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Facility Safety Plan for Material Disposal Area C

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Los Alamos National Laboratory (LANL), operated by Los Alamos National Security (LANS), LLC, for the U.S. Department of Energy under Contract No. DE-AC52-06NA25396, has prepared this document.

Executive Summary

The Material Disposal Area (MDA) C is categorized as a Radiological Site (less than Hazard Category 3) Facility. The justification for this designation was provided by Material Disposal Area (MDA) C Final Hazard Categorization, NES-ABD-0700, R2, and approved by the Los Alamos Site Office (LASO) in COR-SO-6.30.2010-264748 - Response to Final Categorization for Material Disposal Area C

This Facility Safety Plan (FSP) was prepared under the guidance provided in Safety Basis procedures SBT 113-1 and SBT 113-2.

The Responsible Line Manager for MDA C is the TA-21 Facility Operations Director, and the Responsible Associate Director Environmental Programs (ADEP).

Contents

List of Tables

Acronyms

Ci	Curie
DCF	Dose Conversion Factor
DOE	Department of Energy
DP	Delta Prime
DPT	Direct Push Technology
GAA	General Aviation Aircraft
HC	Hazard Category
LANL	Los Alamos National Laboratory
LASO	Los Alamos Site Office
MAR	material-at-risk
MDA	material disposal area
NES	Nuclear Environmental Site
PE-Ci	Plutonium Equivalent Curies
TA	Technical Area
TQ	Threshold Quantity
WCRRF	Waste Categorization, Repackaging, and Removal Facility

Facility Safety Plan for MDA C

1.0 Introduction

As required by 10 CFR 830, Subpart B [1], Material Disposal Area (MDA) C was initially classified as Hazard Category 2 (HC-2) nuclear facility based on its estimated gross radioactive inventory. In 2010 a Final Hazard Categorization (FHC) [2] was performed based on a hazard analysis that considered material form, dispersibility, and interaction with energy sources, but excluded consideration of engineered safety features. This document provided the basis, including a qualitative hazard analysis, to demonstrate that MDA C could be categorized as a Radiological Facility. This document [2] demonstrated that the material-at-risk (MAR) from the worst-case accident that is available for dispersion at MDA C is less than the threshold quantities for Category 3 listed in Table A.1 of U.S. Department of Energy (DOE)-STD-1027-92 [3]. LASO approved the FHC [4] and thus MDA C is presently categorized as a Radiological Facility.

2.0 Description of MDA C

MDA C, a radiological facility, is a 12-acre site located near the west end of Mesita del Buey, north of Pajarito Road and south of Building TA-50-1. MDA C was established in May 1948 and served as the main Laboratory disposal facility for approximately 20 years and has not been used for waste disposal since that time. Routine wastes disposed of at MDA C consisted of radioactively contaminated trash in cardboard boxes and plastic bags, material generated in the chemistry laboratories and barrels of sludge from the waste treatment plants at Building 35, DP West, and TA-45. Non-routine contaminated waste included debris from the demolition of Bayo Site and TA-01, classified materials, and tube alloy chips from shops [5]. The wastes are distributed among 7 pits and 108 shafts.

Figure 1 shows the location of the MDA C with respect to Pajarito Road and Pecos Drive. Also shown are the facility boundary and the waste disposal units. The facility boundary encompasses the entire MDA C site, which has an overall length ranging from approximately 650 ft to 1100 ft and widths ranging from 75 ft to 225 ft. The waste disposal units consist of seven pits (Pits 1–6 and the Chemical Pit) with depths ranging from 12 to 25 ft below the original ground surface, and 108 shafts with depths ranging from 10 to 25 ft below the original ground surface (before a crushed tuff cover was placed over the site in 1984). Pits 1 through 4 are approximately 610 ft long and 40 ft wide; Pit 5 is approximately 705 ft long and 110 ft wide; Pit 6 is approximately 505 ft long and 100 ft wide; and the Chemical Pit is approximately 180 ft long and 25 ft wide. The shafts are located between Pits 4 and 5 (Shaft Field 1), Pits 1 and 3 (Shaft Field 2), and along the western edge of Pits 1 through 4 (Shaft Field 3). The shafts are approximately 2 to 3 ft in diameter and are generally spaced apart on 7.5 ft centers; some are lined with concrete. The entire area has approximately 3 ft to 12 ft of cover material and has been covered and re-seeded.

The radionuclide inventories used for categorization are shown in Table 1 and are taken from the DSA [6]. Table 1 also indicates the Threshold Quantity (TQ) for each isotope for the hazard categorization of the site.

Table 2 indicates the Plutonium Equivalent Curies (PE-Ci) for each isotope, and also the total PE-Ci for the site. This convention simplifies the analysis and also simplifies the comparison of the quantity of radioactive material, in this case PE-Ci, to the TQ for Pu-239.

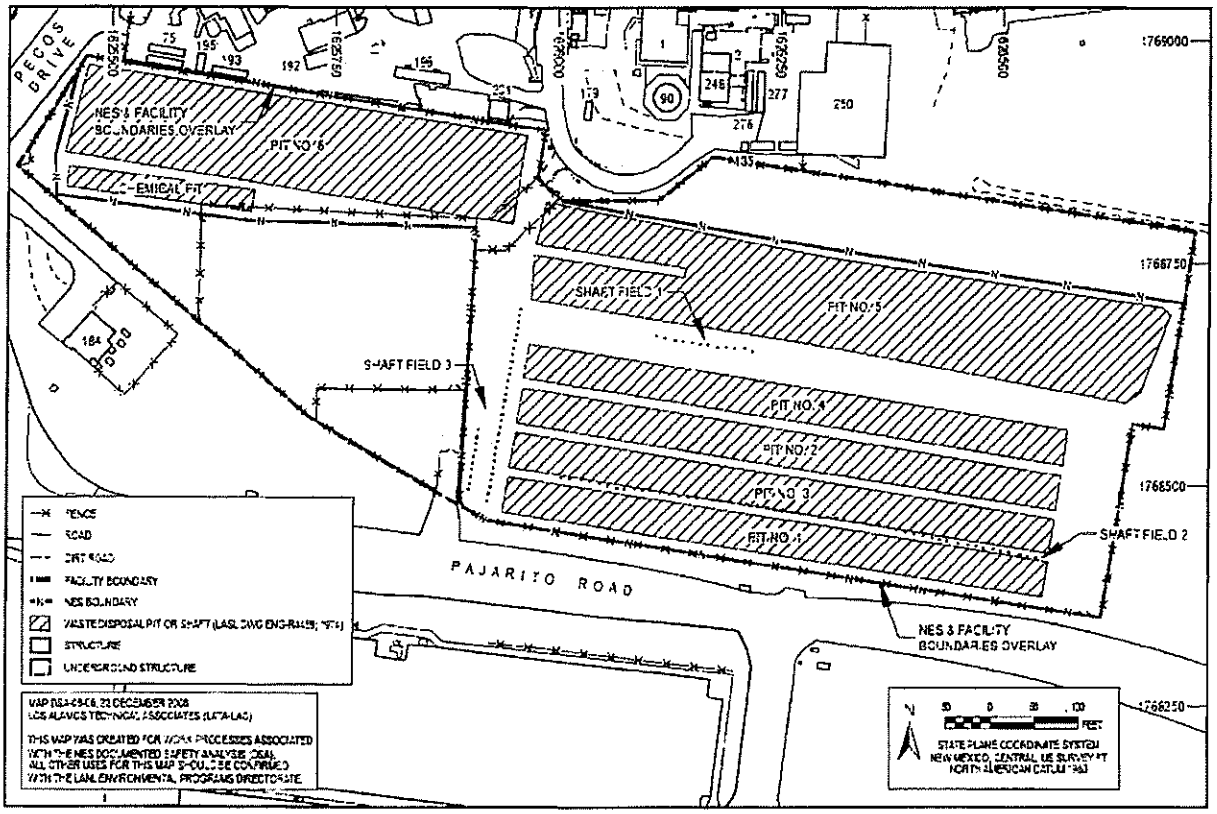

Figure 1. MDA C Site Location

Table 1. MDA C Inventory

Radionuclide	Inventory (Ci)**	TQ for HC2 Ci*	TQ for HC3 Ci*
Tritium (H-3)	2.0E+04	3.0E+5	1.6E+4
Sodium-22	5.8E-01	6.3E+3	2.4E+2
Cobalt-60	2.4E+00	1.9E+5	2.8E+2
Strontium-90	2.1E+01	2.2E+4	1.6E+1
Radium-226	1.0E+00	5.5E+1	1.2E+1
Uranium-233	5.0E+00	2.2E+2	4.2E+0
All Other Uranium (excluding U-235)	2.0E+01	2.4E+2	4.2E+0
Plutonium-238	2.6E+01	6.2E+1	6.2E-1
Plutonium-239	0	5.6E+1	5.2E-1
Americium-241	1.5E+02	5.5E+1	5.2E-1
Plutonium-241	1.5E+03	2.9E+3	3.2E+1
Plutonium-239 Equivalent	1.8E+2	5.6E+1	5.2E-1

* From DOE-STD-1027 [2] Table A.1
**From NES DSA Table E-1 [6]

Table 2
MDA C Plutonium Equivalent (PE)

MDA C Inventory	Isotope	Inventory (Ci)	ICRP-72 DCF (rem/Ci)	PE Ratio	PE (Ci)
Disposal Pits and Shafts	H-3	20000	9.62E+02	5.2E-06	1.04E-01
	Na-22	0.58	4.81E+03	2.6E-05	1.51E-05
	Co-60	2.4	1.15E+05	1.0E-03	1.49E-03
	Sr-90	21	5.92E+05	3.0E-03	6.72E-02
	Ra-226	1	3.52E+07	1.9E-01	1.90E-01
	U-233*	5	3.55E+07	1.92E-01	9.59E-01
	all other U	20	3.55E+07	1.92E-01	3.84E+00
	Pu-238**	26	1.70E+08	9.19E-01	2.39E+01
	Pu-239**	0	1.85E+08	1.0E+00	0.00E+00
	Am-241	150	1.55E+08	8.38E-01	1.26E+02
	Pu-241	1500	3.33E+06	1.8E-02	2.70E+01
				PE-Ci total	**1.81E+02**

* U-233 subtracted from Total U, but its dose conversion factor (DCF) bounds all U isotopes except U-230 and U-232.

** This is a mixture of Pu 238 and Pu 239; since the rem/Ci for Pu-238 is higher than Pu-239, the accident analysis conservatively assumes that all of the mixture is Pu-238. The criticality analysis, Section 5.1, conservatively assumes that all of the mixture is Pu-239.

3.0 Site Activity

3.1 Site Maintenance

If vegetation, such as tree stumps, requires removal, it can be removed to ground level, but will not be removed by digging, pulling, or pushing. General mowing activities and installation of storm water controls are allowable.

3.2 Drilling, Sampling and Characterization

Methods such as drilling are required to collect subsurface samples of the soil surrounding the waste pits and shafts for characterization purposes to provide assurance that there is no significant migration of the radioactive waste into the surrounding soil. Drilling into the waste disposal areas, either Pits or Shafts, at MDA C is prohibited.

Drilling methods typically involve using a hollow-stem auger drill rig or an air-rotary rig; both methods continually deliver core or cuttings to the surface. As drilling advances, cores needed for sampling and analyses are collected in closed barrels/tubes (usually 3 to 4 in. diameter in 5- or 10-ft lengths). During hollow-stem drilling, cuttings travel up the auger and are deposited on the surface near the borehole. During air-rotary drilling, a closed-loop compressed air system forces the cuttings from the borehole to the surface. As the cuttings reach the surface, they are diverted through a dust suppression system before being captured. Both the core and cuttings are monitored for radioactive and hazardous constituents before collecting samples, logging geology, or managing cuttings or excess core.

Direct Push Technology (DPT) sampling can also be used for characterization of surrounding soil. The DPT is a portable drilling device that uses a push-tube technique rather than a rotating bit to extract samples. Vehicles such as bobcats, forklifts, and medium- to large-sized trucks weighing approximately up to 5 tons and potentially more may be used to maneuver the drilling equipment over MDA C.

After drilling, boreholes may be used for environmental monitoring purposes such as moisture and vapor monitoring. Boreholes not needed for monitoring purposes are either backfilled/ stabilized (using grout or other similar material) or capped at the surface to prevent inadvertent intrusion by water.

4.0 Hazard Analysis

This Facility Safety Plan (FSP) for MDA C contains a hazard analysis, per the guidance in SBP 113-1 and SBP 113-2, and was prepared to demonstrate that, for any credible event involving a radiological release, the amount of the release would be less than 0.52 Plutonium Equivalent Curies (PE-Ci) in agreement with Attachment 1 of DOE-STD-1027 [3]. The hazard analysis in this document considers releases that could occur during intrusive activities at MDA C, as discussed in Section 3.0. There are no other operational or process-related initiators of concern that would breach the protective overburden and expose hazardous/radioactive materials. Potential initiators to radiological exposure or releases are limited to a small set of internal initiators and external man-made and natural phenomena events. These events are as follows:

1. Criticality due to water intrusion or contamination movement – This is discussed for MDA C in detail below.
2. Pressurization due to explosions – This is not a credible event, because there are no explosives buried at the site.
3. Overpressurization of storage tanks – This is not a credible event at MDA C, because there are no tanks associated with MDA C.
4. Fire – This is a credible event at MDA C and is discussed in detail below.
5. Loss of Confinement – This is discussed below for two events, inadvertent drilling into the waste and an aircraft crash.
6. Vehicle Impact – This event is bounded by the aircraft crash.
7. Aircraft Crash – This is a credible event for MDA C and is discussed below.
8. Inadvertent penetration of the waste – Drilling of the waste is prohibited, however, drilling of the surrounding areas is allowed. The consequences of an inadvertent drilling into the waste are evaluated.
9. High Wind/Tornado – This is not a credible event for intruding into the waste due to the minimum confinement cover of at least 3 feet and tornadoes are not a credible event at the LANL site.
10. Seismic – A seismic event which would cause significant radioactive material to be ejected is not credible.

4.1 Criticality Event

The potential for a criticality involving fissile or fissionable material in a soil matrix is driven by several factors, including water content in soil, density of soil, and soil type. DOE-STD-1120-2005, Vol. 2, Attachment 3, Section 3.1, "Criticality" [7] states that, with soil concentrations of Pu-239 less than 2.5 g/L, there is no possibility for criticality; the equivalent concentration for U-235 is 1.8 g/L. Table 1 indicates that there is no Pu-239 or U-235 in MDA C. Pu-241 and U-233 have approximately the same fission cross-sections as Pu-239 and U-235, so that the limits would be the same, 2.5 g/L and 1.8 g/L. This information is valid whether the site is an IWS or not. This reference information is applicable to all DOE radioactive waste sites.

To estimate the concentration of fissile materials in MDA C, it was assumed that all of the fissile material was in Pit 7 because this pit is the smallest (55 m × 7.6 m × 3.7 m = 1,550 m^3 from Section 1.6.6 of the DSA for NES [6]) and therefore leads to the highest concentration of fissile material per unit volume when the entire inventory is uniformly distributed within this volume. This is considered a very conservative assumption and is adequate to take account of potential *hot spots* or small areas with higher than average fissile material loading. The conservatism is due to the fact that the radioactive contamination is distributed among 108 shafts and seven pits in MDA C that cover 12 acres (Section 2).

The fissile materials listed in Table 1 are U-233 (5.0 Ci), Pu-241 (1500 Ci) and Am-241 (150 Ci). The specific activities for U-233, Pu-241, and Am-241 are 9.68E-03, 103, and 3.43 Ci/g, respectively. Thus the amount of fissile material in MDA C can be estimated as follows:

- 5.0 Ci of U-233 corresponds to 5.0/9.68E-03 = 517 g,
- 1500 Ci of Pu-241 corresponds to 1500/103 = 14.6 g, and
- 150 Ci of Am-241 corresponds to 150/3.43 = 43.7 g.

The total amount of fissile material listed in Table 1 for MDA C is 575 grams. However, this does not include the following two additional potential sources of fissile material in MDA C:

1. Table 1 shows an All Other Uranium content of 20 Ci. This is either depleted or natural U, and, while this type of U cannot sustain criticality in water or soil, a conservative analysis would include the U-235 as part of the natural or depleted uranium. The maximum concentration of U-235 in natural or depleted uranium is 0.7%, and this will be included in a conservative analysis for criticality concerns.
2. Table 1 indicates a Pu-238 content of 26 Ci, which would not normally be considered in a criticality analysis. However, although not discussed in the DSA, this Pu-238 is actually a mixture of Pu-238 and Pu-239, and was listed in the accident section of the DSA as all Pu-238 since Pu-238 has a higher specific activity than Pu-239. For a criticality analysis, it is thus more conservative to assume that the mixture is all Pu-239.

The following is a conservative estimation of the total amount of additional fissile material in MDA C:

1. The maximum amount of U-235 contained in the amount of natural and depleted U is 0.007*20 = 0.14 Ci.

   The specific activity for U-235 is 2.16E-06 Ci/g

   Thus the amount of U-235 in the site is 0.14/2.16E-06 = **6.5E+4 grams**

2. The amount of Pu-238 listed in Table 1 is 26 Ci, which is conservatively assumed to be all Pu-239.

The specific activity of Pu 239 is 6.22E-02 Ci/g

Thus the amount of Pu 239 in the site is 26/6.22E-02 = **418 grams**

A conservative estimate of the total amount of fissile material in MDA C is 575 + 418 + 65000 = 6.6E+04 grams.

As discussed above, it is conservatively assumed that all of the fissile material is located in Pit 7 since this is the smallest pit, although this is a chemical pit and contains no significant amounts of radioactive material. This results in the highest fissile material concentration to be used in the criticality analysis.

Pit 7 has a total volume of 55 m × 7.6 m × 3.7 m = 1,550 m^3 = 1.55E+06 liters from Section E.4.2 of the NES DSA [4]. Thus a conservative estimate for the fissile material concentration in MDA C is

6.6E+04/1.55E+06 = 0.043 g/L

This is well below the criticality threshold of 1.8 g/liter of fissile material discussed above. Thus a criticality event is not credible at MDA C.

4.2 Aircraft Crash

An aircraft crash that has the capability to penetrate a waste protective overburden, create a sizeable crater, and dispense a high-octane gasoline that results in a fire is one of the most damaging events that can be postulated for a waste site. MDA C is in the vicinity of the Los Alamos Airport, which involves only general aviation aircraft (GAA). These aircraft have relatively low mass and velocity when compared to commercial or military aircraft. There are no airports in the vicinity of MDA C that involve air taxis and military aircraft (i.e., high-mass or high-velocity aircraft). An aircraft crash evaluation is presented in Appendix D, Attachment 3, Section 3.4 of DOE-STD-1120-2005, Vol. 2 [7], with the conclusion that crashes involving this type of aircraft at waste facilities, including MDA C, are not credible for non-airport operations, and thus the only credible aircraft crash involving MDA C was a GAA crash.

The result of the DOE-STD-1120-2005GAA crash evaluation is that the craters as a result of the aircraft crash were 3 feet or less and there were none beyond 3 feet deep. The protective overburden at MDA C is 3 to 12 feet NES DSA [6] and thus the maximum depth due to a GAA aircraft crash at MDA C is the same as the minimum depth of the overburden, as per DOE-STD-1120-2005, Vol. 2 [5]. Thus, although it is not expected that a GA crash would affect the waste, the following conservative evaluation demonstrates that this event does not involve a radioactive release greater than the TQ of 0.52 PE-Ci.

The probability of a GAA crash at a DOE waste site of 20 acres is stated in DOE-STD-1120-2005 (Ref 5) as 9.4E-5/yr. MDA C is a 12 acre site and therefore the probability of a GA crash at MDA C is 9.4E-5×12/20 = 5.7E-5. The concern at MDA C is a crater of 3 feet and 1120 indicates that the probability of a crater between 2 and 3 feet is 0.07 (7%), thus the probability of a 3 foot crater at MDA C is conservatively calculated as 5.7E-5×.07 = 4.0E-6. This is conservative since the 0.07 probability covers the range of craters from 2 to 3 feet.

Although very close to being an improbable event an additional evaluation is performed to determine the radiological release if the crash intruded into the waste. Although the above description indicates there would be little or no intrusion into the waste following the crash, the evaluation conservatively assumes that the aircraft intrudes into the waste a depth of 6". Heindel, G.D. Table 6 [Ref. 7] lists the wing span of a GAA as 50 feet and the skid distance at impact of 60 feet. This results in a volume of contaminated soil which could potentially be dispersed as:

$$0.5 \times 50 \times 60 = 1500 \text{ ft}^3$$

The next step is to determine the concentration of PE-Ci per ft^3 in the waste. The total volume of the 6 pits, pit 7 is a chemical pit and is conservatively not included in the total volume, is calculated based on the following;

The depth of the pits range from 12 to 25 feet; the 12 ft value will be used as a conservatism

Pits 1 through 4 are approximately 610 ft long and 40 ft wide;

Pit 5 is approximately 705 ft long and 110 ft wide;

Pit 6 is approximately 505 ft long and 100 ft wide;

Total volume of Pits = 4×610×40×12 + 705×110×12 + 505×100×12 = 1.17E+6 + 0.93E+6 + 0.61E+6 = 2.71E+6

The total PE-Ci inventory from Table 2 is 181 PE-Ci, this includes the inventory in the shafts as well as the pits. Since the volume associated with shafts is not included in the total volume this is an additional conservatism because the total MDA C MAR from both pits and shafts is presumed to be dispersed among the pits.

Thus the PE-Ci concentration in the pits is = 181/(2.71E+6) = 6.7E-05 PE-Ci/ft^3

T he amount of PE-Ci that could be potentially dispersed due to an aircraft crash = 1500×6.7E-5 = 0.1 PE-Ci

This is much less than the TQ for below HC-3 of 0.52 PE-Ci and demonstrates that the consequences of an aircraft crash are within the criteria for a radiological site.

4.3 Unmitigated Accident Analysis

For Radiological Facilities, DOE-STD-1027-92 [3] states that the dose at 30 meters must be less than 10 rem for any credible event. Attachment 1 of this standard lists the Threshold Quantities (TQ) of hazardous materials that meet these criteria. For a site to be classified as a Radiological site, the amounts of hazardous materials which are available to contribute to the onsite and offsite dose must be less than the TQs listed in Attachment 1.

The only events that could result in waste being exposed to the surrounding environment are an inadvertent drilling into the waste with a resulting drop and spill of the waste, including a fire that disperses the waste in the drilling machine. Accidents related to drilling, either a spill or a fire, bound all handling scenarios because the inadvertent interaction with the buried waste in the waste disposal units presents hazards for exposure to radioactive and hazardous materials. Radioactive material releases resulting from material spills from handling tasks, such as those previously described for drilling tasks, would likely include drops and impacts.

A conservative estimation of the MAR that is available for dispersion, and thus could cause onsite or offsite doses, is calculated as follows. The drill core assumed in the analysis was 3 meters long (9.84 ft) and 0.3 meters in diameter (12 in.). The typical drill core sizes used between the pits and shafts are usually much smaller, the typical size being 3 to 4 in. in diameter and 5 to 10 ft long. Thus the analysis has an additional order-of-magnitude conservatism in the calculation of the MAR that can conceivably be spilled in a single drill event. The volume available is estimated as the height of the core (a cylinder with a diameter of 12 in.) multiplied by the area represented by circle with a 6-in. radius. The volume is then 0.22 m^3. The DPT samples are collected in a sleeve approximately 5.1E-2 m (2 in.) in diameter and 1.5 m (5 ft) long, for a total volume of approximately 3.1E-3 m^3. Thus the bounding case is the use of the larger drill core volume to estimate the worker dose.

The mass of waste is the volume multiplied by the density (g/cc). The density of the waste matrix is conservatively assumed to be 2.65 g/cc, which is assumed to bound the upper range of compacted soil density based on cured concrete. The total mass in a single drill core is then 583 kg (0.22 $m^3 \times$ 2,650 kg/m^3).

As described above for the criticality analysis, the entire radioactive material inventory in MDA C is conservatively assumed to be in a single pit. The bounding case is Pit 7, because this pit is the smallest (55 m × 7.6 m × 3.7 m = 1,550 m^3 from Section 2) and therefore leads to the highest concentration per unit mass when the entire inventory is uniformly distributed within this volume. This is considered a very conservative assumption and is adequate to take account of potential *hot spots* or small areas with higher than average fissile material loading. The conservatism is due to the fact that the radioactive contamination is distributed among 108 shafts and seven pits in MDA C that cover 12 acres (Section 2). The total mass of material in Pit 7 is estimated to be (1,550 $m^3 \times$ 2,650 kg/m^3) = 4.1E+6 kg. The Plutonium Equivalent (PE) total activity for MDA C is listed in the NES DSA [6], Table E-1 as 181 PE-Ci. The concentration of radioactive material per unit mass of Pit 7 is then conservatively estimated to be (181 PE-Ci / [4.1E+6 kg × 1,000 g/kg]) = 4.4E-8 PE-Ci/g.

The total MAR available for release in a single drill event would then be the Pit 7 concentration multiplied by the mass of a single drill core, that is, 0.026 PE-Ci (583 kg × 1,000 g/kg × 4.4E-8 PE-Ci/g). This is more than an order of magnitude less than the TQ for Pu-239 of 0.52 PE-Ci listed in Table A.1 of DOE-STD-1027-92 [3].

Potential Underground Fire

In the event of an inadvertent intrusive drilling into the waste there is a possibility that the introduction of air into waste through the hole could cause an underground fire. Based on the avai;able knowledge of the waste disposal areas the probability of inadvertently drilling into the waste is very unlikely. However, even although the frequency of an underground fire is very unlikely the following evaluation was performed to determine the consequences of such a fire.

The scenario involves an inadvertent drilling into a pit waste site which contains radioactive materials and possibly combustible materials including volatile organic compounds (VOCs), cardboard boxes, and methane. The withdrawal of the drill from the hole in the pit would allow the introduction of air into the waste area with the potential for a fire. The fire could start due to a spark igniting the VOC and methane, or from the potentially spontaneous burning of uranium.

The total amount of radioactive material in the site is **181 PE-Ci**, for the purpose of this evaluation this is assumed to be divided between the six pits, since pit 7 is a chemical pit only, and conservatively ignoring the volume of the 108 shafts. Thus the amount in each pit is 181/6 = 30 PE-Ci, for conservatism this is assumed to be the amount in one of the smaller pits (1 – 4) which has a minimum volume of 610×40×12 = **2.9E+05 ft^3** where 610 ft is the length, 40 ft is the width and 12 ft is the minimum depth.

The amount of uranium in the site is 20 Ci, this is conservatively assumed to be natural uranium which has the lowest activity, 3.4E-7, PE-Ci per gram, and thus results in the highest mass in the pit. Thus the amount of uranium in the pit is 20/3.4E-7 = 5.9E+7 grams = 5.9E+7×0.0022 = 1.3E+5 lbs. Thus the concentration of uranium in the pit is 1.3E+5/2.9E+5 = 0.44 lbs per ft^3. Thus at this density it is unlikely, but still possible, that the uranium could burn.

The concentration of the radioactive material in the pit is 30/2.9E+05 = 1.0E-04 PE-Ci/ft^3 which is 1.0E-04/165 = **6.1E-07 PE-Ci/lb** where the density of the waste material is 2.65 g/cc (165 lbs/ft^3).

Once the fire has started the only supply of air is from the 10 feet in depth, 4 inch diameter hole into the waste due to the removal of the drill. There is a minimum of 3 feet of clean soil over the entire pit which will prevent any appreciable amount of air from contributing to the fire. This would result in a slow burning fire which could last for the duration of the event (24 hours as specified by DOE-1027-92 Attachment 1 [Ref.3]). The fire would most likely continue in burps since the rising smoke would prevent appreciable amounts of air from entering the hole. Thus the decrease in the air entering the hole would diminish the fire which in turn could allow sufficient air to again seep in to reignite the fire. In addition, as the fire expands outward from the drill hole, the air seepage would decrease due to the resistance of the soil.

The "t-squared" small fire is a small fire generating 1.0 megawatts, which assumes that there is unlimited amounts of air accessible to feed the fire. Thus it is reasonable, and conservative, to assume a fire size of 100 kilowatts, or 100 BTUs/second, for the underground fire being considered. This conclusion is based on the amount of air reaching the waste which decreases as more of the waste is burned and the burping effect described above. The amount of heat generated over the 24 hour period assumed for the event duration is $100\times24\times3600 = 8.64E+6$ BTUs. For normal combustible material the heat generated is 8300 BTUs per lb. Applying this to the waste material this would result in a release, over 24 hours, of $8.64E+6/8.3E+3$ = **1040 lbs** of radioactive waste material.

The concentration of waste material in the pit is 6.1E-07 PE-Ci/lb, thus the amount of radioactivity released in the 24 hour event is $6.1E-07\times1.04E+03$ = **6.34E-04 PE-Ci**.

5.0 Hazard Controls

5.1 Drilling Activity Control

5.1.1 Prior to conducting characterization/drilling activities inside the boundaries of MDA C, a location evaluation shall be performed to ensure that the activity will not intrude into the waste inventory.

5.1.2 The drill core size shall not exceed 3 meters long (9.84 feet) and 0.3 meters in diameter (12 inches).

5.1.3 Vegetation, such as tree stumps, requires removal, it can be removed to ground level, but shall not be removed by digging, pulling, or pushing. General mowing activities are allowable.

5.2 Safety Management Programs

Safety Management Programs (SMPs) ensure that a facility is operated in a manner that adequately protects workers, the public, and the environment. The SMPs include configuration management, quality assurance, training and qualification, radiological protection, fire protection, waste management, emergency preparedness, and conduct of operations.

5.3 Protective Overburden

The protective overburden shall be maintained at a minimum of 3 feet.

6.0 Conclusion

The above evaluation demonstrates that characterization/drilling activities can be performed at MDA C with no planned drilling into the waste inventory.

7.0 References

1. 10 CFR 830, Subpart B, *Nuclear Safety Management*, U.S. Code of Federal Regulations, Washington DC, January 1, 2009.

2. Material Disposal Area (MDA) C Final Hazard Categorization, NES-ABD-0700, R2

3. DOE-STD-1027-92, Change Notice 1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, U.S. Department of Energy, Washington DC, September 1997.

4. COR-SO-6.30.2010-264748 - Response to Final Categorization for Material Disposal Area C

5. Rogers, M.A., *History and Environmental Setting of LASL Near-Surface Land Disposal Facilities for Radioactive Wastes (Areas A, B, C, D, E, F, G, and T)*, Los Alamos Scientific Laboratory report LA-6848-MS, Los Alamos NM, June 1977.

6. *Documented Safety Analysis for the Nuclear Environmental Sites at Los Alamos National Laboratory*, NES-ABD-0101, Revision 2, Los Alamos NM, September 2009.

7. DOE-STD-1120-2005, *Integration of Environment, Safety, and Health into Facility Disposition Activities*, Volume 2, U.S. Department of Energy, Washington DC, April 2005.

8. DOE-EM-STD-5502-94, *DOE Limited Standard Hazard Baseline Documentation*, U.S. Department of Energy, Washington DC, August 1994.

9. G. D. Heindel, *Frequency Estimates for Aircraft Crashes into Nuclear Facilities at Los Alamos National Laboratory (LANL)*, Los Alamos National Laboratory report LA-13316-MS, Los Alamos, New Mexico, July 1997

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FOD-9 DCC

Document Action Request

Section 1 – Originator Request

Document No.: TA21-MDAC-FSP-00001		Revision No.: 0
Title: Facility Safety Plan for Material Disposal Area C		Page 1 of 1

Description of requested action (Attach numbered additional sheets if needed.):
New Facility Safety Plan Document Number changed since Material Disposal Area (MDA) C is categorized as a Radiological Site (less than Hazard Category 3) Facility

Originator Name (print):	Z#:	Organization:	Date:
Jose Romero	234904	IRM-DCS	1/20/2010

Section 2 – Responsible Manager Approval for Processing

☒ New Procedure ☐ Minor Revision ☐ Major Revision ☐ Deactivation ☐ Cancellation ☐ Perform Concurrent Periodic Review?

Superseded Document(s) and Revision Number:
NES-MDAC-PLAN-00001 - Facility Safety Plan

☒ Approved ☐ Disapproved (return to originator) Comments:

Signature:	Print Name, Title:	Z#:	Date:
Steve Henry for	Stephani Fuller	222445	1/28/11

Section 3 – Hazard Grading

Hazard Determination: ☒ Low ☐ Moderate ☐ High/Complex

Document is authorized to serve as IWD? ☐ Part I only ☐ Full IWD ☒ N/A

Section 4 – Required Reviews (see P315, Ch 16, Section 16.5.3)

Discipline:	Name:	Signature:	Date:
		SIGNATURES WERE OBTAINED ON DOCUMENT	

Validation Required: ☐ Yes ☒ No ☐ Waive Comment:

Scope of Validation: ☐ Entire Procedure ☐ Change Only

Validation Method: ☐ Walkdown ☐ Simulation ☐ Tabletop ☐ First Time Use

Training Determination completed?: ☐ Yes ☑ N/A Completed by: Mary Ann Garcia for Pam Flores

USQ/USI Number (if needed):	Signature:	Z#:	Date:
N/A JPK 1-28-11	Joseph P Konzleiter	231322	1-28-11

Derivative Classifier: ☒ Unclassified ☐ OUO ☐ UCNI ☐ Classified	Signature: Per Telecon Joseph Lowery by JPKonz	Z#: 085697	Date: 1/28/11

Section 5– Final Approvals

☒ Release ☐ Hold Details:

Responsible Manager Signature:	Print Name, Title:	Z#:	Date:
Steve Henry	Steven Henry, FOD-9	219172	1/28/11