Preparations for Retrieval of Buried Waste at Material Disposal Area B – 9494

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ABSTRACT

Material Disposal Area B, a hazard category 3 nuclear facility, is scheduled for excavation and the removal of its contents. Wastes and excavated soils will be characterized for disposal at approved off-site waste disposal facilities. Since there were no waste disposal records, understanding the context of the historic operations at MDA B was essential to understanding what wastes were disposed of and what hazards these would pose during retrieval. The operational history of MDA B is tied to the earliest history of the Laboratory, the scope and urgency of World War II, the transition to the Atomic Energy Commission in January 1947, and the start of the cold war. A report was compiled that summarized the development of the process chemistry, metallurgy, and other research and production activities at the Laboratory during the 1944 to 1948 timeframe that provided a perspective of the work conducted; the scale of those processes; and the handling of spent chemicals and contaminated items in lieu of waste disposal records. By 1947, all laboratories had established waste disposal procedures that required laboratory and salvage wastes to be boxed and sealed. Large items or equipment were to be wrapped with paper or placed in wooden crates. Most wastes were placed in cardboard boxes and were simply piled into the active trench. Bulldozers were used to cover the material with fill dirt on a weekly basis. No effort was made to separate waste types or loads, or to compact the wastes under the soil cover.

Using the historical information and a statistical analysis of the plutonium inventory, LANL prepared a documented safety analysis for the waste retrieval activities at MDA B, in accordance with DOE Standard 1120-2005, *Integration of Environment, Safety, and Health into Facility Disposition* Activities, and the provisions of 29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*. The selected hazard controls for the MDA B project consist of passive design features as safety-significant structures, systems, and components; specific administrative controls, implemented as limiting conditions of operation; and commitments to safety management programs.

INTRODUCTION

Material Disposal Area (MDA) B, a hazard category 3 nuclear facility, is an inactive subsurface disposal site, designated Solid Waste Management Unit 21-015, located in Technical Area (TA) 21 adjacent to DP Road at Los Alamos National Laboratory (Fig 1). Adjacent properties on DP Road include municipal land transferred from DOE to the Los Alamos School district, Los Alamos County and private properties in a local commercial zone. Los Alamos County and the Los Alamos School district plan on development of the transferred properties in the next few years as part of urban improvements that include retail stores and residential housing projects. From 1944 until it closed in June1948 after a fire, MDA B received contaminated materials from the Laboratory and undoubtedly contains both hazardous and radioactively contaminated wastes. Known in the 1940s as the contaminated dump, MDA B currently is scheduled for excavation and the removal of its contents. Disposal trenches will be completely excavated, and all wastes and excavated environmental media will be characterized for disposal at approved off-site waste disposal facilities. The work is being performed in accordance with the Compliance Order on Consent with the New Mexico Environment Department (signed March 2005) and 10 CFR 830 Nuclear Safety. Administrative activities to comply with the nuclear safety requirements constitute the greatest efforts for the past 2 years. Safety is considered the most important aspect of the project.

Figure 1. Aerial view of TA 21 circa 1995. MDA B is parallel to DP road at top left of photo.

UNDERSTANDING THE BURIED WASTES AT MDA B

Planning for the safe implementation of the MDA B waste retrieval project required information on the location and evolution of the disposal trenches and the nature of the wastes disposed of. Since there were no waste disposal records, and no construction drawings or original site engineering drawings or plans have been found that show the locations of the trenches when they were in use understanding the common research and production elements used at the Laboratory in the 1940s was important for present-day worker and public safety. MDA B contents also have never been directly characterized. Thus, understanding the context of the historic operations at MDA B in the 1944 to 1948 timeframe was essential to understanding what wastes would and would not have been disposed of at MDA B and what hazards these would pose during retrieval.

A report was compiled [1] that reviewed the available documents and information relevant to site operations at MDA B at the time MDA B was in use, including historic records and reports; some previously classified, historic memoranda and other correspondence; and aerial photographs taken in the 1940s, as well as retiree interviews. The report addressed the following questions in lieu of disposal records.

- What information is available concerning the physical boundaries, characteristics, and timing of waste burials at MDA B?
- What programs and organizations were active at Los Alamos in the mid- to late- 1940s that may or may not have contributed wastes to MDA B?
- What specific process information is available that describes the types and quantities of wastes produced?
- What program, organization, or process information is available to exclude wastes from MDA B?

The operational history of MDA B is tied to the earliest history of the Laboratory, the scope and urgency of World War II, the transition to the Atomic Energy Commission in January 1947, and the start of the cold war. The resulting report summarized the development of the process chemistry, metallurgy, and other research and production activities at the Laboratory during the 1944 to 1948 timeframe to provide a perspective of the work conducted at the Laboratory; the scale of those processes; and the handling of spent chemicals, laboratory glassware, and contaminated items. Monthly reports compiled by the operating groups of the period described the application of significant resources and research efforts to the recovery of the then-priceless new materials plutonium and enriched uranium and addressed the measures to ensure that the materials sent to waste were not recoverable and that recoverable solutions were stored until a method to recover them could be developed. These monthly reports documented the development of new and revised processes, the refit and renovation of laboratories, the decontamination and dismantlement of old laboratory areas, and the disposal of items and equipment that did not meet release criteria after decontamination efforts.

Waste generator sites that used MDA B would have been the original technical area (TA-01), DP Site at TA-21, the contaminated laundry, the Bayo Canyon radiolanthanum project, the Omega Site (TA-02) water boiler reactor, and a few other radiological experimental areas of the early Laboratory. This assessment is confirmed by monthly reports and correspondence of the operating groups, as well as log books kept by the drivers of a truck that picked up contaminated trash and debris from these sites and delivered them to MDA B. Explosives wastes were not disposed of at MDA B because Anchor Ranch, S Site and other explosives production and test areas used what is now known as TA 16 MDA R for these types of wastes. During the war, the tech area contained virtually all plutonium and enriched-uranium research, purification, recovery and metal fabrication operations. After the war, DP West assumed operations for pilot plant scale plutonium purification, reduction, metal fabrication and recovery operations. Polonium operations moved to DP East. D Building retained operations with enriched uranium, but converted to plutonium research and analytical support (Note - D Building was replaced by CMR in the early 1950s).

The MDA B pits and trenches are interpreted to be approximately located as shown on the geophysics map (Fig. 2). These pits/trenches were constructed by progressive eastward expansion of a series of semi-contiguous trenches during the 1944 to 1948 period. The earliest trenches were on the far western end of

MDA B. Aerial photographs taken in the 1946 and 1947 were interpreted to document which trenches were active during those years. Figure 3 is an oblique, aerial photograph taken in November 1946 and is believed to be the earliest photograph of MDA B. Unburied waste can be seen in the eastern part of the active trench. By 1947, all laboratories had established waste disposal procedures that required laboratory and salvage wastes to be boxed and sealed. Large items or equipment were to be wrapped with paper or placed in wooden crates and tagged to indicate waste status. Wastes were generally placed in cardboard boxes and were simply piled into the active trench. Using a bulldozer, workers subsequently covered the material with fill dirt on a weekly basis. No effort was made to separate waste types or loads, or to compact the wastes beyond the soil cover compaction efforts. Figure 4 is a photograph of waste boxes similarly placed in MDA A in late 1945.

The vast majority of waste disposed of at MDA B waste was radioactively contaminated, including routine laboratory waste, contaminated glassware, obsolete equipment and wooden laboratory furniture, demolition debris, building materials, clothing, glassware, paper, trash, and minor chemicals from the laboratory areas. All waste from the chemical and metallurgical laboratories (plutonium, uranium and polonium) was considered contaminated trash and all waste and trash was to be thrown into the “hot waste” receptacles placed in each laboratory. The largest waste contributors were the contaminated laundry and building demolition debris as most laboratory structures were upgraded after the war.

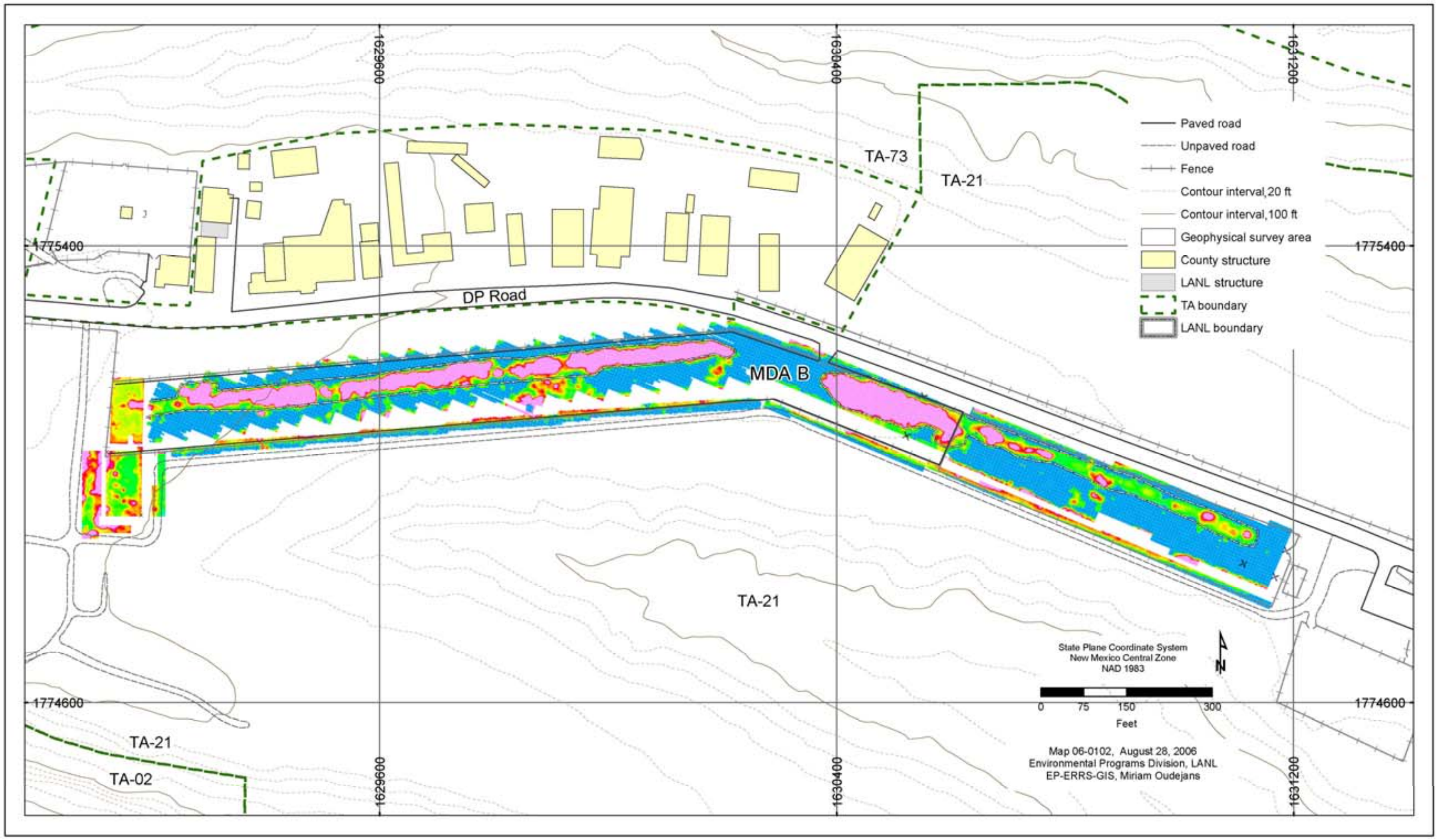

Figure 2. Results of geophysical surveys conducted in 1998 at MDA B depicting locations of burial pits and trenches.

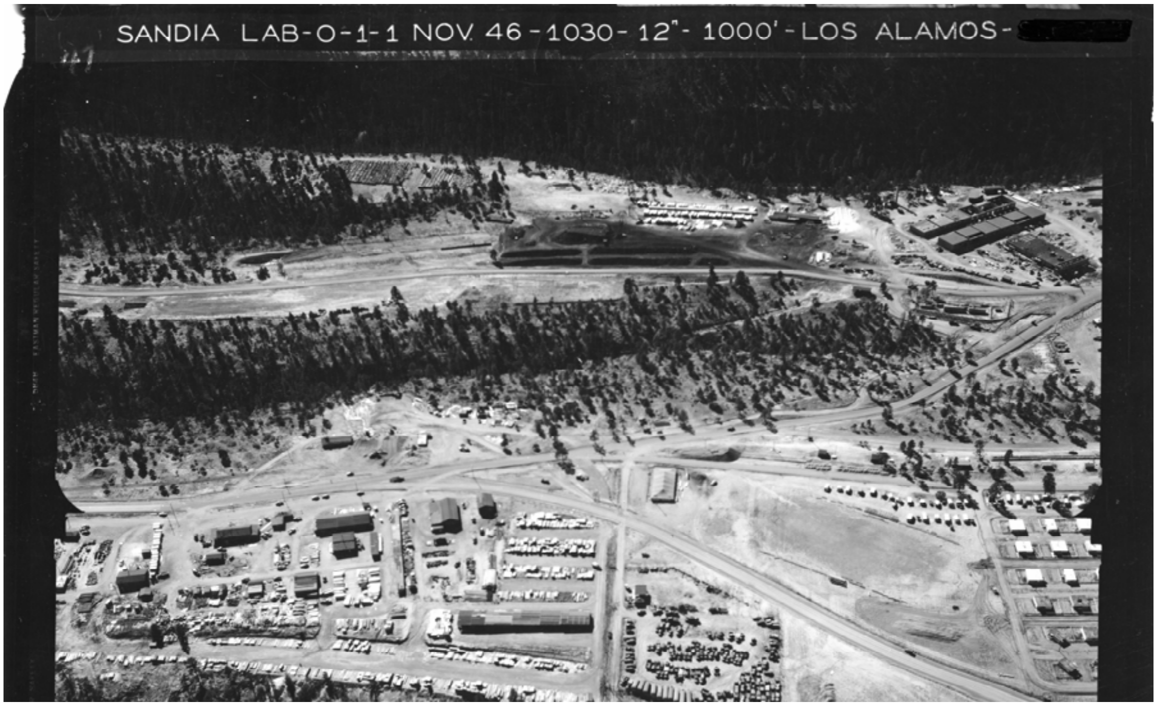

Figure 3. November 1946 oblique aerial photograph of DP Road and western end of MDA B; view to south. The eastern end of MDA B remained vegetated and had not yet been disturbed.

Figure 4. Photograph of waste disposal practices at MDA A in late 1945, similar conditions were assumed to have existed at MDA B (LANL photograph IM-9: 2284)

Disposal of waste in 55-gallon drums was rare. The only documented disposal of liquids in drums was the oil used in the electrostatic filters at DP West and DP East for plutonium and polonium, respectively. The oil was a mineral oil with low flammability for use in electrical devices. The concentration of plutonium in these oils was assumed to have been much less than the 1 mg/L discard limit or recovery would have been implemented. Paper sheet filters from the filter buildings were also disposed, but these were not particularly effective, so the radionuclide concentrations are assumed to be small. High efficiency particulate air (HEPA) filters were not used until after 1949.

Limited chemical inventory records managed to survive. The chemical inventories provided a comprehensive view of chemicals in the stockroom, but did not provide volumes or types of chemical wastes. Process waste liquids and chemicals that contained less than 0.1 milligram/liter of plutonium are known to have been released to the environment through outfalls or absorption beds through a series of acid waste lines, so process liquid waste chemicals are not expected at MDA B. A radioactive liquid process facility was not constructed until 1949. At TA-21, process and excess chemicals were piped to what was called the chemical disposal pit. LANL excavated this pit in 2007, and it was constructed like many of the other absorption beds at TA-21, so it was built to handle a significant volume of liquid. Chemicals were assumed to have been dumped at MDA B on a non-routine basis as either mixtures or as excess reagent in bottles.

The research indicated that almost all process chemistry was aqueous; some experiments were performed with solvent extraction, but nothing larger than bench-top scale until after MDA B closed. Residual chemicals at MDA B may include cleaning solutions, such as trichloroethylene and strong acids. Ethyl ether was used in the plutonium and uranium purification processes until July 1946. The dangers of ethers and peroxide crystals were known during the 1940s period, and waste ether solutions were disposed of in an ether disposal pit located at TA-21.

ESTIMATE OF PLUTONIUM INVENTORY AT MDA B

The MDA B waste disposal units were interpreted in to be located approximately as shown on the geophysical map (Fig. 2). These waste disposal units were constructed by progressive eastward expansion of a series of semi-contiguous waste disposal units during the 1944 to 1948 period. The estimated waste disposal unit depths and historical aerial photos were used to estimate the waste volume in each of 10 areas. A calculation of the plutonium inventory in MDA B presented in the waste analysis used a limited analytical data, measurements, and observations recorded in "Cesium-137, Plutonium-239/240, Total Uranium, and Scandium in Trees and Shrubs Growing in Transuranic Waste at Area B" [3] to estimate the plutonium-239/240 inventory in MDA B. Primary inventory components include the interstitial soils and fill added during waste-disposal operations, gloves and other protective equipment, discarded laboratory glassware and debris, and intact liquid containers. Based on anecdotal information glass bottles are buried in at least one pit on the eastern end of MDA B. Although it was not possible to definitively identify the source of these bottles, it remained a possibility that they may contain residual plutonium or other exotic elements. Based on the known Laboratory operations, the concentrations of plutonium were estimated to be approximately 1 mg/L of plutonium, a concentration considered in the late 1940s to be potentially recoverable, but too concentrated to release into the environment. Application of the soil concentration and surface contamination data ranges and the range of possible liquids in intact containers at MDA B to the calculation method indicated that the total possible MDA B plutonium inventory ranged from 24 to 246 g of plutonium. The results indicate that the 50th percentile value is similar to the historical estimate of 100 grams of plutonium [1].

The plutonium-239 inventory at the 97th percentile indicated the following distributions:

- 97th percentile of total inventory 200 g (12.4 Ci)

- interstitial soil and fill 169 g (10.51 Ci)
- gloves and personal protective equipment 13 g (0.81 Ci)
- glassware and lab debris 10 g (0.62 Ci)
- intact liquid containers 8 g (0.50 Ci)

Assuming uniform distribution and the smallest estimated total waste volume, the resulting concentration was 7.5E-4 Plutonium Equivalent (PE)-Ci/m^3. This dimensional analysis indicated that contaminated soils represent the majority of the plutonium inventory at MDA B and suggested that the inventory is homogenously distributed throughout the entire volume of MDA B. Based on the waste process history during 1945 to 1948, individual items may possess locally higher or lower levels of contamination, but they would not represent a significant change in the majority fraction of the plutonium inventory in MDA B. These data also indicated that the waste at MDA B will be characterized as low-level radioactive waste.

NUCLEAR SAFETY ANALYSIS

Los Alamos National Laboratory prepared a documented safety analysis (DSA) for the removal, characterization, and restoration activities at MDA B [2], in accordance with 10 CFR 830, Subpart B, "Safety Basis Requirements." The purpose of the DSA was to evaluate the hazards and identify the appropriate controls that will ensure that workers, the public, and the environment are protected from the radiological, chemical, and other hazardous materials associated with the MDA B project. The DSA was developed in accordance with environmental restoration activities not conducted in a permanent structure and utilized the safe harbor methodology in DOE Standard 1120-2005, *Integration of Environment, Safety, and Health into Facility Disposition* Activities (DOE 2005a), and the provisions of 29 CFR 1910.120, *Hazardous Waste Operations and Emergency Response*. While most of the MDA B project activities represent radiological and chemical hazards to the workers and will be described in a HAZWOPER health and safety plan, DOE Standard 1120-2005 recommends that information be presented in a separately prepared DSA that provides clear distinction of the facility safety basis information that can be subject to the Unreviewed Safety Question process. The DSA was not expected to address the full scope of standard industrial hazards and controls typically covered by HAZWOPER. The focus of the hazard analysis is the identification of structures, systems, or components and the administrative controls that prevent or mitigate a release of hazardous materials.

The MDA B DSA utilized a what-if checklist as a rigorous, qualitative method for evaluating potential hazards and impacts to identify appropriate type, level, and number of physical and administrative barriers to prevent or mitigate potential accident consequences to the workers, the public, and the environment. The hazard controls and safety management programs for the MDA B project are to be implemented through Technical Safety Requirements. This methodology provides a rigorous implementation and enforcement process.

The hazard identification focused on the following MDA B activities:

- Pre-excavation
- Excavation
- Waste Container Packaging, Transportation, and Staging
- Characterization

The hazard identification and evaluation tables were organized by the work activities. The work activities, processes and hazards were identified from lessons learned during the waste retrievals at the radioactive and classified waste landfills, Sandia National Laboratories, RCRA Closure of Material Disposal Area P, LANL, and Area 300 burial grounds, Hanford reservation, drum retrievals at Rocky Flats, among others. The Occurrence Reporting and Processing System database was searched for applicable accidents/hazardous events that have occurred at other DOE sites to broaden the perspective on potential future facility hazards. Applicable accidents/hazardous events that occurred at MDA B and other DOE sites provided additional input to the hazard identification checklist. The waste retrieval projects at Melton Valley, Oak Ridge National Laboratory, and Pit 4, Idaho Cleanup Project, among others, provided relevant analogs for the MDA B project.

Radiological Hazards. The total MDA B inventory of 12.4 PE-Ci was calculated to be distributed in the total MDA B waste disposal unit volume of 16,515 m^3, resulting in a calculated average concentration of 7.5E-4 PE-Ci/m^3. This indicated that the calculated radioactive material concentration in the landfill is low and that for the specific hazard scenarios the radiological contribution to the hazard consequence was considered low.

Chemical Hazards. The historic review provided a list of chemicals that were used at the Laboratory during 1944–1948 included flammables, pyrophorics, oxidizers, and time-sensitive chemicals. After 60 years of being buried, many of the items were considered to have deteriorated or corroded, thus rendering much of the material noncombustible. Ethyl ether was used from 1945 to 1946 in the plutonium and uranium purification processes, but the processes required that the ether solutions be evaporated, so there were no specific ether wastes. It was recognized, however, that some chemicals may have formed peroxide crystals and may now be shock sensitive. Ethyl ether peroxide formation was assumed to produce the bounding quantity of shock-sensitive material with the potential to cause an explosion. It was presumed that 2- and 4-L containers of ether, typically used in bench top experiments and research, may have been disposed. In consideration of the bounding hazard for shock-sensitive chemicals, a 9-L bottle was chosen as a maximum-sized bottle that could reasonably be present at MDA B. Given the ether disposal practices of the 1940s and the conservatisms that ether was disposed of at MDA B, an explosion accident involving the impact of a bottle of ether with shock-sensitive peroxide crystals was considered to be in frequency case probable for the unmitigated hazard case.

The selected hazard controls for the MDA B project consist of the following set of controls:

- passive design features as safety-significant structures, systems, and components;
- specific administrative controls, implemented as Limiting Conditions of Operation;
- commitments to safety management programs; and
- operational controls as defense in depth.

The safety significant SS structures, systems, and components include personnel shielding and overpressure protection that protect the workers and the public from the effects of an unlikely chemical explosion during excavation activities. The personnel shielding and its placement protect the worker from the hazards of a potential explosion fireball, hazardous fragments, and blast wave overpressures in the unlikely event of a chemical explosion, either from the impact of shock-sensitive chemicals or corroded gas cylinders with a flammable gas during excavation activities. Personnel shielding may be provided by sandbags, Lexan® sheets, Kevlar® body armor, and other blast shield material. The personnel shielding may be erected in stands. Personnel shielding will also be installed on the cab of earth-moving vehicles used during landfill material excavation activities.

The overpressure protection serves to mitigate effects to the public and public structures from overpressures generated from an accidental explosion involving shock-sensitive chemicals. The overpressure protection system shall be consistent with testing completed in experiments conducted at

LANL in support of the MDA B project. The testing used a fabric supplied to LANL by a commercial tension-fabric structure manufacturer that was vertically mounted to a simple wooden frame. The purpose of the testing was to compare the peak overpressures at given distances from an unattenuated explosion and a simulated fabric enclosure. The results indicated that a commercially available, tension-fabric structure can reduce the peak overpressure at the public boundary by approximately half. As a result of the testing, the MDA B project will utilize commercially available tension-fabric structures as enclosures at the excavation areas. The size of an excavation enclosure may vary; a typical design is 24 m (80 ft) wide by 61 m (200 ft) long by 12 m (40 ft) high. The relocatable structures include a metal frame covered with a fire-resistant fabric membrane. The excavation area enclosure contains the dig face, waste sorting and packaging areas, excavator and transfer equipment, waste containers and packaging supplies, monitoring equipment and supplies, fire suppression equipment and materials, and personal protection equipment.

The following specific administrative controls were identified in the hazards analysis:

- Excavation area material at risk (MAR) and distance requirements
- MAR and distance requirements for the field laboratories
- Waste Container Staging Area MAR limits
- Transportation MAR limits
- Excavation Area ventilation
- Air monitoring for radioactive and chemical contamination

DOE-STD-1120-2005 recognizes that waste materials or contamination, such as that at MDA B, may be buried and/or distributed unevenly over a large area and is not subject to dispersive forces until it is exhumed. The MDA B project will retrieve and manage buried wastes that possess inherent uncertainties in the volume, distribution, and type of contamination. Although the pre-excavation characterization will reduce the uncertainties through sampling and analysis of soil and waste materials, the project can additionally reduce the consequences of hazards and accidents by placing physical limits on the MAR. These limits include waste retrieved in the excavation areas, as well as limits on transportation and staging of waste materials. The DSA identifies and manages four distinctive MAR areas. Each of these areas will be separated from the other and limits the MAR in its area to below the HazCat-3 quantity of 0.52 PE-Ci, so that the potential consequences of any accidents are commensurate with those from radiological activities. The distance limits reduce or preclude events in one area from affecting other areas.

Safety Management Programs are implemented as administrative controls to ensure that MDA B is operated in a manner that adequately protects workers, the public and the environment. Individual elements of the programs were credited in the hazard analysis for mitigation of specific hazards, such as size and separation of excavation and waste sorting piles and foam-based fire suppression systems as part of the Fire Protection Program; and excavation control and characterization requirements for intact containers in the Hazardous Material and Waste Management Program.

REFERENCES

[1] *Material Disposal Area B: Process Waste Review, 1945 to 1948*, Los Alamos National Laboratory document LA-UR-07-2379, August 2007.

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[3] W.J. Wenzel, T.S. Foxx, A.F. Gallegos, G. Tierney, J.C. Rodgers, "Cesium-137, plutonium-239,240, total uranium, and scandium in trees and shrubs

growing in transuranic waste at Area B," Los Alamos National Laboratory report LA-11126-MS, November 1987.