COLLIDER DETECTOR FACILITY

SECTION IV CHAPTER 01 OF THE FERMILAB SAD

Revision 4 August 7, 2023

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

SAD Chapter Review

This Section IV, Chapter 01 of the Fermi National Accelerator Laboratory (Fermilab) Safety Assessment Document (SAD), *Collider Detector Facility (CDF)*, was prepared and reviewed by the staff of the Particle Physics Directorate in conjunction with the Environment, Safety & Health Division (ESH) Accelerator Safety Department.

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

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SAD Review Subcommittee Chair

Revision History

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

Author	Rev. No.	Date	Description of Change
Phil Schlabach	4	August 7, 2023	• Update to align with updated SAD Layout • Incorporated Risk Matrix and hazard discussion
Angela Aparicio	3	September 26, 2014	Revision of the SAD after detector dismantling
Keith Schuh	2	January 25, 2001	Revision of SAD for Run II
John Elias (?)	1	June 1, 1995	Revision of SAD
(?)	(?)	(?)	Initial issue of the Collider Detector Facility SAD Chapter

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Acronyms and Abbreviations

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

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

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

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

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

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

IV-1. Collider Detector Facility

IV-1.1. Introduction

This Section IV, Chapter 1 of the Fermi National Accelerator Laboratory (Fermilab) Safety Assessment Document (SAD) covers the CDF Collision Hall segment of the TeVatron accelerator.

IV-1.1.1 Purpose/Function

CDF first detected antiproton/proton collisions in 1985, and continued taking data until the end of the Tevatron Collider physics run in September 2011. A large number of important physics results have been obtained with these data, including the discovery of the Top quark.

Beginning in 2012, the Illinois Accelerator Research Center (IARC) constructed the Office, Technical & Education (OTE) building on the West side of the CDF Assembly Building. The addition is complete and attached to the CDF building. The CDF Assembly Building has been repurposed and renamed the Heavy Assembly Building (HAB). The scope of this chapter is limited to the CDF collision hall.

IV-1.1.2 Current Status

The CDF collision hall segment of the TeVatron accelerator is currently: non-operational.

IV-1.1.3 Description

Since the cessation of Tevatron operations, many components of the former CDF Detector experimental apparatus have been removed from the collision hall for purposes of reuse, recycling and waste disposal. What remains of the detector is located in the collision hall.

There is one elevator and one stairway connecting all levels of the building, located in the middle of the building. A second stairway leads from the first floor to the Assembly Hall pit. The below-ground portions of the two stairways serve as tornado shelters for personnel in the building. Should there be personnel in the collision hall, it is also a tornado shelter.

The Collision Hall, where the CDF detector resides, is connected to the Assembly Hall pit in three different locations: A "controlled access" door at the mouth of a labyrinth, a 50-ton concrete "door" used for "supervised access" and a 1200-ton shield door. An isolation wall separates the Collision Hall from the Tevatron tunnel at both ends of the Collision Hall.

IV-1.1.4 Location

The CDF collision hall of the TeVatron accelerator is located on the Fermilab site in Batavia, IL.

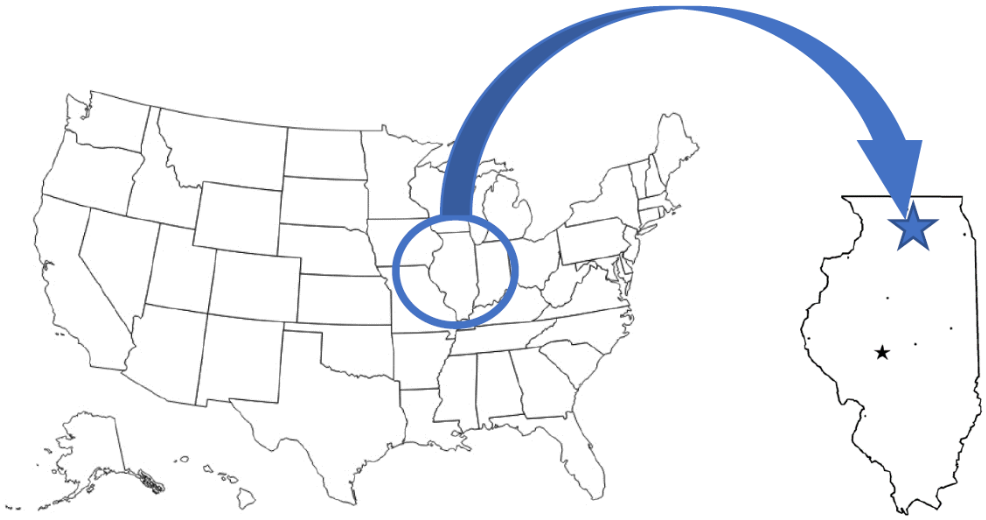

Figure 1. Regional view showing the location of the Fermilab site in Batavia, IL.

The CDF collision is located in the at the B0 straight section of the Tevatron Collider Ring, along D Road, across from the Industrial Center Building. on the Fermilab site.

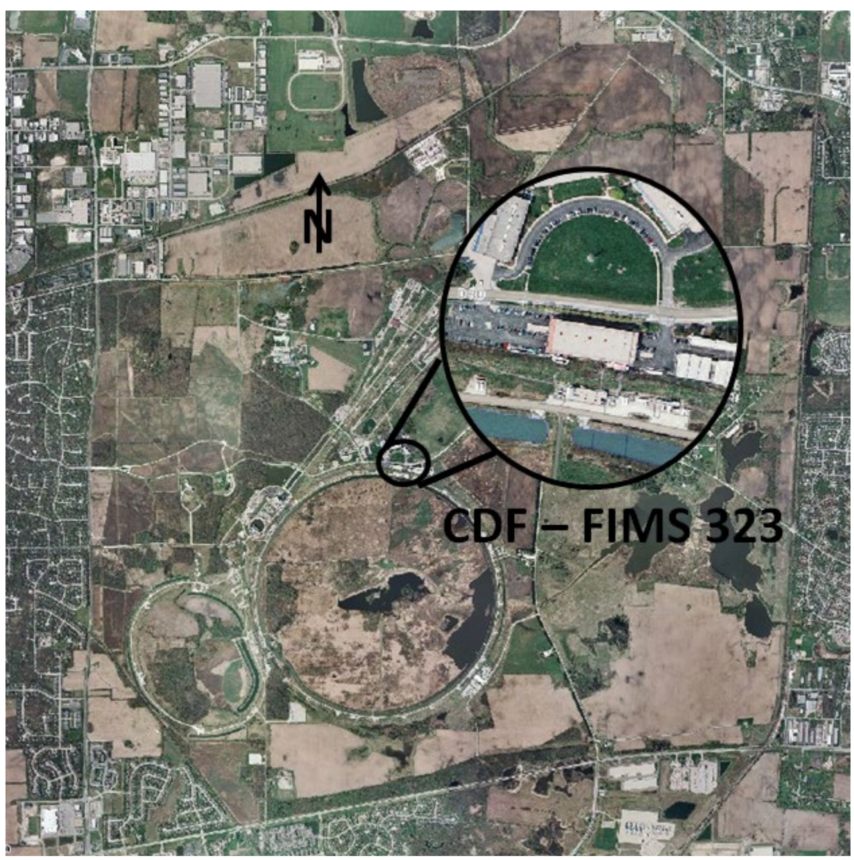

Figure 2. Aerial view of the Fermilab site, indicating the location of the CDF collision hall.

IV-1.1.5 Management Organization

The CDF collision hall is managed by PPD as a tenant of the HAB building and the TeVatron accelerator tunnel.

IV-1.1.6 Operating Modes

CDF is not operating and has not operated since 2012.

IV-1.1.7 Inventory of Hazards

The following table lists all of the identified hazards found in the CDF collision hall enclosure and support buildings. Section IV-1.10 *Appendix – Risk Matrices* describes the baseline risk (i.e., unmitigated risk), any preventative controls and/or mitigative controls in place to reduce the risk, and residual risk (i.e., mitigated risk) for facility worker, co-located worker and Maximally Exposed Offsite Individual (MOI) (i.e., members of the public). A summary of these controls is described within Section IV-1.2 *Safety Assessment.*

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

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

Table 1. Hazard Inventory for the CDF collision hall.

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

IV-1.2. Safety Assessment

All hazards for the CDF collision hall segment of the TeVatron accelerators are summarized in this section, with additional details of the analyses for accelerator specific hazards. Many hazards present when it was operational are no longer valid due the substantial work done.

The Time-of-Flight scintillators were removed from inside the solenoid and have been saved. The electromagnetic sections of the plug calorimeters were removed. The plugs were remounted on the central detector.

The outer muon systems were dismantled. The barrel muon (BMU) chambers were removed from the collision hall. The half-toroid units were cut apart by ironworkers into constituent blocks. The blocks have been transferred to the railhead and are saved for future use as shielding. The 100-ton ceiling steel has been removed. All electronics and cables have been removed. Scintillators and phototubes have been removed and saved for reuse. The central muon extension (CMX) arches were dismantled and chambers removed from the lower section. Columns on the lower section were cut down; the columns and counterweight were taken to the railhead to be scrapped.

Inside the collision hall the shielding around the low-beta quadrupole magnets was removed. All abandoned cables have been removed. Electrical equipment for the 400 Hertz power was scrapped. Any items removed that were found with residual radioactivity have been moved to storage at the Railhead, in accordance with the usual procedures.

Mitigation of risks from operating times is discussed below.

The carcass of the central detector remains in the collision hall.

IV-1.2.1 Radiological Hazards

The CDF collision hall presents radiological hazards in the form of the remaining radioactive sources. These hazards have controls in place that comply with the Fermilab Radiological Control Manual (FRCM)[1].

IV-1.2.1.1 Prompt Ionizing Radiation

N/A.

IV-1.2.1.2 Residual Activation

N/A.

IV-1.2.1.3 Groundwater Activation

N/A.

IV-1.2.1.4 Surface Water Activation

N/A.

IV-1.2.1.5 Radioactive Water (RAW) Systems

N/A.

IV-1.2.1.6 Air Activation

N/A.

IV-1.2.1.7 Closed Loop Air Cooling

N/A.

IV-1.2.1.8 Soil Interactions

N/A.

IV-1.2.1.9 Radioactive Waste

Radioactive waste produced in the course of CDF detector operations and partial decommissioning was removed and any future removals of equipment, if any, will be managed within the established Radiological Protection Program (RPP) and as prescribed in the Fermilab Radiological Control Manual (FRCM).

Radioactive waste is a standard radiological hazard that is managed within the established Radiological Protection Program (RPP) and as prescribed in the Fermilab Radiological Control Manual (FRCM). Waste minimization is an objective of the equipment design and operational procedures. Although production of radioactive material is not an operational function nor was it ever, beam loss and, in the case of some beam diagnostics devices, intentional interception of the beam did result in activation of beam line elements. Reuse of activated items will be carried out when feasible. Activated items that cannot be reused will be disposed of as radioactive waste in accordance with the FRCM requirements. Removal of radioactive waste and materials was an active element of the shutdown activities.

IV-1.2.1.10 Contamination

N/A.

IV-1.2.1.11 Beryllium-7

N/A.

IV-1.2.1.12 Radioactive Sources

The 97 Cesium-137 sources mounted in the arches and end-wall calorimeter remain in place on the detector. The central muon system still contains 153 Iron-55 sources shielded by lead, and the sources are inaccessible without the proper tools. These sources present a potential for low radiation exposures to the worker if handled improperly. All sources will remain on the detector until the detector is fully dismantled. The sources will continue to be managed per the radioactive source controls in the Fermilab Radiological Control Manual (FRCM) Chapter 4: *Radioactive Materials*, and will remain on the Laboratory's inventory of radioactive sources.

The baseline, qualitative risks due to this remaining hazard were assessed, and determined to be risk level I (major concern) for workers, co-located workers, and the public, but through the use of preventive and mitigative hazard controls, the likelihood and consequence of this hazard is reduced, resulting in a risk level of IV, meaning residual risks are of minimal concern for all receptors.

IV-1.2.1.13 Nuclear Material

N/A.

IV-1.2.1.14 Radiation Generating Devices (RGDs)

N/A.

IV-1.2.1.15 Non-Ionizing Radiation Hazards

Class 3B lasers were used during CDF Run II to provide light sources for detector calibration. All lasers have been removed from the building and returned to the collaborators who provided them for the CDF experiment.

IV-1.2.2 Toxic Materials

The passive material in the CDF electromagnetic calorimeters is lead. Lead is a toxic metal that can cause health issues if particulates are inhaled or ingested. The lead remains in the finished modules of the shower counters and is not handled or touched. When the remaining detector is decommissioned, all lead safety practices will be followed, per Fermilab Environment, Safety and Health Manual (FESHM) Chapter: *Special Toxic Hazards – Lead-Containing Materials*. Only workers trained in Lead Handler or Lead Worker training will handle lead components.

The baseline qualitative risk due to potential lead exposure were assessed and resulted in a risk level II to facility workers, co-located workers and members of the public (meaning that lead exposure is a concern), but through the use of a series of preventive and mitigative controls, which reduce likelihood and consequences of such exposure, the residual risk due to lead exposure is risk level IV (meaning lead exposure is a minimal concern).

IV-1.2.2.1 Lead

N/A.

IV-1.2.2.2 Beryllium

Beryllium is a toxic metal that can cause health issues if its particulates are inhaled, ingested or through skin contact. The CDF beam pipe contained approximately 453 grams of beryllium. The beam pipe was removed from the detector and has been returned to the Accelerator Division and placed in storage. Therefore, risk of beryllium exposure no longer exists within this facility.

IV-1.2.2.3 Fluorinert & Its Byproducts

N/A.

IV-1.2.2.4 Liquid Scintillator Oil

N/A.

IV-1.2.2.5 Pseudocumene

N/A.

IV-1.2.2.6 Ammonia

N/A.

IV-1.2.2.7 Nanoparticle Exposures

N/A.

IV-1.2.3 Flammables and Combustibles

Cables remain in the hall; this is the only combustible.

IV-1.2.3.1 Combustible Materials

This hazard has been evaluated within the common Risk Matrix table included in the SAD Section I Chapter 04, Safety Analysis.

IV-1.2.3.2 Flammable Materials

N/A.

IV-1.2.4 Electrical Energy

The 400 Hertz power was disconnected and scrapped. The forward muon toroids were disconnected and removed. The solenoid is disconnected but remains. The counting room was gutted where various power supplies for hall equipment was locked. The low-beta quadrupoles were disconnected from the power supplies in the service building but remain (TeVatron equipment). All abandoned cables have been removed.

IV-1.2.4.1 Stored Energy Exposure

N/A.

IV-1.2.4.2 High Voltage Exposure

N/A.

IV-1.2.4.3 Low Voltage, High Current Exposure

N/A.

IV-1.2.5 Thermal Energy

N/A.

IV-1.2.5.1 Bakeout

N/A.

IV-1.2.5.2 Hot Work

N/A.

IV-1.2.5.3 Cryogenics

N/A.

IV-1.2.6 Kinetic Energy

N/A.

IV-1.2.6.1 Power Tools

N/A.

IV-1.2.6.2 Pumps and Motors

N/A.

IV-1.2.6.3 Motion Tables

N/A.

IV-1.2.6.4 Mobile Shielding

N/A.

IV-1.2.7 Potential Energy

N/At.

IV-1.2.7.1 Crane Operations

N/A.

IV-1.2.7.2 Compressed Gasses

N/A.

IV-1.2.7.3 Vacuum/Pressure Vessels/Piping

N/A.

IV-1.2.7.4 Vacuum Pumps

N/A.

IV-1.2.7.5 Material Handling

N/A.

IV-1.2.8 Magnetic Fields

N/A.

IV-1.2.8.1 Fringe Fields

N/A.

IV-1.2.9 Other Hazards

All gases that created the ODH are no longer in use and the equipment has been removed. The Halon in the collision hall remains but the firing pins have been removed. The Halon systems in the counting rooms were removed and the Halon returned to the Fermilab Refrigerant Manager, per the requirements of the FESHM Chapter: *Refrigeration Management*.

IV-1.2.9.1 Confined Spaces

The subfloor of the detector (crawl space) is a confined space. It is grated to prevent entry and locked with a configuration lock. This is a standard hazard and described in Section I, Chapter 4.

IV-1.2.9.2 Noise

N/A.

IV-1.2.9.3 Silica

N/A.

IV-1.2.9.4 Ergonomics

N/A.

IV-1.2.9.5 Asbestos

N/A.

IV-1.2.9.6 Working at Heights

N/A.

IV-1.2.10 Access & Egress

Shield doors are closed. Access is through the controlled door commonly referred to as the “controlled access door”. Access from the TeVatron tunnel is not possible. The emergency egress door to the tunnel opens only outward from the collision hall.

IV-1.2.10.1 Life Safety Egress

Primary emergency egress is though the controlled access door at the bottom of the central stairwell. There two stairwells available from there: the central one and the one accessible at the northeast corner of the assembly pit. Secondary emergency egress is available through the door to the TeVatron tunnel in the southeast corner of the collision hall and then via the stairs from the tunnel to the surface. Access and egress for facility workers, co-located workers and members of the public are describedin Section 1, Chapter 4.

IV-1.2.11 Environmental

N/A.

IV-1.2.11.1 Hazard to Air

N/A.

IV-1.2.11.2 Hazard to Water

N/A.

IV-1.2.11.3 Hazard to Soil

N/A.

IV-1.3. Summary of Hazards to Members of the Public

The public cannot access the area. Shielding is in place that prevents exposure in any accessible area adjacent to or above the area. Hazards to the public are prevented and mitigated several ways, as described above, and therefore, risks to the public are of minimal concern.

IV-1.4. Summary of Credited Controls

Shielding and fencing are still in place. The area is administratively controlled.

IV-1.4.1 Passive Credited Controls

N/A.

IV-1.4.1.1 Shielding

Shielding per the shielding assessment is still in place.

IV-1.4.1.1.1 Permanent Shielding Including Labyrinths

Shielding per the shielding assessment is still in place.

IV-1.4.1.1.2 Movable Shielding

Shielding per the shielding assessment is still in place.

IV-1.4.1.1.3 Penetration Shielding

Shielding per the shielding assessment is still in place.

IV-1.4.1.2 Fencing

The berm behind CDF is fenced.

IV-1.4.1.2.1 Radiation Area Fencing

The berm behind CDF is fenced.

IV-1.4.1.2.2 Controlled Area Fencing

The berm behind CDF is fenced.

IV-1.4.2 Active Engineered Credited Controls

CDF does not require active controls due to the non-operational status of the detector.

IV-1.4.2.1 Radiation Safety Interlock System

Elements of the infrastructure may remain but are not maintained. The area is controlled administratively.

IV-1.4.2.2 ODH System

N/A.

IV-1.4.3 Administrative Credited Controls

Administrative procedures and programs that were in place (e.g. CDF Supervised Access training) are no longer necessary at the CDF site as the experiment is no longer in operation and no beam is being delivered.

IV-1.4.3.1 Operation Authorization Document

N/A.

IV-1.4.3.2 Staffing

N/A.

IV-1.4.3.3 Accelerator Operating Parameters

N/A.

IV-1.5. Defense-in-Depth Controls

Additional shielding may be in place beyond the requirements stated in the Shielding Assessment.

IV-1.6. Machine Protection Controls

N/A.

IV-1.7. Decommissioning

The remaining components of the CDF Detector will remain secured in the collision hall until final disposition. Final decommissioning of the CDF Experiment will follow the requirements of FESHM Chapter: *Facility Decontamination and Decommissioning*. The PPD ES&H Manual 014 - *ES&H Review of Expired Experiment Decommissioning and Dismantlement* is available to help identify and mitigate ES&H hazards during decommissioning. DOE Field Element Manager approval shall be obtained prior to the start of any decommissioning activities for CDF.

IV-1.8. Summary and Conclusion

The hazards specific to operations and decommissioning of the CDF detector have been identified and assessed in this chapter of the Fermilab Safety Assessment. All designs, controls, and procedures to mitigate CDF-specific hazards are identified and described. The CDF Experiment is subject to the global and more generic safety requirements, controls and procedures outlined in Section 1 of the Fermilab Safety Assessment Document.

Within the specific and generic considerations of this assessment, the CDF Experiment can be decommissioned with a level of safety that will protect people and property and is equal to or exceeding that currently prescribed by Department of Energy orders and Fermilab regulations as put forth in the FESHM and the FRCM.

IV-1.9. References

[1] Fermilab Radiological Control Manual

IV-1.10. Appendix – Risk Matrices

Risk Assessment methodology was developed based on the methodology described in DOE-HDBK-1163-2020. Hazards and their potential events are evaluated for likelihood and potential consequence assuming no controls in place, which results in a baseline risk. A baseline risk (i.e., an unmitigated risk) value of III and IV does not require further controls based on the Handbook. Events with a baseline risk value of I or II do require prevention and/or mitigation measures to be established in order to reduce the risk value to an acceptable level of III or IV. Generally, preventive controls are applied prior to a loss event, reflecting a likelihood reduction, and mitigative controls are applied after a loss event, reflecting a consequence reduction. For each control put in place, likelihood or consequence can have a single “bin drop”, resulting in a new residual risk (i.e., a mitigated risk). This risk assessment process is repeated for each hazard for

Facility Workers (FW), Co-Located Workers (CLW), and Maximally-Exposed Offsite Individual (MOI). At the conclusion of the risk assessments, controls that are in place for the identified accelerator specific hazards are identified as Credited Controls and further summarized in Section IV-1.4 of this Chapter.