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Safety and Risk Technologies, Inc.

October 26, 2001

Mr. Hopkins,
Environmental Restoration Project
Los Alamos National Laboratory
PO Box 1663, Mail Stop:M992
Los Alamos, New Mexico 87544

Dear Mr. Hopkins:

Enclosed are three hard copies with one electronic copy of the final modified Transportation and Worker Risk Assessment for Material Disposal Area (MDA) H, TA-54 at Los Alamos National Laboratory for the Excavation Alternative based on reviewer comments. The risk assessment document is consistent with conducting a semi-qualitative evaluation of the likelihood of the occurrence of potential exposure conditions and the magnitude of radiological, toxic, or other hazardous hazards (e.g., explosives) exposures to workers during excavation and transportation activities.

The document identifies the major hazardous materials present within the site, identifies the major potential exposure scenarios, identifies major controls that could be used in preventing or mitigating such scenarios, determines the frequency or probability of occurrence of such events, and determines the consequences from such exposures.

Please feel free to contact either Louis Restrepo or myself to discuss any questions on this report.

Brian R. Myers
Project Manager

Enclosures

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Transportation and Worker Risk Assessment for Material Disposal Area (MDA) H, TA-54 at Los Alamos National Laboratory for the Excavation Alternative

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September 30, 2001

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EXECUTIVE SUMMARY

This report evaluates the unmitigated and mitigated worker and transportation risks associated with remediating (excavation alternative) the MDA H site at TA-54 at Los Alamos National Laboratory. Unmitigated risk refers to the risk from postulated accident scenarios for which no controls are credited in reducing either the likelihood or consequences of an accident, while the mitigated risk is based on crediting controls that will be established and implemented for all remediation activities.

For completeness, both worker and public risks were estimated, even though the emphasis is on determining the risk to workers from the remediation activities, and the risk to the public from the transportation activities related to remediation. The reason for focusing only on the transportation activities for the public risk is that the risk from other remediation activities is shown to be insignificant.

The risk assessment was performed for all remediation activities and according to various accident categories. The remediation activities include (1) site preparation, (2) site excavation, (3) sort/segregation, (4) declassification, (5) packing/loading, (6) transportation, and (7) site restoration. Accident categories include industrial hazards/accidents, potential fires with release of radioactive or hazardous materials, explosions and associated releases of radioactive materials, spills of radioactive materials, and inadvertent exposures to penetrating radiation. The evaluation goals are to determine (1) the dominant overall worker risk remediation activity, (2) the dominant worker risk accident category for each of the remediation activities, (3) the risk to the public from remedial activities; and (4) to identify the major controls that should be instituted to prevent or mitigate the dominant risk.

All risk estimates were based on semi-quantitative evaluation of the consequences and frequencies for postulated scenarios, and on a qualitative risk-ranking matrix.

The risk assessment indicates clearly that the risk to workers from all remediation activities is dominated by the actual excavation activity (about 25% of the overall risk). Standard or industrial accidents dominate the accident categories with about 50% of the risk, followed by explosion accidents with about 30% of the risk. The overall reduction in total risk between the unmitigated and mitigated risks is about a factor of 1.5, with significant reductions found in a few accident categories. The smallest reduction between the unmitigated and mitigated risks is for the industrial accidents, in which the reduction is less than 20%. This means that implementing controls will have only a relatively minor impact on the risk from standard or industrial accidents during the remediation activities.

The risk to the public from all activities except onsite/offsite transportation is negligible, due mainly to the relatively small quantities of potentially dispersible radioactive or hazardous materials that could be released from any of the postulated accidents. The risk to the public from the transportation accident is dominated by the standard or industrial accident type, which involves only vehicle crashes or accidents associated with onsite/offsite transportation activities in which serious or fatal consequences to the member(s) of the public could occur as a result of the vehicle accident alone.

The materials disposed of at the MDA H site pose negligible risk to the public. This risk assessment reveals there is no credible accident at the site that could impact the public. On-site (i.e., inside the LANL boundaries) transportation (i.e., vehicular) accidents involving workers can be assumed to be standard industrial accidents. An off-site (outside the LANL boundaries) transportation accident is the only credible accident of concern involving the public. Current Department of Transportation statistics indicate that the probability of a fatal crash involving a large truck is 2.5×10^{-8}/fatalities/mile. Based on a maximum of 45,000 miles of truck travel to move MDA H waste offsite per year, the risk of a fatality to a member of the public is estimated to be about 1.13×10^{-3}/year (once every ~900 years). Likewise, the probability of an injury accident involving a truck is 4.5×10^{-7}/injuries/mile or 2.03×10^{-2}/year (once every ~50 years). The risk reduction to be achieved by implementing controls for vehicle accidents, other than required driver certification, is very limited, as it is for workers. Few, if any, controls can be contemplated that would further reduce a number that is already so small.

For all accident scenarios of concern (risk ranking 4 or higher), the total average (between the unmitigated and mitigated) risk to workers from all remediation activities is about a factor of 22 higher than to the public; in other words, the risk to the public is less than 5% of the risk to the worker.

The risk analysis identified several controls that need to be implemented to reduce the overall risk to workers from remediation activities. These controls are identified explicitly in this report and should be implemented formally through procedures and personnel training.

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TABLES

ACRONYMS

AC	administrative control
CFR	Code of Federal Regulations
DOE	Department of Energy
DOT	Department of Transportation
EG	evaluation guideline
EPA	Environmental Protection Agency
ER	environmental restoration
ERPG	Emergency Response Planning Guideline
FMEA	failure modes and effects analysis
HAZOP	hazard and operability analysis
HC	hazard category
HE	high explosive
LANL	Los Alamos National Laboratory
MAR	material at risk
MDA	material disposal area
NDA	non destructive assay
NDE	non destructive examination
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
PrHA	process hazards analysis
RQ	reportable quantity
SIH	standard industrial hazard
TA	technical area
TEDE	total effective dose equivalent
UPS	uninterruptible power supply

1. INTRODUCTION

1.1 Purpose and Goal of the Risk Analysis

The purpose of this report is to evaluate the unmitigated and mitigated worker and transportation risks associated with remediating (excavation alternative) the Material Disposal Area (MDA) H site at Technical Area (TA)-54 at Los Alamos National Laboratory (LANL or the Laboratory). Unmitigated risk refers to the product of the likelihood and consequences from postulated accident scenarios for which no controls are credited in reducing the likelihood of or consequences from such scenarios. The mitigated risk is based on crediting controls that will be established and implemented for all remediation activities.

The risk analysis is performed for all remediation activities and by various accident categories. These remediation activities include:

- site preparation;
- site excavation;
- sort/segregation;
- declassification;
- packaging/loading;
- transportation; and
- site restoration.

Accident categories include:

- industrial hazard/accidents;
- potential fires;
- explosions;
- spills; and
- inadvertent exposures to penetrating radiation.

The goal of this evaluation is to determine the dominant accident category for each of the remediation activities, determine the overall dominant risk remediation activity, and identify the major controls that should be employed to prevent or mitigate the dominant risk.

All risk estimates are based on semi-quantitative evaluation of the frequencies and consequences for postulated scenarios, and on a qualitative risk-ranking matrix.

1.2 Site Description

MDA H is a 70-ft by 200-ft (0.3-acre) fenced area located on Mesita del Buey, a small mesa that lies between Pajarito Canyon and Cañada del Buey. It consists of 9 inactive vertical disposal shafts arranged in a line approximately 15 ft inside its southern fence. Each shaft is cylindrical with a diameter of 6 ft and a depth of 60 ft. To protect against the possible impacts of mesa-edge instability, all MDA H disposal shafts were placed more than 50 ft back from the rim of Pajarito Canyon (the nearest canyon). The surface of MDA H is contoured to concentrate runoff into a single drainage to Pajarito Canyon.

MDA H was the Laboratory's primary disposal area for classified, solid-form waste from May 1960, until August 1986. Disposal was restricted to items or materials that were determined by authorized personnel to be both classified and either excess or no longer required for their intended use. This determination was recorded on disposal request forms accompanying the waste. All material disposed was required to be double packed with an opaque outer material, such as a plastic bag or a drum. Lightweight wastes were dropped into waste disposal shafts, and heavier materials were lowered by heavy equipment. Classified materials were solids, although these solids could contain liquid or gas residue. Shafts were filled to within about 6 ft of the surface. The wastes in shafts 1 through 8 were isolated with 3 ft of concrete, over which an additional 3 ft of crushed tuff was tamped; the waste in shaft 9 was covered with 6 ft of concrete. Each shaft was covered with a steel plate that was padlocked to prevent unauthorized access to classified materials.

Disposals were recorded in a logbook containing a brief, unclassified description of the waste and an approximate weight. The waste descriptions generally include sufficient information to identify, with varying degrees of certainty, the *types* of hazardous and radioactive waste in the inventory; however, the *amount* of waste cannot be quantified absolutely for practical and security reasons. To conduct this risk analysis the inventory quantities (masses of chemicals and activities of radionuclides) were estimated by

both (1) direct approximation based on logbook entries, and (2) bounding overestimates based on expert judgment. The uncertainties in these estimates are considered quantitatively.

2. RISK METHODOLOGY

This section summarizes the methodology used to conduct the risk assessment. This methodology is used to present a comprehensive evaluation of activity-related, natural phenomena, and external hazards that can affect the workers and the public and to systematically evaluate potential accident scenarios that could result form such hazards.

The risk methodology is based on analyzing both hazards already present in the site and those introduced by the remediation activities to be conducted. The process identifies facility hazards and evaluates potential events of interest, consequences that might result from postulated accidents involving these hazards, and identifies the controls that could be used to prevent or mitigate the consequences. The risk analysis is divided into two parts–hazard identification and risk evaluation.

A combination of hazard identification, What If?, and process hazards analysis (PrHA) methods are used in the risk analysis for all remediation activities in order to support the risk assessment. The methods used are modified preliminary hazard analysis and PrHA methods described in the American Institute of Chemical Engineers' *Guidelines for Hazard Evaluation Procedures* and LANL *Hazard Analysis Technical Methodology Handbook* (FWO-OAB-501). The approach is consistent with Department of Energy (DOE)-STD-3009-94 (DOE-STD-3009) and DOE-HDBK-3010-94 (DOE-HDBK-3010).

The following subsections present the methodology used to identify and characterize hazards and to systematically evaluate basic accidents.

2.1 Hazard Identification

The hazard identification process identifies all the hazards intrinsic to the site and associated with the remediation activities. These hazards include not only radiological and hazardous materials (e.g., toxic chemicals), but also energy sources (e.g. explosives).

Hazard identification selects those intrinsic hazards (the materials stored) and the hazards associated with remediation activities that might present a threat to the health and safety of on-site workers or the public. Hazard identification also determines which hazards require more detailed evaluation or analysis based on their potential to cause harm and also serves to screen out those hazards that do not pose any significant consequences to workers or the public.

A team of qualified safety analysts prepared the hazard analysis with input from the environmental restoration (ER) organization at LANL. The team consisted of hazard/risk analysts with backgrounds in nuclear engineering, physics, health physics, statistics, and chemical engineering.

The first step in the hazard identification process is to identify all the intrinsic hazards present at the MDA H site, along with those hazards introduced by the individual remediation activities. To facilitate this process, the remediation effort was divided into the specific major activities illustrated in Figure 1.

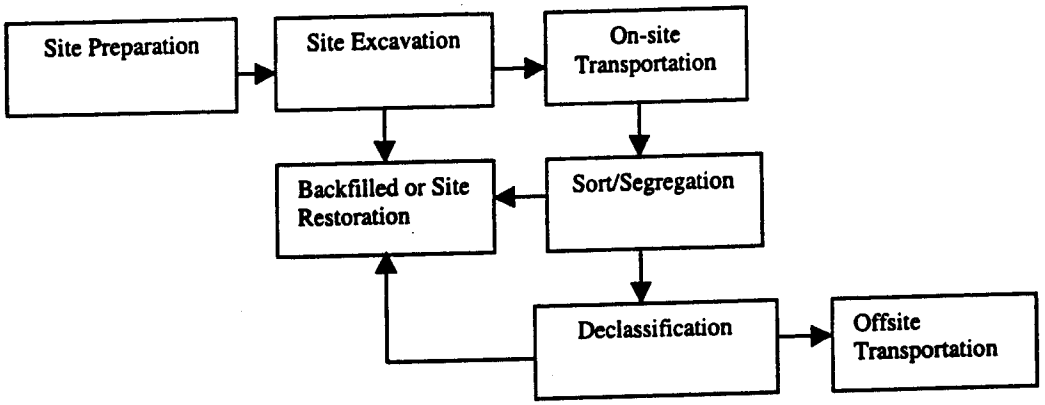

Figure 1. Remediation Activities Evaluated

Hazard identification requires a review of the disposal request forms and discussion with personnel experienced in the remediation activities to be conducted. As part of the process, radioactive and hazardous materials, and energy sources involved in the activities identified above, are identified and documented.

A predefined list of hazards (a hazard identification checklist) is used as a tool for identifying hazards; this hazard identification checklist is similar to the one in the LANL *Hazard Methodology Handbook* (FWO-OAB-501).

The second step is to screen the hazards identified to identify those with the potential to threaten workers or the public. The resulting hazards are identified explicitly in this report. Common industrial hazards that could cause a major injury or death to workers are identified explicitly in this risk evaluation.

The hazards identified in the PrHAs were reviewed and evaluated against the screening criteria in Table 1. The radiological thresholds are based on Category 3 quantities listed in DOE-STD-1027, while the toxic thresholds are based on the reportable quantities (RQs) from the Code of Federal Regulations (CFR) in 40 CFR 302 (for hazardous substances) and 40 CFR 355 (for extremely hazardous substances).

The initial radiological and non-radiological hazard identification screening criteria are designed to identify those hazards that even under unmitigated circumstances will lead to negligible, or no consequences to local workers. The PrHA screening threshold is taken to be such that the unmitigated consequence of the hazardous material or energy release could potentially result in life-threatening or serious health effects to personnel in the immediate vicinity of the event, or could lead to a release of radioactive or hazardous material to the environment, thus potentially impacting the public.

If the hazard exceeds the initial hazard screening threshold value in Table 1, then the hazard is carried forward for additional analysis. Hazards that are considered standard industrial hazards (SIHs) and result in minor worker consequences are screened out and no additional analysis is required except for their potential impact on other hazards of concern. SIHs that might initiate or exacerbate a release of radioactive or hazardous material are not screened out. SIHs and associated accidents refer to those that are routinely encountered in industrial activities.

The third step in the hazard identification process is to characterize those hazards not screened out with respect to their inventory, material form, and location, and to identify existing controls that deal with them. A comprehensive database with detailed data for all radioactive and hazardous materials being stored in the MDA H site was created from the disposal request forms and interviews with past operating personnel (ER, 2001). This database contains information on the material inventory and form, and reports the present storage location. The database was used to support the hazard and accident analysis. The hazard identification checklists contain characterization information on material quantities, forms, and locations in the MDA H site, and on the hazards introduced by the remediation activities themselves.

Table 1. Hazard Screening Criteria

Screening Criteria	Radiological Hazards	Toxicological Hazards	Other Hazards
Initial hazard identification	> 10% of hazard category (HC) HC-3 thresholds in DOE-STD-1027	>10% of 40 CFR 302 or 40 CFR 355 RQs for extremely hazardous chemicals respectively	Industrial hazards or energy sources that will result in releases of hazardous material or will result in serious injuries or fatalities to local workers.
Process hazard analysis (PrHA)	> HC-3 thresholds in DOE-STD-1027	> 40 CFR 302 or 40 CFR 355 RQs for extremely hazardous chemicals respectively	Hazards or energy sources that could result in releases of hazardous material or could result in severe worker injuries or fatalities.

2.2 Risk/Hazard Evaluation

Risk is defined as the product of the frequency of occurrence and the consequences for postulated accident scenarios. Risk evaluation is the process of identifying accidents involving the identified hazards, identifying the controls needed to prevent such accidents or mitigate their consequences, and determining the unmitigated/mitigated consequences and event frequencies. The objective is to identify the major contributors to risk, to identify controls that minimize operational risks, and to identify the most significant controls for the remediation activities.

The major role of the risk analysis effort is to evaluate process and activities to postulate and develop accident scenarios that will define the full spectrum of potential accidents for the remediation activities involving hazardous materials (radioactive, explosive, or toxic). The hazard analysis also identifies and develops a limited set of scenarios for industrial type of accidents to determine if they could be initiators or contributors to the release of hazardous materials.

The first step of the risk evaluation process is to select an appropriate analysis technique to be applied to the hazards and to evaluate the accident scenarios of interest. Several standard techniques are well documented in the industry and provide an acceptable method for performing a risk analysis. These analysis techniques include What-If?, hazards checklist, hazard and operability analysis (HAZOP), fault trees, PrHA and failure modes and effects analysis (FMEA). The type of analysis used for the remediation activities is a combination of the What-If? and the PrHA method. The What-If? technique provides a means for the team to creatively brainstorm accident scenarios that could occur throughout the

facility. The overall purpose of the What-If? analysis is to capture all types of accidents independent of the type or the consequence severity. Accidents of little or no importance (low consequences) are screened out from further analysis after the What-If? analysis is completed.

The second step of the risk assessment process is to use the PrHA technique to evaluate significant hazards for various accident categories. These accident categories include industrial accidents that could result in severe injuries or fatalities to workers, fires, explosions, spills, and inadvertent exposure to penetrating radiation. Other operational events, natural phenomena, or external events could be the initiators for such scenarios.

The PrHA addresses those accident scenarios that were not screened out by the What-If? process. PrHAs are completed for each remediation activity, as a function of hazard and accident category. For each hazard and accident category, potential accident scenarios are identified (from the What-If? table), along with the most likely initiating event. For each of the scenarios and initiating events, the following information is provided:

- semi-quantitative accident scenario frequency category;
- qualitative consequence category;
- corresponding qualitative risk ranking;
- corresponding controls;
- control identification (for purposes of sorting, only);
- control type (i.e., preventive vs. mitigative, process vs. facility, and administrative vs. engineering feature); and
- notes related to the material at risk (MAR), assumptions, identification of significant controls.

Unmitigated or uncontrolled frequency, consequences, and risk ranking are provided for each postulated accident scenario. The PrHAs also identify the fully mitigated or controlled frequency, consequences, and residual risk ranking for each accident scenario.

The expected frequency of occurrence for each unmitigated accident scenario is based on the assumption that none of the controls that either lower its frequency of occurrence (except for the initiating event) or

mitigate its consequences is in place. Table 2 presents a summary of the frequency categories assigned to the various postulated accident scenarios.

Table 2. Consequence Likelihood Categories (FWO-OAB-501)

Frequency Category	Frequency Definition	Frequency Description
I ($>10^{0}$/yr.)	Frequent (expected)	**Likely to occur often during the life of the facility** (Incidents that occur during normal operations)
II ($<10^{0}$/yr. To $> 10^{-2}$/yr.)	Probable (likely)	**Likely to occur several times during the life of the facility** (Incidents that may occur during the lifetime of the facility; these are incidents with a mean expected likelihood of once in 50 years)
III ($<10^{-2}$/yr. To $>10^{-4}$/yr.)	Occasional (unlikely)	**Should not occur during the life of the facility** (Incidents that are not anticipated to occur during the lifetime of the facility but could; these are incidents having a likelihood of between once in 100 years to 10,000 operating years)
IV ($<10^{-4}$/yr. To $> 10^{-6}$/yr.)	Improbable (extremely unlikely)	**Unlikely but possible to occur during the life of the facility** (Incidents that will probably not occur during the lifetime of the facility; these are incidents having a likelihood of between once in 10,000 years and once in a million years)
V ($<10^{-6}$/yr.)	Remote (beyond extremely unlikely)	**Should not occur during the life of the facility** (All other incidents having a likelihood of less than once in 1,000,000 operating years)

Because no controls are assumed to be in place, the estimate of the unmitigated likelihood is based on the initiating event frequency and the enabling event likelihood only. Enabling events are those events that must occur following the initiating event to result in the accident being evaluated. For example, if an accident's initiating event is an earthquake that causes equipment to collapse or fail, the enabling event could be a seismically induced fire, or having radioactive material at risk at the time of the accident. However, for simplicity, the enabling events are ignored in evaluating the unmitigated frequency determination.

To support the assessment of the frequency of occurrence of postulated scenarios, it is also assumed that no special controls are implemented above and beyond standard industrial practices. However, a high-quality industrial safety program is assumed to be in effect.

Accidents initiated by *human error* are generally considered to be in frequency category II (once every 1 to 100 yrs). These accidents include spills such as with container mishandling and accidents from

incorrect operation of equipment. These types of events are expected to occur more frequently, but most will be of minimal significance. The accident scenarios postulated are significant accidents that cause significant releases. These types of accidents are not expected to occur once each year or more frequently.

Equipment failures that lead to significant releases are also generally considered to be in frequency category II. These include failures of radioactive material containers. Similar to human error initiators, equipment failures are expected more frequently, but most will not lead to a significant release.

Operational fires are also generally considered to be in frequency category II as well. This represents the frequency range for fires at typical industrial facilities. A fire at the MDA H site initiated by a brush/forest fire is considered to be in frequency category II. The *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory*, January 1999, estimated the likelihood of a significant fire somewhere on Laboratory property to be about once every 10 yrs. Given the size of the Laboratory site, the likelihood of one of these fires affecting TA-54 and in particular MDA H is less than 1 in 10. This would result in an overall frequency for MDA H of less than 1E-2, or frequency category III. However, a conservative approach will be taken because the MDA H site does not offer much protection from a nearby brush/forest fire. A category II frequency is used for this risk analysis.

Fires and explosions caused by remediation activities are generally considered to be in frequency category III (once every 100 to 10,000 yrs). These events include fires and explosions involving vehicles or other flammable gas/liquid sources used to support remediation activities.

The frequency of an airplane crash is estimated using the methodology of DOE-STD-3014 for TA-54 (LA-13316-MS). The analysis shows that the frequency for an airplane crash into the MDA-H is in frequency category V (or remote), thus it will not be considered in this risk analysis.

Natural phenomena event initiators are generally considered to be in frequency category III (once every 100 to 10,000 yrs). These include a seismic event of 0.22g magnitude, a lightning strike starting a fire at the site during remediation activities, and high winds impacting the site or generating a missile that impacts hazardous materials or injures workers. The likelihood of lightning events themselves are considered to be in the frequency category II.

An explosion of consequence (resulting in severe injuries or fatalities to workers, and potentially releasing radioactive material), such as could occur if buried high explosives (HE) are impacted during remediation activities, is generally considered to be in frequency category III.

As with the frequency categories, qualitative unmitigated consequence severity categories are assigned to each of the postulated accident scenarios. These categories are assessed qualitatively, and for radiological materials consider factors such as inventory, material form, and energy of release. For toxic materials, factors considered include toxicity, inventory, and volatility. Table 3 identifies the various consequence categories and the criteria being used to assess them for the postulated accident scenarios for both the public and the worker. The criteria are used as guidance in determining the consequence category.

Table 3. Consequence Severity Categories [FWO-OAB-501]

Consequence Category (C)	Public (P) Consequence Description	Worker (W) Consequence Description
A	Offsite DOE EG or EPA Exposure Guidelines Exceeded or Challenged: Potential for long-term health effects. • >25 Rem TEDE (DOE EG per Appendix A to DOE-STD-3009) • >ERPG-2	Immediate Health Effects or loss of life
B	Offsite DOE EG or EPA Exposure Guidelines not Exceeded but may be Challenged: Produces irritation or discomfort but no permanent health effects. • From >5 to <25 Rem • From >ERPG-1 to <ERPG-2	Long-term health effects, disability, or severe injury (non life threatening)
C	No Challenge to Offsite DOE EG or EPA Exposure Guidelines: No significant off-site impact. • From >0.1 to <5 Rem • From measurable to <ERPG-1	Lost-time injury but no disability (work restriction)
D	Negligible: No off-site impact • <0.1 Rem (Offsite life-time dose per year per DOE-O-5400.5) • <measurable	Minor injury with no disability and no work restriction
E	None (Can elect not to use this bin if desired)	No measurable consequences

The worker consequences are assigned for the worker closest to the hazard. This is assumed to involve an MDA H remediation worker in the immediate vicinity of the hazard. Mitigated frequency estimates for all scenarios identified in the PrHAs are provided. The mitigated frequency is based on a number of subjective operational considerations, such as the number of operations to be conducted per year, the

complexity of the operation, and the number and adequacy of the controls to prevent and mitigate the accident scenario. The mitigated frequencies and consequences are also used to select the most significant controls. It is important to realize that the frequencies used in the risk analysis are not meant to be taken as absolute numbers, but rather to express expected ranges determined to represent failure of each or all controls. Table 4 lists the frequency reduction factors used for engineering and administrative controls. These reduction factors are based on generic failure rate data for both engineering and administrative controls.

Table 4 is a compendium of industry-wide data, mostly from the nuclear power industry, but they are applicable in this context. Sources include site-specific databases, Nuclear Regulatory Commission databases, and generally accepted sources. These reduction factors were used in deciding the worth of application of the individual and all the controls, and are reflected in the evaluation of the residual risk in the PrHAs.

A consequence severity rank was assigned to each accident scenario in the risk analysis. The ranking includes a consequence severity category from Table 3 for both the public (P), and the worker (W). The highest consequence severity rank of any receptor is the representative consequence severity rank for that scenario. A frequency estimate was determined and assigned for each scenario considered using the likelihood categories from Table 2.

The risk-ranking matrix (Table 5) is used to assign a qualitative risk rank to each scenario evaluated in the PrHAs. This risk matrix is applied to both workers and public.

Table 4. Reduction Factors for Some Generic Types of Controls

Type of Control	Reduction Factor
Engineering Controls	
Passive structural (e.g., building structural design, permanent shielding)	1E-4[1,2]
Passive mechanical	1E-4[1,2]
Passive electrical (e.g., grounding)	1E-4[1,2]
Active fail-safe mechanical (e.g., spring loaded valve)	1E-3[1,2]
Active fail-safe electrical (e.g., fails safe on loss of power)	1E-3[1,2]
Active mechanical safety related pedigree (e.g., safety related pump)	1E-3[1,2]
Active electrical safety related pedigree (e.g., safety related UPS)	1E-3[1,2]
Active mechanical safety related non-pedigree (e.g., industrial like sprinkler)	1E-2[1,2]
Active electrical safety related non-pedigree (e.g., non-safety related switch)	1E-2[1,2]
Fail safe detection and alarm systems	1E-3[1,2]
Non-fail safe detection and alarm systems	1E-2[1,2]
Administrative Controls	
Follow procedures that implement specific TSR administrative control elements	1E-2[3]
Certified personnel (e.g., forklift drivers)	1E-2[3]
Follow written procedures for non-specific safety controls	1E-1[3]
Nonproceduralized practices	1E-1[3]
Preventive maintenance of non-safety related equipment	1E-1[3]
Training with no certification	1E-1[3]

1 Source – Component Failure Rate Data With Potential Applicability to Plutonium Facilities, DPST-CFRP-111, E. I. DuPont de Nemours & Co., Savannah River Laboratory, 1980
2 Source – Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR), NUREG/CR-4639, U.S. NRC, December 1980
3 Source – NUREG/CR-1278 - Handbook of Human Reliability with Emphasis on Nuclear Power Plant Applications, A.D, Swain, H.E. Guttman, August 1983

Table 5. Risk Matrix

Frequency Categories	Consequence Categories				
	E	D	C	B	A
I	1	4	6	8	10
II	1	2	4	6	8
III	1	2	4	6	6
IV	1	1	2	4	6
V	1	1	1	2	4

The matrix in Table 5 is designed to give the highest number designation to those presenting the highest potential risk. The consequences are weighted more heavily than the frequency of accident scenarios when assigning risk ranking. In general, scenarios with an unmitigated risk ranking of 6 or higher should require the implementation of controls to reduce the risk. The goal of the remedial activities is to have no operational accidents with mitigated risks above 4; the exception to this might be standard industrial accidents that are still likely to result in mitigated risk levels of 6. That is, while the frequency of occurrence of such events could be reduced significantly by implementing preventive controls, their consequences still might result in severe injuries and fatalities.

Many initiating events, such as explosions or lightning strikes, themselves have the potential to produce major worker consequences independent of a release of radioactive material. The worker consequences for these cases are based on the initiating event itself. Such accident scenarios are categorized in the major consequence bin (Category A). Worker consequences from fires are based solely on the total amount of hazardous material that could be released as a result of the fire. Worker consequences from the fire itself are not considered.

The frequency and consequence rankings identified above, along with consensus judgment and the risk-ranking matrix in Table 5 are used to assign a qualitative, unmitigated/mitigated risk measure to each accident scenario for both the public and the worker. For practical purposes it is assumed that the environmental consequences and risks are equivalent to those for the public.

The preventive and mitigative controls identified in the PrHA give an indication of the defense-in-depth provided by the activity controls for potential events of interest.

Safety management programs are also used in the PrHA process to provide preventive and mitigative functions in addition to the activity controls. The safety programs might apply when a relevant hazard is identified, and they provide administrative controls (ACs) to support defense-in-depth.

The final step in the risk analysis is to evaluate controls for safety classification. Typically, the PrHA table for each accident scenario with an unmitigated risk rank 6 is reviewed and the most significant controls are identified. Each of these controls (or set of controls, in some cases) is then assessed individually for its effectiveness by determining whether it will reduce the frequency (for preventive features) or consequences (for mitigative features) for both the public and the worker. Even though no

mitigated frequencies, consequences, and risk rankings are developed for each control, the value of the most significant control to prevent or mitigate the postulated scenario is based on engineering judgment. However, the mitigated frequency, consequences, and (residual) risk ranking are estimated for the complete set of controls.

This evaluation identifies controls that can help prevent and/or mitigate the consequences of the postulated events. Those classified as the most important safety controls are identified based on their importance with respect to the criteria defined in DOE-STD-3009 for importance to defense-in-depth or the capability to prevent or mitigate potential worker fatalities or severe injuries. These important controls (equivalent to safety-significant controls as defined by DOE-STD-3009) will be considered for implementation through formal procedures and training.

In the risk analysis, the accident scenarios and their associated risk estimates are sorted by remediation activity and accident category. This allows each of the activities to be evaluated in relation to the accident categories, and vice versa. To determine the total risk for a given accident category (e.g., explosions) for a given remediation activity, the risk of each of the postulated explosion scenarios for each of the remediation activities will be added. All risk estimates are considered to be relative to each other, and in no way represent absolute values.

3. RISK EVALUATION

This risk analysis uses the qualitative values determined in the PrHAs to identify the major risk contributors and to define the residual or mitigated risk from excavation activities, and to identify the most important controls to prevent or mitigate potential accidents from the activities to be conducted at MDA H. This section summarizes the results of the risk evaluation using the methodology described in Section 2.

3.1 Hazard Identification Results

Table 6 lists the major intrinsic hazards–hazards that are integral to the waste material present at the site. All other intrinsic hazards such as tritium, thorium are found either as residual contamination in the waste or in relatively small quantities throughout the entire site (screened out using the initial hazard identification in Table 1). Thus, the consequences from these hazards are relatively small for workers and

the public. These hazards were based on the summary table of hazards in Appendix A and the hazard identification checklists included in Appendix B.

The remedial activities bring hazards that could become accident initiators impacting the intrinsic hazards listed above. The major hazards introduced by the remedial activities are those associated with using heavy equipment, including vehicles, and associated fuels; potential for the use of grinding and cutting (welding) equipment; and relatively high-voltage electrical power lines/equipment. During the sorting/segregation, penetrating radiation associated with non destructive assay/non destructive examination (NDA/NDE) equipment such as radiography units could introduce a serious worker hazard.

Table 6. Major Intrinsic Hazards Within the MDA H Site

Hazard	Description	Quantity	Location
Plutonium (Pu)	Mostly as contamination of metal surfaces	< 2.0×10^{-2} Ci	Shafts 5 and 7
Fuel Elements	It is believed to be non-irradiated fuel elements; most of the activity is U-234	< 42 Ci	Shafts 3 through 7
Enriched Uranium (EU)	Most of the activity is U-234	< 65Ci	Shafts 1,2, 4, 6-8
Depleted Uranium (DU)	Solid metal pieces are found throughout the shafts	< 64 Ci (~ 231,000 lbs of DU)	All shafts
High Explosives (HE)	This includes contaminated HE	< HE ~ 4,800 lbs Contaminated HE parts < 47,200 lbs	HE (pure) in shaft 3 Contaminated HE parts in all shafts
Lithium compounds	These compounds are for the most part reactive or toxic (e.g., LiH)	< ~ 4,950 lbs	Mostly in shafts 3, 4
Mercury	This includes mercury as a metal and as contaminated waste	< ~ 3,900 lbs	All shafts
Lead	Used mostly for shielding and mockups	< ~ 78,200 lbs	All shafts
Beryllium	Metal and waste contaminated materials	< ~ 19,600 lbs	All shafts

3.2 Risk Evaluation Results

This section summarizes the results of the risk evaluation. The detailed evaluation data are included in the What-If? and PrHA tables in appendices C and D, respectively. The analysis followed the methodology described in Section 2. A summary of the hazards that impact the safety of the facility was given in Section 3.1. The What-If? tables include scenarios that roll up into PrHA scenarios covering all remediation activities.

Scenarios involving hazards above the initial hazard identification threshold screening criteria in Table 1 were identified in the What If? What-If? analysis was used as the first step in identifying accident scenarios. Each remediation activity was brainstormed for potential accident scenarios, and the What-If? tables were used to identify the worst consequences for the postulated scenarios and to determine if a scenario was screened out or should be evaluated further by PrHA.

The What-If? analysis was used both as a means to identify a wide spectrum of potential accident scenarios or events that could occur during remediation activities, and as a means to screen accident scenarios for further evaluation in the PrHAs. Over 150 potential accident scenarios were postulated in the What If? tables in Appendix C; a large fraction of these scenarios resulted in serious injuries or fatalities to workers from industrial or routine hazards. Also, many of the postulated scenarios in the What If? tables resulted in minor consequences to both workers and the public, thus they were screened from further evaluation.

More than 30 standard industrial accidents that could result in severe worker injuries were identified for all the remediation activities. Most of these accidents are vehicle accidents, equipment failures, lightning strikes, electrocution, and human errors. For each of the remediation activities, the industrial accidents are grouped under a single generic industrial accident in the PrHA, but the number of such accidents is used to help determine the overall risk to workers from such events.

The What-If? analysis tables included in Appendix C provide traceability through the hazard analysis process primarily because they (1) identify potential accident scenarios that were screened from further analysis in the PrHA, and (2) they provide a roadmap to the condensed set of What If? scenarios that were analyzed in the PrHA.

Several accident scenarios were screened out from further consideration because all the What-If? scenarios developed for them are: (1) standard or industrial accidents (with no significant consequences to workers), and complying with Occupational Safety and Health Administration (OSHA) regulations provides the requisite level of worker protection; (2) not possible, based on the physical situation (e.g., not enough fissile material to create a criticality accident); (3) result only in negligible consequences to both workers and public; or (4) result only in equipment damage or delays in the activities.

If any What-If? scenario for a given remediation activity exceeded the PrHA screening criteria in Table 1, or the scenario is an industrial accident that could result in a severe injury or death, the scenario was carried forward into the PrHA tables.

PrHA tables were developed for all of the remediation activities. For each of the postulated accident scenarios (from the What-If? analysis), potential accident initiators for each scenario were identified. These initiators were taken primarily from the What-If? tables, with additional consideration given to potential initiators identified by discussion with ER personnel and other personnel familiar with remedial operations. The analysis considered potential accident initiators from operational events (involving both facility processes and activities), natural phenomena, and external event.

For each postulated accident scenario and initiating event, the unmitigated frequency of occurrence, the unmitigated consequences, and the risks to workers and the public were determined using the criteria and methodology described in Section 2. The residual or mitigated risk was determined based on the number and overall adequacy of the controls to prevent or mitigate the postulated scenario.

Table 7 presents a summary of the PrHA scenarios in a cross-foot matrix format. This table presents, the number of postulated accident scenarios in each of the risk bins and their relative risk ranking. PrHA scenarios with a risk ranking to either the worker or the public equal to or greater than 4 in the unmitigated condition are considered scenarios of concern and require controls to reduce the overall risk (shown highlighted in Table 7); scenarios with a risk ranking greater than 4 are considered to have a relatively high risk.

Table 7. Number of Accident Scenarios by Risk Bin/Rankings for all Remediation Activities

Frequency Category		Consequence Categories				
		E	D	C	B	A
	Risk Rank	1	4	6	8	10
	I	0 | 0 0 | 0	0 | 0 0 | 0	0 | 0 0 | 0	0 | 0 0 | 0	0 | 0 0 | 0
	Risk Rank	1	2	4	6	8
	II	0 | 29 0 | 0	0 | 7 0 | 0	7 | 2 0 | 0	0 | 0 0 | 0	32 | 2 0 | 0
	Risk Rank	1	2	4	6	6
	III	0 | 2 0 | 29	0 | 29 7 | 9	19 | 0 2 | 0	1 | 0 0 | 0	13 | 0 26 | 2
	Risk Rank	1	1	2	4	6
	IV	0 | 4 0 | 6	0 | 17 21 | 39	1 | 0 2 | 0	7 | 0 18 | 0	12 | 0 4 | 0
	Risk Rank	1	1	1	2	4
	V	0 | 0 0 | 0	0 | 0 0 | 9	0 | 0 5 | 0	0 | 0 1 | 0	0 | 0 3 | 0

UW | UP
MW | MP

Key: UW = Number of scenarios presenting unmitigated risk to the worker
UP = Number of scenarios presenting unmitigated risk to the public
MW = Number of scenarios presenting mitigated risk to the worker
MP = Number of scenarios presenting mitigated risk to the public

Table 8 presents similar results in a table matrix format for all remediation activities; Appendix E presents similar tables for each individual remediation activity.

Table 8. Risk Summary-Totals for All Activities (Number of PrHA Scenarios)

Consequence	E		D		C		B		A	
Frequency	W	P	W	P	W	P	W	P	W	P
I-unmitigated										
I-mitigated										
II-unmitigated		29		7	7	2			32	2
II-mitigated										
III-unmitigated		2		29	19		1		13	
III-mitigated		29	7	9	2				26	2
IV-unmitigated		4		17	1		7		12	
IV-mitigated		6	21	39	2		18		4	
V-unmitigated										
V-mitigated				9	5		1		3	

It is clear from tables 7 and 8 that the majority of the postulated unmitigated and mitigated accident scenarios are in risk bins or have a risk ranking that is acceptable (i.e., below 6). As stated previously, many of the scenarios that fall under the risk bins of concern relate to standard or industrial types of accidents that could result in severe consequences to workers. Mitigated risk for standard or industrial accidents still are considered to be relatively high; that is, while the mitigated frequency of such scenarios could be reduced considerably (i.e., from likely events to extremely unlikely events), the mitigated consequences could still be severe injuries to workers. However, the residual risks from these accident scenarios are typically "accepted," and further risk reduction might not be cost-effective.

The other accident scenarios with potentially large unmitigated risk to workers are those from explosion scenarios when excavating or handling high explosives (HE) during the remediation activities. The risk from explosion scenarios is mitigated mostly by implementing preventive controls, but even so, the mitigated consequences to workers from such scenarios could still be severe. Therefore, risk is still considered to be of concern, and might require formally implementing more controls into procedures and training.

Only two accident scenarios were identified as having potentially relatively high unmitigated and mitigated risk to the public (see Appendix E). These correspond to vehicle accidents during offsite transportation activities that are postulated to result in severe or fatal consequences to members of the public. The materials disposed of at the MDA H site pose negligible risk to the public. This risk assessment reveals there is no credible accident at the site that could impact the public. On-site (i.e., inside the LANL boundaries) transportation (i.e., vehicular) accidents involving workers can be assumed to be standard industrial accidents. An off-site (outside the LANL boundaries) transportation accidents is the only credible accident of concern involving the public. Current Department of Transportation statistics indicate that the probability of a fatal crash involving a large truck is 2.5×10^{-8}/fatalities/mile. Based on a maximum of 45,000 miles of truck travel to move MDA H waste offsite per year, the risk of a fatality to a member of the public is estimated to be about 1.13×10^{-3}/year (once every ~900 years). Likewise, the probability of an injury accident involving a truck is 4.5×10^{-7}/injuries/mile or 2.03×10^{-2}/ year (once every ~50 years). The risk reduction to be achieved by implementing controls for vehicle accidents, other than required driver certification, is very limited, as it is for workers. Few, if any, controls can be contemplated that would further reduce a number that is already so small.

These scenarios have a risk bin and ranking of IIA (8) and IIIA (6), respectively for the mitigated and unmitigated scenarios. That is, the unmitigated vehicle accidents fall under the risk bin of IIA and each has a risk ranking of 8; whereas, the mitigated risk for the same scenarios has a risk bin and ranking of IIIA and 6, respectively. The overall risk ranking for these two scenarios is 16 for the unmitigated scenario and 12 for the mitigated ones. Also notice that the severe consequences are from the vehicle accidents themselves and not from the hazardous materials being transported.

The results in tables 7 or 8 and the tables in Appendix E were used to determine the relative risk ranking of postulated accident scenarios by accident category. This was done by multiplying the number of accident categories in each of the risk matrix bins by the corresponding risk ranking level assigned to the risk bin, and adding the overall number of events.

Appendix F summarizes the unmitigated and mitigated risks as a function of accident category for each of the remediation activities. Table 9 summarizes the relative worker unmitigated and mitigated risk ranking for each remediation activity as a function of accident category.

It is clear from Appendix F and Table 9 that the unmitigated risk for each of the remediation activities is dominated by standard or industrial accidents, with the exception for the sort/segregate and packing/loading activities, in which explosion scenarios dominate the risk. The mitigated worker risk is totally dominated by the standard or industrial accidents; only a few explosion scenarios were identified as having residual risks that are still relatively high. These scenarios are related mostly to the activities in which mechanical insults could lead to an explosion, and thus severe or fatal consequences to workers.

It is also clear from Table 9 that the site excavation activities have the highest unmitigated risk ranking, followed by the sort and segregation activities (relative risk rankings of 126 and 106, respectively). On the other hand, while the mitigated or residual risk is still higher for the site excavation activities (relative risk ranking 98), the packing and loading activities and declassifications seem to have the next highest residual risk rankings (62 and 60). The reason for the lower residual risks for the sort and segregation activities as compared to the declassification and packing/loading activities is because in the former remote equipment will be used to prevent or mitigated the postulated explosions, while for the later (declassification and packing/loading) more direct handling of HE will be required.

An overall summary of controls to prevent the postulated accident scenarios identified in the PrHAs is provided in Table 10. The most significant controls are identified in the table. Most of the controls are administrative in nature; very few are engineering controls. The most significant controls are expected to be implemented through formal procedures and personnel training. Other controls identified should be implemented through general personnel training and might or might not be written into procedures.

The results of these risk estimates can be presented graphically. The unmitigated and mitigated worker risk can be presented in cluster columns to facilitate understanding the dominant risk per accident category and remediation activity. Figures 2 and 3 present such risk estimates, and present the unmitigated and mitigated worker risk with respect to the overall risk ranking.

Table 9. Summary of the Unmitigated and Mitigated Relative Worker Risk Ranking by Remediation Activity and Accident Category

Remediation Activity → / Accident Category ↓		Site Preparation	Site Excavation	Sort and Segregation	Declassification	Packing and Loading	Transportation	Site Remediation	Total Risk
Industrial Accidents	U	46	70	30	36	30	16	30	258
	M	36	54	24	30	30	12	24	210
Fires	U	0	16	16	16	16	6	0	70
	M	0	16	4	4	4	2	0	30
Explosions	U	14	30	34	34	36	12	0	160
	M	18	24	21	21	23	6	0	113
Spills or Loss of Containment	U	0	4	12	8	8	8	0	40
	M	0	2	5	4	4	6	0	21
Inadvertent Exposures	U	0	6	14	4	4	0	0	28
	M	0	2	3	1	1	0	0	7
Total Risk	U	60	126	106	98	94	42	30	556
	M	54	98	57	60	62	26	24	381

*U – Unmitigated, M - Mitigated

Table 10. TA-54 MDH H Excavation Alternative Controls

Control Description	Control Type	Most Significant Controls
General Site Controls		
Job specific training	PSA	√
Site shutdown procedures	MSA	
Access controlled zones (hot, warm, cold)	PSA	√
Run off control	MSA	
Personal protective equipment (PPE)	MSA	
HazMat Team	MSA	
LANL emergency response	MSA	
Waste characterization controls	PSA	
Shaft/pit stabilization (i.e. controlled earth removal)	PSA	√
Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PSA	√
Maintenance of equipment and vehicles	PSA	
Anchoring of domes	PPE	
Fire Controls		
Fire department response	MSA	
Basic personnel fire suppression training	PSA	
Onsite notification of shut down (e.g. lightning)	PSE	
Manual fire equipment (e.g., extinguishers)	MSE	
Dome lightning protection	PPE	
Restriction on hot work/spark producing activities	PSA	√
Green areas around excavation site or buffer fire zone	PSA	√
Fire retardant dome fabric	PPE	
Ignition source control	PSA	√
Combustible loading control in waste areas	PSA	
Dome heating restrictions	PPA	
Restrictions on refueling operations	PSA	√
Transportation Controls		
Use of tie downs for containers	PPA	
Use of containers for transportation of hazardous materials	PPA	
Packaging requirements (per DOT requirements for offsite shipment)	PPA	√
Speed limits onsite	PSA	√
Explosion Controls		
Blast shields/berms	MPE	√
Reactive waste controls	PSA	
Remote removal of waste from shafts	PPA	√

Control Description	Control Type	Most Significant Controls
EOD (explosive) trained personnel	PPA	√
Approved tools and equipment	PSA	
Stand off distance	PPA	√
Remote video camera (excavation only)	PPE	√
Visual examination	PPA	
Explosive use only with approved HCP (e.g. explosive removal of concrete)	PPA	√
Dust control for static discharge	PPA	
Explosive detection equipment	PPE	
Explosive inerting (safe configuration)	PPA	√
Restrictions on digging within and around shafts	PPA	√
HE only in shafts	PSA	
Shafts cover protection	PPE	
Spills and Loss of Containment Controls		
Chemical monitor	MPE	
Radiation monitors	MPE	√
Containerization control plans	PPA	
Inadvertent Exposures		
RTR equipment controls (shielding, interlocks, etc.)	PPE	√
RCT monitoring of areas	PPA	√
Radiation area posting	PPA	√

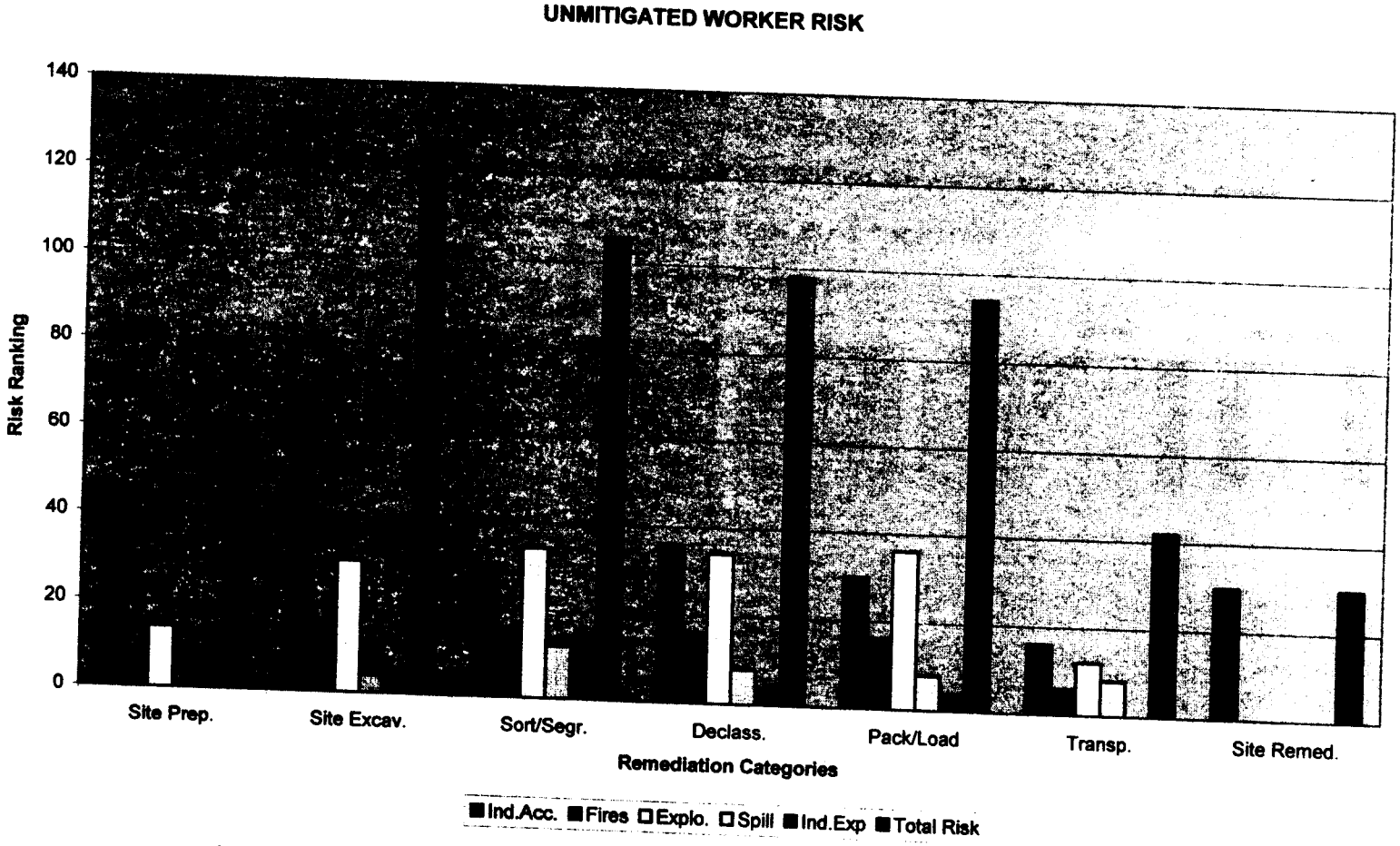

Figure 2. Relative Unmitigated Worker Risk Ranking for the Various Remediation Activities

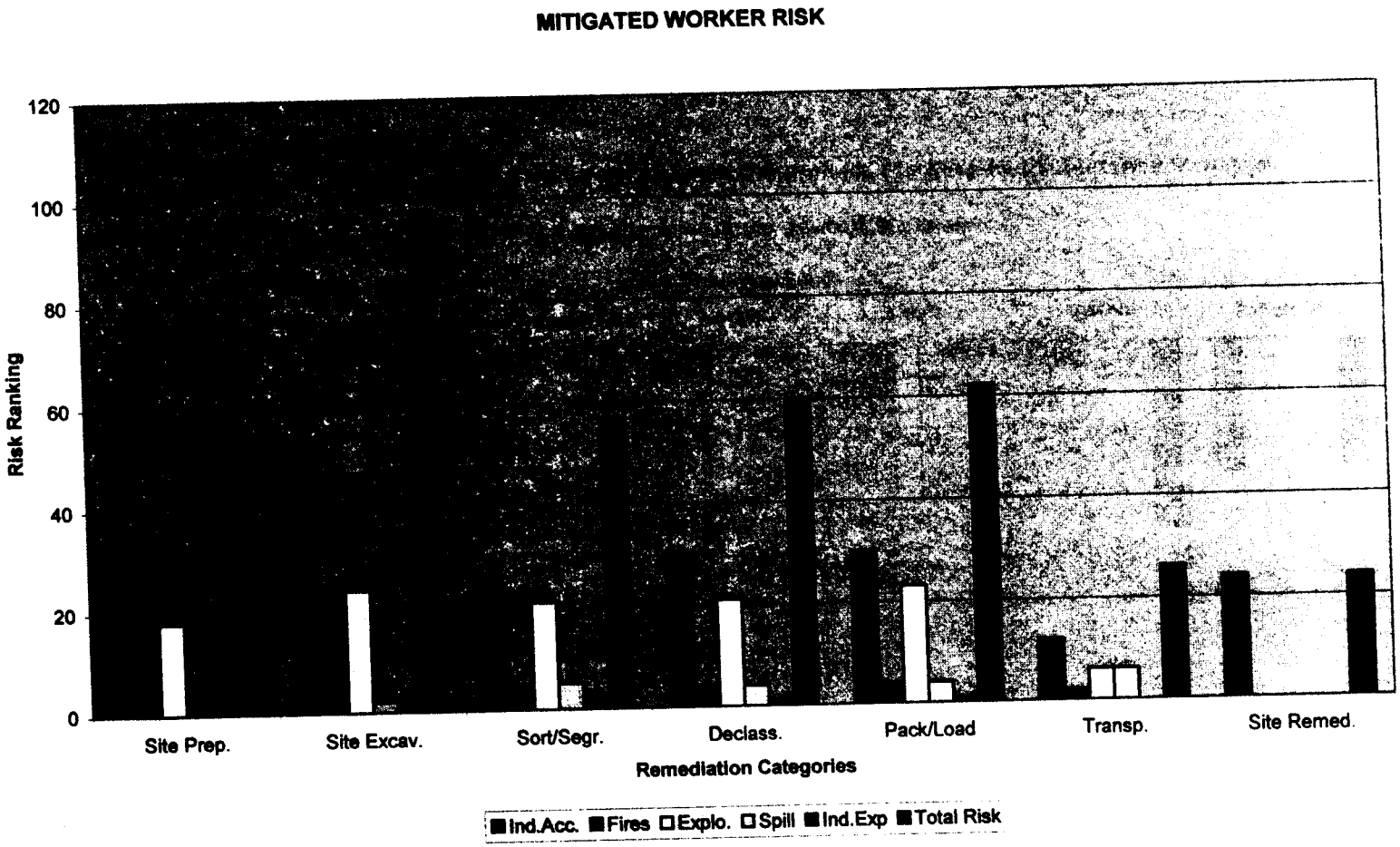

Figure 3. Relative Mitigated Worker Risk Ranking for the Various Remediation Activities

4. CONCLUSIONS

This risk assessment for the excavation alternative leads to the following conclusions.

The materials disposed at MDA H pose negligible risk to workers until remediation activities begin. At that point, risk is dominated by two categories of potential accidents: standard industrial accidents, and explosions (see Figure 2, p. 25). Figures 2 and 3 show that for unmitigated circumstances, standard industrial accidents dominate most remediation activity groups. For mitigated circumstances, standard industrial accidents dominate all remediation activity groups Because workers at LANL are highly trained to deal with, thoroughly briefed on, and accept the risks inherent in working where they do, this assessment has focused on events other than standard industrial accidents. In addition, when a high-quality industrial safety program is in place, as is the case at LANL, additional controls are unlikely to reduce industrial accident risk by a significant amount.

Figures 4 and 5 present the mitigated worker risk as a function of accident category and remediation activity and illustrate the percent contributions of these to the overall remediation activity risks. Figure 4 shows that the overall risk from remedial activities is dominated by standard or industrial types of accidents (58% of the total risk); excluding the standard and industrial types of accidents, the risk from explosions dominates the worker risk for most of the remedial activities. The explosion risk represents about 27% of the overall risk, while the transportation activities (both on-site and off-site) represent only 7% of the overall risk. Figure 5 shows that the risk from all remediation activities is dominated by the site excavation activities, with 26% of the total mitigated worker risk. Similar results can be obtained for the unmitigated worker risk (about 22%).

Table 9 and Appendix F show that the total absolute risk number for workers for *unmitigated* accidents is 556. Of this, 258 is for standard industrial accidents, leaving 298 for all other categories of accidents. The total absolute risk number for *mitigated* accidents is 381. Of this, 210 is for standard industrial accidents, leaving 171 for all other categories of accidents. Implementing controls reduces the absolute risk number for non standard industrial accidents from 298 to 171, a reduction of nearly 43%. A variety of controls will be implemented to achieve this risk reduction. Many will be administrative, but a number will be engineered, including shaft/pit stabilization, blast shields/berms, remote waste removal techniques, remote video surveillance, explosives inerting, and radiation monitors (see Table 10, p. 23).

Additional controls to reduce worker risk significantly (such as all excavation carried out remotely) would be prohibitively costly.

The materials disposed of at the MDA H site pose negligible risk to the public. This risk assessment reveals there is no credible accident at the site that could impact the public. On-site (i.e., inside the LANL boundaries) transportation (i.e., vehicular) accidents involving workers can be assumed to be standard industrial accidents. An off-site (outside the LANL boundaries) transportation accident is the only credible accident of concern involving the public. Current Department of Transportation statistics (DOT HS 809 088) indicate that the probability of a fatal crash involving a large truck is 2.5×10^{-8}/fatalities/mile. Based on a maximum of 45,000 miles of truck travel to move MDA H waste offsite per year, the risk of a fatality to a member of the public is estimated to be about 1.13×10^{-3}/year (once every ~900 years). Likewise, the probability of an injury accident involving a truck is 4.5×10^{-7}/injuries/mile or 2.03×10^{-2}/year (once every ~50 years). The risk reduction to be achieved by implementing controls for vehicle accidents, other than required driver certification, is very limited, as it is for workers. Few, if any, controls can be contemplated that would further reduce a number that is already so small.

In addition, it is clear that the consequence to the public of an offsite vehicular accident, whether it involves a fatality, a severe injury, a minor injury, or merely property damage, is the only consequence of concern. The quantities and hazard intensities of radiological and hazardous materials that will be shipped are so low that even a transportation accident involving a fire and/or an explosion would result in negligible consequences to the public from the waste inventory being transported. Therefore, an off-site transportation accident essentially is a standard industrial accident.

5. REFERENCES

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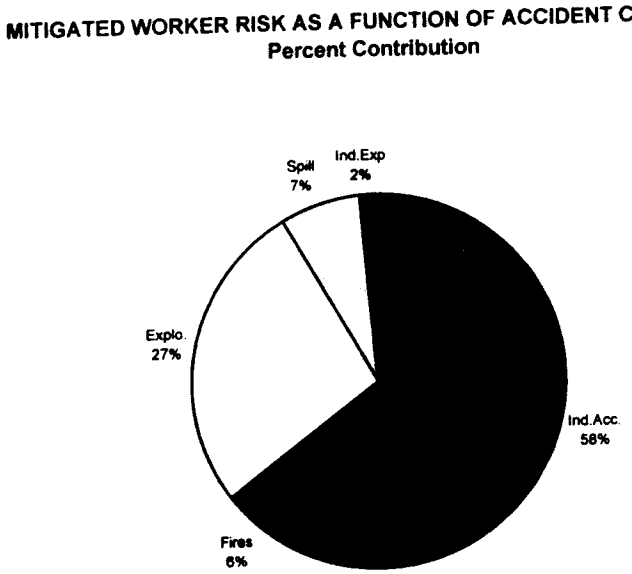

Figure 4. Mitigated Risk Percent Contribution by Accident Category

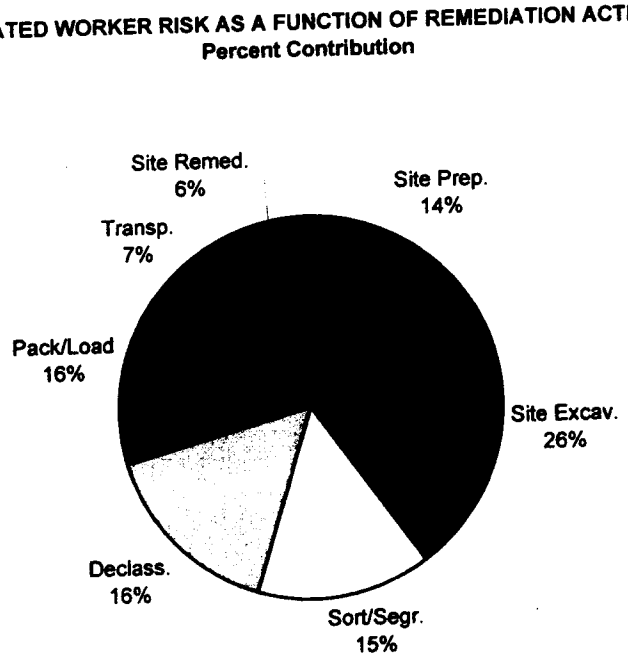

Figure 5. Mitigated Risk Percent Contribution by Remedial Activity

APPENDIX A –
Summary of Major MDA H Intrinsic Hazards

	2	3	4	5	6	7	8	9 [1]	Total	% of Total [2]
Average bulk waste density (w/void space)	49.0	31.4	25.7	23.4	35.5	23.7	25.4	25.2	23.2	29.9	
Total Mass Disposed (lb)	74,838	47,957	39,218	35,653	54,182	36,133	38,791	38,531	25,528	390,831	100.0%
Aluminum (~15%)	11,226	7,194	5,883	5,348	8,127	5,420	5,819	5,780	3,829	58,625	15%
Barium (as part of mock/inert HE) [4]	858	636	60	0	0	0	640	3,110	0	5,304.	1.4%
Beryllium (~5%)	3,742	2,398	1,961	1,783	2,709	1,807	1,940	1,927	1,276	19,542	5.0%
Cadmium (~0.5%)	374	240	196	178	271	181	194	193	128	1,954	0.50%
Chromium (~0.5%)	374	240	196	178	271	181	194	193	128	1,954	0.50%
Copper (~3%)	2,245	1,439	1,177	1,070	1,625	1,084	1,164	1,156	766	11,725	3.0%
Lead (~20%)	14,968	9,591	7,844	7,131	10,836	7,227	7,758	7,706	5,106	78,166	20%
Mercury (~1%)	748	480	392	357	542	361	388	385	255	3,908	1.0%
Silver, non-film (~0.1%)	75	48	39	36	54	36	39	39	26	391	0.10%
Steels, all (~40%)	29,935	19,183	15,687	14,261	21,673	14,453	15,516	15,412	10,211	156,332	40%
Metals of Concern total	64,545	41,447	33,435	30,341	46,109	30,749	33,651	35,900	21,724	337,901	86%
Li compounds			4,408	475			1	60	15	4,959	1.27%
Be			38	100		75	25			238	0.06%
HE			4,783							4,783	1.22%
HE contaminated	200	0	1,800	7,350	5,600	21,875	4,625	5,725		47,175	12.07%
Mock/inert HE	2,145	1,590	150	0	0	0	1,600	7,775	0	13,260	3.39%
CN (as part of mock/inert HE) [4]	858	636	60	0	0	0	640	3,110	0	5,304	1.36%
Film	11,460	12,015	9,500	9,320					1	42,296	10.82%
Graphite	3,145	5,999	6,040	4,350	15,978	1,575	10,685	65	40	47,877	12.25%
Magnetic media							200	1350	2787	4,337	1.11%
Paper		200		175	25		35	220	160	815	0.21%
Plastic	1,875	4,520					150			6,545	1.67%
Shapes and Other	62,116	43,166	25,944	22,988	51,247	33,233	28,281	36,910	17,635	321,520	82.3%
Slides			11		700	140	150	81	141	1,223	0.31%
All plastic type waste components	13,335	16,535	9,511	9,320	700	140	500	1,431	2,929	54,401	13.92%

										Total	% of Total [2]
Radioactive contaminated [5]	60,544	37,251	24,224	18,288	48,282	14,063	33,345	30,665	21,675	288,337	73.8%
Tritium contaminated [7]	1,206	30	782	80	174			115		2,387	0.61%
Pu contaminated					25		275			300	0.08%
EU or HEU containing [6]	2,082	550		1,050		1,005	7,998	4,190		16,875	4.32%
Fuel Elements			255	2,495	2,610	2,725	9,560			17,645	4.51%
Depleted Uranium [5]	48,435	29,801	19,379	14,630	38,626	11,250	26,676	24,532	17,340	230,669	59.0%
% Total Mass in MDA-H	19.15%	12.27%	10.04%	9.13%	13.87%	9.25%	9.93%	9.86%	6.53%	68.5%	

[1] Shaft 9 lacked completed mass information for some of the materials disposed of within the shaft logbook used as a primary source of information
[2] The total percent represents the maximum amount of material thought to be present in the waste, since multiple contaminants are present in much of the waste the total will be over 100% if all types of waste are summed together
[3] The metals of concern represent the maximum amount of material thought to be present in the waste. This amount is based on a percentage of the total waste and is considered to be spread evenly throughout the shafts. This number is thought to be bounding and does not represent the quantity present. Waste metal percentages were generated after review of waste generated from a similar operation at Sandia National Laboratory/NM and then taking into account operational differences. Using this set of numbers for the top 20 feet of each shaft the ratio of 14/54 is used to represent the maximum mass for uptake. This is due to a maximum depth of 60 feet with a 6-foot cap leaving 54 feet of usable space.
[4] Assume 40% barium (Ba) and 40% cyanide (CN) in HE based on 6/20 phone call with D Hickmott; reference to 1082 Work Plan, Sect 5.3
[5] Depleted uranium or D-38 is assumed to represent the majority (80%) of radioactive material within MDA-H based the waste records and materials used, other known radioactive materials are listed separately in addition to being included in this row
[6] Excludes the Fuel Elements
[7] H^3

			Pu-239	Pu-240	Pu-241	Pu-242
Mass fraction of isotope	1.00	0.0001	0.9378	0.06	0.002	0.0002
Activity (Ci) [1]	0.0136	8.35E-05	0.0028	0.00066	0.01006	3.8E-08
Mass (g)	0.0488	4.88E-06	0.0457	0.00293	9.7535E-05	9.7535E-06

[1] Quantity of Pu 52 present based on the maximum of 100 nCi/gram of waste

					EU - Activity (Ci)			
			U238 lbs	U238 lbs	U234 Ci	U235 Ci	U236 Ci	U238 Ci
Mass Fraction	0.00075	0.087	0.0009	0.91135				
Shaft 1	0	0	0	0	0	0	0	0
Shaft 2	0	0	0	0	0	0	0	0
Shaft 3	0.19	22.19	0.23	232.4	0.54	0.02	0.01	0.04
Shaft 4	1.87	217.1	2.25	2,274	5.30	0.21	0.07	0.35
Shaft 5	1.96	227.1	2.35	2,379	5.55	0.22	0.07	0.36
Shaft 6	2.04	237.1	2.45	2,483	5.79	0.23	0.07	0.38
Shaft 7	7.17	831.7	8.60	8,713	20.32	0.82	0.25	1.33
Shaft 8	0	0	0	0	-	0	0	0
Shaft 9	0	0	0	0	-	0	0	0
Total lbs/Activity (Ci)	13.23 lb	1,535 lb	15.88 lb	16,081 lb	37.51 Ci	1.50 Ci	0.47 Ci	2.45 Ci

	HEU [2]				EU [2]			
Mass Fraction	0.0109	0.933	0.0020	0.054	0.0008	0.0870	0.0009	0.9114
Shaft 1	1.1	97.2	0.2	5.6	1.5	172	1.8	1,803
Shaft 2	0.3	25.7	0.1	1.5	0.4	45.5	0.5	476
Shaft 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shaft 4	0.6	49.0	0.1	2.8	0.7	86.8	0.9	909
Shaft 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shaft 6	0.5	46.9	0.1	2.7	0.7	83.1	0.9	870
Shaft 7	4.4	373	0.8	21.5	5.7	661	6.8	6,925
Shaft 8	2.3	196	0.4	11.3	3.0	346	3.6	3,628
Shaft 9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mass (lbs)	**9.2**	**787**	**1.7**	**45.4**	**12.0**	**1,395**	**14.4**	**14,610**
	HEU [2]				**EU [2]**			
Activity (Ci/g)	6.25E-03	2.16E-06	6.47E-05	3.36E-07	6.25E-03	2.16E-06	6.47E-05	3.36E-07
Shaft 1	3.22	0.10	0.01	0.00	4.20	0.17	0.05	0.27
Shaft 2	0.85	0.03	0.00	0.00	1.11	0.04	0.01	0.07
Shaft 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shaft 4	1.62	0.05	0.00	0.00	2.12	0.09	0.03	0.14
Shaft 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shaft 6	1.55	0.05	0.00	0.00	2.03	0.08	0.03	0.13
Shaft 7	12.37	0.37	0.02	0.00	16.15	0.65	0.20	1.06
Shaft 8	6.48	0.19	0.01	0.00	8.46	0.34	0.11	0.55
Shaft 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Activity (Ci)	**26.1**	**0.8**	**0.0**	**0.0**	**34.1**	**1.4**	**0.4**	**2.2**

[1] Fuel elements are accounted in a separate table
[2] Quantity Of Uranium Present Is Based On The Maximum Of 5% HEU And 95% EU Of Waste Mass

	[illegible] Ci	[illegible] Ci	U238 Ci	U235 Ci	Unit Ci	D-38 lbs
Percent of total Activity	41.3%	1.43%	2.03%	55.3%	100.0%	
Shaft 1	5.64	0.13	0.27	7.38	13.43	48,435
Shaft 2	3.47	0.08	0.17	4.54	8.26	29,801
Shaft 3	2.26	0.05	0.11	2.95	5.37	19,379
Shaft 4	1.70	0.04	0.08	2.23	4.06	14,630
Shaft 5	4.50	0.11	0.21	5.89	10.71	38,626
Shaft 6	1.31	0.03	0.06	1.72	3.12	11,250
Shaft 7	3.11	0.07	0.15	4.07	7.39	26,676
Shaft 8	2.86	0.07	0.14	3.74	6.80	24,532
Shaft 9	2.02	0.05	0.10	2.64	4.81	17,340
Total Activity (Ci)	**26.85**	**0.64**	**1.28**	**35.17**	**63.94**	**230,669**

[1] Depleted uranium (D-38) is assumed to represent the majority (80%) of radioactive material within MDA-H based the waste records and materials used, other known radioactive materials are listed separately

[2] The isotopic content for the depleted uranium was assumed to contain the largest portion of U234/U235 in order to be conservative in associated dose calculations

- APPENDIX B –
Hazard Identification Checklists for MDA H

Table B-1. Hazard Identification Checklist

Area/Location: TA-54, MDA-H **Process/Activity:** All – Site Intrinsic Hazards
Prepared By: L. Restrepo **Date:** 8/31/01 **Reviewed By:** R. Kalinski **Date:** 9/28/01

Hazard	Description	Form, Quantity, Packaging
Radiation		
Electromagnetic		See Ionizing Radiation
Gamma Radiation		
High-Intensity Visible Light		
Infrared Radiation		See Appendix A
Ionizing Radiation	Tritium Fuel Elements Uranium- enriched Uranium- depleted Plutonium Other actinides (misc.)	
Laser Radiation		
Microwave/Radio		
Radiant		
Ultraviolet Light		
X-Rays		
Explosives		See Appendix A
Conventional Expl.	H.E. waste in shaft 3	
Explosive Dust		See Appendix A
Flammable Gases	Potential small quantity of hydrogen gas	
Flammable Liquids		
Oxidizer - Exothermic		See Appendix A
Reactive chemicals	Lithium salts (e.g. LiH)	
Hazardous Toxic		
Asphyxiant		See Appendix A
Carcinogen	H.E., Beryllium, cadmium, asbestos	See Appendix A
Corrosive	LiOH, etc.	See Appendix A
Explosive	LiH, etc.	See Appendix A
Irritant	LiOH, silver, etc.	See Appendix A
Mutagen		See Appendix A
Toxic (Poison)	Lithium salts, lead, mercury, cadmium, silver	
Electrical		
Electromagnetic		
Explosion		
High Voltage		
Static/Electrostatic		
Flammable/Combustible		See Appendix A
Combustible Material	Cellulose, plastics	

Hazard	Description	Form, Quantity, Packaging
Flammable Material		
Ignition sources		
Temperature		
High Temperature		
Low Temperature		
Mechanical		
Acceleration	Heavy parts and waste	<20,000 lbs
Deceleration		
Friction		
High Noise/Pitch, etc.		
High Pressure Gases		
High Pressure Liquids		
Metal Fatigue		
Pinch Points		
Rotating Equip.		
Reciprocating Equip.		
Sharp Edges/Points	Heavy waste materials/parts	See Appendix A
Vibration		
Chemical Reaction (nonfire)		
Combination		
Disassociation		
Corrosive		
Others		

Table B-2. Hazard Identification Checklist

Area/Location: TA-54, MDA-H **Process/Activity:** Site Preparation
Prepared By: L. Restrepo **Date:** 8/31/01 **Reviewed By:** R. Kalinski **Date:** 9/28/01

Hazard	Description	Form, Quantity, Packaging
Radiation		
Electromagnetic		
Gamma Radiation		
High-Intensity Visible Light		
Infrared Radiation		
Ionizing Radiation		
Laser Radiation		
Microwave/Radio		
Radiant		
Ultraviolet Light		
X-Rays		
Explosives		
Conventional Expl.		
Explosive Dust		
Flammable Gases	Forklift or equipment fuel (e.g. propane)	<2-30 lb cylinders
Flammable Liquids	Vehicle or equipment fuel (e.g. gasoline)	<200 gallons
Oxidizer - Exothermic		
Reactive chemicals		
Hazardous Toxic		
Asphyxiant		
Carcinogen		
Corrosive		
Explosive		
Irritant		
Mutagen		
Toxic (Poison)		
Electrical		
Electromagnetic		
Explosion		
High Voltage	Power supplies (including portable electrical generators)	110/220 volts
Static/Electrostatic		
Flammable/Combustible		
Combustible Material	Dome fabric, wood pallets, plastics, cellulose, vehicle and equipment fuels, miscellaneous	
Flammable Material	Vehicle and equipment fuels (gas or propane)	
Ignition sources	Cutting/welding activities, electrical equipment, vehicle exhaust systems, miscellaneous	
Temperature		
High Temperature	See ignition sources	

Hazard	Description	Form, Quantity, Packaging
Low Temperature		
Mechanical		
Acceleration	Moving vehicles, cranes	
Deceleration	Same as above	
Friction		
High Noise/Pitch, etc.	General equipment used	
High Pressure Gases	Propane cylinders	<200 psig
High Pressure Liquids	Hydraulic lines on equipment	<1,500 psig
Metal Fatigue		
Pinch Points	Forklift tines and equipment	
Rotating Equip.	Motors	
Reciprocating Equip.		
Sharp Edges/Points	Fence construction, general tools used	
Vibration		Misc.
Chemical Reaction (nonfire)		
Combination		
Disassociation		
Corrosive		
Others		

Table B-3. Hazard Identification Checklist

Area/Location: TA-54, MDA-H **Process/Activity:** Excavation
Prepared By: L. Restrepo **Date:** 8/31/01 **Reviewed By:** R. Kalinski **Date:** 9/28/01

Hazard	Description	Form, Quantity, Packaging
Radiation		
Electromagnetic	Electromagnetic lift devices for removal of magnetic classified waste from shafts	
Gamma Radiation	See Intrinsic Site Hazards	
High-Intensity Visible Light	Halogen work lamps if employed	
Infrared Radiation		
Ionizing Radiation	See Intrinsic Site Hazards	
Laser Radiation		
Microwave/Radio		
Radiant		
Ultraviolet Light		
X-Rays		
Explosives		
Conventional Expl.	See Intrinsic Site Hazards	
Explosive Dust		
Flammable Gases	See Site Preparation Hazards	
Flammable Liquids	Vehicle or equipment fuel (e.g. gasoline)	
Oxidizer - Exothermic	None Identified	
Reactive chemicals	Lithium hydride parts or shapes	
Hazardous Toxic		
Asphyxiant		
Carcinogen	See Intrinsic Site Hazards	
Corrosive	See Intrinsic Site Hazards	
Explosive	See Intrinsic Site Hazards	
Irritant	Dust from excavation (silica dust);	
Mutagen		
Toxic (Poison)	See Intrinsic Site Hazards	
Electrical		
Electromagnetic	Electromagnetic lift devices for removal of magnetic classified waste from shafts	
Explosion		
High Voltage	See Site Preparation Hazards	
Static/Electrostatic	Build-up of charge on equipment	
Flammable/Combustible		
Combustible Material	See Site Preparation and Intrinsic Site Hazards	
Flammable Material		
Ignition sources	See Site Preparation Hazards	
Temperature		
High Temperature	See ignition sources	

Hazard	Description	Form, Quantity, Packaging
Low Temperature		
Mechanical		
Acceleration	See Site Preparation Hazards	
Deceleration	See Site Preparation Hazards	
Friction		
High Noise/Pitch, etc.	See Site Preparation Hazards	
High Pressure Gases	See Site Preparation Hazards	
High Pressure Liquids	See Site Preparation Hazards	
Metal Fatigue		
Pinch Points		
Rotating Equip.	See Site Preparation Hazards	
Reciprocating Equip.	Heavy equipment and waste materials	
Sharp Edges/Points		
Vibration	Equipment	
Chemical Reaction (nonfire)		
Combination		
Disassociation		
Corrosive		
Others		
Soil/Earth Collapse		

Table B-4. Hazard Identification Checklist

Area/Location: TA-54, MDA-H **Process/Activity:** Sorting, Segregation
Prepared By: L. Restrepo **Date:** 8/14/01 **Reviewed By:** R. Kalinski **Date:** 9/28/01

Hazard	Description	Form, Quantity, Packaging
Radiation		
Electromagnetic		<100 Ci Co 60
Gamma Radiation	Portable gamma source for radiography	
High-Intensity Visible Light		
Infrared Radiation		
Ionizing Radiation	Neutron sources	
Laser Radiation		
Microwave/Radio		
Radiant		
Ultraviolet Light		<1 MeV
X-Rays	Portable X-ray unit	
Explosives		
Conventional Expl.		
Explosive Dust		
Flammable Gases		
Flammable Liquids		
Oxidizer - Exothermic		
Reactive chemicals		
Hazardous Toxic		< 200 lbs
Asphyxiant	Liquid Nitrogen	
Carcinogen		
Corrosive		
Explosive		
Irritant		
Mutagen		
Toxic (Poison)		
Electrical		
Electromagnetic		
Explosion		
High Voltage	See Site Preparation Hazards	
Static/Electrostatic		
Flammable/Combustible		
Combustible Material		
Flammable Material		
Ignition sources		
Temperature		
High Temperature		< 200 lbs
Low Temperature	Liquid Nitrogen	

Hazard	Description	Form, Quantity, Packaging
Mechanical		
Acceleration		
Deceleration		
Friction		
High Noise/Pitch, etc.		
High Pressure Gases		
High Pressure Liquids		
Metal Fatigue		
Pinch Points		
Rotating Equip.		
Reciprocating Equip.		
Sharp Edges/Points		
Vibration		
Chemical Reaction (nonfire)		
Combination		
Disassociation		
Corrosive		
Others		

Table B-5. Hazard Identification Checklist

Area/Location: TA-54, MDA-H **Process/Activity:** Declassification
Prepared By: L. Restrepo **Date:** 8-14-01 **Reviewed By:** B. Myers **Date:** 9/15/01

Hazard	Description	Form, Quantity, Packaging
Radiation		
Electromagnetic		
Gamma Radiation		
High-Intensity Visible Light		
Infrared Radiation		
Ionizing Radiation		
Laser Radiation		
Microwave/Radio	Microwave melting (LIR)	
Radiant		
Ultraviolet Light		
X-Rays		
Explosives		
Conventional Expl.	HE for potentially destroying parts (outside MDA-H)	<500g
Explosive Dust		
Flammable Gases	Cutting torches (e.g. oxyacetylene)	< 2 type A cylinders
Flammable Liquids	Burning of classified parts (outside MDA-H)	< 55 gallons (chemicals)
Oxidizer - Exothermic	Hydrogen peroxide or other material for	
Reactive chemicals	Chips and turnings generated from declassification activities	<100 kg
Hazardous Toxic		
Asphyxiant	Inert gas (eg argon)	< 1 type A cylinder
Carcinogen		
Corrosive		
Explosive		
Irritant		
Mutagen		
Toxic (Poison)		
Electrical		
Electromagnetic		
Explosion		
High Voltage	Cutting/grinding/machining/other tools	110/220 Volts
Static/Electrostatic		
Flammable/Combustible		
Combustible Material	See flammable gases	
Flammable Material	See flammable liquids	
Ignition sources	See reactive chemicals	
Temperature		
High Temperature	Furnace or melting equipment	1,500° C

Hazard	Description	Form, Quantity, Packaging
Low Temperature		
Mechanical		
Acceleration	Crushers, presses, shears, etc.	
Deceleration		
Friction		
High Noise/Pitch, etc.		
High Pressure Gases		
High Pressure Liquids	Hydraulics for tools	
Metal Fatigue		
Pinch Points		
Rotating Equip.	Saws, lathes	
Reciprocating Equip.	Saws	
Sharp Edges/Points	General tools and equipment	
Vibration		
Chemical Reaction (nonfire)		
Combination		
Disassociation		
Corrosive		
Others		

Table B-6. Hazard Identification Checklist

Area/Location: TA-54, MDA-H **Process/Activity:** Packaging, Loading, Shipping
Prepared By: B. Myers **Date:** 8-14-01 **Reviewed By:** L. Restrepo **Date:** 8/30/01

Hazard	Description	Form, Quantity, Packaging
Radiation		
Electromagnetic		
Gamma Radiation		
High-Intensity Visible Light		
Infrared Radiation		
Ionizing Radiation		
Laser Radiation		
Microwave/Radio		
Radiant		
Ultraviolet Light		
X-Rays		
Explosives		
Conventional Expl.		
Explosive Dust		
Flammable Gases	See site preparation hazards	
Flammable Liquids	See site preparation hazards	
Oxidizer - Exothermic		
Reactive chemicals		
Hazardous Toxic		
Asphyxiant		
Carcinogen		
Corrosive		
Explosive		
Irritant		
Mutagen		
Toxic (Poison)		
Electrical		
Electromagnetic		
Explosion		
High Voltage		
Static/Electrostatic		
Flammable/Combustible		
Combustible Material	Packing materials	
Flammable Material		
Ignition sources	Vehicle exhaust systems	
Temperature		
High Temperature		
Low Temperature		

Hazard	Description	Form, Quantity, Packaging
Mechanical		
Acceleration	Heavy loads (see site preparation hazards)	
Deceleration		
Friction		
High Noise/Pitch, etc.	See site preparation hazards	
High Pressure Gases	See site preparation hazards	
High Pressure Liquids	See site preparation hazards	
Metal Fatigue		
Pinch Points	See site preparation hazards	
Rotating Equip.		
Reciprocating Equip.		
Sharp Edges/Points		
Vibration		
Chemical Reaction (nonfire)		
Combination		
Disassociation		
Corrosive		
Others		
Soil/Earth Collapse		

Table B-7. Hazard Identification Checklist

Area/Location: TA-54, MDA-H **Process/Activity:** Transportation (Onsite/Offsite)
Prepared By: L. Restrepo **Date:** 8-14-01 **Reviewed By:** R. Kalinski **Date:** 8/30/01

Hazard	Description	Form, Quantity, Packaging
Radiation		
Electromagnetic		
Gamma Radiation		
High-Intensity Visible Light		
Infrared Radiation		
Ionizing Radiation		
Laser Radiation		
Microwave/Radio		
Radiant		
Ultraviolet Light		
X-Rays		
Explosives		
Conventional Expl.		
Explosive Dust		
Flammable Gases		
Flammable Liquids		
Oxidizer - Exothermic		
Reactive chemicals		
Hazardous Toxic		
Asphyxiant		
Carcinogen		
Corrosive		
Explosive		
Irritant		
Mutagen		
Toxic (Poison)		
Electrical		
Electromagnetic		
Explosion		
High Voltage		
Static/Electrostatic		
Flammable/Combustible		
Combustible Material	Vehicle fuels	
Flammable Material		
Ignition sources	Vehicle exhaust systems	
Temperature		
High Temperature		
Low Temperature		

Hazard	Description	Form, Quantity, Packaging
Mechanical		
Acceleration	Moving vehicle	
Deceleration	Stopping of moving vehicle	
Friction		
High Noise/Pitch, etc.		
High Pressure Gases		
High Pressure Liquids		
Metal Fatigue		
Pinch Points		
Rotating Equip.		
Reciprocating Equip.		
Sharp Edges/Points		
Vibration		
Chemical Reaction (nonfire)		
Combination		
Disassociation		
Corrosive		
Others		
Soil/Earth Collapse		

- APPENDIX C –
What If? Tables for all of the Remediation Activities

SITE REMEDIATION – WHAT IF? TABLE

Area/Location: TA-54, Material Disposal Area H **Process/Activity:** Site Preparation

Prepared By: Brian Myers **Date:** 8/29/01 **Reviewed By:** Louis Restrepo **Date:** 9/3/01

ID No.	Location, System, Subsystem	Accident Category	What If? Scenario	Consequence	Notes
Site Preparation (Grading for Security Fencing, Utilities, Dome Construction and Haul road [illegible]					
SP-1		Fire	Vehicle or equipment fuel leaks – operational activities	Fire with potential minor radioactive contamination	Screened due to low contamination levels
SP-2		Fire	Brush fire due to lightning	Fire with potential minor radioactive contamination	Screened due to low contamination levels
SP-3		Fire	Cutting or grinding activities ignites combustibles onsite – operational activities	Fire with potential minor radioactive contamination	Screened due to low contamination levels
SP-4		Fire	Short circuit or severed power line during site preparation – operational activities	Fire with potential minor radioactive contamination	Screened due to low contamination levels
SP-5		Fire	Maintenance activities on vehicle or equipment ignites combustibles – operational activities	Fire with potential minor radioactive contamination	Screened due to low contamination levels
SP-6		Fire	Worker performing maintenance on electrical power supply for structure or equipment, arcs/shorts electrical wires – operational activities	Fire with potential minor radioactive contamination	Screened due to low contamination levels
SP-7		Fire	Forest or brush fire due to fire propagation	Fire with potential minor radioactive contamination	Screened due to low contamination levels
SP-8		Explosion	Digging activities around explosive hazards near surface	Explosive Detonation or deflagration. Worker injury or fatality	PrHA No. 2a
SP-9		Explosion	Fire/explosion during site preparation due to operational activities	Explosive Detonation or deflagration. Worker injury or fatality	PrHA No. 2
SP-10		Explosion	Fire/explosion during site preparation due to lightning	Explosive Detonation or deflagration. Worker injury or fatality	PrHA No. 2b
SP-11		Explosion	Fire/explosion during site preparation due to brush or forest fire propagation	Explosive Detonation or deflagration. Worker injury or fatality	PrHA No. 2c
SP-12		Industrial Accident	Live electrical wires contacted during site preparation	Electrocution - Worker injury/fatality	Standard Industrial Accident –See PrHA No. 1
SP-13		Industrial Accident	Vehicle fails striking worker	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 1

ID No.	Location, System, Subsystem	Accident Category	What If? Scenario	Consequence	Notes
Site Preparation [illegible] Construction, and Haul [illegible]					
SP-14		Industrial Accident	Equipment high pressure line fails striking worker	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 1
SP-15		Industrial Accident	Equipment fails striking worker	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 1
SP-16		Industrial Accident	Equipment fails striking other equipment	Equipment damage, project delayed	Screened due to negligible or low hazard levels
SP-17		Industrial Accident	Dome structural supports fail, structure collapse does not impact waste	Equipment damage, project delayed Worker injury or fatality	Standard Industrial Accident –See PrHA No. 1
SP-18		Industrial Accident	Lightning strikes worker	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 1
SP-19		Spill	Vehicle or equipment fuel leaks onto the ground	Release of fuel contaminates area	Screened due to negligible or low hazard levels
SP-20		Spill	Fluids used for cutting are spilled during operations	Release of fluid contaminates area	Screened due to negligible or low hazard levels
SP-21		Spill	Maintenance activities on vehicle or equipment result in fluid spill	Release of fluid contaminates area	Screened due to negligible or low hazard levels
SP-22		Spill	Vehicle or equipment accident results in fluid leaks	Release of fluid contaminates area	Screened due to negligible or low hazard levels

SITE REMEDIATION – WHAT IF? TABLE

Area/Location: TA-54, Material Disposal Area H **Process/Activity:** Site Excavation

Prepared By: Louis Restrepo **Date:** 8/29/01 **Reviewed By:** R. Kalinski **Date:** 9/28/01

ID No.	Location, System, Subsystem	Accident Category	What If? Scenario	Consequence	Notes
Site Excavation: [illegible] Removal, [illegible] waste removal, Shoring of excavation (if required), Set down of excavated waste [illegible]					
EX-1		Fire	Vehicle or equipment fuel leaks	Fire with potential radioactive material release	PrHA No. 3a
EX-2		Fire	Excavation activities ignites combustibles onsite	Fire with potential radioactive material release	PrHA No. 3
EX-3		Fire	Brush fire due to lightning or fire propagation (forest fire)	Fire with potential radioactive material release	PrHA No. 3b and 3c
EX-4		Fire	Maintenance activities on vehicle or equipment ignites combustibles	Fire with potential radioactive material release	PrHA No. 3d
EX-5		Explosion	Lightning strikes remote excavation equipment during waste removal, HE or detonators initiated	Fire/explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 5c
EX-6		Explosion	Water (rain or decontamination) is diverted into a shaft contacting reactive material (e.g., LiH)	Fire/explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 5e
EX-7		Explosion	Vehicle or equipment fuel leaks	Fire/explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 5b
EX-8		Explosion	Excavation activities ignites combustibles onsite	Fire/explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 5b
EX-9		Explosion	Brush fire due to lightning or fire propagation (forest fire)	Fire/explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 5c and 5d
EX-10		Explosion	Maintenance activities on vehicle or equipment ignites combustibles	Fire/explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 5b
EX-11		Explosion	Mechanical insults from remote excavation equipment, grappling activities impacts HE or detonators in shaft	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 5a

ID No.	Location, System, Subsystem	Accident Category	What If? Scenario	Consequence	Notes
Site Excavation: Overburden removal, Remove waste removal, Shoring of excavation (as required), Set down of excavated soil/rock					
EX-12		Explosion	Waste HE or detonators in shaft are dropped or slide due to removal of other waste in shaft	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 5a and 5b
EX-13		Explosion	Waste HE or detonators removed from shaft are impacted by equipment failure or structure (dome)	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 5a and 5b
EX-14		Explosion	Waste HE or detonators in shaft are impacted from shaft wall collapse	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 5a and 5b
EX-15		Explosion	Waste HE or detonators removed from shaft are impacted by drops from or bumping into non-yielding surfaces during set-down in staging area	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 5a and 5b
EX-16		Exposure	Radioactive waste materials removed from shaft is highly radioactive	Inadvertent worker exposure	PrHA No. 7
EX-17		Industrial Accident	Worker falls into pit	Equipment damage, project delayed Worker injury/fatality	Standard Industrial Accident –See PrHA No. 4
EX-18		Industrial Accident	Vehicle and worker falls down an edge or pit	Equipment damage, project delayed Worker injury/fatality	Standard Industrial Accident –See PrHA No. 4
EX-19		Industrial Accident	Dome structure support fails, structure collapses	Equipment damage, project delayed Worker injury/fatality	Standard Industrial Accident –See PrHA No. 4
EX-20		Industrial Accident	Equipment fails striking other equipment	Equipment damage, project delayed	Screened due to negligible or low hazard levels
EX-21		Industrial Accident	Vehicle fails striking worker	Worker injury/fatality	Standard Industrial Accident –See PrHA No. 4
EX-22		Industrial Accident	Equipment high pressure line fails striking worker	Worker injury/fatality	Standard Industrial Accident –See PrHA No. 4
EX-23		Industrial Accident	Equipment fails striking worker	Worker injury/fatality	Standard Industrial Accident –See PrHA No. 4
EX-24		Industrial Accident	Lightning strikes worker	Worker injury/fatality	Standard Industrial Accident –See PrHA No. 4
EX-25		Industrial Accident	Live electrical wires contacted during site excavation	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 4
EX-26		Spill	Vehicle or equipment impacts waste containers resulting in a spill	Potential radioactive material release	PrHA No. 6
EX-27		Spill	Waste container is dropped or impacted resulting in a spill	Potential radioactive material release	PrHA No. 6

SITE REMEDIATION – WHAT IF? TABLE

Area/Location: TA-54, Material Disposal Area H **Process/Activity:** Sort/Segregation

Prepared By: Brian Myers **Date:** 8/30/01 **Reviewed By:** R. Kalinski **Date:** 9/28/01

ID No.	Location, System, Subsystem	Accident Category	What If? Scenario	Consequence	Notes
Sort/Segregation Activities (Excavated Waste, Remote Waste Monitoring or Radioactive Remote Waste monitoring for HE Segregation, Remote Size Reduction, Identification, Segregation)					
SS-1		Fire	Vehicle or equipment fuel leaks	Fire with potential radioactive material release	PrHA No. 8a
SS-2		Fire	Sort/segregation activities ignites combustibles onsite	Fire with potential radioactive material release	PrHA No. 8 and 8d
SS-3		Fire	Brush fire due to lightning or fire propagation (forest fire)	Fire with potential radioactive material release	PrHA No. 8b and 8c
SS-4		Fire	Maintenance activities on vehicle or equipment ignites combustibles	Fire with potential radioactive material release	PrHA No. 8d
SS-5		Explosion	Vehicle or equipment fuel leaks	Fire/explosion leading to potential radioactive material release, Worker injury or fatality	Screened due to low likelihood of occurrence. Accident more likely preceded by excavation activities
SS-6		Explosion	Sort/segregation activities ignites combustibles onsite	Fire/explosion leading to potential radioactive material release, Worker injury or fatality	Screened due to low likelihood of occurrence. Accident more likely preceded by excavation activities
SS-7		Explosion	Brush fire due to lightning or fire propagation (forest fire)	Fire/explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 10c and 10d
SS-8		Explosion	Maintenance activities on vehicle or equipment ignites combustibles	Fire/explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 10b

ID No.	Location, System, Subsystem	Accident Category	What If? Scenario	Consequence	Notes
Sort/Segregation [illegible] Identification of waste material					
SS-9		Explosion	Water (rain or decontamination) is diverted into sort/segregation area contacting reactive material (e.g., LiH)	Fire/explosion leading to potential radioactive material release, Worker injury or fatality	Screened due to low likelihood of occurrence. Accident more likely preceded by excavation activities
SS-10		Explosion	Lightning strikes HE or detonators in the sort/segregation area	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 10c
SS-11		Explosion	Mechanical insults from remote monitoring equipment impacts HE or detonators in sort/segregation area	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 10a
SS-12		Explosion	Waste HE or detonators in shaft are dropped or impacted by equipment during sort/segregation operations	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 10a
SS-13		Explosion	Static energy or electrical insults to waste HE or detonators are being handled during sort/segregation	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 10e
SS-14		Explosion	Water contacts reactive materials - Potential HE detonation	Fire/explosion with potential radioactive and hazardous material release. Worker injury/fatality	PrHA No. 10f
SS-15		Exposure	Radioactive waste materials being handled during sort/segregation operations is highly radioactive (s)	Inadvertent worker exposure	PrHA No. 14
SS-16		Exposure	Personnel are present within the radiography area during NDE (x-rays or γ-rays) radiography operations	Inadvertent worker exposure	PrHA No. 15
SS-17		Exposure	Radiological equipment failure	Worker injury/fatality	PrHA No. 16
SS-18		Industrial Accident	Equipment fails striking other equipment	Equipment damage, project delayed	Screened due to negligible or low hazard levels
SS-19		Industrial Accident	Dome structural supports fail, structure collapses does not impact waste	Equipment damage, project delayed Worker injury or fatality	Standard Industrial Accident –See PrHA No. 9
SS-20		Industrial Accident	Lightning strikes worker	Worker injury/fatality	Standard Industrial Accident –See PrHA No. 9
SS-21		Industrial Accident	Vehicle fails striking worker	Worker injury/fatality	Standard Industrial Accident –See PrHA No. 9
SS-22		Spill	Vehicle or equipment impacts waste containers resulting in a spill	Potential radioactive material release	PrHA No. 11
SS-23		Spill	Waste container is dropped or impacted resulting in a spill	Potential radioactive material release	PrHA No. 11
SS-24		Spill	Worker is exposed to uncontained hazardous or toxic waste being handled during sort/segregation operations	Inadvertent worker exposure to toxic materials	PrHA No. 13

ID No.	Location, System, Subsystem	Accident Category	What If? Scenario	Consequence	Notes
[redacted]					
SS-25		Spill	Dome structural supports fail, structure collapses impacting waste	Potential radioactive and hazardous material release. Worker injury/fatality	PrHA No. 12

SITE REMEDIATION – WHAT IF? TABLE

Area/Location: TA-54, Material Disposal Area H **Process/Activity:** Declassification

Prepared By: Brian Myers **Date:** 8/30/01 **Reviewed By:** R. Kalinski **Date:** 9/28/01

ID No.	Location, System, Subsystem	Accident Category	What If? Scenario	Consequence	Notes
Declassification: Classification verification, Classified waste deformation, Classified documentation destruction					
D-1		Fire	Vehicle or equipment fuel leaks	Fire with potential radioactive material release	PrHA No. 17a
D-2		Fire	Declassification activities ignites combustibles onsite	Fire with potential radioactive material release	PrHA No. 17
D-3		Fire	Brush fire due to lightning or fire propagation (forest fire)	Fire with potential radioactive material release	PrHA No. 17b and 17c
D-4		Fire	Maintenance activities on vehicle or equipment ignites combustibles	Fire with potential radioactive material release	PrHA No. 17d
D-5		Explosion	Water (rain or decontamination) is diverted into declassification area contacting reactive material (e.g., LiH)	Explosion leading to potential radioactive material release, Worker injury or fatality	Screened due to low likelihood of occurrence. Accident more likely preceded by excavation activities
D-6		Explosion	Lightning strikes HE or detonators in the declassification area	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 19c
D-7		Explosion	Vehicle or equipment fuel leaks	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 17a and 19
D-8		Explosion	Declassification activities ignites combustibles onsite	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 19b
D-9		Explosion	Brush fire due to lightning or fire propagation (forest fire)	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 19c and 19d
D-10		Explosion	Maintenance activities on vehicle or equipment ignites combustibles	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 19b
D-11		Explosion	Mechanical insults from remote monitoring equipment impacts HE or detonators in declassification area	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 19a
D-12		Explosion	Waste HE or detonators in shaft are dropped or impacted by equipment during declassification operations	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 19a

ID No.	Location, System, Subsystem	Accident Category	What If? Scenario	Consequence	Notes
Declassification: Classification verification, Classified waste deformation, Classified documentation destruction					
D-13		Explosion	Static energy or electrical insults to waste HE or detonators are being handled during declassification	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 19e
D-14		Explosion	Incompatible waste materials are packaged together in a container resulting in a undesired reaction - Potential HE detonation	Fire/explosion with potential radioactive and hazardous material release Worker injury/fatality	PrHA No. 19f
D-15		Exposure	Radioactive waste materials being handled during declassification operations is highly radioactive	Worker exposure/fatality	PrHA No. 21
D-16		Industrial Accident	Equipment fails striking other equipment	Equipment damage, project delayed	Screened due to negligible or low hazard levels
D-17		Industrial Accident	Dome structural supports fail, structure collapses does not impact waste	Equipment damage. Worker injury/fatality	Standard Industrial Accident –See PrHA No. 18
D-18		Industrial Accident	Vehicle fails striking worker	Worker injury/fatality	Standard Industrial Accident –See PrHA No. 18
D-19		Industrial Accident	Equipment high pressure line fails striking worker	Worker injury/fatality	Standard Industrial Accident –See PrHA No. 18
D-20		Industrial Accident	Equipment fails striking worker	Worker injury/fatality	Standard Industrial Accident –See PrHA No. 18
D-21		Industrial Accident	Human errors using declassification equipment	Worker injury/fatality	Standard Industrial Accident –See PrHA No. 18
D-22		Industrial Accident	Lightning strikes worker	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 18
D-23		Spill	Vehicle or equipment impacts waste containers resulting in a spill	Potential radioactive material release	PrHA No. 20
D-24		Spill	Waste container is dropped or impacted resulting in a spill	Potential radioactive material release	PrHA No. 20
D-25		Spill	Dome structural supports fail, structure collapse impacts waste	Potential radioactive and hazardous material release. Worker injury/fatality	PrHA No. 20a

SITE REMEDIATION – WHAT IF? TABLE

Area/Location: TA-54, Material Disposal Area H **Process/Activity:** Packing/Loading

Prepared By: Brian Myers **Date:** 8/28/01 **Reviewed By:** R. Kalinski **Date:** 9/28/01

ID No.	Location, System, Subsystem	Accident Category	What If? Scenario	Consequence	Notes
Packing/loading [illegible]					
PLS-1		Fire	Vehicle or equipment fuel leaks	Fire with potential radioactive material release	PrHA No. 22a
PLS-2		Fire	Packing/loading activities ignites combustibles onsite	Fire with potential radioactive material release	PrHA No. 22
PLS-3		Fire	Brush or forest fire propagation	Fire with potential radioactive material release	PrHA No. 22c
PLS-4		Fire	Lightning strike	Fire with potential radioactive material release	PrHA No. 22b
PLS-5		Fire	Maintenance activities on vehicle or equipment ignites combustibles	Fire with potential radioactive material release	PrHA No. 22d
PLS-6		Explosion	Fire in or around the packing/loading area due to miscellaneous activities.	Fire/explosion with potential radioactive and hazardous material release Worker injury/fatality	PrHA No. 24b
PLS-7		Explosion	Incompatible waste materials are packaged together in a container resulting in a undesired reaction - Potential HE detonation	Fire/explosion with potential radioactive and hazardous material release Worker injury/fatality	PrHA No. 24f
PLS-8		Explosion	Water contacts reactive materials - Potential HE detonation	Fire/explosion with potential radioactive and hazardous material release Worker injury/fatality	PrHA No. 24g
PLS-9		Explosion	Mechanical insults from packing/loading equipment, impacts HE or detonators - Potential HE detonation	Fire/explosion with potential radioactive and hazardous material release Worker injury/fatality	PrHA No. 24a
PLS-10		Explosion	Static energy or electrical insults to waste HE or detonators are being handled during packing/loading operations - Potential HE detonation	Fire/explosion with potential radioactive and hazardous material release Worker injury/fatality	PrHA No. 24e

ID No.	Location, System, Subsystem	Accident Category	What If? Scenario	Consequence	Notes
Packing/loading, classified waste transfer at LANL, Declassified waste handling					
PLS-11		Explosion	Brush or forest fire propagation - Potential HE detonation	Fire/explosion with potential radioactive and hazardous material release Worker injury/fatality	PrHA No. 24d
PLS-12		Explosion	Lightning strikes waste HE or detonators during packing/loading operations - Potential HE detonation	Fire/explosion with potential radioactive and hazardous material release Worker injury/fatality	PrHA No. 24c
PLS-13		Industrial Accident	Packing/loading equipment fails	Equipment damage, project delayed	Standard Industrial Accident –See PrHA No. 23
PLS-14		Industrial Accident	Dome structural supports fail, structure collapse does not impact waste	Equipment damage, project delayed. Worker injury/fatality	Standard Industrial Accident –See PrHA No. 23
PLS-15		Industrial Accident	Vehicle or forklift fails striking worker during packing/loading operations	Worker injury/fatality	Standard Industrial Accident –See PrHA No. 23
PLS-16		Industrial Accident	Packing/loading equipment high pressure line fails striking worker	Worker injury/fatality	Standard Industrial Accident –See PrHA No. 23
PLS-17		Industrial Accident	Packing/loading equipment fails striking worker	Worker injury/fatality	Standard Industrial Accident –See PrHA No. 23
PLS-18		Spill	Waste container is dropped or impacted during packing/loading operations resulting in a spill	Potential radioactive and hazardous material release.	PrHA No. 25
PLS-19		Spill	Vehicle, forklift or other equipment impacts waste containers during packing/loading operations resulting in a spill	Potential radioactive and hazardous material release.	PrHA No. 25
PLS-20		Spill	Dome structural supports fail, structure collapse impacts wastes	Potential radioactive and hazardous material release. Worker injury/fatality	PrHA No. 26
PLS-21		Spill	Waste containing pressurized tritium gas, operations release waste	Worker exposure	Screened due to negligible or low hazard levels
PLS-22		Exposure	Radioactive waste materials being handled during packing/loading operations is misidentified	Worker exposure/fatality	PrHA No. 27

SITE REMEDIATION – WHAT IF? TABLE

Area/Location: TA-54, Material Disposal Area H **Process/Activity:** Onsite/Offsite transport (Shipping)

Prepared By: Brian Myers **Date:** 8/29/01 **Reviewed By:** R. Kalinski **Date:** 9/28/01

ID No.	Location, System, Subsystem	Accident Category	What If? Scenario	Consequence	Notes
Onsite/Offsite Transport (Shipping) Securing Containers Prior to Transport Offsite					
OT-1		Fire	Vehicle accident leads to fuel leak	Fire with potential minor radioactive contamination	PrHA No. 28a
OT-2		Explosion	Vehicle accident or equipment fuel leaks during transport activities	Fire/explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 30b
OT-3		Explosion	Fire/explosion in or around the Onsite/Offsite transport area due to operational activities	Fire/explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 30
OT-4		Explosion	Mechanical insults during transport activities impacts HE or detonators	Explosion leading to potential radioactive material release, Worker injury or fatality	PrHA No. 30a
OT-5		Industrial Accident	Vehicle accident (no waste are containers impacted) during transport activities	Equipment damage, project delayed Worker injury or fatality	Standard Industrial Accident –See PrHA No. 29
OT-6		Industrial Accident	Vehicle fails striking worker during transport activities	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 29
OT-7		Spill	Vehicle accident spills waste containers during transport activities	Potential radioactive and hazardous material release.	PrHA No. 31a
OT-8		Spill	Waste containers securing equipment fails during transport during transport activities	Potential radioactive and hazardous material release.	PrHA No. 31b
OT-9		Exposure	Radioactive waste materials being handled during transport activities is misidentified	Public exposure / Worker exposure/fatality	Screened due to negligible or low hazard levels

SITE REMEDIATION – WHAT IF? TABLE

Area/Location: TA-54, Material Disposal Area H **Process/Activity:** Site Remediation

Prepared By: Brian Myers **Date:** 8/29/01 **Reviewed By:** R. Kalinski **Date:** 9/28/01

ID No.	Location, System, Subsystem	Accident Category	What If? Scenario	Consequence	Notes
Site Remediation: Contouring, site landscaping, and revegetation, etc.					
SR-1		Fire	Vehicle or equipment fuel leaks – operational activities	Worker injury or fatality	Screened due to negligible or low hazard levels
SR-2		Fire	Brush fire due to lightning	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 32a
SR-3		Fire	Cutting or grinding activities ignites combustibles onsite – operational activities	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 32c
SR-4		Fire	Short circuit or severed power line during site remediation – operational activities	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 32c
SR-5		Fire	Maintenance activities on vehicle or equipment ignites combustibles – operational activities	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 32c
SR-6		Fire	Worker performing maintenance on electrical power supply for structure or equipment, arcs/shorts electrical wires – operational activities	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 32c
SR-7		Fire	Forest or brush fire due to fire propagation	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 32b
SR-8		Industrial Accident	Lightning strikes worker during site remediation	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 33
SR-9		Industrial Accident	Live electrical wires contacted during site remediation	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 33
SR-10		Industrial Accident	Vehicle fails striking worker	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 33
SR-11		Industrial Accident	Equipment high pressure line fails striking worker	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 33
SR-12		Industrial Accident	Equipment fails striking worker	Worker injury or fatality	Standard Industrial Accident –See PrHA No. 33
SR-13		Industrial Accident	Equipment fails striking other equipment	Equipment damage, project delayed	Screened due to negligible or low hazard levels

- APPENDIX D –
Hazard Analysis Tables for all of the Remediation Activities

HAZARD ANALYSIS TABLE

Site: Los Alamos National Laboratories, TA-54 **Location:** Material Disposal Area H **Activity:** Site Preparation
Preparer: Louis Restrepo **Date:** 8/29/01 **Reviewer:** R. Kalinski **Date:** 9/28/01

ID No	Hazard	Accid. Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq.		Risk		Notes (e.g., MAR, assumptions)
									W	P	W	P	
1	INDST	SIH	All	Industrial hazards associated with site preparation activities injure or causes a fatality	**UNCONTROLLED**			II	A	E	8	1	
					Job specific training	TR-JOB	PSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Personal protective equipment (PPE)	CO-PPE	MSA						
					HazMat Team	ER-HAZ	MSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						
					Shaft/pit stabilization (i.e. controlled earth removal)	CO-STB	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Residual Risk			III	A	E	6	1	
2	HE	EXPLO	All	Explosive Detonation or deflagration	**UNCONTROLLED**			IV	A	D	6	2	See Appendix A for Hazard Inventory
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					All controls in PrHA 2								
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Approved tools and equipment	CO-ATL	PSA						
					Basic personnel fire suppression training	FP-PRN	PSA						
					Combustible loading control in waste areas	FP-CLC	PSA						
					Fire department response	FP-FDR	MSA						
					Fire retardant dome fabric	FP-DFR	PPE						
					HE only in shafts	IC-HES	PSA						
					Ignition source control	FP-IGN	PSA						
					Job specific training	TR-JOB	PSA						
					LANL emergency response	ER-LER	MSA						
					Manual fire equipment (e.g., extinguishers)	FP-EQP	MSE						
					Shafts cover protection	HM-SCP	PPE						
					HazMat Team	ER-HAZ	MSA						
					Residual Risk			V	A	D	4	1	

ID No	Hazard	Accid. Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq.		Risk		Notes (e.g., MAR, assumptions)
									W	P	W	P	
2a	HE	EXPLO	Digging activities around explosive hazards ignites HE		**UNCONTROLLED**			IV	A	D	8	2	See Appendix A for Hazard Inventory
					All controls in PrHA 2								
					Explosive detection equipment	HM-XPD	PPE						
					Waste characterization controls	IC-WCC	PSA						
					Restrictions on digging within and around shafts	CO-DGS	PPA						
					Residual Risk			V	A	D	2	1	
2b	HE	EXPLO	Lightning strike		**UNCONTROLLED**			IV	A	D	4	1	See Appendix A for Hazard Inventory
					All controls in PrHA 2								
					Dome lightning protection	FP-DLP	PPE						
					Onsite notification of shut down (e.g. lightning)	ER-NOT	PSE						
					Residual Risk			V	A	E	2	1	
2c	HE	EXPLO	Brush or forest fire propagation		**UNCONTROLLED**			IV	A	D	4	1	See Appendix A for Hazard Inventory
					All controls in PrHA 2 and 2b								
					Green areas around excavation site or buffer fire zone	FP-GRN	PSA						
					Residual Risk			V	A	D	4	1	

HAZARD ANALYSIS TABLE

Site: Los Alamos National Laboratories, TA-54 **Location:** Material Disposal Area H **Activity:** Site Excavation
Preparer: Louis Restrepo **Date:** 8/29/01 **Reviewer:** R. Kalinski **Date:** 9/28/01

ID No.	Hazard	Accid Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq.		Risk		Notes (e.g., MAR, assumptions)
									W	P	W	P	
3	RAD	FIRE	All	Fire leads to release of radioactive material release	**UNCONTROLLED**			II	C	D	3	2	
					Fire department response	FP-FDR	MSA						
					Basic personnel fire suppression training	FP-PRN	PSA						
					Manual fire equipment (e.g., extinguishers)	FP-EQP	MSE						
					Fire retardant dome fabric	FP-DFR	PPE						
					Ignition source control	FP-IGN	PSA						
					Combustible loading control in waste areas	FP-CLC	PSA						
					LANL emergency response	ER-LER	MSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Residual Risk			III	D	D	2	2	
3a	RAD	FIRE	Vehicle or equipment fuel leaks		**UNCONTROLLED**			II	C	D	4	2	
					All controls in PrHA 3								
					Restrictions on refueling operations	FP-RFR	PSA						
					Speed limits onsite	TC-SPD	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Residual Risk			III	D	D	2	2	
3b	RAD	FIRE	Brush fire due to lightning		**UNCONTROLLED**			II	C	D	4	2	
					All controls in PrHA 3								
					Dome lightning protection	FP-DLP	PPE						
					Onsite notification of shut down (e.g. lightning)	ER-NOT	PSE						
					Residual Risk			IV	D	D	1	1	
3c	RAD	FIRE	Brush or forest fire propagation		**UNCONTROLLED**			II	C	D	4	2	
					All controls in PrHA 3								
					Green areas around excavation site or buffer fire zone	FP-GRN	PSA						
					Residual Risk			IV	D	D	1	1	
3d	RAD	FIRE	Electrical, maintenance, or other operational excavation activities		**UNCONTROLLED**			III	C	D	4	2	
					All controls in PrHA 3								
					Restriction on hot work/spark producing activities	FP-HOT	PSA						
					Dome heating restrictions	FP-DHR	PPA						
					Residual Risk			IV	D	D	1	1	

ID No.	Hazard	Accid Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq. W	Conq. P	Risk W	Risk P	Notes (e.g., MAR, assumptions)
4	INDST	SIH	All	Industrial hazards associated with site excavation activities injure or causes a fatality	**UNCONTROLLED**			II	A	E	8	1	
					Job specific training	TR-JOB	PSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Personal protective equipment (PPE)	CO-PPE	MSA						
					HazMat Team	ER-HAZ	MSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						
					Shaft/pit stabilization (i.e. controlled earth removal)	CO-STB	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Residual Risk			III	A	E	6	1	
5	HE	EXPLO	All	Explosive Detonation or deflagration	**UNCONTROLLED**			III	A	E	6	1	See Appendix A for Hazard Inventory
					HE only in shafts	IC-HES	PSA						
					Job specific training	TR-JOB	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					LANL emergency response	ER-LER	MSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Approved tools and equipment	CO-ATL	PSA						
					HazMat Team	ER-HAZ	MSA						
					Blast shield/berms	HM-XSH	MPE						
					Residual Risk			IV	B	D	4	1	
5a	HE	EXPLO	Waste H.E or detonators in shaft are impacted mechanically during retrieval		**UNCONTROLLED**			II	A	D	8	2	See Appendix A for Hazard Inventory
					All controls in PrHA 5								
					Remote removal of waste from shafts	HM-RRM	PPA						
					EOD (explosive) trained personnel	HM-EOD	PPA						
					Approved tools and equipment Stand off distance	CO-ATL HM-STD	PSA PPA						
					Remote video camera	HM-VDO	PPE						
					Visual examination	HM-VEX	PPA						
					Explosive use only with approved HCP (e.g. explosive removal of concrete)	HM-EXP	PPA						
					Dust control for static discharge	HM-DST	PPA						
					Explosive detection equipment	HM-XPD	PPE						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Shaft/pit stabilization (i.e. controlled earth removal)	CO-STB	PSA						
					Residual Risk			IV	A	D	6	1	

ID No.	Hazard	Accid Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq. W	Conq. P	Risk W	Risk P	Notes (e.g., MAR, assumptions)
5b	HE	EXPLO	Fire/explosion during site excavation due to operational activities		**UNCONTROLLED**								
					See PrHA No. 2 and 2b			III	A	D	6	2	See Appendix A for Hazard Inventory
					Residual Risk			IV	A	D	6	1	
5c	HE	EXPLO	Lightning strike		**UNCONTROLLED**								
					See PrHA No. 2 and 2c			III	A	D	6	2	See Appendix A for Hazard Inventory
					Residual Risk			IV	A	D	6	1	
5d	HE	EXPLO	Brush or forest fire propagation		**UNCONTROLLED**								
					See PrHA No. 2 and 2d			III	A	D	6	2	See Appendix A for Hazard Inventory
					Residual Risk			IV	A	D	6	1	
5e	HE	EXPLO	Water (rain or decontamination) is diverted into a shaft contacting reactive material (e.g., LiH)		**UNCONTROLLED**								
					See PrHA No. 2 and 2d			IV	B	D	4	1	See Appendix A for Hazard Inventory
					Residual Risk			V	C	D	1	1	
6	RAD	SPILL	All	Mechanical impacts lead to loss of waste container capability	**UNCONTROLLED**								
					Job specific training	TR-JOB	PSA	II	C	D	4	2	
					Site shutdown procedures	PR-SHT	MSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Run off control	CO-ROC	MSA						
					Personal protective equipment (PPE)	CO-PPE	MSA						
					HazMat Team	ER-HAZ	MSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						
					Shaft/pit stabilization (i.e. controlled earth removal)	CO-STB	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Chemical monitor	HM-CHM	MPE						
					Radiation monitors	RP-MNT	MPE						
					Containerization control plans	CO-CNT	PPA						
					Residual Risk			III	D	D	2	2	

ID No.	Hazard	Accid Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq.		Risk		Notes (e.g., MAR, assumptions)
									W	P	W	P	
7	RAD	EXPOS	Radioactive waste materials removed from shaft is highly radioactive	Inadvertent worker exposure	**UNCONTROLLED**			III	B	E	6	1	
					See PrHA No.								
					RCT monitoring of areas	RP-RCT	PPA						
					Radiation area posting	RP-PST	PPA						
					Radiation monitors	RP-MNT	MPE						
					Personal protective equipment (PPE)	CO-PPE	MSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						
					Remote removal of waste from shafts	HM-RRM	PPA						
					Residual Risk			IV	C	E	2	1	

Site: Los Alamos National Laboratories, TA-54
Preparer: Louis Restrepo **Date:** 8/29/01

HAZARD ANALYSIS TABLE

Location: Material Disposal Area H
Reviewer: R. Kalinski

Activity: Sort/Segregation
Date: 9/28/01

ID No.	Hazard	Accid Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq. W	Conq. P	Risk W	Risk P	Notes (e.g., MAR, assumptions)
8	RAD	FIRE	All	Fire leads to release of radioactive material release	**UNCONTROLLED**			III	C	D	4	2	
					Fire department response	FP-FDR	MSA						
					Basic personnel fire suppression training	FP-PRN	PSA						
					Manual fire equipment (e.g., extinguishers)	FP-EQP	MSE						
					Fire retardant dome fabric	FP-DFR	PPE						
					Ignition source control	FP-IGN	PSA						
					Combustible loading control in waste areas	FP-CLC	PSA						
					LANL emergency response	ER-LER	MSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Residual Risk			IV	D	D	1	1	
8a	RAD	FIRE	Vehicle or equipment fuel leaks		**UNCONTROLLED**			III	C	D	4	2	
					All controls in PrHA 8								
					Restrictions on refueling operations	FP-RFR	PSA						
					Speed limits onsite	TC-SPD	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Residual Risk			IV	D	D	1	1	
8b	RAD	FIRE	Brush fire due to lightning		**UNCONTROLLED**			III	C	D	4	2	
					All controls in PrHA 8								
					Dome lightning protection	FP-DLP	PPE						
					Onsite notification of shut down (e.g. lightning)	ER-NOT	PSE						
					Residual Risk			IV	D	D	1	1	
8c	RAD	FIRE	Brush or forest fire propagation		**UNCONTROLLED**			III	C	D	4	2	
					All controls in PrHA 8								
					Green areas around excavation site or buffer fire zone	FP-GRN	PSA						
					Residual Risk			IV	D	D	1	1	

ID No.	Hazard	Accid Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq. W	Conq. P	Risk W	Risk P	
8d	RAD	FIRE	Electrical, maintenance, or other operational sort/segregation activities		**UNCONTROLLED**			III	C	D	4	2	
					All controls in PrHA 8								
					Restriction on hot work/spark producing activities	FP-HOT	PSA						
					Dome heating restrictions	FP-DHR	PPA						
					Residual Risk			IV	D	D	1	1	
9	INDST	SIH	All	Industrial hazards associated with sort/segregation activities injure or causes a fatality	**UNCONTROLLED**			II	A	E	8	1	
					Job specific training	TR-JOB	PSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Personal protective equipment (PPE)	CO-PPE	MSA						
					HazMat Team	ER-HAZ	MSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Residual Risk			III	D	E	2	1	
10	HE	EXPLO	All	Explosive Detonation or deflagration	**UNCONTROLLED**			III	A	D	6	2	See Appendix A for Hazard Inventory
					Job specific training	TR-JOB	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					LANL emergency response	ER-LER	MSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Approved tools and equipment	CO-ATL	PSA						
					HazMat Team	ER-HAZ	MSA						
					Blast shield/berms	HM-XSH	MPE						
					Residual Risk			IV	B	D	4	1	
10a	HE	EXPLO	Waste H.E or detonators in sort/segregation area are mechanically impacted during sort/segregation		**UNCONTROLLED**			III	A	D	6	2	See Appendix A for Hazard Inventory
					All controls in PrHA 10								
					EOD (explosive) trained personnel	HM-EOD	PPA						
					Approved tools and equipment	CO-ATL	PSA						
					Explosive use only with approved HCP (e.g. explosive removal of concrete)	HM-EXP	PPA						
					Explosive detection equipment	HM-XPD	PPE						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Residual Risk			IV	B	D	4	1	

ID No.	Hazard	Accid Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq. W	Conq. P	Risk W	Risk P	
10b	HE	EXPLO	Fire in or around the sort/segregation area due to misc operational activities		**UNCONTROLLED**			III	A	D	6	1	See Appendix A for Hazard Inventory
					See PrHA No. 2b								
					Residual Risk			IV	B	D	4	1	
10c	HE	EXPLO	Lightning strike		**UNCONTROLLED**			IV	A	D	6	1	See Appendix A for Hazard Inventory
					See PrHA No. 2c								
					Residual Risk			IV	B	D	4	1	
10d	HE	EXPLO	Brush or forest fire propagation		**UNCONTROLLED**			IV	A	D	6	1	See Appendix A for Hazard Inventory
					See PrHA No. 2d								
					Residual Risk			IV	B	D	4	1	
10e	HE	EXPLO	Static energy or electrical insults to waste H.E. or detonators are being handled during sort/segregation		**UNCONTROLLED**			III	A	D	6	2	See Appendix A for Hazard Inventory
					All controls in PrHA 10								
					Dust control for static discharge	HM-DST	PPA						
					Explosive inerting (safe configuration)	HM-XPI	PPA						
					Residual Risk			IV	B	D	4	1	
10f	HE	EXPLO	Water contacts reactive materials - Potential HE detonation		**UNCONTROLLED**			IV	B	D	4	1	See Appendix A for Hazard Inventory
					All controls in PrHA 10								
					Dust control for static discharge	HM-DST	PPA						
					Explosive inerting (safe configuration)	HM-XPI	PPA						
					Residual Risk			V	C	D	1	1	
11	RAD	SPILL	Container drops, equipment falls on container, or loss of container integrity during handling	Mechanical impacts lead to loss of waste container capability, and release of radioactive material	**UNCONTROLLED**			II	C	C	4	2	
					Job specific training	TR-JOB	PSA						
					Site shutdown procedures	PR-SHT	MSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Run off control	CO-ROC	MSA						
					Personal protective equipment (PPE)	CO-PPE	MSA						
					HazMat Team	ER-HAZ	MSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Radiation monitors	RP-MNT	MPE						
					Containerization control plans	CO-CNT	PPA						
					Residual Risk			III	D	D	2	2	
12	RAD	SPILL	Dome structural supports fail, structure collapses impacting waste	Mechanical impact lead to loss of waste container capability, and release of radioactive material	**UNCONTROLLED**			II	C	D	4	2	
					Anchoring of domes	MP-DAN	PPE						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						

ID No.	Hazard	Accid Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq. W	Conq. P	Risk W	Risk P	
					Radiation monitors	RP-MNT	MPE						
					Containerization control plans	CO-CNT	PPA						
					Residual Risk			III	D	D	2	2	
13	TOXIC	SPILL	Toxic material is present in the waste during the sort/segregation activities	Worker is exposed to uncontained hazardous or toxic waste	**UNCONTROLLED**			III	C	D	4	2	It is assumed that very limited quantities of hazardous if any are present in the waste at MDA H
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Personal protective equipment (PPE)	CO-PPE	MSA						
					HazMat Team	ER-HAZ	MSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Chemical monitor	HM-CHM	MPE						
					Containerization control plans	CO-CNT	PPA						
					Residual Risk			IV	D	D	1	1	
14	RAD	EXPOS	Radioactive waste materials being sort/segregated is highly radioactive (s)	Inadvertent worker exposure	**UNCONTROLLED**			IV	B	E	4	1	
					All controls in PrHA 11								
					RCT monitoring of areas	RP-RCT	PPA						
					Radiation area posting	RP-PST	PPA						
					Radiation monitors	RP-MNT	MPE						
					Personal protective equipment (PPE)	CO-PPE	MSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						
					Remote removal of waste from shafts	HM-RRM	PPA						
					Residual Risk			IV	D	E	1	1	
15	RAD	EXPOS	Personnel present within the radiography area during NDE (x-rays or γ-rays) radiography operations	Inadvertent worker exposure	**UNCONTROLLED**			III	A	E	6	1	It is assumed that radiography machine has enough intensity to produce lethal doses from direct exposure within relative short period of time
					All controls in PrHA 11								
					Job specific training	TR-JOB	PSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Radiation monitors	RP-MNT	MPE						
					RTR equipment controls (shielding, door interlocks, etc.)	RP-RTR	PPE						

ID No.	Hazard	Accid Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq.		Risk		
									W	P	W	P	
					RCT monitoring of areas	RP-RCT	PPA						
					Collimator or focus equipment is installed -aligned during (x- or γ-rays) radiography operations	RP-CAF	PPE						
					Radiation area posting	RP-PST	PPA						
16	RAD	EXPOS	Radioactive equipment malfunction	Inadvertent worker exposure	**Residual Risk**			IV	D	E	1	1	
					UNCONTROLLED			IV	B	E	4	1	
					All controls in PrHA 11								
					RCT monitoring of areas	RP-RCT	PPA						
					Radiation area posting	RP-PST	PPA						
					Radiation monitors	RP-MNT	MPE						
					LANL emergency response	ER-LER	MSA						
					Collimator or focus equipment is installed -aligned during (x- or γ-rays) radiography operations	RP-CAF	PPE						
					Remote removal of waste from shafts	HM-RRM	PPA						
					Residual Risk			IV	D	E	1	1	

HAZARD ANALYSIS TABLE

Site: Los Alamos National Laboratories, TA-54 **Location:** Material Disposal Area H **Activity:** Declassification
Preparer: Louis Restrepo **Date:** 8/28/01 **Reviewer:** R. Kalinski **Date:** 9/28/01

ID *No.	Hazard	Accident Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq.		Risk		Notes (e.g., MAR, assumptions)
									W	P	W	P	
17	RAD	FIRE	All	Fire leads to release of radioactive material release	**UNCONTROLLED**			III	C	D	4	2	
					Fire department response	FP-FDR	MSA						
					Basic personnel fire suppression training	FP-PRN	PSA						
					Manual fire equipment (e.g., extinguishers)	FP-EQP	MSE						
					Fire retardant dome fabric	FP-DFR	PPE						
					Ignition source control	FP-IGN	PSA						
					Combustible loading control in waste areas	FP-CLC	PSA						
					LANL emergency response	ER-LER	MSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Residual Risk			IV	D	D	1	1	
17a	RAD	FIRE	Vehicle or equipment fuel leaks		**UNCONTROLLED**			III	C	D	4	2	
					All controls in PrHA 16								
					Restrictions on refueling operations	FP-RFR	PSA						
					Speed limits onsite	TC-SPD	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Residual Risk			IV	D	D	1	1	
17b	RAD	FIRE	Brush fire due to lightning		**UNCONTROLLED**			III	C	D	4	2	
					All controls in PrHA 16								
					Dome lightning protection	FP-DLP	PPE						
					Onsite notification of shut down (e.g. lightning)	ER-NOT	PSE						
					Residual Risk			IV	D	D	1	1	
17c	RAD	FIRE	Brush or forest fire propagation		**UNCONTROLLED**			III	C	D	4	2	
					All controls in PrHA 16								
					Green areas around excavation site or buffer fire zone	FP-GRN	PSA						
					Residual Risk			IV	D	D	1	1	

ID *No.	Hazard	Accident Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq.		Risk		Notes (e.g., MAR, assumptions)
									W	P	W	P	
17d	RAD	FIRE	Electrical, maintenance, or other operational declassification activities		**UNCONTROLLED**			III	C	D	4	2	
					All controls in PrHA 16								
					Restriction on hot work/spark producing activities	FP-HOT	PSA						
					Dome heating restrictions	FP-DHR	PPA						
					Residual Risk			IV	D	D	1	1	
18	INDST	SIH	All	Industrial hazards associated with declassification activities injure or causes a fatality	**UNCONTROLLED**			II	A	E	8	1	
					Job specific training	TR-JOB	PSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Personal protective equipment (PPE)	CO-PPE	MSA						
					HazMat Team	ER-HAZ	MSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Residual Risk			III	A	E	8	1	
19	HE	EXPLO	All	Explosive Detonation or deflagration	**UNCONTROLLED**			III	A	D	8	2	See Appendix A for Hazard Inventory
					Job specific training	TR-JOB	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					LANL emergency response	ER-LER	MSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Approved tools and equipment	CO-ATL	PSA						
					HazMat Team	ER-HAZ	MSA						
					Blast shield/berms	HM-XSH	MPE						
					Residual Risk			IV	B	D	4	1	
19a	HE	EXPLO	Waste H.E or detonators in declassification area are mechanically impacted during retrieval		**UNCONTROLLED**			III	A	D	6	2	See Appendix A for Hazard Inventory
					All controls in PrHA 18								
					EOD (explosive) trained personnel	HM-EOD	PPA						
					Approved tools and equipment	CO-ATL	PSA						
					Explosive use only with approved HCP (e.g. explosive removal of concrete)	HM-EXP	PPA						
					Explosive detection equipment	HM-XPD	PPE						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Residual Risk			IV	B	D	4	1	

ID *No.	Hazard	Accident Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq.		Risk		Notes (e.g., MAR, assumptions)
									W	P	W	P	
19b	HE	EXPLO	Fire/explosion in or around the declassification area due to misc operational activities		UNCONTROLLED			III	A	D	8	1	See Appendix A for Hazard Inventory
					See PrHA No. 2 and 5								
					Residual Risk			IV	B	D	4	1	
19c	HE	EXPLO	Lightning strike		UNCONTROLLED			IV	A	D	6	1	See Appendix A for Hazard Inventory
					See PrHA No. 2 and 2c								
					Residual Risk			IV	B	D	4	1	
19d	HE	EXPLO	Brush or forest fire propagation		UNCONTROLLED			IV	A	D	6	1	See Appendix A for Hazard Inventory
					See PrHA No. 2 and 2d								
					Residual Risk			IV	B	D	4	1	
19e	HE	EXPLO	Static energy or electrical insults to waste H.E. or detonators are being handled during declassification		UNCONTROLLED			III	A	D	8	2	See Appendix A for Hazard Inventory
					See PrHA No. 2 and 2d								
					Residual Risk			IV	B	D	4	1	
19F	HE	EXPLO	Incompatible waste materials are packaged together in a container resulting in a undesired reaction - Potential HE detonation		UNCONTROLLED			IV	B	D	4	1	See Appendix A for Hazard Inventory
					See PrHA No. 2 and 2d								
					Residual Risk			V	C	D	1	1	
20	RAD	SPILL	Container drops, equipment falls on container, or loss of container integrity during handling	Mechanical impacts lead to loss of waste container capability, and release of radioactive material	UNCONTROLLED			II	C	D	4	2	
					Job specific training	TR-JOB	PSA						
					Site shutdown procedures	PR-SHT	MSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Run off control	CO-ROC	MSA						
					Personal protective equipment (PPE)	CO-PPE	MSA						
					HazMat Team	ER-HAZ	MSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Radiation monitors	RP-MNT	MPE						
					Containerization control plans	CO-CNT	PPA						
					Residual Risk			III	D	D	2	2	

ID *No.	Hazard	Accident Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq.		Risk		Notes (e.g., MAR, assumptions)
									W	P	W	P	
20a	RAD	SPILL	Dome structural supports fail, structure collapses impacting waste	Mechanical impact lead to loss of waste container capability, and release of radioactive material	UNCONTROLLED			III	C	D	4	2	
					See PrHA No. 12								
					Residual Risk			III	D	D	2	2	
21	RAD	EXPOS	Radioactive waste materials being declassified is highly radioactive	Inadvertent worker exposure	UNCONTROLLED			IV	B	E	4	1	
					See PrHA No. 11								
					Residual Risk			IV	D	E	1	1	

HAZARD ANALYSIS TABLE

Site: Los Alamos National Laboratories, TA-54 **Location:** Material Disposal Area H **Activity:** Packaging/Loading
Preparer: Louis Restrepo **Date:** 8/28/01 **Reviewer:** R. Kalinski **Date:** 9/28/01

ID *No.	Hazard	Accident Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq. W	Conq. P	Risk W	Risk P	Notes (e.g., MAR, assumptions)
22	RAD	FIRE	All	Fire leads to release of radioactive material release	**UNCONTROLLED**			III	C	D	4	2	
					Fire department response	FP-FDR	MSA						
					Basic personnel fire suppression training	FP-PRN	PSA						
					Manual fire equipment (e.g., extinguishers)	FP-EQP	MSE						
					Fire retardant dome fabric	FP-DFR	PPE						
					Ignition source control	FP-IGN	PSA						
					Combustible loading control in waste areas	FP-CLC	PSA						
					LANL emergency response	ER-LER	MSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Residual Risk			IV	D	D	1	1	
22a	RAD	FIRE	Vehicle or equipment fuel leaks		**UNCONTROLLED**			III	C	D	4	2	
					All controls in PrHA 16								
					Restrictions on refueling operations	FP-RFR	PSA						
					Speed limits onsite	TC-SPD	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Residual Risk			IV	D	D	1	1	
22b	RAD	FIRE	Brush fire due to lightning		**UNCONTROLLED**			III	C	D	4	2	
					All controls in PrHA 16								
					Dome lightning protection	FP-DLP	PPE						
					Onsite notification of shut down (e.g. lightning)	ER-NOT	PSE						
					Residual Risk			IV	D	D	1	1	
22c	RAD	FIRE	Brush or forest fire propagation		**UNCONTROLLED**			III	C	D	4	2	
					All controls in PrHA 16								
					Green areas around excavation site or buffer fire zone	FP-GRN	PSA						
					Residual Risk			IV	D	D	1	1	
22d	RAD	FIRE	Electrical, maintenance, or other packing/loading activities		**UNCONTROLLED**			III	C	D	4	2	
					All controls in PrHA 16								
					Restriction on hot work/spark producing activities	FP-HOT	PSA						
					Dome heating restrictions	FP-DHR	PPA						
					Residual Risk			IV	D	D	1	1	

ID *No.	Hazard	Accident Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq.		Risk		Notes (e.g., MAR, assumptions)
									W	P	W	P	
23	INDST	SIH	All	Industrial hazards associated with packing/loading activities injure or causes a fatality	**UNCONTROLLED**			II	A	E	8	1	
					Job specific training	TR-JOB	PSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Personal protective equipment (PPE)	CO-PPE	MSA						
					HazMat Team	ER-HAZ	MSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Residual Risk			III	A	E	6	1	
24	HE	EXPLO	All	Explosive Detonation or deflagration	**UNCONTROLLED**			III	A	D	4	1	See Appendix A for Hazard Inventory
					Job specific training	TR-JOB	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					LANL emergency response	ER-LER	MSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Approved tools and equipment	CO-ATL	PSA						
					HazMat Team	ER-HAZ	MSA						
					Blast shield/berms	HM-XSH	MPE						
24a	HE	EXPLO	Waste H.E or detonators in packing/loading area are mechanically impacted during packing/loading		**Residual Risk**			IV	B	E	4	1	
					UNCONTROLLED			III	A	D	6	2	See Appendix A for Hazard Inventory
					All controls in PrHA 18								
					EOD (explosive) trained personnel	HM-EOD	PPA						
					Approved tools and equipment	CO-ATL	PSA						
					Explosive use only with approved HCP (e.g. explosive removal of concrete)	HM-EXP	PPA						
					Explosive detection equipment	HM-XPD	PPE						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Residual Risk			IV	B	D	4	1	
24b	HE	EXPLO	Fire in or around the packing/loading area due to operational activities		**UNCONTROLLED**			IV	A	D	6	1	See Appendix A for Hazard Inventory
					See PrHA No. 2 and 5								
					Residual Risk			IV	B	E	2	1	
24c	HE	EXPLO	Lightning strike		**UNCONTROLLED**			IV	A	D	6	1	See Appendix A for Hazard Inventory
					See PrHA No. 2 and 2c								
					Residual Risk			IV	B	D	4	1	

ID *No.	Hazard	Accident Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq.		Risk		Notes (e.g., MAR, assumptions)
									W	P	W	P	
24d	HE	EXPLO	Brush or forest fire propagation		UNCONTROLLED			IV	A	D	6	1	See Appendix A for Hazard Inventory
					See PrHA No. 2 and 2d								
					Residual Risk			IV	B	D	4	1	
24e	HE	EXPLO	Static energy or electrical insults to waste H.E. or detonators are being handled during packing/loading		UNCONTROLLED			III	A	D	6	1	See Appendix A for Hazard Inventory
					See PrHA No. 2 and 2d								
					Residual Risk			IV	B	D	4	1	
24f	HE	EXPLO	Incompatible waste materials are packaged together in a container resulting in a undesired reaction - Potential HE detonation		UNCONTROLLED			IV	C	D	2	1	See Appendix A for Hazard Inventory
					See PrHA No. 2 and 2d								
					Residual Risk			V	C	D	1	1	
24g	HE	EXPLO	Water contacts reactive materials		UNCONTROLLED			IV	B	D	4	1	See Appendix A for Hazard Inventory
					See PrHA No. 2 and 2d								
					Residual Risk			V	C	D	1	1	
25	RAD	SPILL	Container drops, equipment fails on container, or loss of container integrity during handling.	Mechanical impacts lead to loss of waste container capability, and release of radioactive material	UNCONTROLLED			III	C	D	4	2	
					Job specific training	TR-JOB	PSA						
					Site shutdown procedures	PR-SHT	MSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Run off control	CO-ROC	MSA						
					Personal protective equipment (PPE)	CO-PPE	MSA						
					HazMat Team	ER-HAZ	MSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Radiation monitors	RP-MNT	MPE						
					Containerization control plans	CO-CNT	PPA						
					Residual Risk			III	D	D	2	2	
26	RAD	SPILL	Dome structural supports fail, structure collapses impacting waste	Mechanical impact lead to loss of waste container capability, and release of radioactive material	UNCONTROLLED			III	C	D	4	2	
					See PrHA No. 12								
					Residual Risk			III	D	D	2	2	
27	RAD	EXPOS	Radioactive waste materials being declassified is highly radioactive	Inadvertent worker exposure	UNCONTROLLED			IV	B	E	4	1	
					See PrHA No. 11								
					Residual Risk			IV	D	E	1	1	

ID *No.	Hazard	Accident Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq. W	Conq. P	Risk W	Risk P	Notes (e.g., MAR, assumptions)
30a	HE	EXPLO	Mechanical insults during transport activities impacts HE or detonators		**UNCONTROLLED**			III	A	D	6	2	See Appendix A for Hazard Inventory
					All controls in PrHA 18								
					EOD (explosive) trained personnel	HM-EOD	PPA						
					Approved tools and equipment	CO-ATL	PSA						
					Explosive use only with approved HCP (e.g. explosive removal of concrete)	HM-EXP	PPA						
					Residual Risk			IV	B	D	4	1	
30b	HE	EXPLO	Vehicle accident leads to an explosion		**UNCONTROLLED**			IV	A	D	6	2	See Appendix A for Hazard Inventory
					See PrHA No. 27								
					Residual Risk			V	B	D	2	1	
30c	HE	EXPLO	Static energy or electrical insults to waste H.E. or detonators are being handled during Onsite/Offsite transport		**UNCONTROLLED**			IV	A	D	6	1	See Appendix A for Hazard Inventory
					See PrHA No. 2 and 2d								
					Residual Risk			IV	B	E	2	1	
31	RAD	SPILL	All	Mechanical impacts lead to loss of waste container capability, and release of radioactive material	**UNCONTROLLED**			II	C	C	4	4	
					Job specific training	TR-JOB	PSA						
					Waste characterization controls	IC-WCC	PSA						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Containerization control plans	CO-CNT	PPA						
					Residual Risk			III	D	D	1	1	
31a	RAD	SPILL	Vehicle accident spills waste		**UNCONTROLLED**			II	C	D	4	2	
					See PrHA No. 28								
					Waste container securing devices								
					Residual Risk			III	C	D	4	2	
31b	RAD	SPILL	Waste containers securing equipment fails during transport during transport activities		**UNCONTROLLED**			III	C	D	4	2	
					See PrHA No. 28								
					Waste container securing devices								
					Residual Risk			IV	C	D	2	1	

HAZARD ANALYSIS TABLE

Site: Los Alamos National Laboratories, TA-54 **Location:** Material Disposal Area H **Activity:** Site Remediation
Preparer: Louis Restrepo **Date:** 8/29/01 **Reviewer:** R. Kalinski **Date:** 9/28/01

ID No.	Hazard	Accident Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq.		Risk		Notes (e.g., MAR, assumptions)
									W	P	W	P	
32	FIRE	SIH	All	Operational fire injures workers	**UNCONTROLLED**			II	C	E	4	1	
					Fire department response	FP-FDR	MSA						
					Basic personnel fire suppression training	FP-PRN	PSA						
					Manual fire equipment (e.g., extinguishers)	FP-EQP	MSE						
					Ignition source control	FP-IGN	PSA						
					Combustible loading control in waste areas	FP-CLC	PSA						
					LANL emergency response	ER-LER	MSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Residual Risk			III	D	E	2	1	
32a	FIRE	SIH	Brush fire due to lightning		**UNCONTROLLED**			II	C	E	4	1	
					All controls in PrHA 30								
					Onsite notification of shut down (e.g. lightning)	ER-NOT	PSE						
					Residual Risk			III	D	E	2	1	
32b	FIRE	SIH	Brush or forest fire propagation		**UNCONTROLLED**			II	C	E	4	1	
					All controls in PrHA 30								
					Green areas around excavation site or buffer fire zone	FP-GRN	PSA						
					Residual Risk			III	D	E	2	1	
32c	FIRE	SIH	Electrical, maintenance, or other operational remediation activities		**UNCONTROLLED**			II	A	E	8	1	
					All controls in PrHA 30								
					Restriction on hot work/spark producing activities	FP-HOT	PSA						
					Residual Risk			III	D	E	2	1	
33	INDST	SIH	All	Industrial hazards associated with site remediation activities injure or causes a fatality	**UNCONTROLLED**			II	A	E	8	1	
					Job specific training	TR-JOB	PSA						
					Access controlled zones (hot, warm, cold)	CO-ACZ	PSA						
					Personal protective equipment (PPE)	CO-PPE	MSA						
					HazMat Team	ER-HAZ	MSA						
					LANL emergency response	ER-LER	MSA						
					Waste characterization controls	IC-WCC	PSA						

ID No.	Hazard	Accident Type	Cause or Initiating Event	Scenario	Control Description	Control Id	Control Type	Freq.	Conq.		Risk		Notes (e.g., MAR, assumptions)
									W	P	W	P	
					Shaft/pit stabilization (i.e. controlled earth removal)	CO-STB	PSA						
					Approved Hazard Control Plans (HCPs), Work Permits, and Procedures	PR-HCP	PSA						
					Onsite notification of shut down (e.g. lightning)	ER-NOT	PSE						
					Maintenance of equipment and vehicles	MP-EQP	PSA						
					Residual Risk			III	D	E	2	1	

- APPENDIX E –
Summary of Accident Scenarios by Risk Bin for all Accident Scenarios in the PrHA by Remedial Activity

Risk Summary- Totals for all activities (number of PrHA scenarios)

Consequence Frequency	E		D		C		B		A	
	W	P	W	P	W	P	W	P	W	P
I-unmitigated										
I-mitigated										
II-unmitigated		29		7	7	2			32	2
II-mitigated										
III-unmitigated		2		29	19		1		13	
III-mitigated		29	7	9	2				26	2
IV-unmitigated		4		17	1		7		12	
IV-mitigated		6	21	39	2		18		4	
V-unmitigated										
V-mitigated				9	5		1		3	

Risk Summary - Site Preparation (number of PrHA scenarios)

Consequence Frequency	E		D		C		B		A	
	W	P	W	P	W	P	W	P	W	P
I-unmitigated										
I-mitigated										
II-unmitigated		6								
II-mitigated									6	
III-unmitigated										
III-mitigated		6								
IV-unmitigated									6	
IV-mitigated				3					3	
V-unmitigated										
V-mitigated				3					3	

Risk Summary - Site Excavation (number of PrHA scenarios)

Consequence Frequency	E		D		C		B		A	
	W	P	W	P	W	P	W	P	W	P
I-unmitigated										
I-mitigated										
II-unmitigated		8		3	2				9	
II-mitigated										
III-unmitigated		1		4	1		1		3	
III-mitigated		8	2	2					8	
IV-unmitigated				1			1			
IV-mitigated		1	3	8	1		1		4	
V-unmitigated										
V-mitigated				1	1					

Risk Summary - Sort / Segregation (number of PrHA scenarios)

Consequence Frequency	E		D		C		B		A	
	W	P	W	P	W	P	W	P	W	P
I-unmitigated										
I-mitigated										
II-unmitigated		1		1	2	1			1	
II-mitigated										
III-unmitigated		1		10	6				5	
III-mitigated		1	3	2						
IV-unmitigated		2		3			3		2	
IV-mitigated		3	8	11			5			
V-unmitigated										
V-mitigated				1	1					

Risk Summary - Declassification (number of PrHA scenarios)

Consequence Frequency	E		D		C		B		A	
	W	P	W	P	W	P	W	P	W	P
I-unmitigated										
I-mitigated										
II-unmitigated		5		1	1				5	
II-mitigated										
III-unmitigated				8	5				3	
III-mitigated		5	2	2					5	
IV-unmitigated		1		3			2		2	
IV-mitigated		1	5	9			5			
V-unmitigated										
V-mitigated				1	1					

Risk Summary - Packing / Loading (number of PrHA scenarios)

Consequence Frequency	E		D		C		B		A	
	W	P	W	P	W	P	W	P	W	P
I-unmitigated										
I-mitigated										
II-unmitigated		4		1	1				4	
II-mitigated										
III-unmitigated				7	6				2	
III-mitigated		4	2	2					1	
IV-unmitigated		1		5	1		3		3	
IV-mitigated		1	5	9			533			
V-unmitigated										
V-mitigated				2	2					

Risk Summary - Transportation (number of PrHA scenarios)

Consequence Frequency	E		D		C		B		A	
	W	P	W	P	W	P	W	P	W	P
I-unmitigated										
I-mitigated										
II-unmitigated				1	1	1			2	2
II-mitigated										
III-unmitigated				3	2				1	
III-mitigated				2	2				2	2
IV-unmitigated				2					2	
IV-mitigated				3	1		2			
V-unmitigated										
V-mitigated				1			1			

Risk Summary - Site Remediation (number of PrHA scenarios)

Consequence Frequency	E		D		C		B		A	
	W	P	W	P	W	P	W	P	W	P
I-unmitigated										
I-mitigated										
II-unmitigated		2							2	
II-mitigated										
III-unmitigated										
III-mitigated		2							2	
IV-unmitigated										
IV-mitigated										
V-unmitigated										
V-mitigated										

- APPENDIX F –
Unmitigated and Mitigated Risk Estimates for Remedial Activities

Unmitigated Worker Risk								
	Site Prep.	Site Excv.	Sort/Segr.	Declass.	Packing/Loading	Transport.	Site Remed.	Total
Industrial Accidents	46	70	30	36	30	16	30	258
	5.IIA+1IIIA	8.IIA+1.IIIA	3.IIA+1.IIIA	5.IIIA+1.IIIA	4.IIA+1.IIIA	2.IIA	3.IIA+1.IIIA	
Fires	0	16	16	16	16	6	0	70
		2.IIIC+2.IIC	4.IIIC	4.IIIC	4.IIIC	1.IIIA		
Explosions	14	30	34	34	36	12	0	160
	1.IVA+2.VA	2.IIA+3.IIIA+1.IVB	3.IIIA+2.IVA+1IVB	3.IIIA+2.IVA+1.IVB	2.IIIA+3.IVA+1.IVB+1.IVC	1.IIIA+1.IVA		
Spills	0	4	12	8	8	8	0	40
		1.IIC	1.IIC+2.IIIC	1.IIC+1.IIIC	1.IIC+1.IIIC	2.IIC		
Industrial Exposures	0	6	14	4	4	0	0	28
		1.IIIB	2.IVB+1.IIIA	1.IVB	1.IVB			
Total Risk	60	126	106	98	94	42	30	556
Risk Contribution %								
Industrial Accidents	76.67%	55.56%	28.30%	36.73%	31.91%	38.10%	100.00%	52.47%
Fires	0.00%	12.70%	15.09%	16.33%	17.02%	14.29%	0.00%	10.78%
Explosions	23.33%	23.81%	32.08%	34.69%	38.30%	28.57%	0.00%	25.83%
Spill	0.00%	3.17%	11.32%	8.16%	8.51%	19.05%	0.00%	7.17%
Industrial Exposures	0.00%	4.76%	13.21%	4.08%	4.26%	0.00%	0.00%	3.76%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Relative Risk								
	Site Prep.	Site Excav.	Sort/Segr.	Declass.	Pack/Load	Transp.	Site Remed.	Risk Rank
Industrial Accidents	46	70	30	36	30	16	30	258
Fires	0	16	16	16	16	6	0	70
Explosions	14	30	34	34	36	12	0	160
Spill	0	4	12	8	8	8	0	40
Industrial Exposures	0	6	14	4	4	0	0	28
Total Risk	60	126	106	98	94	42	30	556

Unmitigated Worker Risk								
	Site Prep.	**Site Excv.**	**Sort/Segr.**	**Declass.**	**Packing/Loading**	**Transport.**	**Site Remed.**	**Total**
Industrial Accidents	46	70	30	36	30	16	30	258
	5.IIA+1IIIA	8.IIA+1.IIIA	3.IIA+1.IIIA	5.IIIA+1.IIIA	4.IIA+1.IIIA	2.IIA	3.IIA+1.IIIA	
Fires	0	16	16	16	16	6	0	70
		2.IIIC+2.IIC	4.IIIC	4.IIIC	4.IIIC	1.IIIA		
Explosions	14	30	34	34	36	12	0	160
	1.IVA+2.VA	2.IIA+3.IIIA+1.IVB	3.IIIA+2.IVA+1IVB	3.IIIA+2.IVA+1.IVB	2.IIIA+3.IVA+1.IVB+1.IVC	1.IIIA+1.IVA		
Spills	0	4	12	8	8	8	0	40
		1.IIC	1.IIC+2.IIIC	1.IIC+1.IIIC	1.IIC+1.IIIC	2.IIC		
Industrial Exposures	0	6	14	4	4	0	0	28
		1.IIIB	2.IVB+1.IIIA	1.IVB	1.IVB			
Total Risk	60	126	106	98	94	42	30	556
Risk Contribution %								
Industrial Accidents	76.67%	55.56%	28.30%	36.73%	31.91%	38.10%	100.00%	52.47%
Fires	0.00%	12.70%	15.09%	16.33%	17.02%	14.29%	0.00%	10.78%
Explosions	23.33%	23.81%	32.08%	34.69%	38.30%	28.57%	0.00%	25.83%
Spill	0.00%	3.17%	11.32%	8.16%	8.51%	19.05%	0.00%	7.17%
Industrial Exposures	0.00%	4.76%	13.21%	4.08%	4.26%	0.00%	0.00%	3.76%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Relative Risk								
	Site Prep.	Site Excav.	Sort/Segr.	Declass.	Pack/Load	Transp.	Site Remed.	Risk Rank
Industrial Accidents	46	70	30	36	30	16	30	258
Fires	0	16	16	16	16	6	0	70
Explosions	14	30	34	34	36	12	0	160
Spill	0	4	12	8	8	8	0	40
Industrial Exposures	0	6	14	4	4	0	0	28
Total Risk	60	126	106	98	94	42	30	556

Mitigated Worker Risk								
	Site Prep.	Site Excv.	Sort/Segr.	Declass.	Packing/Loading	Transport.	Site Remed.	Total
Industrial Accidents	36	54	24	30	30	12	24	210
	6.IIIA	9.IIIA	4.IIIA	5.IIIA	5.IIIA	2.IIIA	4.IIIA	
Fires	0	16	4	4	4	2	0	30
		1.IIID+3.IVD	4.IVD	4.IVD	4.IVD	1.IVC		
Explosions	18	24	21	21	23	6	0	113
	3.VA	4.IVA	5.IVB+1VC	5.IVB+1.VC	5.IVB+1.VC+1.VB	1.IVB+1.VD		
Spills	0	2	5	4	4	6	0	21
		1.IIID	2.IIID+1.IVD	2.IIID	2.IIID	1.IIIC+1.IVC		
Industrial Exposures	0	2	3	1	1	0	0	7
		1.IVC	3.IVD	1.IVD	1.IVD			
Total Risk	54	98	57	60	62	26	24	381
	Site Prep.	Site Excav.	Sort/Segr.	Declass.	Pack/Load	Transp.	Site Remed.	Total
Ind.Acc.	66.67%	55.10%	42.11%	50.00%	48.39%	46.15%	100.00%	58.34%
Fires	0.00%	16.33%	7.02%	6.67%	6.45%	7.69%	0.00%	6.31%
Explo.	33.33%	24.49%	36.84%	35.00%	37.10%	23.08%	0.00%	27.12%
Spill	0.00%	2.04%	8.77%	6.67%	6.45%	23.08%	0.00%	6.72%
Ind.Exp	0.00%	2.04%	5.26%	1.67%	1.61%	0.00%	0.00%	1.51%
Total Risk	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%