DOE-EA -1269

Decontamination and Volume Reduction System for Transuranic Waste at Los Alamos National Laboratory, Los Alamos, New Mexico Environmental Assessment

Final Document

Date Prepared: June 23, 1999

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TABLE OF CONTENTS

TABLES

FIGURES

ACRONYMS AND TERMS

AED	*aerodynamic equivalent diameter*
AMAD	*aerodynamic mean average diameter*
ARF	*airborne release fraction*
CEDE	*committed effective dose equivalent*
Ci	*curie*
DOE	*Department of Energy*
DR	*damage ratio*
DVRS	*decontamination and volume reduction system*
EA	*environmental assessment*
EIS	*environmental impact statement*
ESH	*environment, safety, and health*
FRP	*fiberglass-reinforced plywood*
gal.	*gallon*
HEPA	*high-efficiency particulate air*
in.	*inch*
ft	*feet or foot*
kg	*kilogram*
km	*kilometer*
L	*liter*
LANL	*Los Alamos National Laboratory*
LCF	*latent cancer fatality*
LLW	*low-level radioactive waste*
LPF	*leak path factor*
m	*meter*
m^3	*cubic meter*
MACCS2	*MELCOR Accident Consequence Code System version 1.12*
MAR	*material-at-risk*
MEOI	*maximally-exposed off-site individual*
mi	*mile*
mi^2	*square mile*
mrem	*millirem*
MW	*mixed waste*
NDA	*non-destructive assay*
NEPA	*National Environmental Policy Act*
NRC	*Nuclear Regulatory Commission*
PE	*plutonium equivalent*
PRAs	*Probabilistic Risk Assessments*
psi	*pound per square inch*
RAM	*radiation air monitor*
RCRA	*Resource Conservation and Recovery Act*
rem	*roentgen equivalent man*
RF	*respirable fraction*
ROD	*record of decision*
SAR	*safety analysis report*
Sv	*Seivert(s)*
TA	*technical area*
TRU	*transuranic*
TRUPACT	*Transuranic waste package transporter*
μ	*microns*
μm	*micro meter*
WIPP	*Waste Isolation Pilot Plant*
WIPP SEIS	*Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*

EXPONENTIAL NOTATION: Many values in the text and tables of this document are expressed in exponential notation. An exponent is the power to which the expression, or number, is raised. This form of notation is used to conserve space and to focus attention on comparisons of the order of magnitude of the numbers (see examples):

1×10^4	=	10,000
1×10^2	=	100
1×10^0	=	1
1×10^{-2}	=	0.01
1×10^{-4}	=	0.0001

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EXECUTIVE SUMMARY

The Proposed Action is to reduce the volume of oversized metallic transuranic (TRU) wastes at Los Alamos National Laboratory (LANL) that would require disposal at the Waste Isolation Pilot Plant (WIPP) by using a decontamination and compaction process. The proposed process, called the decontamination and volume reduction system (DVRS), would be implemented within an existing structure at the Department of Energy's (DOE's) solid radioactive waste storage and disposal area located at Technical Area (TA) 54. The preferred location is Dome 226. Other equivalent locations would be Domes 229, 230, and 231, adjacent to Dome 226, or a pre-engineered structure that would be placed adjacent to Dome 226.

The proposed DVRS would provide the capability to process and dispose of approximately 3,120 yd^3 (2,400 m^3) of oversized metallic TRU waste currently in storage at TA-54 within a substantially reduced operating period. The majority of this oversized metallic TRU waste, which is currently too big to fit into the approved waste containers used for the WIPP Project, would be sorted, segregated, and decontaminated to meet low-level radioactive waste (LLW) criteria, and then compacted and disposed of on-site as LLW. The remainder of the oversized metallic TRU waste, which cannot be sufficiently decontaminated to meet LLW criteria, would be cut up and compacted to fit into the WIPP-approved waste containers, packaged, and shipped as TRU waste to WIPP. In addition to the existing inventory of oversized metallic TRU waste, the proposed DVRS would also be able to process an additional 3,900 yd^3 (3,000 m^3) of oversized metallic TRU waste that may result from on-site decontamination and decommissioning activities and equipment replacement at other LANL facilities. The DVRS is expected to process the total estimated 7,020 yd^3 (5,400 m^3) of oversized metallic TRU waste in about six years.

The proposed construction and implementation of the DVRS at LANL would provide DOE with a low-risk, high-benefit opportunity to implement previously used technology (a similar unit has been used at Erwin, Tennessee) to dispose of LANL's oversized metallic TRU waste in an environmentally safe manner. In line with the DOE TRU Waste Management Plan for LANL (LANL 1996), the DVRS would enable DOE to accelerate cleanup objectives while achieving substantial cost savings.

Environmental effects under either the Proposed Action or the No Action alternative would be minimal. On average, worker doses would remain well below allowable DOE limits for the Proposed Action. Worker doses could be higher under the No Action alternative but should also remain well below DOE limits. The volume of TRU waste sent to WIPP for disposal would be reduced from 7,020 yd^3 (5,400 m^3) to 442 yd^3 (340 m^3) under the Proposed Action.

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1.0 PURPOSE AND NEED FOR AGENCY ACTION

1.1 Introduction

The *National Environmental Policy Act of 1969* (NEPA) (42 U.S.C 4371 *et seq.*) requires federal agencies to consider the environmental consequences of their proposed actions before decisions are made. Analysis of agency considerations is documented, for the purpose of public participation, in environmental impact statements (EISs) and environmental assessments (EAs). The Department of Energy (DOE) complies with both the Council on Environmental Quality regulations (40 Code of Federal Regulations [CFR] 1500-1508) and NEPA.

In accordance with the Council on Environmental Quality regulations, DOE implemented its own internal agency procedures for compliance with NEPA (10 CFR 1021). DOE may prepare an EIS or an EA for a DOE proposed action, or, when appropriate, it may categorically exclude the action from the need to prepare either document when appropriate. In preparing an EA, DOE analyzes potential impacts of the proposed action on the environment and develops sufficient evidence to determine whether to prepare an EIS or issue a Finding-of-No-Significant-Impact.

In this EA, DOE is analyzing the construction and operation of a decontamination and volume reduction system (DVRS) for the decontamination and volume reduction of transuranic[1] (TRU) radioactive waste at Los Alamos National Laboratory (LANL) in Los Alamos, New Mexico. This EA (1) analyzes the baseline environmental conditions at the proposed DVRS site location; (2) analyzes the potential effects to the existing environment from construction and operation of the DVRS; and (3) compares the effects of the Proposed Action to the No Action alternative. In addition, the EA provides DOE with environmental information that could be used in developing possible actions to mitigate, minimize, or avoid impacts to the integrity of the human environment and natural ecosystems should DOE decide to proceed with construction and operation of the DVRS. Ultimately, the goal of NEPA and this EA is to aid DOE officials in making decisions based on understanding of the environmental consequences that could result from the implementation of proposed actions.

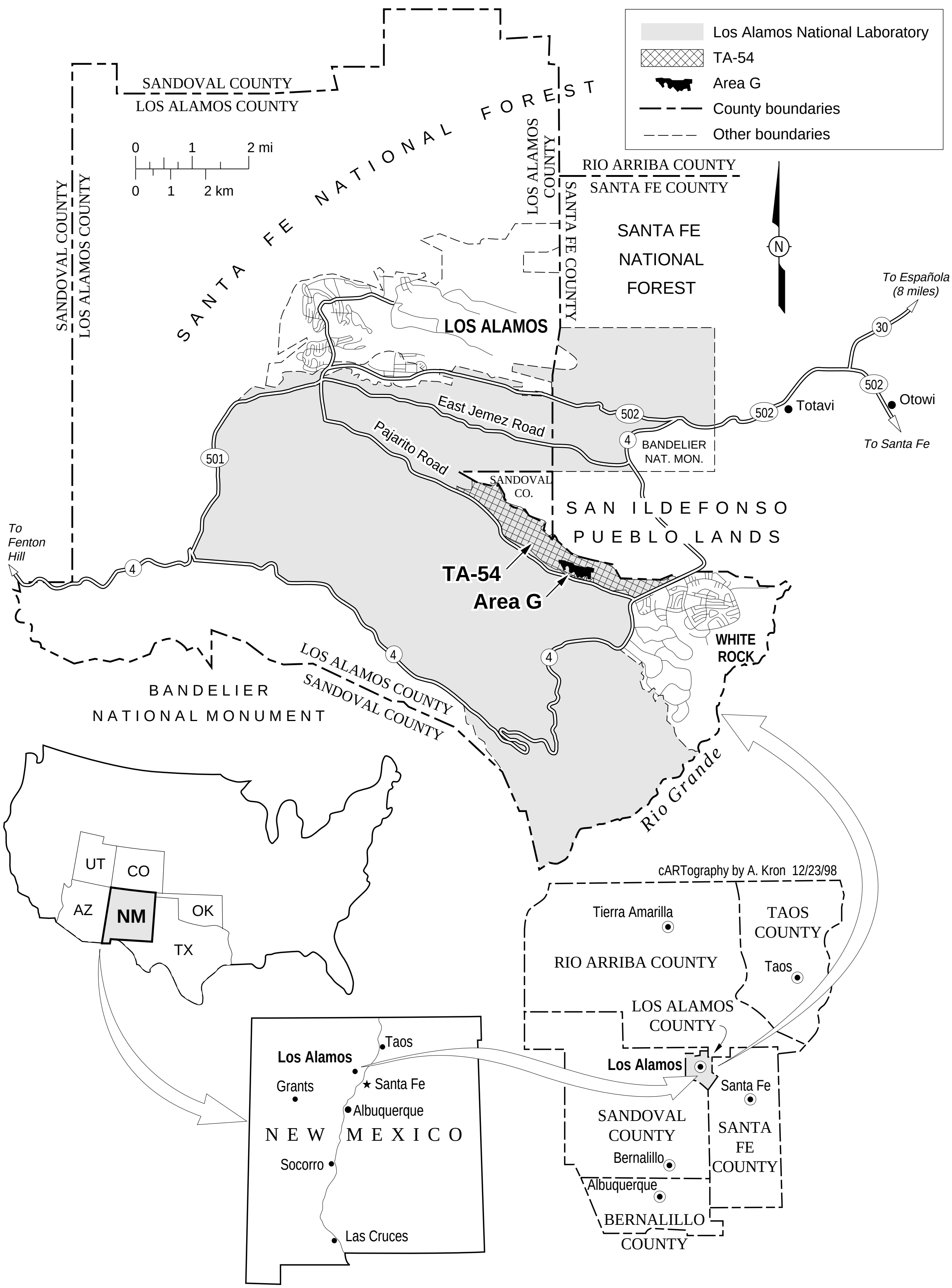
1.2 Background

In January 1998, DOE issued its Record of Decision (ROD) for the disposal of DOE-generated TRU waste at the WIPP site (DOE 1997b). It was supported by the *Waste Isolation Pilot Plant (WIPP) Disposal Phase Final Supplemental Environmental Impact Statement* (WIPP SEIS). Later the same month, DOE also issued its ROD for the treatment and storage of TRU waste pursuant to the *Final Waste Management Programmatic Environmental Impact Statement* (DOE 1997a). This ROD stated DOE's decision to store and treat TRU waste at LANL pending its disposal at WIPP, and the intention to develop and operate mobile and fixed facilities to characterize and prepare TRU waste for disposal at WIPP.

There are currently about 3,120 cubic yards (yd^3) (2,400 cubic meters [m^3]) of large metallic TRU waste in storage at Technical Area (TA-) 54, Area G, at LANL (Figure 1). These metallic wastes are too big to fit into the WIPP-approved waste shipment containers (the metallic wastes are "oversized" for the intended shipment containers). Some of the items that make up these oversized metallic TRU wastes are discarded gloveboxes, broken or non-usable equipment, and pieces of ventilation ductwork. These large

[1]Transuranic waste is waste contaminated with alpha-emitting radionuclides of atomic number greater than 92 (e.g., the radioactive isotopes of plutonium), with half-lives generally greater than 20 years, and present in concentrations greater than 100 nanocuries per gram of waste (DOE 1997a).

Figure 1. Location of LANL's Material Disposal Area G



metallic waste objects were placed inside fiberglass-reinforced plywood (FRP) boxes for storage at LANL until a disposal site could be identified by DOE. Some of these boxes are over 20 years old and have undergone, in some cases, long-term unprotected exposure to the weather. Some of the storage boxes now exhibit noticeable effects from weathering, for example, wood decay and delamination of the plywood. None of the boxes have lost their structural integrity as of the date of publication of this document, but if this were to happen in the future, wastes could be directly exposed to the elements.

To dispose of these oversized metallic TRU wastes at WIPP, one of the following would be required: (1) the wastes would have to undergo size reduction before packaging in the existing WIPP-approved waste containers (also known as "TRUPACT-II" containers), or (2) larger TRUPACT-IIs would need to be developed to contain the wastes for shipment purposes. Pursuing option (2) would be very costly and time consuming for the Department, and there are currently no plans for DOE to do so. DOE anticipates that an additional 3,900 yd^3 (3,000 m^3) of oversized metallic TRU waste may be generated at LANL by facility upgrades (i.e., replacement of old equipment) and facility decontamination and decommissioning activities.

1.3 Purpose and Need for DOE Action

DOE needs to manage its existing oversized metallic TRU waste inventory at LANL in a safe, environmentally appropriate, and fiscally responsible manner. The existing inventory of oversized metallic TRU wastes at LANL currently resides in wooden boxes that continue to deteriorate. DOE needs to take action now at LANL to address the identified storage container deficiencies of the oversized metallic TRU waste inventory. In taking action, DOE must do so pursuant to its recent complex-wide RODs for TRU waste management, treatment, and disposal at DOE sites. To meet the applicable waste acceptance criteria at WIPP, the oversized metallic wastes at LANL must be reduced in size and placed into the proper containers. The existing and anticipated inventory of oversized metallic TRU waste at LANL makes this facility a prime candidate for an efficient waste size reduction system to facilitate the ultimate disposal of oversized metallic TRU waste at WIPP in accordance with the *Final Waste Management Programmatic Environmental Impact Statement* (DOE 1997a) ROD issued in January 1998.

1.4 Scope of this Environmental Assessment

This DVRS EA considers the potential effects of constructing and operating a system of TRU waste decontamination and volume reduction for waste requiring shipment and disposal at WIPP. The DVRS would, through decontamination efforts, allow certain waste items to be reclassified from TRU wastes to low-level radioactive waste [2] (LLW), which could then be disposed of at the existing LLW disposal area at TA-54. The TRU wastes that could not be reclassified through decontamination efforts would still require disposal at WIPP. Both the resulting LLW and remaining TRU waste streams would be sheared into small pieces and then compacted into very small volumes by a combination shearer and baler machine. The DVRS equipment would be constructed in such a way that it could be decontaminated, dismantled, and moved from LANL to other DOE sites, or be processed into LLW and disposed of at LANL at the end of its usefulness to DOE.

A "sliding-scale" approach, following DOE Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements (DOE 1993), is the basis for effects analysis in this EA. That is, certain aspects of the Proposed Action have a greater potential for creating adverse

[2]LLW is waste that contains radioactivity and is not classified as high-level waste, TRU waste, spent nuclear fuel, or tailings from the milling of uranium or thorium ore. LLW may include test specimens of fissionable material irradiated for research and development purposes only, and not for the production of power or plutonium, provided that the material's concentration of TRU isotopes is less than 100 nCi/g (DOE 1997a).

environmental effects than others; they are discussed in greater detail than those aspects of the action that have little potential for effect. For example, in this EA, routine operations[3] are given less coverage than the postulated accidents because routine operations are expected to have minimal environmental effects.

When details about a Proposed Action are incomplete, a "bounding" analysis is often used to assess potential effects. When this approach is used, reasonable maximum assumptions are made regarding the input parameters needed for the modeling of the Proposed Action scenario. Such an analysis usually provides an overestimation of potential effects. In addition, any future actions that exceed the assumptions ("bounds") of the effects analysis would not be allowed until an additional NEPA review could be performed and a decision to proceed with that action(s) is then made. This approach was taken in the accident analysis to maximize the potential effects for evaluation purposes.

1.5 Public Involvement

DOE provided written notification of the initiation of this project's NEPA review to the State of New Mexico Environment Department, the four Accord[4] Pueblos (San Ildefonso, Santa Clara, Jemez, and Cochiti Pueblos), and the Mescalero Tribe. This predecisional draft EA has been made available to the public for review through placement in DOE Public Reading Rooms in Los Alamos and in Albuquerque, New Mexico. The predecisional draft may also be accessed electronically through the World Wide Web Internet system at http://tis.eh.doe.gov/nepa, or, upon request, a hard copy of the document may be obtained by contacting Elizabeth Withers, Los Alamos Area Office NEPA Compliance Officer, at (505) 667-8690.

2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

This section describes the Proposed Action and No Action alternative and discusses alternatives that were considered but dismissed from further analysis. The No Action alternative is analyzed as a baseline to compare with the consequences of implementing the Proposed Action.

2.1 Proposed Action

DOE proposes to reduce LANL's volume of oversized metallic wastes contaminated with TRU residues that require disposal at WIPP by using a decontamination and compaction process. This process would be modeled after an existing system used at a commercial facility in Erwin, Tennessee, for decontamination and volume reduction of similar wastes.

The proposed process would first unpackage, separate, and decontaminate the oversized metallic TRU waste. The decontamination process, using various mechanical means (including a high-pressure wash), would result in most of the TRU waste being decontaminated so that it then could be classified as LLW. This would serve to minimize the amount of TRU waste requiring disposal at WIPP while marginally adding to the amount of LLW requiring disposal at LANL. The system would then reduce the volume of the resulting streams of both LLW and TRU waste through shearing and compaction. As proposed, this

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[3] Routine operations when done according to approved procedures would not result in excessive increases in emissions, waste volumes, or worker doses.

[4] Accord refers to the written agreements signed by DOE and the four Pueblos on December 8, 1992, stating the basic understanding and commitments of the parties and describing the general framework for working together. Subsequently, cooperative agreements between each Pueblo and DOE, and between each Pueblo and the University of California have been signed, which specify further details related to the accord agreements.

two-part process would effectively separate existing oversized metallic TRU waste into two components: a compacted LLW that would meet the acceptance criteria for on-site disposal at LANL's Area G; and a compacted TRU waste that would meet the acceptance criteria for disposal at WIPP. Based on industry experience, more than 75 percent (approximately 2,340 yd^3 [1,800 m^3]) of the oversized metallic TRU waste currently stored at LANL could be reclassified as LLW, and the volume of this LLW would be reduced by a factor of greater than four to one through compaction to less than 585 yd^3 (450 m^3) of LLW from 2,340 yd^3 (1,800 m^3) of what had been classified as TRU waste. Thus, only about one-fifth of the original volume of the oversized metallic TRU waste would remain in the form of LLW for on-site disposal. The remaining oversized metallic TRU waste (about one-fourth of the original volume of the oversized metallic TRU waste) would then be repackaged, certified for disposal, and relocated to WIPP. In addition, this process would enable all 7,020 yd^3 (5,400 m^3) of LANL's current and projected oversized metallic TRU wastes to be disposed of in about 6 years as opposed to the 17 years anticipated in the current DOE TRU Waste Management Plan (LANL 1996).

The oversized metallic TRU wastes at TA-54 consist of gloveboxes, broken or non-usable equipment, pieces of ventilation systems, and other large metallic objects that have been placed inside FRP boxes. These boxes vary in size from about 4 ft by 4 ft by 8 ft (1.2 m by 1.2 m by 2.4 m) up to about 10 ft by 10 ft by 40 ft (3 m by 3 m by 12 m), depending upon their contents. Because many of these boxes are over 20 years old and were, at one time or another, stored with little or no protection from the elements, their structural integrity is starting to deteriorate (e.g., the boxes show some signs of aging but are still intact). Therefore, best management practices dictate that these wastes either be processed and disposed of in the near future or repackaged into new containers.

Under the Proposed Action, a fully integrated (e.g., all operations and equipment contained in one unit) DVRS would be constructed within a modular containment system structure inside Dome 226 (the preferred location) or one of the other existing adjacent domes at TA-54 in Area G at LANL, or in a pre-engineered structure that would be placed adjacent to Dome 226. The DVRS Process is described in detail in the following text, including the facilities that would house the DVRS and all of its components.

2.1.1 Facility Description

The proposed DVRS operations would be performed in Dome 226 (or one of the other alternative domes: 229, 230, or 231, or in a pre-engineered structure that would be placed adjacent to Dome 226). The selected dome or pre-engineered structure would be used exclusively for DVRS operations. Only operations and storage materials associated with the DVRS operations would be located in the selected dome or structure. The selected dome or structure would function to contain the majority of the equipment and processes involved in the DVRS operations, provide ventilation, and provide weather protection for the equipment and the personnel. The inventory of oversized metallic waste that would be processed through the DVRS is presently stored in these dome structures.

The domes are located at the eastern end of TA-54, Area G (Figure 2). These domes have been constructed to meet the performance goals specified in DOE-STD-1020-92, Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities, for performance criteria 2 structures. All domes are equipped with lightning protection; Dome 226 is already equipped with a ventilation system. Air is exhausted through a filtration system that includes a high-efficiency particulate air (HEPA) filter, and an exhaust stack. Stack monitoring would be provided in accordance with environment, safety, and health (ESH) requirements.

Should the pre-engineered structure be selected, a concrete pad would be poured immediately adjacent to the concrete pad already in place beneath Dome 226. The pre-engineered structure would be placed onto the concrete pad. The existing ventilation system in Dome 226 would be modified to provide ventilation

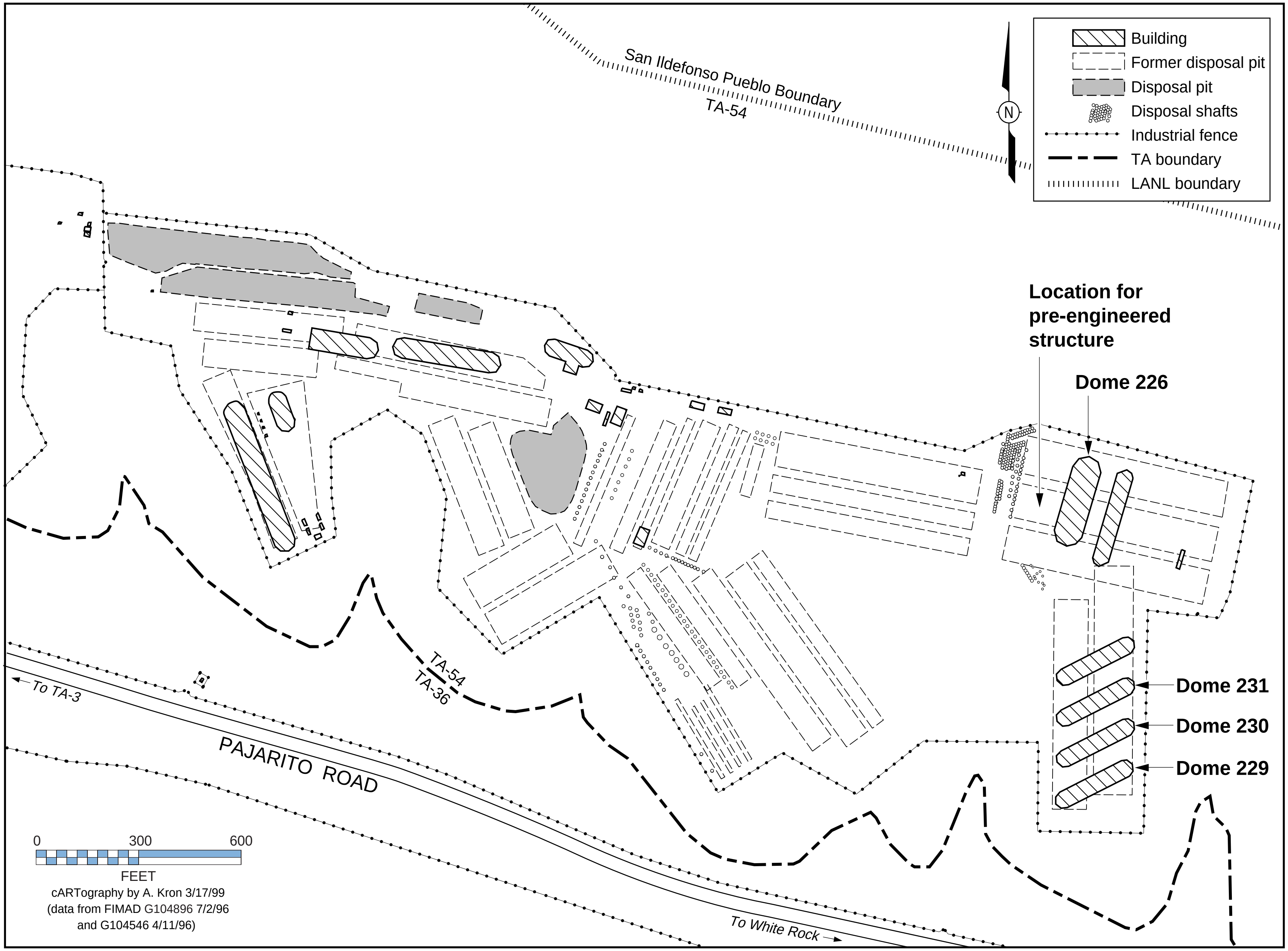


Figure 2. Location of Dome 226 at LANL's Material Disposal Area G.

for the pre-engineered structure. The pre-engineered structure would be constructed to meet the performance goals specified in DOE-STD-1020-92, Natural Phenomena Hazards Design and Evaluation Criteria for DOE Facilities, for performance criteria 2 structures.

2.1.2 Modular Containment System Structure

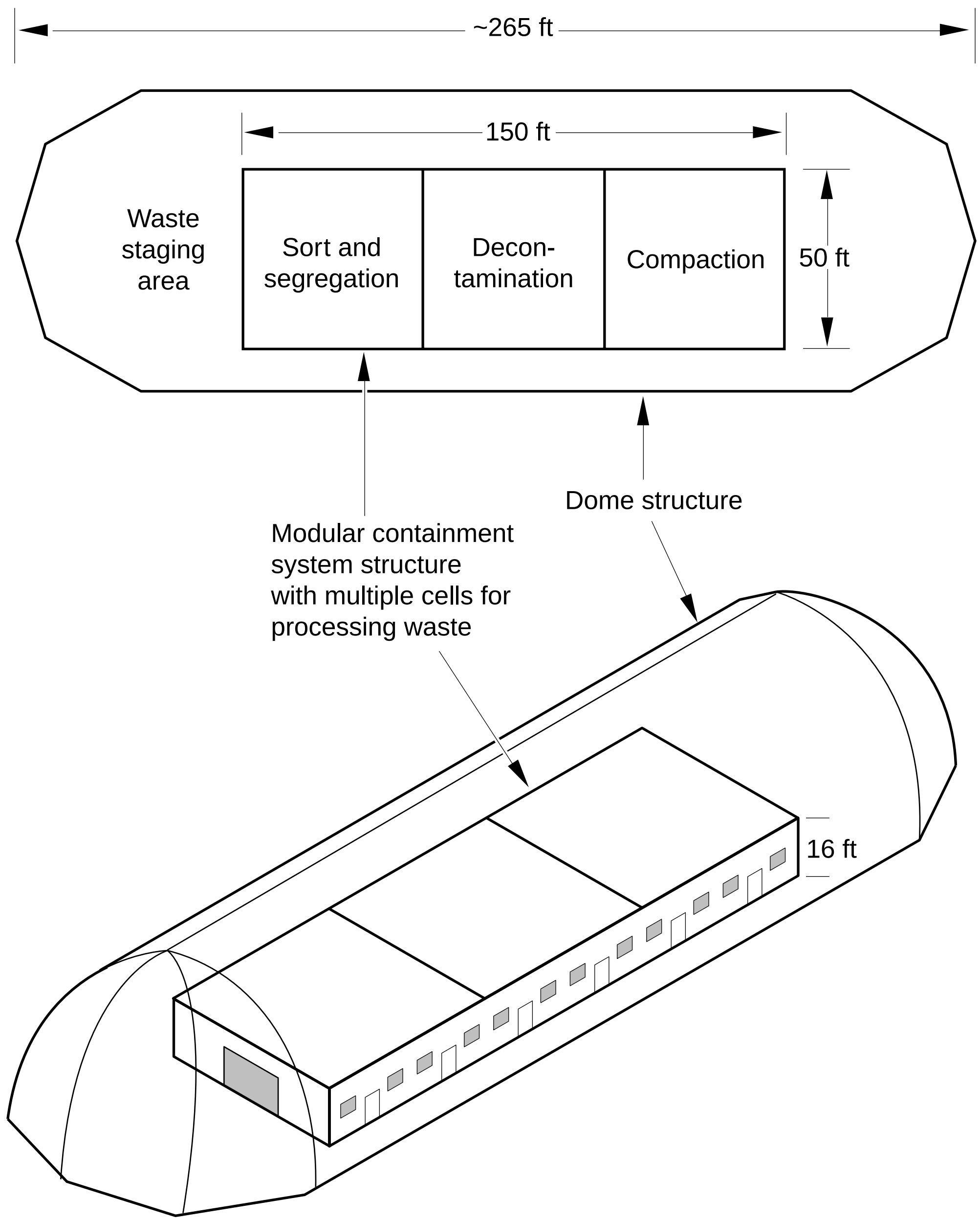
The DVRS, consists of a modular containment system that would be constructed entirely within the selected dome or pre-engineered structure (Figure 3). There would be three individual cells to the modular containment system structure, each used for a specific function of the DVRS operation. The cells would be equipped with personnel doors as well as large roll-up doors so that people, equipment, and material could access the structure and move from one chamber to the other. Each cell would have additional access ports for pneumatic tool air hoses. Negative ventilation air pressure would be maintained throughout the structure with discharge through a multi-stage HEPA-filtered stack. The entire modular containment system structure would be about 150 ft long by 50 ft wide by 16 ft high (45 m long by 15 m wide by 5 m high). It would sit on an above-grade, concrete floor.

One cell would be used to sort and segregate the waste and would contain various hand-operated tools to assist in dismantling the wooden crates. A second cell would be used for decontamination and would contain an ultra-high-pressure water system. Approximately 30 gal. (114 L) of water at a time would be needed for the ultra-high-pressure water system. The entire ultra high-pressure water system would be designed so that any radioactive contamination in the water system could not reach a critical mass. Wash water would be collected, processed through a series of filters (25 microns to 0.5 microns), then passed through ion-exchange columns and filtration polymers before being recirculated for reuse. A radiation area monitoring (RAM) system would constantly monitor the plutonium levels within filtration units and throughout cells 2 and 3 to ensure criticality control and operator safety. The RAM would provide notification when filters or the water in the system need to be changed. In addition to the protection provided by the RAM, facility limits and administrative controls would ensure safe working conditions. The third cell would be used to compact and package the decontaminated waste. It would contain a shearer and baler, a compacting machine similar to a car crusher. It would provide 377 tons of shear capability and 180 tons of compaction force. It could accept waste items of a size less than 6 ft by 6 ft by 12 ft (1.8 m by 1.8 m by 3.6 m), which will accommodate most waste gloveboxes, duct pieces, etc., into its loading hopper. It would shear and compact the waste item and deliver a 16-in. (41-cm) -diameter compacted cylindrical metallic mass (called a “puck”) of variable thickness, typically between 3 and 5 in. (7.6 and 12.7 cm), because thicker pucks would be too heavy for personnel to easily handle. The entire shearer-baler would be constructed to contain radioactive particulates: shearing and baling would take place within a tightly sealed compartment.

2.1.3 DVRS Process

The proposed DVRS process would consist of a non-destructive assay (NDA) system that would determine the residual levels of contamination on the waste items, a RAM system that would monitor radiation levels within cells 2 and 3, a decontamination system that would be used to reduce the amount of surface contamination on the metallic objects, a high-capacity shearer that would cut the metallic objects into smaller pieces, and a baler that would compact those pieces into pucks that would fit neatly into waste disposal containers such as 55-gal. (209-L) drums. About five people would be required to run the process; all workers would adhere to radiological work permit requirements for personal protection equipment. These persons would operate machinery and equipment, change filters, read and interpret information displayed by monitors and computers, keep records of the waste stream, handle waste both remotely and directly, and move around within the dome and the cells of the modular containment structure. Detailed descriptions of each step in the process follows and is illustrated by Figure 4.

Figure 3. Modular Containment Facility Depicted Inside of a Dome Structure



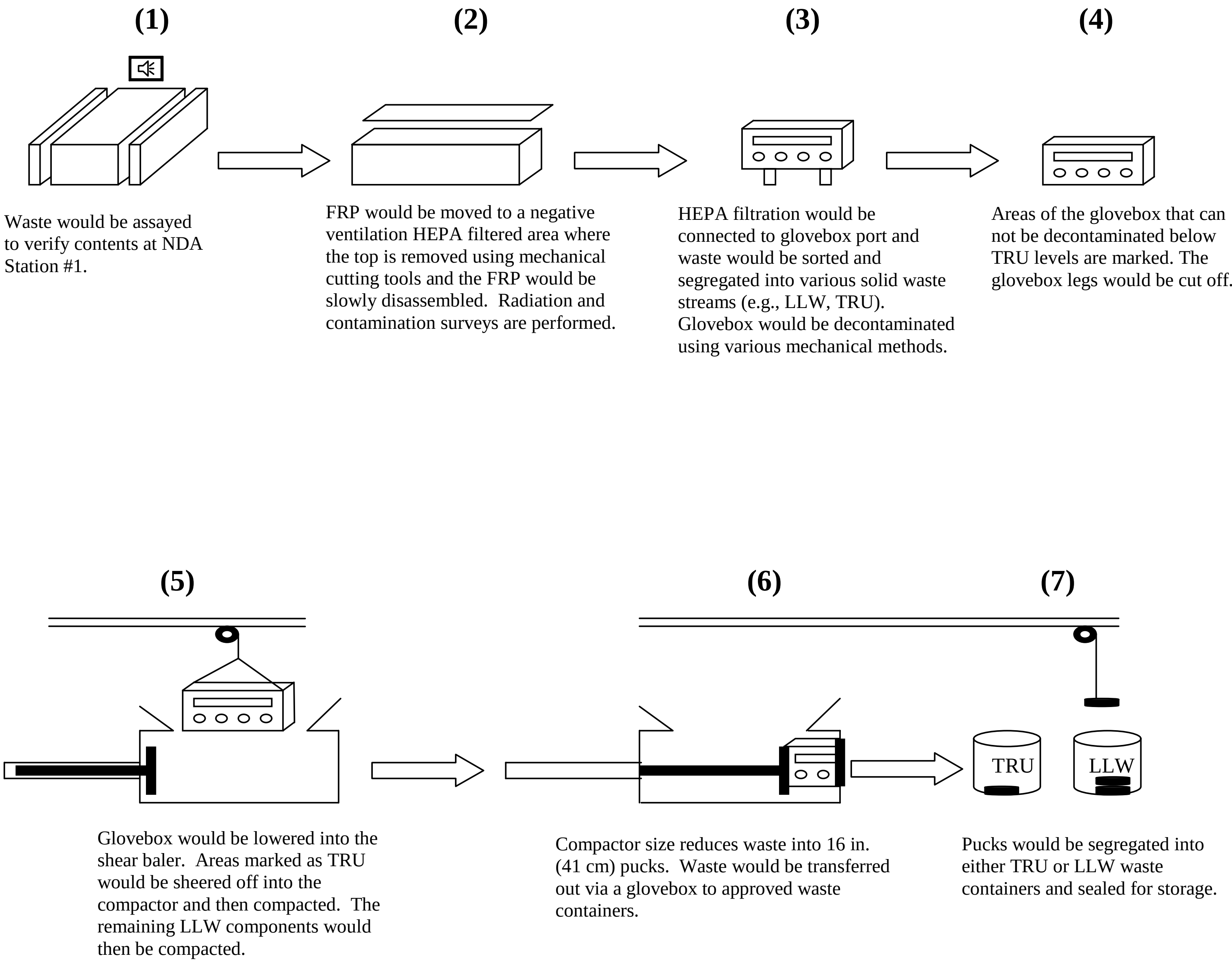


Figure 4. DVRS Flow Path

Currently, the waste boxes are stored in Dome 230 at TA-54, Area G. Step one in the process would be to assay boxes in their current location using the two portable passive NDA neutron detectors (slab monitors). NDA systems do not require sample preparation and they do not invade the system in any way. These systems would measure neutrons and isotopic information that allows derivation of quantities of TRU radioactive materials in each box and would locate any spots within the boxed equipment where radioactive residue was concentrated or elevated. These assays, conducted on the sealed boxes, would provide general information to the workers so they would know if the equipment contained within the box was just slightly contaminated, highly contaminated, or contaminated just in a spot or two.

Some waste boxes may contain oversized metallic waste wrapped or packaged in material that may be combustible, plus other miscellaneous items such as small parts or small amounts of soil that would be inappropriate for further decontamination and volume reduction. Combustible materials would be assayed, repackaged, and disposed of along with the FRP (described under step 2 in a subsequent paragraph). Small parts and soil would be assayed, repackaged, and placed into the appropriate waste stream. For example, if the small parts met LLW disposal criteria for Area G, then they would be disposed of at Area G. If they were characterized as TRU waste, they would be packaged for shipment to WIPP.

At step 2, a few boxes at a time would be loaded onto a forklift, transported to the selected dome or pre-engineered building, and placed inside the sort and segregation cell. The box would be taken apart using standard mechanical cutting tools (pneumatic or electrically powered). Radiation contamination surveys would be performed the entire time. If necessary, fixatives would be applied to control any loose radioactive surface contamination. Tools would be equipped with filtered suctions to contain wood dust and particles generated during the cutting process. Wastes would be assayed when disposed of according to applicable regulations. The disassembled boxes would be removed from the dome and disposed of as LLW at TA-54, Area G. Some metallic items inside the boxes have lead components. Lead would be removed and transferred to the lead-recycling program already in place at LANL.

Step 3 would move the waste item from the sort and segregation cell into the decontamination cell using a forklift, hoist, or crane. A localized ventilation system with HEPA filters would be applied to the waste item where possible. If the item were a glovebox, then the ventilation system could be directly attached to the glovebox. If the item were something else, then a hose or duct connected to the ventilation system would be held as close as possible to the item or the specific area of the item being worked on. The item would then be washed with ultra-high-pressure water or by hand using rags, scrubbers, brushes, and a standard cleaning solution.

In step 4, the item would be transferred to the compaction and packaging cell to be prepared for shearing and baling. Any areas of the item where TRU levels of contamination could not be removed would be marked. If the item were a glovebox, the legs would be cut off and segregated as LLW. Step 5 would be the shearing stage, controlled by a human operator. The item could be sheared off at different levels, similar to slicing a loaf of bread. Each slice would be either classified as LLW or TRU waste so that the resulting puck would be either LLW or TRU waste. The operator would know just how far to lower the item into the shearer because the areas containing TRU waste contamination would have been clearly marked in the previous step. Additionally, the operator would control the size of the slices so that the resulting puck would be less than 5 in. (12.7 cm) thick.

Step 6 would be the compacting stage. As a slice is sheared off, it would be pushed into the compactor where it would be compressed into a 16-in. (40.6-cm) -diameter puck. The puck would be passed from the compactor to a glovebox where it would be placed into a drum awaiting final characterization. The final step, 7, would be to place the pucks into either a TRU waste or LLW container such as a 55-gal. (209-L) drum, as appropriate. Based on final characterization, the waste containers would be sealed when full and placed into storage at TA-54 pending shipment to WIPP, or disposed of at the LLW disposal facility at TA-54, Area G.

2.1.4 Construction Activities

The Proposed Action may involve pouring a concrete pad and placing a pre-engineered structure on it, but probably would involve only minor modifications to an existing facility. These modifications are estimated to include the installation of the modular containment structure within the selected dome, modification of the existing ventilation system (in Dome 226, or installation of ventilation system if one of Domes 229, 230, or 231 were selected) to allow for connection to the modular containment structure and associated gloveboxes, installation of a breathing air system, installation of a compressed air system, installation of the prefabricated combination shearer and baler, and modification of existing utilities to support the DVRS. If the pre-engineered structure was selected, a concrete pad would be poured immediately adjacent to the concrete pad already in place under Dome 226. The pre-engineered structure would then be placed on the concrete pad.

2.1.5 Waste Shipment

No additional on-site or off-site shipment of waste would be required by the Proposed Action except for the disposal of the small amount of anticipated secondary wastes generated by this process. The secondary wastes would consist of those materials used in or resulting from stations of the decontamination process and are process dependent. If mechanical decontamination processes were used, secondary wastes would be rags, brushes, etc., with a total anticipated volume of 26 yd^3 (20 m^3). If an ultra-high-pressure wash were used, secondary wastes would primarily be water with an anticipated volume of less than 120 gal. (456 L) and 39 yd^3 (30 m^3) of water filters as TRU waste. Two hundred fifty-four yd^3 (195 m^3) of HEPA filters would be appropriately disposed of in accordance with applicable regulations. This waste volume estimate assumes that LANL would process both the current inventory (7.020 yd^3 [5,400 m^3]) plus anticipated decontamination and decommissioning wastes (3,900 yd^3 [3,000 m^3]).

2.1.6 Future Uses of the DVRS

At the completion of the proposed project (e.g., when LANL’s current inventory and project wastes totaling about 7,020 yd^3 [5,400 m^3] of oversized metallic TRU wastes have been processed), the DVRS may be dismantled, decontaminated, crated, and moved to another DOE site away from LANL or processed into LLW and disposed of on-site. The DVRS could even be decommissioned before any decontamination and decommissioning wastes (3,900 yd^3 [3,000 m^3]) were treated. The actual final disposition of the DVRS facility and the required NEPA compliance review(s) to implement such actions would be determined at that time.

2.2 No Action Alternative

The No Action alternative provides an environmental baseline against which to compare the potential effects of the Proposed Action. In addition, DOE is required by law to include a No Action alternative. In 10 CFR 1021.321(c), it states that “DOE shall assess the No Action alternative in an EA, even when the proposed action is specifically required by legislation or a court order.”

Under the No Action alternative, LANL would either size reduce (i.e., cut up) the oversized metallic TRU wastes and repackage the items for ultimate disposal at WIPP or store them indefinitely on-site. All packages small enough to be handled by the existing size reduction facility at TA-50 would be transported to TA-50, size reduced, packaged as TRU waste, and returned to the storage area at TA-54, Area G until they could be shipped to WIPP. The remaining packages too large for compaction at the

TA-50 facility would continue to be stored at TA-54. The existing waste storage boxes are beginning to show signs of aging. Therefore, fabrication of "overpacks," into which the existing boxes and their contents could be placed to maintain safe storage, would be preferred. Alternatively, an approved facility could be built to unpack the aging waste storage boxes and repackage the oversized metallic TRU waste into new packages. The Nuclear Regulatory Commission (NRC) approved the TRUPACT-II container for shipping TRU waste to WIPP. The TRUPACT-II is not large enough to contain the oversized metallic TRU wastes currently stored at LANL. Therefore, until a larger container is designed, approved by the NRC, and manufactured, the oversized metallic TRU waste would remain in storage at LANL under the No Action alternative. If such a container became available, then the total volume of material (approximately 7,020 yd^3 [5,400 m^3]) would ultimately be shipped to WIPP with little or no volume reduction. With no reduction in volume, transportation costs and human health risks would be much greater than for the Proposed Action.

2.3 Alternatives Considered but Dismissed from Analysis

Three alternatives to the Proposed Action for managing the oversized metallic TRU wastes at LANL were considered but dismissed from analysis. These alternatives are discussed below.

2.3.1 Permanent Decontamination and Compaction Facility

DOE has a need to process and dispose of approximately 7,020 yd^3 (5,400 m^3) of oversized metallic TRU waste that is either in storage or is anticipated to result from on-site decontamination and decommissioning activities at LANL. Once this oversized metallic TRU waste has been processed (about six years), no additional oversized metallic TRU wastes would be routinely generated. At this time the facility would no longer be needed. Since there is no need for the DVRS facility after all wastes have been processed, a temporary facility is sufficient to meet the DOE's Purpose and Need. Therefore, the construction and operation of a permanent facility is not analyzed in this EA.

2.3.2 Off-Site Processing

Off-site processing would require the shipment of TRU wastes in NRC-approved containers. The TRUPACT-II is the largest container approved by the NRC that is available currently for shipping TRU wastes. LANL's oversized metallic TRU wastes do not fit within the TRUPACT-II. There are no plans to develop a larger container. Based on NRC experience and requirements for developing hazardous material shipping containers, it could take many years to develop a new TRU waste shipping container. LANL's wastes could not be shipped off-site for processing for many years. This alternative would not satisfy DOE's Purpose and Need, therefore, it was dismissed from further analysis.

2.3.3 On-Site Location - Not Area G

Construction and operation of the proposed DVRS at a location within LANL, but not at TA-54, was considered but dismissed. Although this alternative would meet DOE's stated purpose and need for action, it was dismissed because no other facility had the available infrastructure to support the DVRS process. In addition, modification of infrastructure at another location would not be justified (e.g., permits, access control, storage, etc.) because of the limited duration (about six years) of the proposed project.

2.4 Other NEPA Documents

On-site shipment of TRU waste from decontamination and demolition projects at LANL was analyzed in the Site-Wide EIS (DOE 1979) and covered by the subsequent ROD; it has also been analyzed in the new

LANL Site-Wide EIS recently issued (DOE 1999). Future shipments to WIPP of LANL TRU waste was analyzed in the WIPP SEIS (DOE 1997b) and covered by the subsequent SEIS ROD.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

The Proposed Action would take place within an existing structure (Dome 226 is preferred but nearby Domes 229, 230, or 231 could also be used, or a pre-engineered structure could be placed adjacent to Dome 226) at TA-54 (Figure 2). Table 3-1 lists potential environmental issues and their applicability to this EA.

The radioactive waste storage and disposal area at LANL is Area G within TA-54 located on Mesita de Buey, a narrow southeast-trending mesa about 2.5 mi (4 km) long. Mesita del Buey is bordered by Cañada del Buey on the north and Pajarito Canyon on the south. San Ildefonso Pueblo land is located to the northeast of TA-54. The boundary between DOE land at TA-54 and San Ildefonso Pueblo land lies along the south edge of the top of the next mesa to the northeast of Cañada del Buey, an unnamed mesa south of Cedro Canyon. This boundary is about 650 ft (195 m) northeast of the edge of Cañada del Buey at Area G.

Area G is 5.2 mi (8.0 km) from Royal Crest Trailer Park, 1.0 mi (1.6 km) from White Rock, 4.2 mi (6.7 km) from Los Alamos, 3.2 mi (5.1 km) from Bandelier National Monument, and 0.13 mi (0.2 km) from San Ildefonso Pueblo lands. Although the distance to the nearest San Ildefonso Pueblo boundary is only 0.13 mi (0.2 km), this is not the distance to the nearest residential area at San Ildefonso. Distance to the nearest human habitation on Pueblo lands is 3.6 mi (5.8 km) at Totavi. The mesa top on San Ildefonso Pueblo lands nearest the DOE boundary may be used for other intermittent purposes, but no dwellings are located there.

Table 3-1. Potential Environmental Issues

Potential Issue	Applicability	Described in Section
Human Health	Yes	3.1
Waste Management	Yes	3.2
Air Quality	Yes	3.3
Environmental Justice	No (no off-site effects)	3.4
Environmental Restoration	NA (no change in status of Area G)	NA
Cultural Resources	NA (would be avoided)	NA
Land Use	NA (would be located within a previously developed area)	NA
Ecological Resources, Wetlands, Floodplains	NA (would be located within a previously developed area)	NA
Water Quality	NA (would generate only 120 gal. (456 L) of wastewater total to be treated at Rad Liquid Waste Treatment Plant)	NA
Aesthetics	NA (would be located within a previously developed area)	NA
Socioeconomics	NA (assembled quickly and operated by five persons)	NA
Noise Levels	NA (noise levels would fall within the range of noise due to existing operations at TA-54, Area G)	NA
Visual Resources	NA (would be located within a previously developed area)	NA

There would be essentially no increase in the environmental effects associated with the Proposed Action over routine Area G operations. The potential environmental consequences of the Proposed Action are expected to be less than those for the No Action alternative assuming the indefinite storage of oversized metallic TRU waste at LANL. The risks from worker exposures or releases to the environment would increase with management (e.g., inspection, inventory, testing, etc.) of wastes held in indefinite storage. Detailed descriptions of LANL's physical and socioeconomic environment, its climate, meteorology, hydrology, cultural resources, waste management, floodplains, wetlands, and threatened and endangered species are presented in the 1999 Site-Wide Environmental Impact Statement for Continued Operation of Los Alamos National Laboratory (DOE 1999) and the most recent Environmental Surveillance at Los Alamos during 1997 (LANL 1998).

3.1 Human Health

3.1.1 Radiological Dose and Risk

Since worker dose is not associated with any particular operation at Area G, is maintained at or below DOE administrative limits, and no additional workers would be needed to perform DVRS operations, the Proposed Action would not result in any increased radiation risks to workers above current operations under the No Action alternative. Radiation risks to workers under the No Action alternative could actually increase as a result of managing wastes (e.g., conducting inventories, repackaging, etc.) held for long-term storage.

In order to determine radiological dose, radiation is characterized as either penetrating (in reference to the human body) or non-penetrating. Penetrating radiation is generally associated with beta, gamma, x-ray and neutron radiation. Non-penetrating radiation is generally associated with alpha radiation. Under the Proposed Action, workers would be exposed to both penetrating and non-penetrating radiation.

Personnel at TA-54 are exposed to radiation from working with the various types of wastes. Personnel are not exclusively assigned to work only with one type of waste, so their doses represent an integration of exposures to all waste types. In 1995, of the 470 individuals working at Area G who were required to wear dosimetry badges, 408 received no dose. For the 62 workers who did receive a dose, the average dose was 18 mrem resulting in an individual chance of excess latent cancer fatality (LCF) of approximately 8 in a million or 8×10^{-6}. In 1996, out of 228 badged personnel, 213 had no dose. For the 15 workers who did receive a dose, the average dose was 38 mrem resulting in an individual chance of excess LCF of 1.9 in ten thousand or 0.00019. These doses are well below the DOE annual administrative occupational dose limit of 2,000 mrem, which represents an excess LCF of approximately 8 in ten thousand or 0.0008.

Based on past experience at Area G, it is estimated that the proposed DVRS operations would be performed by a base work force of five persons with a combined exposure of less than 500 mrem per year or an individual exposure of less than 100 mrem per person per year. If any individual achieved an accumulated exposure approaching the DOE administrative limit for workers of 2,000 mrem per year, they would be moved to a different assignment and a new person assigned to the team.

3.1.2 Accident Analysis

This EA documents the analysis of three hypothetical accident scenarios that have a reasonable chance of occurrence at the DVRS. The three accidents are a fire, an aircraft crash, and a spill or rupture of a crate. Based upon the analyses of potential accidents (Appendix A), no other potentially severe accidents are likely to occur (e.g., criticality). No excess LCFs (i.e., excess LCFs < 1.0) are expected from any accident scenario.

This accident analysis was performed in parallel with similar analyses done to modify the Safety Analysis Report (SAR) for TA-54 to accommodate operations anticipated under the Proposed Action.

The postulated accidents involve the release of radiological materials. Other potential radiological accident scenarios are possible such as a rupture of the Perma Con or dome structures during normal decontamination activities, pressurization of a container resulting from radiolytic decomposition, etc. However, the consequences from these accident scenarios are known to be “bounded” by (i.e., of less consequence than) the selected accidents.

The accidents chosen for analysis tend to represent an overestimate of risk because assumptions used in calculations were biased in the direction that is considered “conservative” or protective of human health. Additional details on the accident scenarios and methods employed, as well as details of the results, are provided in Appendices A–C.

Although possible toxic chemical releases were also considered, only lead is expected to be present in quantities that are large enough to justify consideration here. However, the physical form of the lead, metal as shielding, has a very low volatility and relatively low toxicity. Therefore, the effects from an exposure of a lead release are expected to be substantially lower than the three radiological accidents.

3.1.2.1 Scenario 1: Fire at DVRS Caused by Operational or External Events

Fires could be caused by operational activities such as cutting, grinding, electrical shorts, etc., or by external events such as lightning that ignites combustibles within the dome or DVRS system itself. In order for a fire to affect the radioactive material that would be handled or staged within the facility, not only must the above initiating events occur, but failure of the fire protection program (LIR 402-910-01.1 LANL Fire Protection Program) within the facility must occur. Using methods detailed in Appendix A, this type of accident would have, at worst, an estimated likelihood of occurrence of about once in 10,000 years (1×10^{-4} per year), which is considered to be a “very unlikely event.”

Consequences for the accidents were estimated as the “50-year committed effective dose equivalent (CEDE),” in rem, to a maximally-exposed off-site individual (MEOI) member of the public and to individuals at several other locations including the individual nearest to the DVRS and the nearest downwind individual (Appendix C).

Radiation doses to DVRS workers involved in potential accident scenarios have not been estimated because workers would be wearing protective clothing and would be alerted to evacuate in the event of an accident. Therefore, the MEOI is used to evaluate accident doses because it represents the bounding case dose to either nearby workers or members of the public.

The consequences, detailed in the appendix, were computed assuming the worst possible physical form of radiological material, i.e., the most dispersible, and the highest amount of radiological material-at-risk (MAR) that can be acted upon by the energetic forces of the accident. Therefore, the resultant estimate of consequences are relatively “conservative” in that they overestimate any likely consequence. The MEOI dose consequence was estimated as 0.086 rem (Appendix C), which equates to a calculated risk of an excess LCF of 4.3 in one hundred thousand or 4.3×10^{-5}. A CEDE of 0.086 rem is not expected to cause adverse health effects, disability, or lost work time.

3.1.2.2 Scenario 2: Aircraft Crash into DVRS

Although the airspace above LANL is considered “restricted,” this scenario is based on a postulated accident whereby an aircraft flying towards or away from the Los Alamos County Airport strays from its intended course, crashes into the DVRS facility, and causes a fire or explosion. The likelihood or chance of this accident occurring was computed using the methods prescribed by DOE-STD-3014-96, as shown in Appendix B. The frequency of occurrence of this accident scenario is about two occurrences in one million years (2×10^{-6} per year).

For calculating the dose consequence, it was assumed that the entire inventory allowed within the dome—three crates—is involved and that one of the three crates has the maximum inventory of TRU waste. The MEOI dose consequence was estimated to be 0.018 rem (Appendix C), which equates to a calculated risk of excess LCF of 9 in 1 million or 9.0×10^{-6}. A CEDE of 1.8×10^{-2} rem is not expected to cause adverse health effects, disability, or lost work time.

3.1.2.3 Scenario 3: Spill or Rupture of Radionuclide Crates

Spills or ruptures of crates or building confinement systems could result from mishandling or various activities that could breach a container (Appendix C). In this scenario, primary, Perma Con, and dome confinements must all be lost, effectively eliminating the HEPA filtration capability. The frequency of occurrence, or chance, of this accident scenario is between once in 100 years and once in 10,000 years (1×10^{-2} to 1×10^{-4} per year).

For calculating the dose consequence, the same conservative assumptions about number of drums within the facility and container contents were made. The MEOI dose consequence was estimated as 1.3×10^{-4} rem (Appendix C), which equates to a calculated risk of excess LCF of 6.5 in 100 million (6.5×10^{-8}). A CEDE of 1.3×10^{-4} rem is not expected to cause adverse health effects, disability, or lost work time.

3.1.3 Radiation Risks to Nearby Populations

Risk was computed for two local residential populations—White Rock and the Los Alamos townsite. Using the highest of the three accident doses computed for White Rock and Los Alamos as shown in Appendix C —9.4×10^{-2} and 3.2×10^{-4} rem per year, respectively—and population estimates of 10,000 and 10,000 for White Rock and Los Alamos, respectively, a total of 940 person-rem collective population dose is estimated for White Rock and 3.2 person-rem is estimated for Los Alamos. Applying the dose conversion factor of five excess LCFs per 10,000 person-rem (5×10^{-4} cancer deaths per person-rem), these population doses are estimated to result in totals of less than one excess LCF for both White Rock (0.47 LCFs) and Los Alamos (1.6×10^{-3} LCFs).

3.1.4 Construction Activities

The current workforce at Area G excavates new disposal cells as part of routine operations. Construction and relocation activities can expose workers to a variety of risks, such as being crushed beneath heavy equipment, back injuries, electrical hazards, and those related to working below grade. All work is performed according to facility procedures for each type of task and LANL-wide general standards promulgated under the integrated safety management system used at LANL.

Assembly of the DVRS and modifications to the existing structure that would house it would be conducted under approved standard operating procedures and would adhere to all applicable ESH requirements. Construction and modification activities would be short term and similar to other construction activities that have occurred at Area G. There would be no anticipated adverse effects resulting from construction. In addition DVRS construction would have little or no likely effect on routine Area G construction or operation activities.

3.2 Waste Management

Under the Proposed Action, liquid effluents would be limited to water change-out (30 gal. [114 L] per change), and this effluent would be processed through the existing Radioactive Liquid Waste Treatment Facility located at TA-50. Liquid effluent would be transported from TA-54 to TA-50 in a tank truck; the road would be closed during these shipments. Shipment dates would be coordinated with operations at the TA-50 Radioactive Liquid Waste Treatment Facility. Secondary radioactive solid wastes (wastes generated by the decontamination process) would be kept to a minimum (about 2,485 yd^3 [1,900 m^3] over the life of the project) and would be disposed of as LLW on-site or as TRU waste at WIPP. Approximately 254 yd^3 (195 m^3) of HEPA filters and 39 yd^3 (30 m^3) of water filters would be disposed of appropriately in accordance with applicable regulations. The volume of material ultimately needing disposal at WIPP would be reduced from about 7,020 yd^3 (5,400 m^3) to 442 yd^3 (340 m^3), and the time required to process all 7,020 yd^3 (5,400 m^3) would be reduced from about 17 years to 6 years. No expansion of Area G would be needed to accommodate the Proposed Action.

As described in Section 2.1.3, there may be small amounts of waste that could not be decontaminated and volume reduced. These wastes would be placed into the appropriate waste stream at TA-54, Area G, according to established procedures.

Based on a review of the waste identified for DVRS operation, the main RCRA hazardous waste constituent within the TRU waste stream is lead. Based on past operations, lead is found in three primary forms, lead sheets or bricks used for shielding, lead-lined gloves, and lead-impregnated glass. Most of the lead is shielding in the form of lead sheets or bricks. The maximum amount of lead identified in a single crate was 2,420 lbs (1,100 kg) with the average amount per crate being 730 lbs (332 kg). Out of the 336 crates initially evaluated for DVRS operations, 51 percent have been identified as containing lead. Before decontamination, the lead sheets and bricks would be separated from the other material and put into the lead recycling program already in place at LANL at TA-50. Lead would be moved from TA-54 to TA-50 by truck. The road would be closed during shipments if necessary in order to comply with Department of Transportation requirements. The lead-lined gloves and lead-impregnated glass would be disposed as TRU mixed wastes. All TRU mixed waste would be characterized and sent to WIPP for disposal.

Under the No Action alternative, most of the oversized metallic TRU waste would eventually have to be repackaged in “overpacks” or FRPs to ensure waste container integrity. Any TRU waste that could be repackaged into smaller containers would be repackaged to satisfy WIPP criteria and shipped for disposal. The repackaged oversized metallic TRU waste would have to be stored until a facility exists that can size reduce this waste, or until a shipping container large enough for the oversized waste could be designed, built, and approved. Therefore, the No Action alternative would increase the probability for worker exposure resulting in increased risks to human health.

3.3 Air Quality

On-site and off-site air monitoring stations are used to measure radionuclide emissions that affect air quality. These stations collect samples that are analyzed for radionuclides in routine emissions and resuspended dust. Eight such sampling stations are located around the developed footprint of Area G. LANL’s annual surveillance report documents tritium, plutonium, uranium, and americium emissions in comparison with the DOE allowable concentration guides. During routine operations under the Proposed Action, all air emissions would pass through a series of HEPA filters that would remove 99.99 percent of any particulates and would meet all applicable standards and regulations. Increases in radioactive air emissions that could adversely affect air quality would not be expected. Because of the nature of ongoing waste management operations at Area G, potential effects on air quality would be essentially the same under the No Action alternative as under the Proposed Action.

3.4 Environmental Justice

As per Presidential Executive Order 12898 of February 11, 1994, this EA must consider the potential for disproportionate adverse health or environmental effects on Environmental Justice communities. However, no disproportionally high and adverse human health or environmental effects on minority and low-income populations adjacent to LANL would be expected if the Proposed Action is implemented since there would be no anticipated measurable effects to the general public from this action. Similarly, the No Action alternative would not result in a disproportionate adverse effect on minority or low income populations because of the oversized TRU waste that would continue to be stored on-site.

4.0 CUMULATIVE EFFECTS

Cumulative effects on the environment result from the incremental effect of an action when added to other past, present, and reasonably foreseeable actions, regardless of what agency or person undertakes such other actions. Cumulative effects can result from individually minor, but collectively significant, actions taking place over a period of time (40 CFR 1508.7). Use of the DVRS at LANL would contribute a negligible increase to the air emissions and LLW generation from routine LANL operations. Potential radiation exposures to workers would be maintained below as low as reasonably achievable guidelines. The small amounts of secondary solid waste and air emission volumes generated from operating the DVRS would not affect the life expectancy of the waste disposal facility at LANL or WIPP, nor would it affect the air emission management program at LANL. Environmental effects resulting from the Proposed Action would be minimal. Cumulative effects on human health and the environment at LANL resulting from implementing the Proposed Action would also be minimal.

Under routine operating conditions, cumulative effects would result from the generation of about 585 yd^3 (459 m^3) of LLW for on-site disposal and about 195 yd^3 (150 m^3) of TRU waste for shipment to WIPP. However, the overall volume of waste currently in storage would be reduced from the existing 3,120 yd^3 (2,400 m^3) into these two smaller volumes. In addition, without the DVRS, the entire 3,120 yd^3 (2,400 m^3) would ultimately be shipped to WIPP. If the additional 3,900 yd^3 (3,000 m^3) of similar waste is generated by facility upgrades (i.e., replacement of old equipment) and decontamination and decommissioning activities, 732 yd^3 (563 m^3) of LLW and 244 yd^3 (188 m^3) of TRU waste would be generated.

5.0 AGENCIES AND PERSONS CONSULTED

No federal or state agencies were consulted during the preparation of this EA.

REFERENCES

CPV (Compliance Plan Volume), 1998a. The Federal Facilities Compliance Order Site Treatment Plan Compliance Plan Volume, Revision 7.0. LANL 1998.

CPV (Compliance Plan Volume), 1998b. The Federal Facilities Compliance Order Site Treatment Plan Compliance Plan Volume, Revision 8.0. LANL 1998.

DOE 1979: U.S. Department of Energy "Final Environmental Impact Statement: Los Alamos Scientific Laboratory Site, Los Alamos, New Mexico," U.S. Department of Energy report DOE/EIS-0018, December 1979.

DOE 1990: Final Supplemental Environmental Impact Statement, Waste Isolation Pilot Plant. U.S. Department of Energy, Office of Environmental Management. DOE/EIS-0026-FS. Washington D.C. January 1990.

DOE 1993: Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements. Office of NEPA Oversight, U.S. Department of Energy, May 1993.

DOE 1994: DOE Handbook: Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities, DOE/HDBK-3010 94, Washington, DC, December.

DOE 1997a: Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste. U.S. Department of Energy, Office of Environmental Management. DOE/EIS-0200-F. Washington, D.C. May 1997.

DOE 1997b: Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement. U.S. Department of Energy, Carlsbad Area Office. DOE/EIS-0026-S-2. Carlsbad, New Mexico. September 1997.

DOE 1999: U.S. Department of Energy, Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory, DOE/EIS-0238, Albuquerque Operations Office, Albuquerque, New Mexico, 4 Volumes (January 1999).

DOE-STD-3014: Draft DOE Standard, Accident Analysis for Aircraft Crash Into Hazardous Facilities, SAFT-0030 prepared under Contract DOE-STD-3014-96 for the U.S. Department of Energy, Washington, DC, July 1996.

LANL 1996: LANL TRU Waste Management Plan. Los Alamos National Laboratory. LA-UR-96-2847. Los Alamos, New Mexico.

LANL 1997: Description of Technical Areas and Facilities at LANL. Los Alamos National Laboratory. LA-UR-97-4275. Los Alamos, New Mexico.

LANL 1998: Environmental Surveillance at Los Alamos during 1997. Los Alamos National Laboratory. LA-13487-ENV. Los Alamos, New Mexico.

LIR (Laboratory Implementing Requirement) 402-910-01.1: LANL Fire Protection Program. http://iosun:1800/hdir/.

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APPENDIX A: Methods for the Analysis of Abnormal Events/Accidents for the Decontamination and Volume Reduction System

1.0 Methodology

This section summarizes the general process that was followed for identifying bounding accident scenarios for inclusion in the EA for the DVRS. It describes the methodology for the source term derivation and consequence (radiation dose) analysis, including the models and computer codes that were used.

1.1 Selection of Bounding Accident Scenarios

Selection of accident scenarios was identified based on review of the proposed activities, associated hazards, and interview of TA-54 personnel cognizant of the activities that would take place within the facility. Accident scenarios were identified based on their potential to have the highest consequences to off-site or public receptors as long as they are considered to be credible (i.e., frequency of occurrences equal or greater than 1×10^{-6} per year), not based on their potential risk. As such, the postulated accident scenarios to be evaluated as part of the EA are considered to be bounding with respect to the expected consequences.

1.2 Frequency of Occurrence Estimates

Frequencies of occurrence of radiological accident scenarios are necessary to estimate the risk from these accidents. Since the DVRS process facility is a new facility and there are no previous evaluations of potential accident scenarios including their expected frequencies of occurrences, such frequencies are estimated as part of this accident analysis. For this EA, only qualitative frequency estimates presented in terms of frequency categories or bins were used; such frequency estimates were based on the description of the scenario. Engineering judgement was used for the most part to estimate the frequency category of such accident scenarios. Such frequency estimates are based on a qualitative assessment of the likelihood of the initiating event and the number and potential effectiveness (availability) of the preventive and mitigative controls that are required to fail in order for the scenario to occur. Quantitative evaluations (such as event or fault tree analyses) have not been performed.

Frequency categories recommended in the *Preparation Guide for U.S. DOE Nonreactor Nuclear Facility Safety Analysis Reports*; DOE-STD-3009 as shown in Table A-1 were used in this EA.

Table A-1. Accident Frequencies

Frequency Category	Frequency (annual)	Frequency Group
Likely	greater than 1×10^{-2}	I
Unlikely	1×10^{-2} to 1×10^{-4}	II
Extremely Unlikely	1×10^{-4} to 1×10^{-6}	III
Beyond Extremely Unlikely (incredible)	less than 1×10^{-6}	IV

It was recognized that airplane crash scenarios were important due to the location of the DVRS facility relative to the Los Alamos airport. An analysis of airplane crash frequencies for the DVRS facility has been performed for the EA using the methods and guidance in DOE-STD-3014.

1.3 Source Term Determination

For each accident selected, a source term or amount of respirable airborne radioactive material release from the facility was determined. The source term would be calculated using the five-factor formula in DOE-HDBK-3010-94 (DOE 1994), that is:

$$\text{Source Term (PE Ci)} = \text{MAR (PE Ci)} \times \text{DR} \times \text{ARF} \times \text{RF} \times \text{LPF} \qquad (1)$$

The five-factor formula (DOE-HDBK-3010-94) was used to define all the parameters and phenomenological models used to derive the source terms for the bounding accident scenarios. Each of these parameters are described below:

<u>Material-at-Risk (MAR)</u>

The MAR is defined as the amount of hazardous material available to be acted on by a given physical stress (DOE-HDBK-3010-94). The following assumptions are made with respect to determining the MAR to be used in the accident analysis section of this EA.

1. The MAR would be based on the current inventory of radioactive material stored at TA-54 that is waiting to be processed by the DVRS facility.

2. For accident scenarios postulated to affect a single operation, a single crate or container, i.e., a spill, the MAR is based on the maximum inventory of the containers being identified to be processed within the facility.

3. For accident scenarios postulated to affect large areas, multiple crates or containers, e.g., airplane crash, the MAR is based on a combination of the average and maximum inventory of the containers identified to be processed within the facility.

4. Given the fact that only a very small fraction of the crates or containers have inventories greater than 100 PE-Ci (<5%) and the likelihood of having the postulated accident scenarios at the time those containers are being handled, it is considered to be either extremely unlikely or incredible for such scenarios to occur. As such, container inventories with greater than 100 PE-Ci are not considered in the accident analysis for accident scenarios in which the frequency of occurrence drops below 1×10^{-6} per year. This approach is consistent with DOE/EPA guidance on accident analysis.

5. Hazardous materials stored outside the DVRS process facility are within the scope of the TA-54 authorization basis. As such, they are excluded from the EA for the DVRS process facility.

6. As stated above, the MAR was based on the actual inventories of material to be processed within the DVRS facility and interviews with operating personnel to clarify uncertainties in the data. For all accident scenarios, the MAR represents the maximum inventory of material that is at risk from the given accident scenario (unless noted). As such, it represents the upper bounds of the MAR for each of the facility/processes being affected by the postulated accident scenario. It is also important to notice, that under most circumstances the accident scenarios selected for the DVRS EA represent not only the bounding scenarios for the facility, but also represented a set of extremely bounding assumptions with respect to the energy release from such scenarios.

<u>Damage Ratio (DR)</u>

The DR represents the fraction of the MAR actually affected by the energy generated by the postulated accident scenarios. For conservatism the DR was assumed to be one (1.0) for all bounding accident scenarios (failure of all controls). That is, all the MAR in the affected area was assumed to be affected by the postulated accident scenarios. Phenomenological characteristics that define the amount of energy release and thus potentially affect the MAR (e.g., temperatures, pressures, etc.) for the various accident scenarios were not be evaluated, since it is assumed that the DR is equal to 1.

Phenomenological evaluations of the response of the facility with respect to external and natural phenomena events were not performed due to both time constraints and the fact that the facility is assumed to either fail or have no mitigation role with respect to the release of hazardous materials from the facility. That is, for the design-basis earthquake and airplane crash events, it is assumed that the facility would not be able to withstand or mitigate the releases created by these types of accident scenarios.

<u>Airborne Release Fraction and Respirable Fraction (ARF/RF)</u>

The ARF represents that fraction of the MAR that is affected by the accident scenarios (i.e., MAR × DR) that becomes airborne or thus suspended in air as an aerosol and thus available for transport due to the physical stress created by the accident scenario. The RF represents the fraction of the airborne material that is respirable or could be inhaled by humans. It is assumed to include particles 10 μm Aerodynamic Equivalent Diameter (AED) or less.

An ARF/RF for each postulated accident scenario was selected from the DOE-HBDK-3010-94, or other acceptable references. The ARF/RF from the DOE Handbook was selected to represent the material form and accident characteristics of the various accident scenarios postulated.

A bounding ARF/RF was used for all accident scenarios. However, for those scenarios involving a large number of containers or crates, medium ARF/RF may be used to present a more realistic measure of the consequences from such accident scenarios.

<u>Leak Path Factor (LPF)</u>

The LPF defines the efficiency with which airborne contaminants, generated as a consequence of a postulated accident within the DVRS process facility, are transported to the environment. In other words, it represents the fraction of the airborne contaminants that are transported out of the confinement (i.e., building) to the environment.

Transport efficiency is characterized in terms of the fraction of aerosolized MAR that is transported from its point of origin to the environment. The evaluation of the LPF requires the phenomenological modeling of the in-facility transport mechanisms (e.g., deposition, plate-out, etc.) of such airborne hazardous material and the impact of HEPA filters (for accident scenarios in which the building confinement is assumed not to be impacted by the postulated accident scenario). For simplicity, no deposition or plate-out within the facility was assumed, so for those accident scenarios that bypass the HEPA filters (e.g., airplane crash, earthquake, etc.), the LPF is assumed to be 1.0.

1.4 Dispersion and Consequence Methodology

This section identifies methodology and/or computer codes that were used in determining the consequences from postulated accident scenarios. All postulated accident scenarios for the DVRS process facility involve an airborne release of radioactive material, hazardous toxic releases were deemed to have very low consequences in comparison to radiological releases, due to the *de-minimus* quantities of such materials within the waste to be processed, low volatility, and toxicity (e.g., applies to lead).

<u>Population Data</u>

No LANL population estimates were used in the consequence calculations. Population for the Los Alamos County is estimated to be approximately 20,000 people, with the Los Alamos townsite including the original area of development and the residential areas known as Eastern Area, Western Area, North Community, Barranca Mesa, and the North Mesa have an estimated population of 10,000 people. The White Rock area (including the residential areas of White Rock, La Senda, and Pajarito Acres) also has approximately 10,000 residents. White Rock is the closest off-site location to the DVRS process facility (TA-54) where a member of the general public resides. In addition to population distributions, the location of the MEOI was defined for the DVRS facility. The MEOI was assumed to be located at the LANL/DOE boundary.

Location of the MEOI

It was conservatively assumed that the MEOI would be located at the boundary of LANL/DOE site for the entire duration of the accident without taking any protective action. The distance from the various release points was provided for each of the 16 polar grid directions, based on map readings. The distance was based on the minimum distance from the release point to the LANL/DOE boundary. Because the DVRS facility is small compared to the distance to the boundary, the distances for all release points within Area G were based on the center of the area. Table A-2 presents the distances to the MEOI, by direction, from the release location (i.e., DVRS facility).

Table A-2. Radial Distances from DVRS for MACCS2 Code Input

Boundary Point Id.*	Direction from DVRS	Distance from DVRS (m)
Pueblo Land	N	250
Pueblo Land	NNE	275
Pueblo Land	NE	325
Pueblo Land	ENE	400
Pueblo Land	E	700
White Rock/State Rd. 4	ESE	1700
White Rock/State Rd. 4	SE	1300
White Rock/State Rd. 4	SSE	2100
Bandelier Nat. Mon./ State Rd. 4	S	6700
Bandelier Nat. Mon./ State Rd. 4	SSW	6700
Bandelier Nat. Mon./ State Rd. 4	SW	4900
Bandelier Nat. Mon./ State Rd. 4	WSW	5900
Los Alamos West Area/HWY 501	W	8000
Los Alamos West Area/HWY 501	WNW	10100
Pueblo Land	NW	700
Pueblo Land	NNW	375

* All of these locations are about 100 ft (30.5 m) below the DVRS site with the exception of the Los Alamos Western Areas which are approximately the same elevation.

Meteorological Data

Actual site-specific meteorological data were obtained to support the consequence calculations. Meteorological data (such as wind speed, wind direction, and stability class) consisting of hourly sequential data was obtained from LANL (LANL 1997). The data were for 1997. The data were from the

TA-54 meteorological tower. This year was considered to be the base year for the EA. It is expected that the consequences would not vary much if data from other years were used.

<u>Computer Code Used and Assumptions in its Use</u>

All radiological off-site consequences were determined by the use of the MELCOR Accident Consequence Code System version 1.12 (MACCS2) computer code (MACCS2, March 1997). MACCS2 is a DOE/NRC sponsored code that has been widely used in support of Probabilistic Risk Assessments (PRAs) for the nuclear power plant industry and the NRC. It also has been widely used in many consequence analyses for safety documentation (e.g., SARs, EAs, EISs) throughout the DOE Complex.

The MACCS2 code used three separate input modules to perform transport and dose calculations for selected ranges or locations from a postulated release location. These input modules consist of ATMOS, EARLY, and CHRONC. Other input files are needed to support the runs; these included a meteorological data file, a site data file containing the population distribution around the postulated release location (not used for these analyses), and a dose-conversion file. Both early and chronic consequences were calculated with MACCS2.

Buoyant plume releases were modeled only for large explosion or fire scenarios in which the building was assumed to be lost as part of the accident scenario (i.e., airplane crash). A heat release of 1 mixed waste (MW) fire was assumed for these large fires, and all other release scenarios were assumed to be non-buoyant releases.

All MACCS2 runs used weather bin sampling from one year's worth of meteorological data (1997). Precipitation data were included in the meteorological input files, but were conservatively zeroed out for the analyses. This tended to maximize the calculated population doses.

Sampling from at least one year worth of meteorological data was used in the consequence calculations using MACCS2. Such meteorological sampling provides a probability distribution of the consequences (e.g., doses, or health effects) to receptor(s) downwind from the point of release. The mean and 95th-percentile values of the consequences calculated by MACCS2 were used in this EA. Notice however, that even though the mean consequence value is being reported, the assumptions that went into such evaluations (dispersion and consequence input variables) are for the most part very conservative (e.g., no evacuation, all respirable releases, etc.) with the exception of the meteorological conditions.

Normalized consequence calculations were performed using MACCS2, e.g., based on unit activity release (1 Ci of Pu-239). That is, a single plutonium-239-equivalent Curie (1 PE-Ci) was used as input as part of ATMOS. The dose for the postulated scenarios was calculated based on the source term calculated for each individual scenario and scaling the dose from the 1 PE-Ci with the calculated source terms.

Multiple output options were requested as a function of location from each MACCS run to ensure that, all possible output needs were satisfied. These output options included both individual centerline (MEOI and other receptor) doses, and individual centerline cancer risk. All dose calculations are given in Seiverts (Sv) in MACCS2, and are presented for various percentile distributions (e.g., mean, 50th, 90th, 95th percentile, etc.). Also as part of the output options centerline concentrations, ground-level dilution (dispersion factor - X/Q), among other dispersion information, was obtained for all exposure locations.

Because of the complex terrain features around the TA-54 site and because a large fraction of the MEOI receptors are located about 100 ft (30.5 m) below the release location (DVRS facility), a simulated elevated release was modeled along with a ground level release to simulate the receptors that are either at the same altitude or higher than the release location. Furthermore, two different MACCS2 runs were conducted to model buoyant (large fires) and non-buoyant releases. In summary, a total of four MACCS2 runs were performed: (1) a ground release with no buoyant plume rise, (2) a ground release with a 1-MW fire buoyant plume, (3) an elevated 30.5-m release with buoyant plume rise, and (4) an elevated 30.5-m release with no buoyant plume rise.

The uncertainty associated with the consequence analyses is directly related to the uncertainties of both the source term calculations (assumed to be at least one order of magnitude conservative), and the dispersion/transport modeling (assumed to be no less than the mean value). As such, the uncertainty of the consequences is at least no lower than the uncertainty of the source terms (i.e., at least one order of magnitude more conservative).

The following basic assumptions and inputs were used in the dispersion/consequence modeling (using MACCS2):

- All particle sizes were assumed to be 1 μm AMAD.
- Particle deposition velocity of 1 cm/s was used for the above particle size.
- Ground and elevated releases were modeled as described above.
- No building wake effects were modeled.
- No evacuation (all cohorts are assumed to be exposed to the entire postulated release).
- No sheltering or any other mitigating actions.
- Weather category bin sampling from one year worth of meteorological data.
- Both early and chronic consequences were calculated.

APPENDIX B: Airplane Crash Frequency Analysis for the Decontamination and Volume Reduction System at TA-54

1.0 Introduction

Aircraft crash impact frequencies for facilities are determined using the "four-factor" formula from DOE-STD-3014-96. This formula considers (1) the number of aircraft operations, (2) the probability that an aircraft will crash, (3) the probability that, given a crash, the aircraft crashes into a one-square-mile area where the facility of interest is located, and (4) the size of the facility. The formula from DOE-STD-3014 is:

$$F = \Sigma\, N_{ijk} \bullet P_{ijk} \bullet f_{ijk}(x,y) \bullet A_{ij},$$

where

F = estimated annual aircraft crash impact frequency for the facility of interest (number/year),

N_{ijk} = estimated annual number of site-specific airport operations (takeoffs, landings, in-flights) for each applicable summation parameter,

P_{ijk} = aircraft crash rate for each applicable summation parameter,

$f_{ijk}(x,y)$ = aircraft crash location conditional probability (per mi^2) given a crash evaluated at the facility location for each applicable summation parameter,

A_{ij} = site-specific effective area for the facility of interest that includes the skid and fly-in effective areas (mi^2) for each applicable summation parameter,

I = index for flight phases, (takeoff, in-flight, and landing),

j = index for aircraft category or subcategory, and

k = index for flight source (specific runways).

The results of this analysis and a discussion of how the "four-factor" formula was applied to DVRS follow.

2.0 Potential Aircraft Crash Frequencies

Table B-1 below presents the total annual aircraft impact frequency for both airport and non-airport operations, along with the overall total aircraft crash probability for DVRS. These frequencies come from Tables 4 through 7 of DOE-STD-3014 using the "four-factor" formula discussed above.

Table B-1. Annual Aircraft Impact Frequency for the DVRS Facility

Type of Crash	Aircraft Operation	Aircraft Crash Frequency (yr^{-1})
Airport	Fixed wing (single engine) and Commercial aviation (air taxi)	1.1×10^{-6}
Non-Airport	Fixed wing (single engine) and Commercial aviation (air taxi)	1.0×10^{-6}
Total Aircraft Crash Frequency (yr^{-1})	Fixed wing (single engine) Commercial aviation (air taxi)	2.1×10^{-6}

The impact frequency presented above tends to be dominated by general aviation type aircraft and aircraft operations. The other types of aircraft can be screened out of further analysis because each of the other aircraft are less than the 1×10^{-6} per year Evaluation Guideline from DOE-STD-3014 for one or more of the facilities. On a facility by facility basis, individual types of aircraft that have a significant contribution to the overall frequency should be evaluated for their structural response to determine whether or not an impact can result in a release of hazardous or radioactive material. When a material release does not occur, the frequency of impact from that aircraft type can be subtracted from the annual impact frequency. If the annual impact frequency decreases below 1×10^{-6} per year, no further analysis is required. In the case of the DVRS, if an impact occurs, the tension-support dome structure, under which it is located, is such that the structure would be breached.

3.0 Impact Frequencies from Airport Operations

This section describes the determination of the potential impact frequency of aircraft into the DVRS facility due to airport operations at Los Alamos Airport (i.e., takeoffs and landings). The calculations for the DVRS facility are located in Table B-2 of this report. There are no other airports in the general area of DVRS that may impact the frequency of occurrence of such events.

Helicopter flights were not considered in the analysis. According to DOE-STD-3014, helicopters must fly over a facility for the flight to pose a hazard to the facility. Most helicopter operations would not fly near the DVRS facility, and since the impact frequency for the DVRS facilities is already less than the 1×10^{-6} per year Evaluation Guideline in DOE-STD-3014, helicopters were not further considered in this analysis.

Table B-2. Aircraft Crash Frequency Calculation for Airport Operations

Aircraft operation	Number of operations per year	X distance	Y distance	f (x,y) values (Tables B2-13)	P, crash rate (Table B1)	A (mi^2), effective area (Table A.8.3)	Impact frequency per year
General aviation aircraft (takeoff)	8,830	1.94	-3.36	4.4×10^{-4}	1.1×10^{-5}	5.09 × 10-3	2.174×10^{-7}
General aviation aircraft (landing)	8,830	-1.94	3.36	9.7×10^{-4}	2.0×10^{-5}	5.09 × 10-3	8.715×10^{-7}
Commercial aviation air taxi (takeoff)	3,600	1.94	-3.36	2.0×10^{-4}	1.0×10^{-5}	1.05 × 10-2	7.541×10^{-9}
Commercial aviation air taxi (landing)	3,600	-1.94	3.36	0	2.3×10^{-6}	1.05 × 10-2	0
Total aircraft crash frequency (per year)	24,860						1.096×10^{-6}

3.1 Estimated Annual Number of Aircraft Operations

The number of aircraft operations at Los Alamos Airport was provided by Los Alamos Airport staff. These values are presented in Table B-2 for each type of aircraft that operates at the airport.

3.2 Distance from Runway to Facility

Table B-2 lists the orthonormal distance (Cartesian distance in miles, both x and y coordinates) from the runway of concern for the applicable DVRS facility. This distance was calculated from the distance and angle of the facility from each runway as recommended by DOE-STD-3014.

3.3 Generic Aircraft Crash Location Probability

From the orthonormal distance described above, the generic aircraft crash location probability was determined using Tables B-2 through B-13 from DOE-STD-3014. These tables list the probability that, given a crash upon takeoff or landing of a specific type of aircraft, the crash would occur in the 1 mi^2 where the facility of interest is located.

3.4 Aircraft Crash Rate

The takeoff and landing crash rates for each type of aircraft listed in Table B-2 are taken from Table B-1 of DOE-STD-3014. This table lists the probability that a given type of aircraft will crash upon takeoff or landing.

Table B-2 provides a summary of the aircraft crash frequency for the facility for each type of aircraft operation. The table is further broken down into airport type crashes (due to takeoffs or landings) and non-airport type crashes (overflights). The bottom of the summary table sums the aircraft crash frequency for each type of aircraft to give an overall aircraft impact frequency for each facility at DVRS.

3.5 Facility Effective Area

Table B-3 lists the effective area for the facility of interest that is used in the “four-factor” formula to determine the impact frequency of aircraft. The effective area of the facility is calculated in Table B-3. The calculation of the effective area was based on two components: the fact that the aircraft can crash directly into the facility or the aircraft can skid into the facility. The effective area of the facility is, therefore, dependent on the type of aircraft and the actual dimensions of the facility.

Multiple factors affect the facility effective area depending on the type of aircraft. The wingspan dictates how close the aircraft can come to the facility and still impact it. The type of aircraft also dictates the angle of impact into the facility and the cotangent of this angle is used in the calculation. The skid distance of the aircraft is also defined by the type of aircraft and is a function of the aircraft airspeed.

These variables are given in DOE-STD-3014 (Tables B-16, B-17, and B-18) for each type of aircraft. Their values have been used in Table F-2.1 to determine the effective area of the facilities.

The facility dimensions, i.e., the facility height, width, and length are input into Table B-3. The width and length are used to calculate the length of the diagonal of the facility, R. Each of these parameters are then used to calculate the effective fly-in area of the facility (A_f) and the effective skid area (A_s) of the facility according to the following formulas from DOE-STD-3014. These two areas are then summed to determine the effective area of the facility (A_{eff}).

$$R = (L^2 + W^2)^{1/2}$$

$$A_f = (WS + R) \bullet H \bullet \cot(phi) + (2 \bullet L \bullet W \bullet WS)/R + (L \bullet W)$$

$$A_s = (WS + R) \bullet S$$

$$A_{eff} = A_f + A_s$$

Table B-3. Affective Area Data and Calculation for DVRS (TA-54)

Variable	General Aviation	Helicopters	Commercial Air Carrier	Commercial Air Taxi	Military Large (takeoff)	Military Large (landing)	Military Small (takeoff)	Military Small (landing)
WS(ft)	50	50	50	50	223	223	78	78
R (ft)	297.32	297.32	297.32	297.32	297.32	297.32	297.32	297.32
H (ft)	35	35	35	35	35	35	35	35
Cot (phi)	8.2	0.58	10.2	10.2	7.4	9.7	8.4	10.4
L (ft)	280	280	280	280	280	280	280	280
W (ft)	100	100	100	100	100	100	100	100
S (ft)	60	0	1,440	1,440	780	368	246	447
Af (ft^2)	4.92×10^{-3}	1.60×10^{-3}	6.73×10^{-3}	5.97×10^{-3}	7.34×10^{-3}	8.85×10^{-3}	5.49×10^{-3}	6.43×10^{-3}
As (ft^2)	1.70×10^{-4}	0	6.38×10^{-3}	4.51×10^{-3}	6.70×10^{-3}	3.16×10^{-3}	9.26×10^{-4}	1.68×10^{-3}
Aeff (ft^2)	5.09×10^{-3}	1.60×10^{-3}	1.31×10^{-2}	1.05×10^{-2}	1.40×10^{-2}	1.20×10^{-2}	6.42×10^{-3}	8.11×10^{-3}

where

R	=	length of the diagonal of the facility;
L	=	length of the facility;
W	=	width of the facility;
A_f	=	effective fly-in area of the facility;
WS	=	aircraft wingspan;
H	=	facility height;
cot (phi)	=	mean of the cotangent of the aircraft; impact angle, from Table B-17 in DOE-STD-3014;
A_s	=	effective skid area;
S	=	aircraft skid distance, from Table B-18 in DOE-STD-3014;
A_{eff}	=	the effective area.

Facility height (30 ft) was provided by the DVRS facility architectural drawings.

3.6 Impact Frequency

The aircraft impact frequency per year for airport operations is determined by multiplying the number of operations, the conditional crash probability, the crash probability, and the effective area of the facility as described in the "four-factor" formula above. The total impact frequency for airport operations is included in Table B-2.

4.0 Impact Frequency for Non-Airport Operations

Although typically small, the impact frequency contribution for non-airport operations cannot be overlooked when following the DOE-STD-3014 methodology. The impact frequency for non-airport operations is calculated from the same "four-factor" formula used for airport operations except that the first three terms are lumped together and given in DOE-STD-3014 (Tables B-14 and B-15). The Standard provides site-specific values for the probability of an impact occurring in a 1-mi^2 area at the center of the site for each type of aircraft.

The values from this table for DVRS are listed in Table B-4. These values are multiplied by the facility effective area discussed above to determine the non-airport impact frequency per year. These frequencies are listed in Table B-4 and were used along with the airport impact frequencies to determine the overall aircraft impact frequency per year for the DVRS.

Table B-4. Aircraft Crash Probabilities for Non-Airport Operations

Type of Aircraft	Impact Frequency for LANL	(mi^2)	Non-Airport Crash Frequency (per year)
General Aviation Aircraft	2×10^{-4}	5.09×10^{-3}	1.0×10^{-6}
Commercial Aviation Air Carrier	2×10^{-7}	1.31×10^{-2}	2.6×10^{-9}
Commercial Aviation Air Taxi	3×10^{-6}	1.05×10^{-2}	3.1×10^{-8}
Military Aviation Large Aircraft	1×10^{-7}	1.40×10^{-2}	1.4×10^{-9}
Military Aviation Small Aircraft	5×10^{-6}	8.11×10^{-3}	4.1×10^{-8}

Table B-5 summarizes the total aircraft crash probabilities for the DVRS facility (TA-54), as a function of aircraft type and type of operation.

Table B-5. Total Aircraft Crash Probabilities DVRS (TA-54)

Type of Crash	Aircraft Operation	Aircraft Crash Frequency (per year)
Airport	Fixed Wing - Single Engine (Takeoff)	2.17×10^{-7}
	Fixed Wing - Single Engine (Landing)	8.72×10^{-7}
	Commercial Aviation Air Taxi (Takeoff)	7.54×10^{-9}
	Commercial Aviation Air Taxi (Landing)	0
Total of Airport Operations Aircraft Crash Frequency		1.1×10^{-6}
Non-Airport	General Aviation	1.02×10^{-6}
	Commercial Aviation Air Carrier	2.62×10^{-9}
	Commercial Aviation Air Taxi	3.14×10^{-8}
	Military Aviation Large Aircraft	1.40×10^{-9}
	Military Aviation Small Aircraft	4.06×10^{-8}
Total of Non-Airport Operations Aircraft Crash Frequency		1.1×10^{-6}
Total Aircraft Crash Frequency		2.2×10^{-6}

APPENDIX C: Accident Analysis Results

This section identifies and describes the bounding accident scenarios that are being selected for analysis in the EA, it also discusses the frequency of occurrence of such accident scenarios, the expected source terms, consequences, and risk from such postulated accident scenarios.

1.0 Postulated Accident Scenarios

Consequences to the public or the MEOI from radiological or toxic releases from the DVRS process facility are postulated to be bounded by the following accident scenarios:

1. a fire scenario initiated by operational activities, external fires (external events), or lightning (natural phenomena event) that ignites combustibles within the dome/Perma Con,
2. an aircraft crash (external event) into the DVRS facility that leads to a fire/explosion, and
3. catastrophic release of radioactive airborne material from the container(s) being processed or staged within the facility.

Other potential accident scenarios are also possible such as releases of radioactive material due to rupture of the Perma Con structure during normal decontamination activities, a pressurization of a container due to radiolytic decomposition, etc. However, the consequences from the latter accident scenarios are considered to be bounded by the former ones.

2.0 Frequency Estimates

The frequency of occurrence of the above mentioned accident scenarios can be determined based on the approach outlined below.

1. A fire within the Perma Con or dome could occur due to multiple potential initiator events. These initiator events could result from normal operations such as cutting, grinding operations, electrical shorts, etc. Also, lightning events could result in a fire within the facility, external fires could also propagate to the facility. In order for a fire to impact the radioactive material to be handled or that would be staged within the facility, not only the above initiating events would have to occur, but failure of the combustible control programs within the facility would have to occur, and failure of the fire suppression system or actions. Based on engineering judgement, the type of initiating events that would have to take place and the failure of mitigating controls that would have to occur, the frequency of occurrence of this type of accident scenarios is likely to be in the upper range of the frequency category II, i.e., an expected frequency of 1×10^{-4} per year.

2. The airplane crash annual probability was determined using the methodology and guidance in DOE-STD-3014. According to Appendix C, the annual frequency of occurrence of such accident scenario was determined to be about 2×10^{-6} per year or in the frequency category IV.

3. A catastrophic release of radioactive material from a spill or rupture of confinement of a crate or container. This type of accident scenario could occur due to the mishandling activities, or plain failure of primary confinement during decontamination activities. This event assumes that not only the primary confinement volume is lost but also the Perma Con and dome confinement and filtration capability. The frequency of occurrence of this type of accident scenario is postulated to be in the order of 1×10^{-2} and 1×10^{-4} per year or a frequency category II, or an expected frequency of 1×10^{-3} per year.

3.0 Radiological Source Term

Material-at-Risk (MAR):

MAR from these accident scenarios could range from an FRP box or a crate within the Perma Con to a couple of boxes or crates being processed and awaiting processing within the DVRS process facility. The material form in the FRP boxes or crates could range from combustible filter media, surface contamination on metal or combustible surfaces, and contaminated soil.

The database on the inventories and material forms in the containers to be handled, processed, or staged within the DVRS facility (Appendix A) indicates that about 75 percent of the material awaiting processing is in metal form (e.g., contaminated gloveboxes and equipment). The other material forms include contaminated combustibles (general cellulose and filter media) with about 18 percent, respectively; and soil with about 8 percent. Table C-1 summarizes the MAR by material form and inventory.

Table C-1. Summary of the DVRS MAR by Material Form and Inventory

Radioactive Material Form	Typical Average Inventory (PE-Ci)	Maximum Inventory (PE-Ci)
Combustibles (wood, paper, plastics)	7.5×10^{-2}	409.3
Combustibles (filter media)	(1)	(1)
Metals	4.0	309.2
Soil contamination	1.3	8.9

(1) The PE-Ci for filter media is insignificant for accident analysis when compared to the other MAR inventory. The only toxic chemical that is present within the waste to be processed in the DVRS facility in significant quantities is lead in metal form as shielding to gloveboxes and other equipment. It is estimated that 51 percent of the containers contain lead, with an average amount of 332 kg. However, due to the low volatility of lead (about 1×10^{-4} for ARF) and the relatively low toxicity (IDLH of 100 mg/m^3), the consequences from lead releases are well bounded by those from radiological ones.

For the fire and the spill accident scenarios, one container or crate containing maximum inventory of radioactive material is assumed to be impacted by the postulated accident scenario. For the airplane crash scenario, it is assumed that the scenario would impact the entire inventory within the facility (i.e., a maximum of three containers); however, only one of them would be postulated to have a maximum inventory. For the former, it is assumed that some of these containers would be in process while the others would be staged within the facility awaiting to be processed or shipped out of the facility.

ARF/RF:

The respirable fraction (<10 μm AMAD for particulates) of the MAR that could be potentially released from the above postulated accident scenarios is represented by the Airborne Release Fraction and the Respirable Fractions (ARF/RF). Values for the ARF/RF for various material forms and suspension stresses (e.g., thermal stress, spill, shock wave, blast stress) are given by the DOE Handbook on Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities [DOE-HDBK-3010-94].

Median and Bounding ARF/RFs for the typical material forms found within the DVRS process facility for the above postulated accident scenarios are given below in Tables C-2 and C-3.

Table C-2. Median and Bounding ARF/RFs for Thermal Stress (i.e. fires and airplane crash) for Typical MAR Forms to be Processed Within the DVRS Facility

Material Form	ARF		RF	
	Median	Bounding	Median	Bounding
Enclosed contamination on filter media	NA*	5×10^{-4}	NA	1.0
Surface contamination on metal	NA	6×10^{-3}	NA	0.01
Packed contaminated general combustible materials	8×10^{-5}	5×10^{-4}	1.0	1.0
Soil contamination	NA	6×10^{-3}**	NA	0.01

* N/A not available
** Represented by composite solids (e.g., aggregate, dirt, etc.)

Table C-3. Median and Bounding ARF/RFs for Shock-Vibration or Impaction Stress for Typical MAR Forms to be Processed within the DVRS Facility

Material Form	ARF		RF	
	Median	Bounding	Median	Bounding
Enclosed contamination on filter media	NA*	5×10^{-4}	NA*	1.0
Surface contamination on metal	NA*	1×10^{-3}	NA*	1.0
Packed contaminated general combustible materials	NA*	1×10^{-3}	NA*	0.1
Soil contamination	NA	6×10^{-3}**	NA	0.01

* N/A not available
** Represented by composite solids (e.g., aggregate, dirt, etc.)

Because the bounding ARF/RFs for general combustibles and filter media are basically the same, these would be combined into a single material form, i.e., combustibles.

DR/LPF:

The DR for these accident scenarios would be assumed to be 1.0. The LPF on the other hand is assumed to be 1.0 for the fire scenario and the airplane crash; however, for the spill a LPF of 1×10^{-4} (based on efficiency of 99.99 percent for the HEPA filters) would be used. Table C-4 summarizes the source term (using the five-factor formula) for the three postulated accident scenarios as a function of material form.

Dispersion and Consequence Analysis

For simplicity purposes, the MEOI consequences from the postulated accident scenarios are calculated assuming one PE-Ci released from the facility. The MACCS2 computer code was run using one year of meteorological data from TA-54 (1997 met data) for four cases: elevated (100 ft) and ground release with buoyancy and without buoyancy. EISs and EAs only require the use of mean consequence results. The receptor locations at which the highest mean X/Q values (s/m^3) occur are given in Table C-5, along with the corresponding X/Q values.

Table C-4. Source Terms for the Postulated Accident Scenarios

Accident Scenario	Contaminated Material Form	MAR (PE Ci)		Bounding DR•ARF•RF•LPF	Source Term (PE Ci)	
		Avg.	Max.		Avg.	Max.
Fire	Combustibles	7.5×10^{-2}	409.3	5×10^{-4}	3.8×10^{-5}	2.0×10^{-1}
	Metal	4.0	309.2	6×10^{-5}	2.4×10^{-4}	1.8×10^{-2}
	Soil	1.3	8.9	6×10^{-5}	7.8×10^{-5}	5.3×10^{-4}
Airplane Crash	Combustibles	2.3×10^{-1}*	409.5	5×10^{-4}	1.1×10^{-4}	2.0×10^{-1}
	Metal	12.0	317.2	6×10^{-5}	7.2×10^{-4}	1.9×10^{-2}
	Soil	3.9	11.5	6×10^{-5}	2.3×10^{-4}	6.9×10^{-4}
Spill	Combustibles	7.5×10^{-2}	409.3	1×10^{-7}	7.5×10^{-9}	4.1×10^{-5}
	Metal	4.0	309.2	1×10^{-6}	4×10^{-6}	3.1×10^{-4}
	Soil	1.3	8.9	1×10^{-7}	1.3×10^{-7}	8.9×10^{-7}

* Assumes that for the average MAR, three average containers are located or being processed in the DVRS facility.
** The maximum inventory assumes that all three containers are impacted by the accident scenario (i.e., airplane crash) but only one has the maximum inventory.

Table C-5. Highest Mean X/Q-values and Their Corresponding Locations (Direction Independent)

Type of Release	Highest X/Q-values (s/m^3)	Range (km) at which Highest X/Q Occur
Ground release/nonbuoyant	8.9×10^{-4}	0.2 - 0.3
Ground release/buoyant	2.9×10^{-5}	0.2 - 0.3
Elevated release/nonbuoyant	2.5×10^{-5}	0.4 - 1.0
Elevated release/buoyant	2.9×10^{-6}	0.4 - 1.0

Table C-6 summarizes the mean consequence (dose) results of the MACCS2 runs for selected receptor locations for the three accident scenarios and release conditions. Notice that not all the release conditions are applicable to each of the selected receptors, because of the limitations of MACCS2 with respect to complex terrain features. For example, a receptor at the closest radial distance to the DOE site boundary (at the Pueblo, north from the DVRS process facility, or at a receptor located at the closest distance to Pajarito Road) needs to be modeled as an elevated release, because of its altitude differential with respect to the release location. This is also the case for a receptor within the LANL boundary, located at the closest distance to Pajarito Road (about 200 to 300 m from the DVRS location). As such, a ground release is not applicable to such a receptor. All the consequence estimates in Table C-6 are based on a one-curie of plutonium-239 equivalent (1 PE-Ci).

Based on the results from Tables C-4 and C-6, the mean doses to some of the special receptors identified in Table C-6 are summarized in Table C-7 for the maximum inventories and worst material forms. From Table C-4, it is clear that combustibles present the highest airborne radioactive release and therefore consequence potential, this is followed by releases from contaminated solid (non-combustible materials). The likelihood of a postulated accident scenario impacting combustible materials is about a factor of 5 lower than for contaminated solid waste. The consequences from accident scenarios involving contaminated non-combustible metals are about an order of magnitude lower than those presented in Table C-7.

Table C-6. Summary of MACCS Mean Consequence (dose) Results for Selected Receptors for each Accident Scenario and Release Conditions - for 1 PE-Ci (^{239}Pu) Release

Receptor(s) (rem)	Fire Scenario* (nonbuoyant release)	Airplane Crash (buoyant release)	Spill Scenario (nonbuoyant release)	Release Condition
Closest distance to boundary (Pueblo, north sector) or at Pajarito Road	4.3×10^{-1}	9.0×10^{-2}	4.3×10^{-1}	elevated
Highest boundary dose (sector dependent)	5.2	1.2	5.2	ground
Highest boundary dose location (sector independent)	56.1	3.2	56.1	ground
White Rock (SE)	4.7×10^{-1}	3.3×10^{-2}	4.7×10^{-1}	elevated
Los Alamos (W)	1.4×10^{-3}	1.6×10^{-3}	1.4×10^{-3}	ground

* Modeled for conservatism purposes as a non- or low-buoyant release, buoyant release was reserved for an airplane crash.

Table C-7. Summary of Mean Consequences (rem) for the Postulated Accident Scenarios

Receptor(s)	Fire Scenario	Airplane Crash	Spill Scenario
MEOI at 250 m (north sector)	8.6×10^{-2}	1.8×10^{-2}	1.3×10^{-4}
Highest boundary dose (sector dependent)	1.0	2.4×10^{-1}	1.6×10^{-3}
Highest body dose location (sector independent)	11.2	6.4×10^{-1}	1.7×10^{-2}
White Rock (SE)	9.4×10^{-2}	6.6×10^{-3}	1.5×10^{-4}
Los Alamos (W)	2.8×10^{-4}	3.2×10^{-4}	4.3×10^{-7}

The risk from DVRS process activities can be obtained by combining the consequence results in Table C-7 with the frequency estimates for the postulated accident scenarios. Table C-8 presents the mean risk in rem/yr for a selected number of receptors for the three postulated accident scenarios.

It is clear that the highest risk from the operation of the DVRS facility comes from a fire, with an airplane crash having the lowest risk due to its low annual probability of occurrence.

Table C-8. Summary of the Mean Risk* (rem/yr) for Postulated Accident Scenarios

Receptor(s)	Fire Scenario	Airplane Crash	Spill Scenario
MEOI at 250 m (north sector)	8.6×10^{-6}	1.8×10^{-8}	8.3×10^{-7}
Highest boundary dose (sector dependent)	1.0×10^{-4}	2.4×10^{-8}	1.6×10^{-6}
Highest body dose location (sector independent)	1.1×10^{-3}	6.4×10^{-7}	1.7×10^{-5}
White Rock (SE)	9.4×10^{-6}	6.6×10^{-9}	1.5×10^{-7}
Los Alamos (W)	2.8×10^{-8}	3.2×10^{-10}	4.3×10^{-10}

* Based on the worst material form and inventory.

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Glossary of Terms

active neutron detectors Neutron-based analytical equipment that is used to determine the amount of neutron emitting material in a particular waste matrix/media.

committed effective dose equivalent (CEDE) A measure of the whole body dose a person could receive over a period of 50 years but is assigned during the year of initial exposure.

critical mass The mass of fissionable material of a particular shape and configuration that is sufficient to sustain a nuclear chain reaction.

curie A quantity of radioactivity equal to 3.7×10^{10} disintegrations per second.

US Department of Energy (DOE) The federal agency that sponsors energy research and regulates nuclear materials used for weapons production.

decontamination and volume reduction system (DVRS) This is a system for decontaminating and compacting oversized waste containers such as gloveboxes and other large pieces of equipment.

environmental assessment (EA) A report that identifies potentially significant environmental impacts from any federally approved or funded project that may change the physical environment. If an EA identifies significant impacts, an environmental impact statement is required.

environmental impact statement (EIS) A detailed report, required by federal law, on the significant environmental impacts that a proposed major federal action would have on the environment. An EIS must be prepared by a government agency when a major federal action that will have significant environmental impacts is planned.

fiberglass-reinforced plywood box (FRP) A storage box constructed of plywood and other common building material that has been reinforced with a coating of fiberglassing material.

high-purity germanium detectors Analytical equipment that uses the energy associated with specific types of radioactive decay to identify the radioactive material (i.e., isotope).

holdup measurements Measurements used to determine the amount of radioactive material that is being held up or contained in a specific location (i.e., in a corner of a container).

latent cancer fatalities (LCFs) Excess cancer deaths estimated to occur as a result of exposure to ionizing radiation.

low-level radioactive waste (LLW) The level of radioactive contamination in LLW is not strictly defined. Rather, LLW is defined by what it is not. It does not include high-level waste, nuclear fuel rods, wastes from processing nuclear fuels, transuranic (TRU) waste, or uranium mill tailings.

leak path factor (LPF) The fraction of airborne contaminants that are transported out of the confinement area (e.g., building) to the environment.

material-at-risk (MAR) The amount of hazardous material available to be acted on by a given physical stress.

maximally-exposed off-site individual (MEOI) The hypothetical person who, because of their duration in a specific location, receives the highest calculated dose from a release of radioactive material to the environment.

National Environmental Policy Act (NEPA) This federal legislation, passed in 1969, requires federal agencies to evaluate the impacts of their proposed actions on the environment before decision making. One provision of NEPA requires the preparation of an EIS by federal agencies when major actions significantly affecting the quality of the human environment are proposed.

non-destructive assay (NDA) The remote determination of the radionuclide content inside a package using noninvasive techniques.

"oversized" "Oversized" in this assessment refers to the physical size of the waste as compared to the WIPP waste acceptance criteria. This criteria requires the waste transported to WIPP be able to fit within a 55-gal. drum or standard waste box (DOE 1990). A standard waste box is actually a cylinder 37 in. high by 72 in. in diameter. Most of this oversized metallic waste is composed of used gloveboxes and equipment.

passive neutron detector Neutron-based analytical equipment that is used to determine the amount of neutron emitting material in a particular media.

plutonium equivalent (PE) The amount of Plutonium-239 that would present the same risk as a measured amount of other elements or a mixture of isotopes.

puck Defined in this text as a metallic waste processed through a compactor, for volume reduction, having dimensions of 16 inches in diameter by several inches thick.

radiation area monitor (RAM) A detector used to monitor radiation fields in a general area.

Resource Conservation and Recovery Act (RCRA) RCRA is an amendment to the first federal solid waste legislation, the Solid Waste Disposal Act of 1965. Under RCRA, Congress established initial directives and guidelines for EPA to regulate solid and hazardous wastes.

transuranic-mixed waste Waste with both TRU and chemicals regulated as hazardous under RCRA.

transuranic (TRU) waste Transuranic waste is waste containing more than 100 nanocuries of alpha-emitting TRU isotopes per gram of waste, with half-lives generally greater than 20 years. This type of waste may be further characterized as remote-handled waste or contact-handled waste based on the radiation level at the surface of the waste container.

Transuranic Waste Inspectable Storage Project A project to remove approximately 16,000 containers that have been residing under earthen covered storage in a dense pack array. These containers will be inspected, cleaned, repackaged and, if necessary, placed into an inspectable storage array.

transuranic waste package transporter (TRUPACT-II) A container that is approved by the NRC for the shipment of TRU waste to WIPP.

waste acceptance criteria Criteria enforced to ensure that waste containers accepted for storage meet the safety requirements and performance objectives for a given facility.