



# U.S. Department of Energy Office of Environmental Management

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## Accident Investigation Report

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### Phase 2

## Radiological Release Event at the Waste Isolation Pilot Plant, February 14, 2014

April 2015



## Disclaimer

On February 14, 2014, an airborne radiological release occurred at the Department of Energy Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. On March 4, 2014, an Accident Investigation Board (the Board) was appointed by Matthew Moury, Deputy Assistant Secretary, Safety, Security, and Quality Programs to determine the cause of the release. Because access to the underground was restricted following the event, the investigation was broken into two phases. The first phase, Phase 1, focused on how the radiological material was released into the atmosphere and the results were issued on April 22, 2014, in a Phase 1 investigation report.

On May 19, 2014, James Hutton, Deputy Assistant Secretary, Safety, Security, and Quality Programs, U.S. Department of Energy, Office of Environmental Management, appointed an Accident Investigation Board to complete the investigation (Phase 2). Phase 2 was performed once limited access to the underground was re-established and focused on how the radiological material was released. For both Phases, the Board was appointed to perform an accident investigation and to prepare an investigation report in accordance with Department of Energy Order 225.1B, *Accident Investigations*.

The discussion of the facts as determined by the Board and the views expressed in the report do not assume and are not intended to establish the existence of any duty at law on the part of the U.S. Government, its employees or agents, contractors, their employees or agents, or subcontractors at any tier, or any other party.

This Phase 2 report neither determines nor implies liability.

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## Release Authorization

On March 4, 2014, an Accident Investigation Board was appointed to investigate a radiological release event at the U.S. Department of Energy, Waste Isolation Pilot Plant site near Carlsbad, New Mexico, that occurred on February 14, 2014. The Board's responsibilities with respect to Phase 1 of the investigation, the radiological release to the atmosphere, were completed and a final report issued on April 22, 2014.

On May 19, 2014, James Hutton, Deputy Assistant Secretary, Safety, Security, and Quality Programs, U.S. Department of Energy, Office of Environmental Management appointed an Accident Investigation Board to continue Phase 2 of the investigation, focused on the radiological release from transuranic waste container 68660 at the Waste Isolation Pilot Plant site.

The analysis and the identification of the contributing causes, the root cause and the Judgments of Need resulting from this investigation were performed in accordance with DOE Order 225.1B, *Accident Investigations*.

The Phase 2 report of the Accident Investigation Board was accepted and the authorization to release this Phase 2 report was granted for general distribution on April 16, 2015.



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James Hutton  
Deputy Assistant Secretary for  
Safety, Security, and Quality Programs  
Environmental Management



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Date



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## Acronyms

ADEP	Associate Directorate/Director of Environmental Programs
AK	Acceptable Knowledge
AKTSS	Acceptable Knowledge Tracking Spread Sheet
Am	Americium
ARF	Airborne Release Fraction
ARP	Accelerated Retrieval Project
Be	Beryllium
BIO	Basis for Interim Operation
CAM	Continuous Air Monitor
CAQ	Condition Adverse to Quality
CAR	Corrective Action Report
CAS	Contractor Assurance System
CBFO	Carlsbad Field Office
CCP	Central Characterization Program
CH	Contact-Handled
CIS	Characterization Information Summary
CON	Conclusion
Cs	Cesium
DL	Discard Limit
DOE	U.S. Department of Energy
DQO	Data Quality Objective
DSA	Documented Safety Analysis
DR	Damage Ratio
EM	Office of Environmental Management
EMCBC	Office of Environmental Management Consolidated Business Center
EMRTC	Energetic Materials Research and Testing Center
EPA	Environmental Protection Agency
EPO	Environmental Projects Office
ES	EnergySolutions, LLC
EWMO	Environmental and Waste Management Operations
FAS	Fixed Air Sampler
FGA	Flammable Gas Analysis
FTE	Full-time Equivalent
FTIR	Fourier Transform Infrared Analysis
GC-MS	Gas Chromatography-Mass Spectroscopy

HEPA	High Efficiency Particulate Air
HSS	Office of Health, Safety and Security (HSS)
HWFP	Hazardous Waste Facility Permit
IC	Ion Chromatography
ICP	Inductively Coupled Plasma
ICP-ES	Inductively Coupled Plasma Emission Spectrometry
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
ISM	Integrated Safety Management
ISMS	Integrated Safety Management System
JHA	Job Hazard Analysis
JON	Judgment of Need
K	Potassium
NA-LA	NNSA Los Alamos Field Office (formerly Los Alamos Site Office – LASO)
NMAC	New Mexico Administrative Code
LANL	Los Alamos National Laboratory
LANL-CO	Los Alamos National Laboratory Carlsbad Office
LANS	Los Alamos National Security, LLC
LLC	Limited Liability Company
LPF	Leakpath Factor
MP	Management Procedure
M&O	Management and Operating
MgO	Magnesium Oxide
MIN02	LANL Waste Stream LA-MIN 02-V.001, Mixed Inorganic
MST	Mountain Standard Time
NCR	Nonconformance Report
NaI	Sodium Iodide
NDA	Non-Destructive Assay
NMED	New Mexico Environment Department
NNSA	National Nuclear Security Administration
Np	Neptunium
NWP	Nuclear Waste Partnership LLC
ORPS	Occurrence Reporting and Processing System
Pa	Protactinium
Pb	Lead
PBI	Performance Based Incentive
PCB	Polychlorinated biphenyl

PE-Ci	<sup>239</sup> Plutonium equivalent curies
PISA	Potential Inadequacy in the Safety Analysis
Po	Polonium
POP	Pipe Overpack
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAP	Quality Assurance Program
QAPD	Quality Assurance Program Document
QAPjP	Quality Assurance Program Project Plan
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RF	Respirable Fraction
RH	Remote Handled
Rn	Radon
RTR	Real-Time Radiography
SCG	Summary Category Group
SCWE	Safety Conscious Work Environment
SEM	Scanning Electron Microscopy
SME	Subject Matter Expert
SPM	Site Project Manager
SSSR	Sort, Segregate, and Size Reduction
SWB	Standard Waste Box
SWB	Standard Waste Box
TA	Technical Area
TAT	Technical Assessment Team
TDOP	Ten Drum Overpack
Th	Thorium
TOC/TIC	Total Organic/Inorganic Carbon Analysis
TRAMPAC	TRU Waste Authorized Methods for Payload Control
TRU	Transuranic
TRUPACT	Transuranic Package Transporter
TSDf	Treatment, Storage, and Disposal Facility
TSR	Technical Safety Requirement
U	Uranium
USQ	Unreviewed Safety Question
USQD	Unreviewed Safety Question Determination

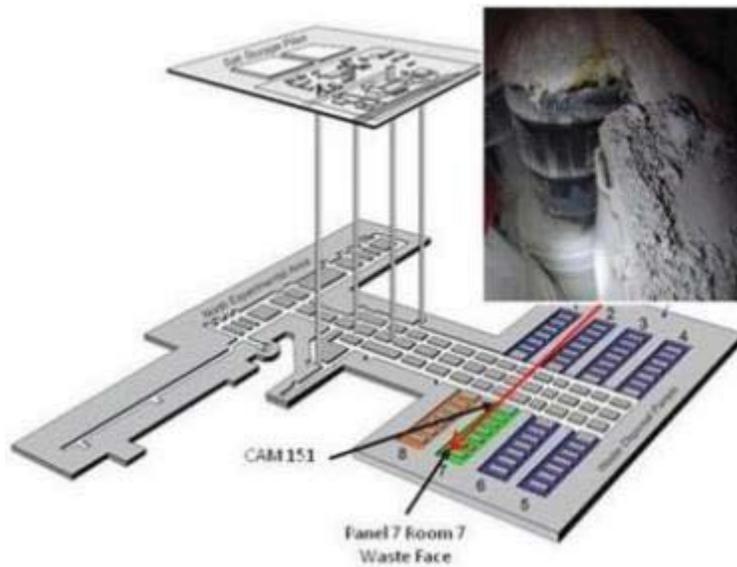
VE	Visual Examination
WAC	Waste Acceptance Criteria
WAP	Waste Analysis Plan
WCG	Waste Characterization Glovebox
WCO	Waste Certification Official
WCRRF	Waste Characterization, Reduction, and Repackaging Facility
WCS	Waste Control Specialists, LLC
WDP	Waste Disposition Project
WDS	Waste Data System
WIPP	Waste Isolation Pilot Plant
WSPF	Waste Stream Profile Form
WTS	Washington TRU Solutions, LLC
WWIS	WIPP Waste Information System



## Executive Summary

### Accident Description

On February 14, 2014, there was a release of radioactive material from a transuranic (TRU) waste container emplaced in Panel 7 Room 7 of the Department of Energy (DOE) Waste Isolation Pilot Plant (WIPP) underground (Figure ES-1) near Carlsbad, New Mexico. The release was detected by a continuous air monitor (CAM) monitoring the Panel and an alarm activated on the Central Monitoring System in the Central Monitoring Room on the WIPP surface, which initiated a shift to filtration of the underground ventilation.



**Figure ES-1: Location of the Accident**

Because access to the underground was restricted following the radiological release and examination of the area and containers was not possible, the investigation was broken down into two phases. Phase 1 focused on the WIPP response to the alarm and associated radiological release to the atmosphere. On April 24, 2014, the results were published in a final report, *Phase 1, Radiological Release Event at the Waste Isolation Pilot Plant*. The Executive Summary of the Phase 1 report is provided in Attachment G of this report.

Phase 2 of the investigation was initiated. This phase of the investigation focused on the mechanism(s) of release from the waste containers in the underground and included entries, sampling, and additional forensics.

Once limited access to the underground was re-established,

On February 19, 2014, the Carlsbad Field Office (CBFO) requested that the Los Alamos National Laboratory Carlsbad Office (LANL-CO) develop a list of potential source containers for the release. On February 20, 2014, the LANL-CO provided the list based on a comparison of isotopic ratios calculated from the Waste Data System (WDS) radionuclide data for each emplaced container in Room 7 of Panel 7 and isotopic ratios calculated from data obtained from analysis of WIPP Station A air filter samples. The list included containers from an Idaho - Rocky Flats waste stream and several drums containing nitrate salts from LANL. Subsequently, on May 1, 2014, CBFO declared a Potential Inadequacy in the Safety Analysis (PISA) regarding the potential for untreated nitrate salt waste being emplaced, which later prompted LANL to declare a PISA as well. On May 15, 2014, photographic evidence confirmed that a LANL-LA-MIN02-V.001 waste stream container (drum 68660) was in fact breached.

On May 19, 2014, James Hutton, Deputy Assistant Secretary, Safety, Security, and Quality Programs for the U.S. Department of Energy, Office of Environmental Management appointed a Phase 2 Accident Investigation Board (the Board) to complete the radiological release investigation and determine the cause of the TRU waste container(s) failure in accordance with DOE Order 225.1B, *Accident Investigations*.

The Board has completed the investigation and submitted this Phase 2 final report to the appointing official on March 31, 2015. Based upon the evidence gathered and analyzed during the investigation, the Board concluded that the release from the container(s) was preventable. If LANL had adequately developed and implemented repackaging and treatment procedures that incorporated suitable hazard controls and included a rigorous review and approval process, the release would have been preventable.

### History of LANL Waste Generation and Treatment

On July 1, 1979, operations commenced at LANL Technical Area 55 (TA-55) (Figure ES-2) for the extraction and recovery of plutonium from residues and scraps generated from operations at various LANL facilities and other DOE sites in the defense complex. The scrap and residues were processed to recover as much plutonium as economically feasible. The recovered plutonium was converted into pure plutonium feedstock. This recovery process generated evaporator nitrate salt and bottom wastes.



**Figure ES-2: LANL Technical Area 55**

These nitrate salt wastes were vacuum-dried, packaged in double bags, and then placed in polyethylene liners within lead-lined 55-gallon drums. Filteraid<sup>®</sup> absorbent was added to absorb any moisture. The drums were then closed with a lid and a filter vent and placed into storage in the TA-55 Plutonium Facility Building 4 (PF-4). On November 12, 1985, parent drum S855793 was processed in this manner and placed into storage as contact handled (CH) TRU waste.

In late 2006 and early 2007, LANL conducted an expedited project to modify and upgrade an existing 30-year old glovebox facility to become the Waste Characterization, Reduction, and Repackaging Facility (WCRRF) which was designed to support sampling, examination, characterization, size reduction, and repackaging of TRU waste, including the LANL Area TA-55 CH TRU waste. In April 2007, the Basis for Interim Operation (BIO) and Technical Safety Requirements (TSRs) for the WCRRF were issued and an Operational Readiness Review was performed in mid-2007 resulting in approval to begin operations at the WCRRF.

On May 23, 2007, LANL issued procedure EP-WCRR-WO-DOP-0233, *WCRRF Waste Characterization Glovebox Operations*, Revision 0. This procedure provided instructions for remediating TRU waste which did not meet WIPP WAC and Acceptable Knowledge (AK) requirements. The CH TRU nitrate salt wastes in storage at TA-55 since 1979 were within the scope of this procedure.

Remediation of nitrate salt drums at the WCRRF began on September 1, 2011. Remediation consisted of retrieving drums from storage and transporting them to the WCRRF where the drum contents were processed in the Waste Characterization Glovebox (Figure ES-3).



**Figure ES-3: Waste Characterization Glovebox in WCRRF at LANL**

Processing at that time included:

- Removal of the waste items from the drum;
- Adding WasteLock® 770 absorbent;
- Mixing the waste and absorbent;
- Placing the mixed waste into daughter drums; and
- Moving the remediated waste drums to storage in TA-54.

In February 2012, LANL issued a memorandum titled *Legacy TA-55 Nitrate Salt Wastes at TA-54, Potential Applicability of RCRA D001/D002/D003 Waste Codes*. This paper incorrectly concluded that nitrate salt drums did not meet the Environmental Protection Agency (EPA) ignitability or reactivity criteria, and that wastes containing free liquids must be remediated prior to shipment. The WIPP HWFP stated that:

*“...the prohibition of liquid in excess of Treatment, Storage, and Disposal Facility Waste Acceptance Criteria limits and containerized gases prevents the shipment of corrosive, ignitable, or reactive wastes.”*

The Board concluded that liquid prohibition alone was ineffective in preventing the shipment of ignitable wastes.

On March 8, 2012, processing of nitrate salt waste was put on hold due to concerns about the compatibility of the WasteLock<sup>®</sup> 770 absorbent with the nitrate salt waste matrix. Meetings between LANS, EnergySolutions, LLC (ES), a subcontractor to LANS, and the LANL-CO Difficult Waste Team were held in April 2012 to determine the path forward for the nitrate salt waste.

On May 8, 2012, the LANL-CO Difficult Waste Team issued a white paper titled Amount of Zeolite Required to Meet the Constraints Established by the EMRTC Report RF 10-13: Application of LANL Evaporator Nitrate Salts. This paper defined the amount of “Kitty Litter/Zeolite clay” to be added per volume of nitrate salts and was based on EMRTC Report RF 10-13 Results of Oxidizing Solids Testing, dated April 12, 2010.

In July 2012, LANS issued *Solution Package (SP) Report-72, Salt Waste (SP #72)* (Revision 1) to address the processing steps for nitrate salt drums. This document concluded that the glovebox procedure must be revised or replaced to ensure that the final waste mixture meets or exceeds 1.2:1 kitty litter/zeolite:nitrate salt as specified by May 8, 2012, LANL-CO white paper.

In response to SP #72, LANS prepared a major revision to the glovebox operations procedure. Section 10.6 was added to provide instructions for nitrate salt drum processing. Paragraph 10.6[3] stated “ensure an organic absorbent (Kitty Litter/Zeolite<sup>®</sup> absorbent) is added to the waste material at a minimum of 1.5 absorbent to 1 part waste ratio.” The Board concluded that specifying the use of “organic” absorbent and the omission of the word “clay” in the WCRRF glovebox procedure was not consistent with the direction provided in the white paper.

On September 27, 2012, Swheat Scoop<sup>®</sup> kitty litter, an organic absorbent, was purchased and on October 1, 2012, ES personnel began remediation of nitrate salt waste drums previously remediated with WasteLock<sup>®</sup> 770, an organic compound.

### **Parent Drum S855793 Repackaging**

On December 4, 2013, ES remediated parent drum S855793 in accordance with the glovebox operations procedure, producing daughter drums LA00000068660 (68660) and LA00000068685 (68685). Swheat Scoop<sup>®</sup> was added as the absorbent and pH was adjusted using KOLORSAFE<sup>®</sup> Liquid Acid Neutralizer. A tungsten lined glovebox glove was added as secondary waste to the waste/absorbent/neutralizer mixture. Drum 68660 was then closed with a lid and a filter vent.

On December 12, 2013, Central Characterization Program (CCP) personnel at LANL performed real-time radiography (RTR) on drum 68660.

On January 2, 2014, CCP personnel at LANL performed nondestructive assay (NDA) on drum 68660.

On January 3, 2014, CCP personnel at LANL performed flammable gas analysis (FGA) on drum 68660.

On January 21, 2014, based on RTR, NDA, FGA, and document review, CCP waste certification personnel certified drum 68660 as WIPP compliant.

On January 29, 2014, drum 68660 was shipped from LANL to WIPP with shipment LA140017. This shipment arrived and was accepted by WIPP. The WIPP receipt acceptance process included verification of the shipping manifest, performance of external surface radiological surveys, visual examination for physical damage (severe rusting, apparent structural defects, signs of pressurization, etc.) and leakage.

On January 31, 2014, drum 68660 was emplaced at Panel 7 Room 7, Row 16, Column 4 (R16:C4) in the WIPP underground.

On February 5, 2014, a salt haul truck caught on fire in another location in the WIPP underground. The fire was the subject of a DOE accident investigation.<sup>1</sup> The evacuation and subsequent investigation restricted access to the underground. There were no personnel in the underground at the time of the release event. The Board determined that the fire had no direct impact on waste stored in Panel 7.

### **Radiological Release Event**

On February 14, 2014, an exothermic reaction involving the mixture of the organic materials (Swheat Scoop<sup>®</sup> absorbent and/or neutralizer) and nitrate salts occurred inside drum 68660. This exothermic reaction resulted in pressurization of the drum, failure of the drum locking ring, and displacement of the drum lid. The energetic release propelled TRU waste from the drum up into polypropylene magnesium oxide (MgO) super sacks on top of the containers and onto adjacent waste containers. The super sacks of MgO are an assurance feature to ensure that consistent and favorable chemical conditions are maintained in WIPP brines after final facility closure by reacting with any carbon dioxide produced by the decay of organic carbon in the waste and waste emplacement materials. WIPP HWFP states “Magnesium oxide (MgO) will be used as a backfill in order to provide chemical control over the solubility of radionuclides in order to comply with the requirements of 40 CFR §191.13.”

At 2314, a CAM monitoring airflow in Panel 7 exhaust drift, where drum 68660 was stored, detected this release and an alarm was received on the Central Monitoring System in the Central Monitoring Room on the WIPP surface and automatically initiated a shift to filtration of the underground ventilation system. While the majority of the release was directed by the ventilation system through high efficiency particulate air (HEPA) filters, a small portion bypassed the HEPAs via leakage around the ventilation system dampers and exhausted directly to the atmosphere. The Phase 1 Department of Energy (DOE) Accident Investigation Board completed an investigation of the atmospheric release and the results were published on April 22, 2014, in the Phase 1 Accident Investigation Board report.

On May 19, 2014, James Hutton, Deputy Assistant Secretary, Safety, Security, and Quality Programs, U.S. Department of Energy, Office of Environmental Management appointed an Accident Investigation Board to begin Phase 2 of the investigation to determine the cause of the radiological release from container(s) in the WIPP underground.

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<sup>1</sup> The Executive Summary of this report is found in Attachment G of this report. The full copy of this report can be found at [http://www.wipp.energy.gov/wipprecovery/accident\\_desc.html](http://www.wipp.energy.gov/wipprecovery/accident_desc.html).

## Direct, Root, and Contributing Causes

**Direct Cause:** The immediate events or conditions that caused the accident.

The Board identified the direct cause of this accident to be an exothermic reaction of incompatible materials in LANL waste drum 68660 that led to thermal runaway, which resulted in over-pressurization of the drum, breach of the drum, and release of a portion of the drum's contents (combustible gases, waste, and wheat-based absorbent) into the WIPP underground.

The Board reached this conclusion based on post-event forensic and fire analyses that determined that:

- Isotopic ratios in air sample media analyzed post-event are consistent with drum 68660 which is unique from other drums in the area of the release.
- The contents of waste drum 68660 included incompatible materials which created the potential for an exothermic reaction.
- Waste drum 68660 was the only waste container with an identified breach.
- The visual evidence associated with the identified breach was consistent with an exothermic reaction within drum 68660. This reaction resulted in internal heating of the drum that led to internal pressure buildup of combustible gases within the drum which exceeded the drum venting capacity. The drum lid extruded beyond the lid retention ring, deflected the lid, and resulted in rapid release of the materials from the drum. The combustible gases and solids ignited which then spread to other combustible materials within the waste array, i.e., fiberboard and polyethylene slip sheets, reinforcement plates, stretch wrap, cardboard stiffeners and polypropylene super sack fabric.

**Root Cause:** Causal factors that, if corrected, would prevent recurrence of the same or similar accidents. Root causes can be local (specific to the one accident), and/or systemic (common to a broad class of similar accidents). For this accident, the Board identified both local and systemic root causes.

**Local Root Cause:** A specific deficiency that, if corrected, would prevent recurrence of the same accident.

The Board identified the local root cause of the radioactive material release in the WIPP underground to be the failure of LANS to understand and effectively implement the LANL Hazardous Waste Facility Permit and Carlsbad Field Office directed controls. Specifically, LANL's use of organic, wheat-based absorbent instead of the directed inorganic absorbent such as kitty litter/zeolite clay absorbent in the glovebox operations procedure for nitrate salts resulted in the generation, shipment, and emplacement of a noncompliant, ignitable waste form.

**Systemic Root Cause:** A deficiency in a management system that, if corrected, would prevent the occurrence of a class of accidents, e.g., operational accidents caused by procedural deficiencies.

The Board identified the systemic root cause as the Los Alamos Field Office (NA-LA) and National Transuranic Program/Carlsbad Field Office (CBFO) failure to ensure that LANL had adequately developed and implemented repackaging and treatment procedures that incorporated suitable hazard controls and included a rigorous review and approval process. NA-LA and CBFO did not ensure the adequate flow down of the Resource Conservation and Recovery Act and other upper tier requirements, including the WIPP Hazardous Waste Facility Permit, Attachment C, Waste Analysis Plan, WIPP Waste Acceptance Criteria, and the LANL Hazardous Waste Facility Permit requirements into operating procedures at LANL.

**Contributing Causes:** Events or conditions that collectively with other causes increased the likelihood or severity of an accident but that individually did not cause the accident.

The Board identified twelve contributing causes to the radiological release investigated in Phase 2:

1. Failure of Los Alamos National Security, LLC (LANS) to implement effective processes for procedure development, review, and change control. Execution of the Waste Characterization, Reduction, and Repackaging Facility (WCRRF) glovebox procedure resulted in a combination of incompatible materials and the generation of an ignitable, noncompliant waste.
2. Failure of Los Alamos National Security, LLC (LANS) to develop and implement adequate processes for hazard identification and control. As a result, an incompatible absorbent was specified and used during nitrate salt bearing waste processing.
3. Failure of the Los Alamos National Security, LLC (LANS) Contractor Assurance System (CAS) to identify weaknesses in the processes for operating procedure development; hazard analysis and control; and review that resulted in an inadequate glovebox operation procedure for processing the nitrate salt bearing waste.
4. Failure of the Central Characterization Program (CCP) to develop an Acceptable Knowledge (AK) for the mixed inorganic nitrate waste stream (LA-MIN02-V.001) that adequately captured all available information regarding waste generation and subsequent repackaging activities in order to prevent the generation, shipment, and emplacement of corrosive, ignitable, or reactive waste. Specifically, the AK Summary Report did not capture changes made to the Waste Characterization, Reduction, and Repackaging Facility (WCRRF) glovebox procedure. The addition of a secondary waste material was not adequately considered.
5. Failure of Los Alamos Field Office (NA-LA) and the National Transuranic (TRU) Program/Carlsbad Field Office (CBFO) to ensure that the CCP and LANS complied with Resource Conservation and Recovery Act (RCRA) requirements in the WIPP Hazardous Waste Facility Permit (HWFP) and the LANL HWFP, as well as the WIPP Waste Acceptance Criteria (WAC). Examples include the unapproved treatment (neutralization and absorption of liquids) and the addition of incompatible materials. As a result, waste containing incompatible materials was generated and sent to WIPP.
6. Failure of Los Alamos National Security, LLC (LANS), EnergySolutions, LLC (ES), and the NNSA Los Alamos Field Office (NA-LA) to ensure that a strong safety culture existed within the Environmental and Waste Management Operations (EWMO) organization at the

Los Alamos National Laboratory (LANL). As a result, although there was a questioning attitude, there was a failure to adequately resolve employee concerns which could have identified the generation of noncompliant waste prior to shipment.

7. Failure of the execution of the LANL Unreviewed Safety Question (USQ) process to identify the lack of a hazard analysis of the proposed changes to the Waste Characterization, Reduction, and Repackaging Facility (WCRRF) glovebox waste repackaging procedure (i.e., consistent with Integrated Safety Management (ISM) core functions]), and to recognize that an incompatible reactive nitrate salt bearing waste would be created by using “organic” absorbents. As a result, the Unreviewed Safety Question Determination (USQD) did not ensure that nuclear safety basis documents, including the WCRRF and Area G Basis for Interim Operation (BIO), were updated to evaluate hazards associated with material incompatibility in the nitrate salt-bearing waste stream and to specify preventive or mitigative controls.
8. Failure of NNSA Los Alamos Field Office (NA-LA) to establish and implement adequate line management oversight programs and processes in accordance with DOE Order 226.1B, *Implementation of Department of Energy Oversight Policy*. As a result, weaknesses in Los Alamos National Security, LLC (LANS)/ EnergySolutions, LLC (ES) programs and waste operations procedures were not identified and corrected which allowed an ignitable, noncompliant nitrate salt-bearing waste to be generated, shipped, and emplaced at WIPP.
9. Failure of DOE Headquarters to perform adequate or effective line management oversight required by DOE Order 435.1, *Radioactive Waste Management*, dated July 9, 1999. As a result, waste containing incompatible materials was generated and sent to WIPP.
10. Failure of Nuclear Waste Partnership LLC (NWP) to ensure that the WIPP Fire Hazard Analysis (FHA) recognized the potential for a fire starting within the waste array as well as the potential for propagation within the array. As a result, fire protection controls focused on prevention of propagation to the array from external sources (e.g., vehicles) and did not consider the magnitude of the combustible material hazard.
11. Failure of Los Alamos National Security, LLC (LANS)/EnergySolutions, LLC (ES) to adequately train and qualify ES operators and supervisors in the identification and control of incompatible materials during waste processing. As a result, personnel did not question the instruction to add organic absorbent and other secondary waste items to the nitrate salt-bearing waste.
12. Failure of EnergySolutions, LLC (ES) operators and Los Alamos National Security, LLC (LANS)/ES supervisors to effectively execute the stop work process when unexpected conditions, including foaming reactions and smoke during waste processing, were encountered at Waste Characterization, Reduction, and Repackaging Facility (WCRRF). This resulted in waste containing incompatible materials being generated and sent to WIPP.

### Conclusions and Judgments of Need

Based upon the evidence obtained during this accident investigation, the Board concluded that the release from the container(s) was preventable. If LANL had adequately developed and implemented repackaging and treatment procedures that incorporated suitable hazard controls and included a rigorous review and approval process, the release would have been preventable.

Table ES-1 summarizes the Conclusions (CONs) and Judgments of Need (JONs) determined by the Board. The conclusions are derived from the analytical results performed during this accident investigation for determining what happened and why it happened. Per DOE O 225.1B, *Accident Investigations*, the report must demonstrate that the Judgments of Need (JONs) are based on objective analysis and application of the core analytical techniques using the facts to develop the root and contributing causes. The report must also identify DOE and contractor management systems that, if corrected, could have prevented the accident so those systems can be addressed and corrected to prevent recurrence. Table D-2 in the body of the report provides more detail, including the causal factors, specific conditions related to the causal factors, and associated CONs and JONs.

**Table ES-1: Conclusions and Judgments of Need**

<b>Conclusion (CON)</b>	<b>Judgments of Need (JON)</b>
<p><b>CON 1:</b> Implementation of the characterization processes established in the Waste Isolation Pilot Plant (WIPP) Hazardous Waste Facility Permit (HWFP), Attachment C, Waste Analysis Plan (WAP) was not fully consistent with the criteria in 40 CFR 261.21, <i>Characteristic of Ignitability</i>. Specifically, characterization processes should have identified LA-MIN02-V.001 as ignitable because:</p> <ul style="list-style-type: none"> <li>• It is an oxidizer; and</li> <li>• Addition of the organic absorbent created conditions that made the waste capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture or spontaneous chemical changes and, when ignited, burning so vigorously and persistently that it creates a hazard.</li> </ul>	<p><b>JON 1:</b> The National Transuranic (TRU) Program needs to re-evaluate and strengthen the flow down of requirements regarding the compilation of Acceptable Knowledge (AK) in order to more clearly demonstrate that the WIPP HWFP, Attachment C, WAP waste characteristics prohibitions and chemical compatibility requirements are met consistent with 40 CFR 261.21.</p>
<p><b>CON 2:</b> Execution of the National Transuranic (TRU) Program certification audit process for the LANL waste generator activities where Central Characterization Program (CCP) performs TRU waste characterization and certification failed to include key elements of waste packaging and characterization processes. In part, this was attributed to a lack of clear roles and responsibilities; and expectations. Specific elements include:</p> <ul style="list-style-type: none"> <li>• Waste Characterization, Reduction, and Repackaging Facility (WCRRF) glovebox treatment and repackaging operations;</li> </ul>	<p><b>JON 2:</b> The National TRU Program needs to re-evaluate and strengthen the certification audit process across the DOE complex at all generator sites to include:</p> <ul style="list-style-type: none"> <li>• Evaluation of waste generator repackaging operations that prepare TRU waste for characterization;</li> <li>• Implementation of waste generator site processes as they relate to TRU waste management;</li> <li>• Verification that changes to processes are correctly incorporated into acceptable knowledge summary reports;</li> </ul>

<b>Conclusion (CON)</b>	<b>Judgments of Need (JON)</b>
<ul style="list-style-type: none"> <li>• Ensuring that TRU waste accepted for management and disposal at WIPP complies with the WIPP Hazardous Waste Facility Permit (HWFP), applicable laws, and regulations described in the Waste Acceptance Criteria (WAC); and</li> <li>• Verification that Los Alamos National Security, LLC (LANS) prepared implementation documentation and programs to meet the requirements and criteria of the WIPP Waste Acceptance Criteria (WAC) and that the CCP maintained an accurate and compliant Acceptable Knowledge Summary Report for the LA-MIN02-V.001 waste stream.</li> </ul>	<ul style="list-style-type: none"> <li>• Verification of effective implementation documentation and programs to ensure that waste generator activities comply with the generator site Resource Conservation and Recovery Act (RCRA) permit; and</li> <li>• Evaluation of local site office oversight of TRU waste operations.</li> </ul>
<p><b>CON 3:</b> The NNSA Los Alamos Field Office (NA-LA) oversight activities were ineffective in identifying weaknesses in the execution of waste packaging, characterization and certification of transuranic (TRU) waste at Los Alamos National Laboratory (LANL).</p>	<p><b>JON 3:</b> NA-LA oversight of characterization and certification of TRU waste sites needs to be improved to include:</p> <ul style="list-style-type: none"> <li>• Waste Characterization, Reduction, and Repackaging Facility (WCRRF) repackaging operations that prepare TRU waste for characterization;</li> <li>• Implementation of waste generator site processes as they relate to TRU waste management; and</li> <li>• Verification that waste generator activities comply with the generator site Resource Conservation and Recovery Act (RCRA) permit.</li> </ul>
<p><b>CON 4:</b> Carlsbad Field Office (CBFO) oversight activities associated with the characterization and certification of transuranic (TRU) waste were ineffective in identifying programmatic weaknesses through the execution of certification audits and surveillances at LANL.</p>	<p><b>JON 4:</b> The CBFO oversight of characterization and certification of TRU waste sites needs to be improved to include:</p> <ul style="list-style-type: none"> <li>• Waste generator repackaging operations that prepare TRU waste for characterization;</li> <li>• Implementation of waste generator site processes as they relate to TRU waste management;</li> <li>• Verification of effective implementation documentation and programs to ensure that waste generator activities comply with the generator site Resource Conservation and Recovery Act (RCRA) permit; and</li> <li>• Evaluation of local site office oversight of TRU waste operations.</li> </ul>

<b>Conclusion (CON)</b>	<b>Judgments of Need (JON)</b>
	<p><b>JON 5:</b> CBFO needs to evaluate and restructure their organization such that objective oversight of the National TRU Program is evident and effective in ensuring that waste generator sites comply with requirements including appropriate separation of CBFO line management and oversight functions and responsibilities.</p> <p><b>JON 6:</b> DOE Headquarters needs to review expectations documented in existing National TRU Program policy directives and take action necessary to clearly assert that CBFO, as the manager of the WIPP repository, has the authority to conduct oversight of waste generator site programs and processes necessary to provide assurance that <b>any</b> activities that could impact characterization and certification of waste are verified to be compliant.</p>
<p><b>CON 5:</b> Implementation of requirements listed in CCP-PO-001, <i>CCP Transuranic Waste Characterization Quality Assurance Project Plan</i>, did not ensure that waste characterization methods and Acceptable Knowledge (AK) were effective in preventing the shipment of corrosive, ignitable, or reactive wastes.</p>	<p><b>JON 7:</b> The Central Characterization Program (CCP) needs to improve implementation of requirements in CCP-PO-001 such that characterization methods are able to ensure that all WIPP Waste Acceptance Criteria (WAC) requirements are met.</p>
<p><b>CON 6:</b> The preparation, review and approval of CCP-AK-LANL-006, <i>Acceptable Knowledge (AK)</i> summary report revisions by the Central Characterization Program (CCP) was not effective in identifying the potential impact of adding incompatible secondary waste items to the LA-MIN02-V.001 waste stream, in part due to poor communications between LANS and CCP.</p>	<p><b>JON 8:</b> The CCP needs to improve the level of rigor in reviewing and approving AK summary reports for compliance with requirements.</p>
<p><b>CON 7:</b> Los Alamos National Security, LLC (LANS) did not adequately evaluate the impact on the WIPP Waste Acceptance Criteria (WAC) or effectively control the addition of secondary job waste into transuranic (TRU) waste containers.</p>	<p><b>JON 9:</b> LANS needs to improve the level of rigor in evaluating and controlling the addition of secondary job waste into TRU waste containers.</p>
<p><b>CON 8:</b> Los Alamos National Security, LLC (LANS) did not adequately incorporate upper tier requirements into the development of repackaging activities in the Waste Characterization, Reduction and Packaging Facility (WCRRF). Specifically:</p> <ul style="list-style-type: none"> <li>• The Carlsbad Field Office (CBFO) directed controls contained in the LANL-CO white</li> </ul>	<p><b>JON 10:</b> LANS needs to strengthen the processes that ensure the flow down of upper tier requirements into their implementing procedures such that execution of work is compliant.</p> <p><b>JON 11:</b> CBFO needs to conduct an extent of condition review of other waste generator sites to determine the adequacy of the flow down into the operating procedures and implementation</p>

<b>Conclusion (CON)</b>	<b>Judgments of Need (JON)</b>
<p>paper based on the Energetic Materials Research and Testing Center (EMRTC) Report RF 10-13; and</p> <ul style="list-style-type: none"> <li>• The requirements associated with the Los Alamos National Laboratory (LANL) Hazardous Waste Facility Permit (HWFP):                             <ul style="list-style-type: none"> <li>• Nitrate salt-bearing wastes did not fully meet the LANL HWFP “special requirements” for managing ignitable wastes, including segregation and separation, and use of non-sparking tools;</li> <li>• Did not comply with the LANL HWFP requirement that the nitrate salt-bearing waste drums be labeled with all applicable Environmental Protection Agency (EPA) Hazardous Waste Numbers;</li> <li>• Placed incompatible wastes and materials in the same container and did not impose special precautions;</li> <li>• Did not label the nitrate salt-bearing waste prior to transport and remediation at the WCRRF; and</li> <li>• Did not label the unremediated nitrate salt-bearing waste drums which contained liquids as Resource Conservation and Recovery Act (RCRA) corrosive.</li> </ul> </li> </ul>	<p>of RCRA requirements contained in the WIPP Waste Acceptance Criteria (WAC) and hazardous waste permits regarding the treatment and repackaging of TRU waste.</p>
<p><b>CON 9:</b> The preparation, review and approval of CCP-AK-LANL-006, Acceptable Knowledge (AK) summary report revisions by the Central Characterization Program (CCP) was not effective in identifying the potential impact of changes to EP-WCRR-WO-DOP-233 Glovebox Operations, on the LA-MIN02-V.001 waste stream, in part due to poor communications between LANS and CCP.</p>	<p><b>JON 12:</b> The Central Characterization Program (CCP) needs to reevaluate and strengthen the process used to conduct review and approval of source documents that have an impact on Acceptable Knowledge.</p>
<p><b>CON 10:</b> Los Alamos National Security, LLC (LANS) failed to provide sound technical basis for decisions regarding repackaging procedures and processes for the LA-MIN02-V.001 waste stream.</p>	<p><b>JON 13:</b> LANS needs to strengthen documentation to include a detailed technical basis to justify decisions made regarding change control for procedures and processes for the LA-MIN02-V.001 waste stream.</p>

<b>Conclusion (CON)</b>	<b>Judgments of Need (JON)</b>
<p><b>CON 11:</b> Los Alamos National Security, LLC (LANS) did not utilize a formal engineering change control process to develop modifications to repackaging activities in the Waste Characterization, Reduction and Packaging Facility (WCRRF).</p>	<p><b>JON 14:</b> LANS needs to implement an effective engineering change control process that includes defensible technical bases to justify process modifications.</p>
<p><b>CON 12:</b> Los Alamos National Security, LLC (LANS) failed to ensure that there was sufficient detail provided in the Waste Characterization, Reduction, and Repackaging Facility (WCRRF) glovebox procedure to ensure safe, consistent, and compliant repackaging of waste and accurate documentation of the contents of the waste drums in the records.</p>	<p><b>JON 15:</b> LANS needs to revise the WCRRF glovebox operations procedure to contain the necessary level of detail to ensure safe, consistent, and compliant remediation of nitrate salt bearing waste.</p> <p><b>JON 16:</b> The glovebox operations procedure needs to be revised to require operators to document critical process steps in a quality record, e.g., initial pH, absorbent added, neutralizer used, adjusted pH.</p> <p><b>JON 17:</b> Operators need to be adequately trained on the revised glovebox operations procedure.</p>
<p><b>CON 13:</b> Available data indicated that oxidation was occurring in the Standard Waste Box (SWB) where sibling drum 68685 was stored, along with other similarly remediated waste drums.</p>	<p><b>JON 18:</b> Los Alamos National Security (LANS) needs to investigate and determine the cause for oxidation in sibling drum 68685 and take action to mitigate the condition as well as prevent future nitrate salt bearing waste drums (remediated and unremediated) from oxidizing.</p>
<p><b>CON 14:</b> The Waste Characterization, Reduction, and Repackaging Facility (WCRRF) Basis for Interim Operation (BIO) did not thoroughly describe or evaluate nitrate salt processing or waste storage activities.</p>	<p><b>JON 19:</b> The WCRRF BIO needs to be revised to include more specificity in description of nitrate salt processing activities and then update the hazard analysis to include identification of all hazards and their evaluations.</p> <p><b>JON 20:</b> LANS needs to review the Area G BIO in light of changes made to the WCRRF BIO and update accordingly.</p> <p><b>JON 21:</b> LANS needs to conduct an extent of condition review for issues that are similar to nitrate salt bearing waste processing in WCRRF and Area G.</p>
<p><b>CON 15:</b> The Los Alamos National Security, LLC (LANS) Unreviewed Safety Question (USQ) process was ineffective in ensuring that important procedure changes related to processing of nitrate salts were adequately evaluated for impacts to the safety basis.</p>	<p><b>JON 22:</b> LANS needs to ensure that USQ evaluators are organizationally independent of line management.</p> <p><b>JON 23:</b> LANS needs to conduct retraining of USQ process evaluators/approvers focused on implementation of the Unreviewed Safety Question Determination (USQD) process</p>

<b>Conclusion (CON)</b>	<b>Judgments of Need (JON)</b>
	<p>consistent with DOE Guide 424.1-1B, <i>Implementation Guide for Use in Addressing Unreviewed Safety Question Requirements</i>.</p> <p><b>JON 24:</b> The NNSA Los Alamos Field Office (NA-LA) needs to conduct an assessment of the LANS USQ program.</p>
<p><b>CON 16:</b> The Los Alamos National Security, LLC (LANS) contractor assurance system was not effective in identifying weaknesses in the process for developing/changing procedures, analyzing and controlling hazards, performing work to repackage nitrate salt bearing wastes, and feedback mechanisms which resulted in the production and shipping of noncompliant waste drums to the Waste Isolation Pilot Plant and Waste Control Specialists, LLC (WCS).</p>	<p><b>JON 25:</b> LANS Environmental and Waste Management Operations (EWMO) needs to develop and implement a fully integrated contractor assurance system that provides DOE and LANS confidence that work is performed compliantly, risks are identified, and control systems are effective and efficient.</p> <p>Specific areas to be addressed include:</p> <ul style="list-style-type: none"> <li>• Ensuring adequate scope and associated depth and breadth of self-assessments, independent assessments and management assessments;</li> <li>• Clarifying the oversight role of LANS EWMO with regard to subcontractors and waste processing/packaging operations;</li> <li>• Ensuring required environmental program oversight i.e., the Resource Conservation and Recovery Act (RCRA) (hazardous waste determination, upper tier requirements flow down into implementing procedures, waste determination, records);</li> <li>• Including the necessary rigor in implementation of the change control process (review and approval by subject matter experts);</li> <li>• Verifying that requirements are flowed down into implementing procedures, e.g., RCRA requirements, TRU Waste Authorized Methods for Payload Control, etc.; and</li> <li>• Evaluating and responding to feedback from Waste Characterization, Reduction, and Repackaging Facility (WCRRF) operations by LANS senior management, e.g., notification of reactions in the glovebox.</li> </ul>
<p><b>CON 17:</b> The NNSA Los Alamos Field Office (NA-LA) oversight was ineffective in identifying weaknesses that contributed to this event.</p>	<p><b>JON 26:</b> NA-LA needs to strengthen its oversight of Los Alamos National Security, LLC (LANS) Environmental and Waste Management Operations (EWMO) to ensure that:</p>

Conclusion (CON)	Judgments of Need (JON)
	<ul style="list-style-type: none"> <li>• Resource Conservation and Recovery Act (RCRA) oversight is performed;</li> <li>• Focus is placed on operational oversight in addition to budget/financial oversight;</li> <li>• On the ground operational oversight expands beyond that performed by the Facility Representatives to include adequate subject matter expertise;</li> <li>• NA-LA performs oversight of contractor activities related to waste certification in accordance with the WIPP Waste Acceptance Criteria (WAC);</li> <li>• Roles and responsibilities for oversight of Waste Characterization, Reduction, and Repackaging Facility (WCRRF) operations are made clear;</li> <li>• Staffing shortages are addressed, including:               <ul style="list-style-type: none"> <li>• Facility Representatives, short three full-time equivalencies (FTEs);</li> <li>• Senior Technical Safety Manager, short two FTEs;</li> <li>• The staffing reduction in environmental compliance, down from five to three FTEs since 2011; and</li> <li>• Senior technical advisor position has been vacant since 2008.</li> <li>• Formal verification that there is an effective LANS Contractor Assurance System (CAS) in place for environmental compliance.</li> </ul> </li> </ul> <p><b>JON 27:</b> NA-LA needs to verify that LANS has developed and implemented a DOE Order 226.1B, <i>Implementation of Department of Energy Oversight Policy</i> compliant CAS.</p>
<p><b>CON 18:</b> The Federal roles, responsibilities and execution for oversight of the activities between the generator site transuranic (TRU) waste program (LANL) and the TRU Waste Central Characterization Program (CCP) were inadequate.</p>	<p><b>JON 28:</b> The National TRU Program needs to clarify NA-LA and CBFO expectations and oversight roles and responsibilities between the generator site TRU waste program (LANL) and the TRU waste CCP.</p> <p><b>JON 29:</b> NA-LA and CBFO needs to perform effective Federal oversight of CCP review and approval of waste management operating procedures/process changes, e.g., WCRRF</p>

<b>Conclusion (CON)</b>	<b>Judgments of Need (JON)</b>
	<p>glovebox operating procedure.</p> <p><b>JON 30:</b> DOE Headquarters and CBFO need to conduct an extent of condition review of the overall Federal oversight across the DOE complex in all three key segments of the National TRU Program: the Generator Site TRU Waste Program, TRU Waste Certification Program, and the Disposal System Program (WIPP).</p>
<p><b>CON 19:</b> DOE Headquarters did not perform DOE O 435.1, <i>Radioactive Waste Management</i>, oversight activities for implementation of requirements associated with the operational performance within the National Transuranic (TRU) Program.</p>	<p><b>JON 31:</b> DOE Headquarters needs to develop and implement a DOE O 435.1 comprehensive oversight program for National TRU Program activities.</p>
<p><b>CON 20:</b> Los Alamos National Security, LLC (LANS) existing processes governing the preparation, review, and approval of Environmental Programs procedures did not contain sufficient guidance related to hazard analysis and subject matter expert review necessary to ensure safe, consistent, and compliant execution of waste processing.</p>	<p><b>JON 32:</b> LANS needs to review and revise EP-DIR-AP-10007, <i>Environmental Programs Procedure Preparation, Revision, Review, Approval, and Use</i>, to ensure that all procedures and procedure revisions contain:</p> <ul style="list-style-type: none"> <li>• The necessary level of detail to ensure the safe, consistent, and compliant performance of work, including process steps, materials, and material substitutions;</li> <li>• Explicit requirements and criteria regarding inclusion of appropriate subject matter experts and their review and concurrence with new and revised procedures; and</li> <li>• Requirements that a Job Hazard Analysis (JHA) is appropriately amended when new activities such as nitrate salt remediation that could introduce new hazards are incorporated into existing processes.</li> </ul>
<p><b>CON 21:</b> The WIPP Fire Hazard Analysis (FHA) was ineffective in identifying and analyzing the potential for a fire starting within the waste array, as well as the potential for fire propagation within the array.</p>	<p><b>JON 33:</b> Nuclear Waste Partnership LLC (NWP) needs to re-evaluate the quantities, type and form of exposed combustible emplacement materials used in the waste array and take action to minimize the fire ignition and propagation risks (e.g., eliminate unnecessary materials, and include fire retardant additives).</p> <p><b>JON 34:</b> NWP needs to revise the waste array emplacement strategy to include criteria that limit the risk of fire propagation within the array, to include limiting the quantity of radiological waste that is at-risk from a single fire or</p>

<b>Conclusion (CON)</b>	<b>Judgments of Need (JON)</b>
	<p>explosion event.</p> <p><b>JON 35:</b> NWP needs to revise the FHA to identify and address all credible fire and explosion scenarios initiated within the waste array underground.</p> <p><b>JON 36:</b> NWP needs to reevaluate and revise the WIPP FHA to better characterize the fire risks associated with transuranic (TRU) waste packaging during handling and storage. This needs to include reevaluation of actions detailed in the WIPP Recovery Plan.</p> <p><b>JON 37:</b> The Office of Environmental Management Headquarters needs to ensure that waste generator site’s FHAs adequately characterize the fire risks associated with TRU waste packaging during handling and storage.</p>
<p><b>CON 22:</b> EnergySolutions, LLC (ES) operators and supervisors were not adequately trained and qualified to process waste with regard to identification and control of incompatible materials.</p>	<p><b>JON 38:</b> LANS needs to evaluate and strengthen the operator and supervisor training programs of LANS and their subcontractors to ensure adequate understanding of basic chemistry interactions and associated controls.</p>
<p><b>CON 23:</b> Los Alamos National Security, LLC (LANS), EnergySolutions, LLC (ES) and NNSA Los Alamos Field Office (NA-LA) allowed the safety culture at the Los Alamos National Laboratory (LANL) to deteriorate within pockets of the organization as evidenced by the workers’ feedback that they did not feel comfortable identifying issues that may adversely affect management direction, delay mission-related objectives, or otherwise affect cost or schedule. In addition, management failed to effectively respond to workers’ issues regarding unexpected conditions, i.e., generation of smoke and foaming, encountered during waste processing activities.</p> <p><b>CON 24:</b> Questioning attitudes were not welcomed by management and many issues and hazards did not appear to be readily recognized by site personnel.</p>	<p><b>JON 39:</b> LANS and NA-LA need to develop and implement a more rigorous, effective integrated safety management system that embraces and implements the attributes of DOE G 450.4-1C, <i>Integrated Safety Management Guide</i>, including but not limited to:</p> <ul style="list-style-type: none"> <li>• Demonstrated leadership in risk-informed, conservative decision making;</li> <li>• Improved learning through error reporting and effective resolution of problems;</li> <li>• Line management encouraging a questioning attitude without fear of reprisal and following through to resolve issues identified by the workforce.</li> <li>• Consideration should also be given to some additional contract incentive associated with leading a culture change that fosters the desired work environment. The LANS, ES, and NA-LA stop work related processes need to ensure that response to issues raised by workers are based on sound, technical justification.</li> </ul> <p><b>JON 40:</b> DOE Headquarters needs to engage safety culture expertise to provide training and</p>

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	mentoring to LANS, ES, and NA-LA management on the principles of a strong safety culture and take appropriate corrective action based on the outcome.