following:<ul style="list-style-type: none"><li>▪ Wilson Hall</li></ul></li></ul></li></ul>



- Ramsey Auditorium
- Lederman Science Center
- Building 327

<b>Credited Control</b>	The following MPrimary beam intensity, sent to MCenter, shall not be exceeded: $2.75e15$ protons/hr at 120 GeV.
<b>Required Surveillance</b>	none
<b>Response</b>	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.

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## Neutrino: 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
  - 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:

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

Permanent Shielding

*Table 27. Neutrino Muon Longitudinal Credited Shielding.*

<b>Transverse Station (ft) or (cell)</b>	<b>Credited Shielding (efd)</b>
<b>1520-1536</b>	16.3
<b>1536-1633</b>	16.3
<b>1633-1708</b>	11.4
<b>1708-1752</b>	16.3
<b>1752-2070</b>	16.3
<b>2070-2224</b>	13.9
<b>2224-2285</b>	13.9
<b>2285-2390</b>	13.9
<b>2390-2417</b>	13.9
<b>2417-2420</b>	13.9
<b>2420-2430</b>	16.3
<b>2430-2690</b>	16.3
<b>2690-2763</b>	16.3
<b>2763-3090</b>	16.3
<b>3090-3110</b>	16.3
<b>3110-3146</b>	16.3
<b>3146-3179</b>	16.3

Table 28. Neutrino Muon Transverse Credited Shielding.

Transverse Station (ft) or (cell)	Credited Shielding (efd)
NC11330	18.7
NC11510	16.3
NC11700	16.3
NC11800	16.3
NC11900	16.3
NC12180	13.9
NC12260	13.9
NC12285	13.9
NC12400	13.9
NC12460	16.3
NC12600	16.3
NC12720	16.3

Movable Shielding

- The NM4 experimental hall target cave surrounding shielding consisting of a combination of steel and concrete shielding blocks and the primary beam absorber.

**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 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 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
- 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 NM’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:

- G2
- N01
- NM2
- NM3

- NM4

Required components of the RSIS shall be specified in the 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 29: NM 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 the 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 the NM will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

*Engineered – Oxygen Deficiency Hazard (ODH) System*

**Applicability**

During personnel access into NM3 Target Cave and NM4 Enclosure

**Basis**

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

<b>Credited Control</b>	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: <ul style="list-style-type: none"> <li>•</li> </ul>
<b>Required Surveillance</b>	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.
<b>Response</b>	Personnel access into MPrimary enclosures M02, M03, M04, and M05 shall be limited to the Cryo Coordinator 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 MPrimary will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

*Administrative – Operation Authorization Document*

<b>Applicability</b>	During beam operations to the NM segment of the Fermilab Main Accelerator.
<b>Basis</b>	To summarize the Credited Controls for safe operation of the NM, and to provide explicit approval for operations of the NM.
<b>Credited Control</b>	An approved NM Beam Permit & Running Condition shall be issued prior to NM beam operations.
<b>Required Surveillance</b>	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.
<b>Response</b>	Beam operation to the 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 the NM will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.

*Administrative – Staffing*

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



<b>Credited Control</b>	<p>The following staffing shall be in place during applicable beam operation:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• At least one member of the AD Operations Department shall be present in the Main Control Room (MCR).</li> <li>• These requirements could be satisfied by a single person.</li> </ul>
<b>Required Surveillance</b>	none
<b>Response</b>	<p>Beam operation to the 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 the NM will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.</p>

*Administrative – Accelerator Operating Parameters*

<b>Applicability</b>	During beam operations to the NM segment of the Fermilab Main Accelerator.
<b>Basis</b>	<p>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:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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</li> <li>• 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.             <ul style="list-style-type: none"> <li>○ Batavia Road, Prairie Path (MBO), parking lots open to the public.</li> <li>○ All General Access Areas, including, but not limited to the following:                 <ul style="list-style-type: none"> <li>▪ Wilson Hall</li> <li>▪ Ramsey Auditorium</li> </ul> </li> </ul> </li> </ul>

- Lederman Science Center
- Building 327

<b>Credited Control</b>	The following intensity shall not be exceeded: $2.75 \times 10^{15}$ protons/hr 120 GeV.
<b>Required Surveillance</b>	none
<b>Response</b>	Beam operation to the 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 the NM will not resume until approval is received from the AD Associate Lab Director and the DOE Field Element Manager.