D-Zero Detector

Section III – Chapter 2

Revision 4
November 13, 2014

Revision History

Author(s)	Description of Change	Revision No. & Date
Angela Aparicio	Implement new SAD layout Revisions to the SAD following Tevatron retirement	Revision 4 November 13, 2014
	Update of SAD for Run II	February 12, 2001
	Revision of D0 SAD	September 21, 1994
	Initial D0 SAD Release	March 6, 1994

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III - 2.1 D-Zero Detector Location on Fermi National Accelerator (Fermilab) Site

The site location of the D-Zero experiment is the D-Zero straight section of the Fermilab Tevatron. The Detector operated in the Collision Hall west of the D-Zero Assembly Building (DAB) in a locally enlarged portion of the accelerator tunnel. A twelve foot thick shield block wall normally separates the two halls.

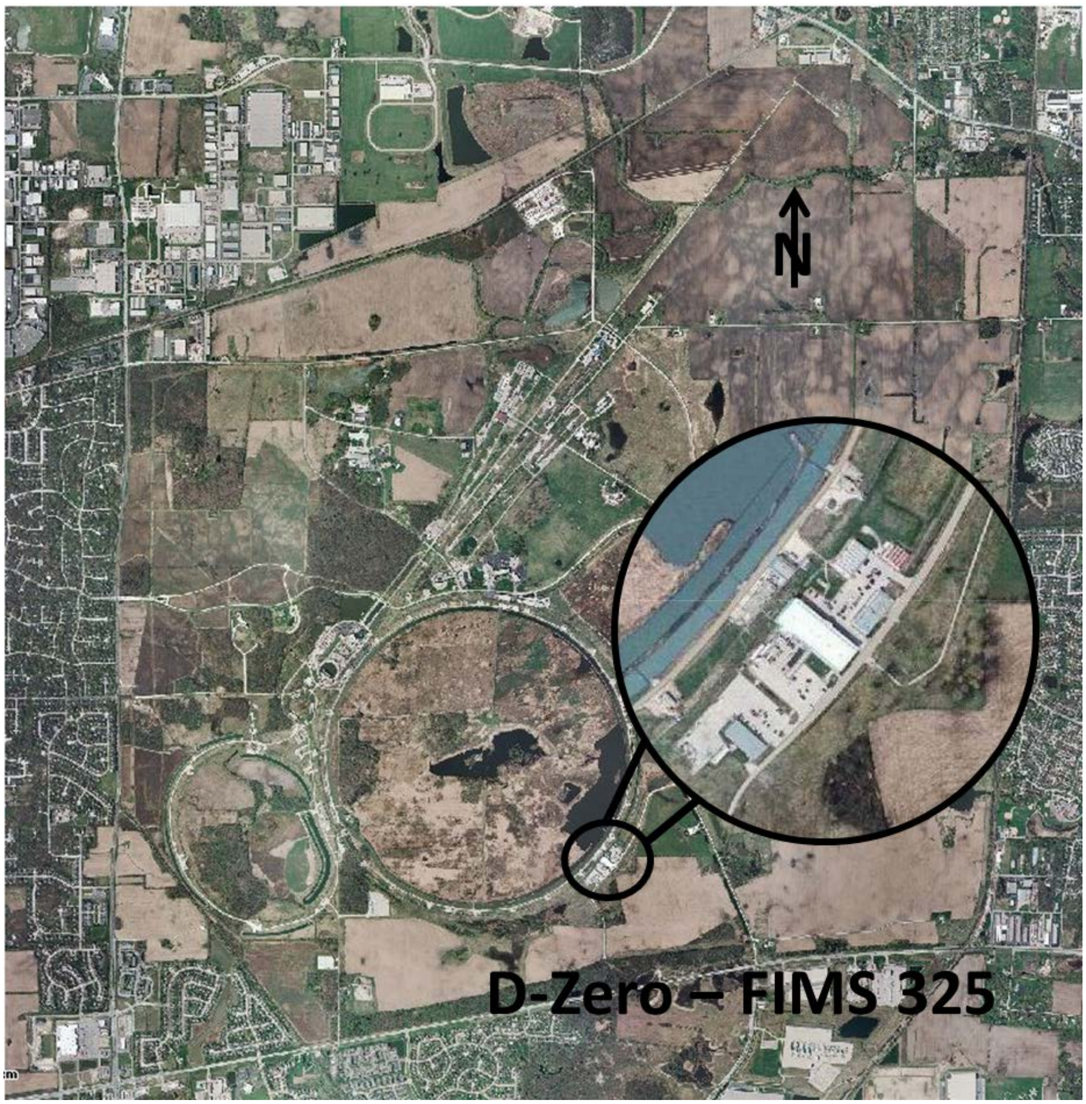

Figure 1: Aerial view of D-Zero site.

III - 2.2 Inventory of Hazards

The following table lists the identified hazards found at the D-Zero site. All hazards with an * have been discussed in Chapters 1-10 of the Fermilab Safety Assessment Document and are covered no further in this section.

Radiation Depleted Uranium Sealed radioactive sources Residual radiation	**Kinetic Energy** Power tools* Pumps and motors*
Toxic Materials Beryllium Lead	**Potential Energy** Crane operations* High pressure*
Flammable & Combustible Materials Cables*	**Magnetic Fields** Superconducting solenoid
Electrical Energy High voltage*	**Gaseous Hazards** Confined spaces* Cryogenics Oxygen Deficiency Hazard Halon Fire Suppression System
Thermal Energy None	**Access / Egress** None

III - 2.3 Introduction

This Section III, Chapter 2 of the Fermilab Safety Assessment Document (SAD) covers the D-Zero site and current conditions.

III - 2.3.1 Historical Background

D-Zero is a 5,000-ton collider detector comprised of an inner silicon detector, a scintillating fiber tracker and preshower, a liquid argon calorimeter, and a muon system (consisting of wire chambers and scintillator).

The D-Zero Detector began operating in 1992. In 1995, both the Collider Detector at Fermilab (CDF) and D-Zero physics collaborations announced the discovery of the top quark. D-Zero was also involved in the discovery of the exotic baryons and observation of B-meson mixing.

After the Tevatron run ended in late 2011, the D-Zero Assembly Building High Bay was cleared out to be used as assembly space for future Fermilab experiments, such as the Micro Booster Neutrino Experiment (MicroBooNE).

Figure 2: The D-Zero Detector.

III - 2.3.2 Description of the D-Zero Facility

The D-Zero facility is comprised of the Assembly Building (DAB), which is connected to the Collision Hall. The DAB offers assembly space in the pit and high bay with a large capacity overhead crane and office spaces within its 64,000 square feet.

The D-Zero Detector resides in the Collision Hall. The Detector measures about 30 feet by 30 feet by 50 feet and weighs almost 5,500 tons. The collision region consists of a set of tracking detectors and a transition radiation detector. During operations in the Tevatron era, the surrounding calorimeter system was comprised of detector elements within an ionization medium of liquid argon, and the outer shell consisted of muon detectors (see Section III-2.3.4 for further details). At present there are no plans to dismantle or relocate the D-Zero Detector.

III - 2.3.3 Operating Modes

D-Zero completed operations in September 2011 when the Tevatron colliding beam program ceased operations. The remains of the Detector currently reside within the Collision Hall.

III - 2.3.4 Changes to the D-Zero Facility

Almost all operating systems for the Detector have been emptied, turned off and stabilized. The LCW cooling water has been shut down. The silicon microstrip tracker (SMT) chiller has been shut down and drained. The liquid argon was drained from the detector and storage dewars and the liquid was transferred to other experiments on-site (Long Baseline Neutrino Experiment (LBNE) 35T and MicroBooNE). The spare Visible Light Photon Counters (VLPCs) were given to the International Muon

Ionization Cooling Experiment (MICE) collaboration. The muon readout electronics, some high-voltage equipment, blowers, computers, rack monitors, turbo pumps, and cryogenic components have been removed and reused by other experiments.

An exhibit has been completed for visitors to view the Collision Hall and moveable counting house. A portion of the Tevatron in the vicinity of the D-Zero Detector is accessible for touring as well.

The DAB has been utilized by the MicroBooNE, Muon g-2 and Chicagoland Observatory for Underground Particle Physics (COUPP) experiments for detector research, development and assembly. The DAB will continue to be an assembly space for future experiments.

III - 2.4 Safety Assessment

This section discusses the hazards identified in Section III-2.2 and how the hazards are managed.

III - 2.4.1 Radiological Hazards

III - 2.4.1.1 Depleted Uranium (DU)

Depleted uranium plates are housed in the calorimeter cryostats, each 3 mm to 6 mm in thickness (D-Zero Detector contains 237,792 kg of depleted uranium, the outdoor prototype cryostat contains 21,016 kg). The plates are contained inside welded double-walled stainless steel cryostats, which provide some shielding. The radiological hazards associated with the D-Zero depleted uranium are small external dose rates when very near the cryostats; and the potential for small amounts of DU or DU oxide dust particulates in the argon blanket system.

Following the termination of the D-Zero Detector's operation, the liquid argon in the calorimeters was transferred back into the liquid argon storage dewar. The calorimeters were warmed up and filled with dry argon gas with slight positive pressure to minimize oxidization of the depleted uranium (the formation of oxide powder poses a potentially serious radioactive contamination problem and the oxides can be pyrophoric). An automated Cryogenic System Programmable Logic Controller monitors argon gas pressures. If positive gas pressure is lost, an automated phone dialer will notify one of the employees on the automatic dialer list. The responding employee will take action to return the pressure to normal.

III - 2.4.1.2 Sealed Radioactive Sources

Twelve Ruthenium (Ru)-106 sources and twelve Americium (Am)-241 sources remain in place within the D-Zero Detector. As situated, the sources are inaccessible without the proper tools. These sources present a potential for low radiation exposures to the worker if handled improperly.

During the course of operating the D-Zero Detector, a variety of sealed radioactive sources were used for checks and calibrations of the Detector, and kept in the Radioactive Source box in the pit. The source box keeps the radiological materials segregated from non-radioactive materials. The Radioactive Source box remains in the pit, and may contain sources being used for various ongoing work activities. The ESH&Q section manages the sources inside the source box, routinely inspects the sources, and takes unused sources into custody.

All sources are managed following Fermilab Radiological Control Manual (FRCM) Chapter 4: *Radioactive Materials*, and remain on the Laboratory's inventory of radioactive sources.

III - 2.4.1.3 Residual radiation

Residual radiation due to beam-induced activation may still be present. Radiological surveys are performed throughout the D-Zero site semi-annually, as part of the Snoop Program, to document radiation levels. Contamination wipes are also taken periodically in the Collision Hall to show that there are no contamination issues. Residual radioactivity will be dealt with according to the requirements and procedures specified in the FRCM.

Shielding associated with the D-Zero Collision Hall enclosure remains unchanged.

III - 2.4.2 Toxic Materials

III - 2.4.2.1 Beryllium

Beryllium is a toxic metal that can cause health issues if its particulates are inhaled, ingested or absorbed through skin contact. The D-Zero Detector contains beryllium within the beam pipe and the silicon microstrip tracker. The beryllium remains in place on the detector, and is difficult to access without the proper tools.

At the time of dismantlement of the detector, proper beryllium handling precautions will be taken, following Fermilab Environment, Safety and Health Manual (FESHM) Chapter: *Chronic Beryllium Disease Prevention.*

III - 2.4.2.2 Lead

Lead is a toxic metal that can cause health issues if particulates are inhaled or ingested. Approximately 30 tons of lead are integrated into the forward muon shielding located to the north and south of the End Calorimeter cryostats. This lead, in the form of rectangular plates typically two inches thick, is encased in welded steel boxes along with polyethylene sheets. The boxes are attached to the outer surfaces of additional steel shielding blocks that reside in the north and south muon end torroids and on the north and south C-layer muon trusses. The lead shielding is purely passive and isolated from personnel.

In addition, approximately one ton of lead is integrated into the preshower detectors in the form of thin sheets approximately 0.5 cm and 1 cm thick. This lead is also passive in nature, covered with other detector elements, and therefore isolated from personnel. Should handling of any preshower lead sheets ever be necessary, procedures will be developed and appropriately trained personnel and protective clothing will be used.

III - 2.4.3 Gaseous Materials

III - 2.4.3.1 Cryogenic Liquids

The cryogenic system at D-Zero supplied liquid nitrogen refrigeration to the three liquid argon calorimeter cryostats. The cryogenic control system enabled the automatic operation of the calorimeter cryostats at a fixed pressure and liquid argon level. A superconducting solenoid magnet and two VLPC cryostats were added to the D-Zero Detector in 2000. The magnet equipment required cryogenic services of both liquid nitrogen and liquid helium.

Following termination of the detector's operation, the liquid argon within the calorimeters was transferred into the argon storage dewar. All three calorimeters were warmed and filled with gaseous argon to keep the depleted uranium plates within under a dry blanket.

Two liquid nitrogen storage dewars and the liquid argon storage dewar have been emptied so that the liquid may be used for other experiments (i.e. LBNE 35T Prototype & MicroBooNE).

III - 2.4.3.2 Oxygen Deficiency Hazard (ODH)

All previous ODH analyses of the D-Zero Collision Hall during operations were ODH Class 0, which is the least hazardous ODH class and requires no special precautions. Following the Tevatron shut-down in September 2011, the cryogenic systems were stabilized, warmed, and the cryogenic liquids were sent for use in other experimental apparatuses.

No cryogenic liquids remain in any of the vessels, and there are no plans to refill the vessels with cryogenic liquids. With no hazard remaining, the ODH monitoring equipment was shut down and removed. The ODH monitoring equipment is no longer required for good engineering practice and has been disabled.

All gases that created the ODH are no longer in use, eliminating the hazard. See D-Zero Engineering Notes #3740.510-EN-332 and #3823.000-EN-585.

III - 2.4.3.3 Halon Fire Suppression System

Halon is an inert gas with a high global warming potential. The United States government banned Halon manufacturing in 1994 for atmospheric environmental protection reasons, but allows existing systems to remain in use. All Halon systems are maintained by the Fermilab Fire Systems Maintenance Group to prevent accidental releases.

The manual Halon extinguishing systems in the Collision Hall are still charged and operational (operated from the control room or the lobby control panel). The automatic Halon extinguishing systems in the moveable counting house and fixed counting house are also still charged and operational. Should the Halon system ever be decommissioned, it will be handled like other ozone-depleting substances, following the guidelines of FESHM Chapter: *Air Emissions Control Program, Appendix A.*

III - 2.4.4 Magnetic Field Hazards

The D-Zero 2.0 Tesla superconducting solenoid has been warmed and power has been locked out. There are no current plans to reuse the solenoid. Magnetic field hazards no longer exist in D-Zero.

III - 2.5 Credited Controls

Credited controls are the primary controls that assure that the level of risk to all workers, the public, and the environment is maintained at an acceptable level.

III - 2.5.1 Passive Controls

The D-Zero Detector is no longer in an operational state, thus does not require passive controls.

III - 2.5.2 Active Controls

D-Zero does not have any active engineered credited controls.

III - 2.5.3 Administrative Controls

Administrative procedures and programs that were in place (e.g. D0 Hazard Awareness Training) are no longer necessary at the D-Zero site as the experiment is no longer in operation and no beam is capable of being delivered due to the Tevatron being in standby mode.

III - 2.6 Decommissioning

The D-Zero Assembly Building will be utilized as R&D and construction space for future experiments. The D-Zero Detector will remain in the Collision Hall until final disposition. Final decommissioning of the D-Zero Experiment will follow the requirements of FESHM Chapter: *Facility Decontamination and Decommissioning.* The Particle Physics Division 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.

III - 2.7 Summary & Conclusion

The hazards specific to operations and decommissioning the D-Zero Detector have been identified and assessed in this chapter of the Fermilab Safety Assessment. All designs, controls, and procedures to mitigate D-Zero specific hazards are identified and described. The D-Zero 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 D-Zero 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.

III - 2.8 Glossary, Acronyms

DAB	D-Zero Assembly Building
ES&H	Environment, Safety and Health
EPA	Environmental Protection Agency
Fermilab	Fermi National Accelerator Laboratory
FESHM	Fermilab Environment, Safety, and Health Manual
FRCM	Fermilab Radiological Control Manual
LBNE	Long Baseline Neutrino Experiment
ODH	Oxygen Deficiency Hazard
PPD	Particle Physics Division
R&D	Research and Development
SAD	Safety Assessment Document
VLPC	Visible Light Photon Counter

III - 2.9 References

D-Zero Run II SAD: https://esh-docdb.fnal.gov:440/cgi-bin/ShowDocument?docid=937

D-Zero Test Calorimeter SAD: https://esh-docdb.fnal.gov:440/cgi-bin/ShowDocument?docid=935

D-Zero Engineering Note #3823.000-EN-585: D0 Decommissioning, Storage of depleted uranium modules inside D0 calorimeters after the termination of D0 experiment.

D-Zero Engineering Note #3740.510-EN-332: D-Zero Detector Collision Hall Oxygen Deficiency Hazard Analysis

Engineering Note H991216A: VESDA and Halon Systems at Dzero