U.S. Department of Energy
Office of Environmental Management

Accident Investigation Report

Underground Salt Haul Truck Fire at the Waste Isolation Pilot Plant February 5, 2014

March 2014

Disclaimer

This report is an independent product of the Accident Investigation Board appointed by Matthew Moury, Deputy Assistant Secretary, Safety, Security, and Quality Programs, U.S. Department of Energy, Office of Environmental Management. The Board was appointed to perform an Accident Investigation and to prepare an investigation report in accordance with Department of Energy (DOE) 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 report neither determines nor implies liability.

Release Authorization

On February 7, 2014, an Accident Investigation Board was appointed to investigate a fire at the U.S. Department of Energy, Waste Isolation Pilot Plant site near Carlsbad, New Mexico, that occurred on February 5, 2014. An aged EIMCO 985-T15 dump truck (salt haul truck) caught fire in the underground. The Board's responsibilities have been completed with respect to this investigation. 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 report of the Accident Investigation Board has been accepted and the authorization to release this report for general distribution has been granted.

MB Moury

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Deputy Assistant Secretary
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3/13/14

Date

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Acronyms

ALARA	As Low as Reasonably Achievable
BNA	Baseline Needs Assessment
CAS	Contractor Assurance System
CBFO	Carlsbad Field Office
CC	contributing cause
CH	contact handled
CHAMPS	Computerized History and Maintenance Planning System
CLR	Conveyance Loading Room
CMC	Carlsbad Medical Center
CMR	Central Monitoring Room
CMRO	Central Monitoring Room Operator
CMS	Central Monitoring System
CMT	Crisis Management Team
CON	Conclusion
CONOPS	Conduct of Operations
DOE	U.S. Department of Energy
DC	Direct Cause
DNFSB	Defense Nuclear Facilities Safety Board
EAL	emergency action level
EAP	Employee Assistance Program
EMCBC	Office of Environmental Management Consolidated Business Center
EMS	Emergency Medical Services
EOC	Emergency Operations Center
EPA	U.S. Environmental Protection Agency
ERO	Emergency Response Organization
ERT	Emergency Response Team
EST	Emergency Services Technician
EXO	Enriched Xenon Observatory
FHA	Fire Hazard Analysis
FLIRT	First Line Initial Response Team
FPP	Fire Protection Program
FR	Facility Representative
FSM	Facility Shift Manager
FSS	Fire Suppression System
GET	General Employee Training

HEPA	high-efficiency particulate absorption
HQ	Headquarters
ICS	Incident Command System
ISM	Integrated Safety Management
ISMS	Integrated Safety Management System
JHA	Job Hazard Analysis
JON	Judgments of Need
JIC	Joint Information Center
LPU	Local Processing Unit
M&O	Management and Operations
MRT	Mine Rescue Team
MST	Mountain Standard Time
MW	Megawatt
NFPA	National Fire Protection Association
NWP	Nuclear Waste Partnership LLC
MSHA	Mine Safety and Health Administration
MST	Mountain Standard Time
OE	Operational Emergency
O&M	Operations and Maintenance
PA	public address
RH	Remote handled
RC	Root Cause
RCRA	Resource Conservation and Recovery Act
SAA	Shaft Access Area
SCFM	standard cubic feet per minute
SCSR	Self-Contained Self-rescuer
SLA	Service Level Agreement
SME	subject matter expert
SMP	Safety Management Program
TRU	Transuranic
U/G	Underground
WH	Waste Handling
WIPP	Waste Isolation Pilot Plant

Executive Summary

On Wednesday, February 5, 2014, at approximately 1045 Mountain Standard Time, an underground mine fire involving an EIMCO Haul Truck 74-U-006B (salt haul truck) occurred at the Department of Energy (DOE) Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico. There were 86 workers in the mine (underground) when the fire occurred. All workers were safely evacuated. Six workers were transported to the Carlsbad Medical Center (CMC) for treatment for smoke inhalation and an additional seven workers were treated on-site.

On February 7, 2014, Matthew Moury, Deputy Assistant Secretary for Safety, Security, and Quality Programs, U.S. Department of Energy, Office of Environmental Management formally appointed an Accident Investigation Board (the Board) to investigate the accident in accordance with DOE Order (O) 225.1B, based on this accident meeting Accident Investigation Criteria 2.d.1 of DOE O 225.1B, *Accident Investigations*, Appendix A.

The Board began the investigation on February 10, 2014, completed the investigation on March 8, 2014, and submitted findings to the Deputy Assistant Secretary for Safety, Security, and Quality Programs Environmental Management on March 11, 2014.

The Board concluded that this accident was preventable.

Accident Description

The fire is believed to have originated in the truck's engine compartment and involved hydraulic fluid and/or diesel fuel which contacted hot surfaces on the truck, possibly the catalytic converter, and then ignited. The fire burned the engine compartment and consumed the front tires which contributed significantly to the amount of smoke and soot in the underground.

The Operator had just unloaded salt from the truck at approximately 1045 Mountain Standard Time (MST) when he noticed an orange glow and then flames between the engine and the dump sections of the truck (see Figure ES-1). The Operator attempted to extinguish the fire with a portable fire extinguisher stored on the truck and then by activating the salt haul truck's fire suppression system. Both attempts to extinguish the fire were unsuccessful. The Operator then used a mine phone to notified Maintenance of the fire, and his Supervisor overheard the conversation over a nearby mine phone, which can also be heard throughout the underground. Two nearby workers heard the discussion on the mine phone and, based on the urgency of the Operator's voice, went to the scene to see if they could assist. They began pushing a nearby 300-pound fire extinguisher to the fire when their carbon monoxide monitor alarmed and the smoke worsened. One of the workers called the Central Monitoring Room (CMR) to report the fire and smoke, and recommended evacuation of the underground.

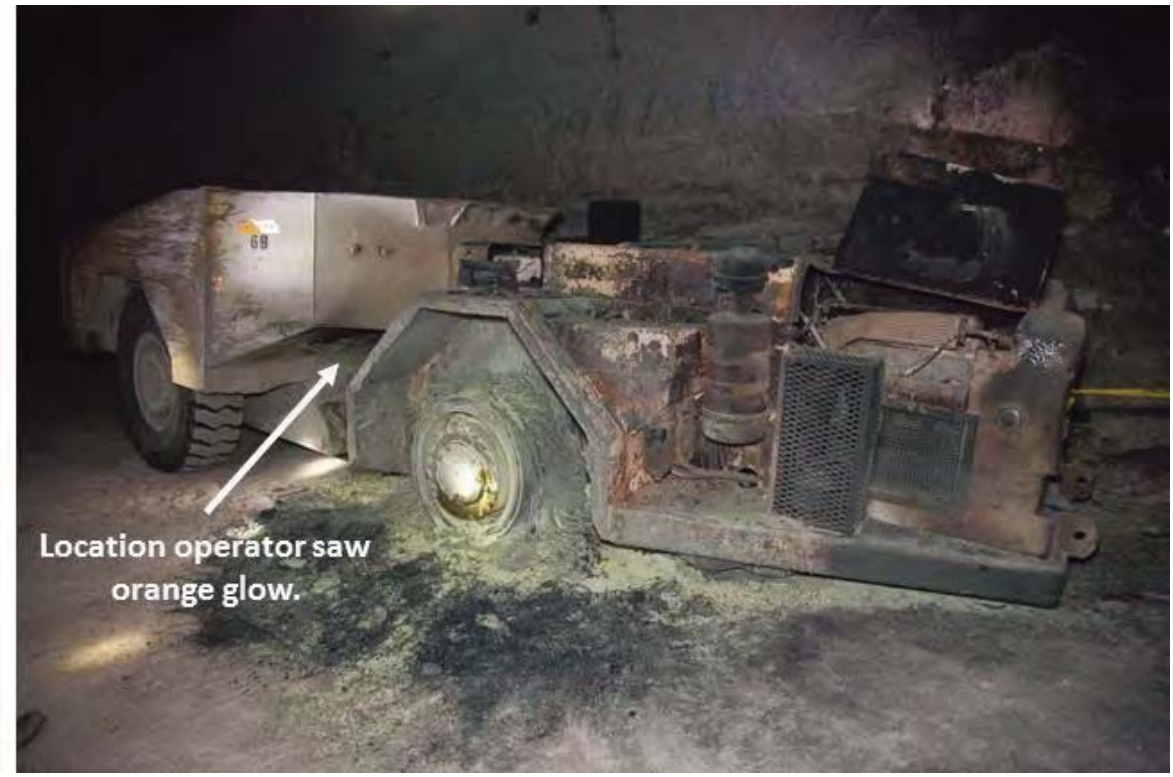

Figure ES-1: EIMCO Haul Truck 74-U-006B after Fire

At 1051, the Central Monitoring Room Operator (CMRO) sounded the evacuation "yelp" alarm for approximately two seconds and then made a public address system (PA) announcement that there was a fire in the underground and for all personnel to evacuate via the area egress stations. A subsequent announcement directed the workers to the waste hoist. As reported by some workers, this instruction was not heard throughout the underground. Some workers learned of the fire and need to evacuate through the "chatter" (discussions) on the mine phone, through co-workers, or through their supervisors.

At 1058, the Facility Shift Manager (FSM) directed the CMRO to switch the ventilation system from normal to filtration mode believing this would reduce both the fire and smoke in the underground. However, this resulted in the flow of smoke into areas of the underground, which the workers expected to have "good" air. The first group of workers arrived at the waste hoist and the first of three trips to evacuate the workers from the mine via the Waste Hoist (mantrips) to the surface was completed. The CMR activated the Emergency Operations Center (EOC) at 1103 and the Joint Information Center (JIC) was activated at 1125.

Other workers continued to make their way on foot or on electric carts from various locations throughout the underground to the waste hoist. At this point, there was smoke in most areas of the underground and smoke could be seen on the surface exiting the Salt Handling Shaft. Workers had difficulty reaching the waste hoist due to poor visibility from their primary evacuation routes and obscured evacuation route reflectors; this was compounded by a delay in activating the evacuation strobe lights. Some workers also had difficulty opening and/or donning their self-rescuers or self-contained self-rescuers (SCSRs). The second mantrip of underground

personnel was completed at 1120 and the third and final mantrip was completed at 1134. Full accountability of all underground workers was achieved at 1135.

All surface waste-handling activities were suspended and the Mine Rescue Team (MRT) was activated at 1120.

Once on the surface, workers were evaluated by Emergency Service Technicians (ESTs) and six personnel were transported to the CMC for treatment of smoke inhalation. At 1420, all personnel were released from the CMC.

The MRT performed carbon monoxide gas checks and entered the underground via the Air Intake Shaft at 1746. They proceeded to the reported fire location via the Air Intake Shaft and arrived at the salt haul truck at 1825. No fire was observed. Oxygen levels were at 21 percent and methane and carbon monoxide were at 0 percent. The MRT noted that the air was clear but that there were embers at the location of the right front tire. They expended their fire extinguishers on these embers and proceeded to the surface at 1915.

At 2202, a second MRT entered the underground via the salt hoist, took additional air quality readings, and drove the underground rescue vehicle to the scene of the fire. They applied all the extinguishing foam from the rescue vehicle and the fire appeared to be fully extinguished. They then unchained a number of bulkhead doors which had been chained open prior to the incident. On Thursday, February 6, 2014, at 0025, the MRT exited the underground via the salt hoist.

At 0105 on February 6, 2014, the event was terminated and the EOC and JIC were deactivated.

Direct, Root, and Contributing Causes

Direct Cause (DC) – the immediate events or conditions that caused the accident.

The Board identified the direct cause of this accident to be contact between flammable fluids (either hydraulic fluid or diesel fuel) and hot surfaces (most likely the catalytic converter) on the salt haul truck, which resulted in a fire that consumed the engine compartment and two front tires.

Root Cause (RC) – causal factors that, if corrected, would prevent recurrence of the same or similar accidents.

The Board identified the root cause of this accident to be the failure of Nuclear Waste Partnership LLC (NWP) and the previous management and operations (M&O) contractor to adequately recognize and mitigate the hazard regarding a fire in the underground. This includes recognition and removal of the buildup of combustibles through inspections and periodic preventative maintenance (e.g., cleaning), and the decision to deactivate the automatic onboard fire suppression system.

Contributing Causes (CC) – events or conditions that collectively with other causes increased the likelihood or severity of an accident but that individually did not cause the accident. For the purposes of this investigation, contributing causes include those related to the cause of the fire, as well as those related to the subsequent response.

The Board identified ten contributing causes to this accident or resultant response:

1. The preventative and corrective maintenance program did not prevent or correct the buildup of combustible fluids on the salt truck. There is a distinct difference between the way waste-handling and non-waste-handling vehicles are maintained.
2. The fire protection program was less than adequate in regard to flowing down upper-tier requirements relative to vehicle fire suppression system actuation from the Baseline Needs Assessment into implementing procedures. There was also an accumulation of combustible materials in the underground in quantities that exceeded the limits specified in the Fire Hazard Analysis (FHA) and implementing procedures. Additionally, the FHA does not provide a comprehensive analysis that addresses all credible underground fire scenarios including a fire located near the Air Intake Shaft.
3. The training and qualification of the operator was inadequate to ensure proper response to a vehicle fire. He did not initially notify the CMR that there was a fire or describe the fire's location.
4. The CMR Operations response to the fire, including evaluation and protective actions, was less than adequate.
5. Elements of the emergency/preparedness and response program were ineffective.
6. A nuclear versus mine culture exists where there are significant differences in the maintenance of waste-handling versus non-waste-handling equipment.
7. The NWP Contractor Assurance System (CAS) was ineffective in identifying the conditions and maintenance program inadequacies associated with the root cause of this event.
8. The DOE Carlsbad Field Office (CBFO) was ineffective in implementing line management oversight programs and processes that would have identified NWP CAS weaknesses and the conditions associated with the root cause of this event.
9. Repeat deficiencies were identified in DOE and external agencies assessments, e.g., Defense Nuclear Facility Safety Board (DNFSB) emergency management, fire protection, maintenance, CBFO oversight, and work planning and control, but were allowed to remain unresolved for extended periods of time without ensuring effective site response.
10. There are elements of the Conduct of Operations (CONOPS) program that demonstrate a lack of rigor and discipline commensurate with the operation of a Hazard Category 2 Facility.

Table ES-1: Conclusions and Judgments of Need

Conclusion (CON)	Judgments of Need (JON)
CON 1: The FSM and Central Monitoring Room Operator (CMRO) did not fully follow the procedures for response to a fire in the underground (U/G). This can be attributed to the complexity of the alarm and communication system, lack of effective drills and training, and additional burdens placed on the FSM due to the lack of a structured Incident Command System (ICS).	**JON 1:** NWP needs to evaluate and correct deficiencies regarding the controls for communicating emergencies to the underground, including the configuration and adequacy of equipment (alarms, strobes, and public address). **JON 2**: NWP needs to evaluate the procedures and capabilities of the FSM and CMRO in managing a broad range of emergency response events through a comprehensive drill and requalification program.
CON 2: NWP management allows expert-based, rather than a process/systems-based approach to decision making, e.g., shift to filtration during a fire, sheltering decisions, etc.	**JON 3**: NWP needs to evaluate and apply a process/systems-based approach for decision making relative to credible emergencies in the U/G, including formalizing response actions, e.g., decision to change to filtration mode during an ongoing evacuation.
CON 3: The emergency management program was not structured such that personnel were driven to adequately size up, properly categorize, and classify emergency events. The WIPP (NWP and CBFO) emergency management program is not fully compliant with DOE O 151.1C, *Comprehensive Emergency Management System*, e.g., activation of the EOC, classification and categorization, emergency action levels, implementation of the ICS, training, triennial exercise, etc. Weaknesses in classification, categorization, and emergency action levels (EALs) were previously identified by external reviews and uncorrected.	**JON 4**: NWP and CBFO need to evaluate their corrective action plans for findings and opportunities for improvement identified in previous external reviews, and take action to bring their emergency management program into compliance with requirements. **JON 5**: NWP and CBFO need to correct their activation, notification, classification, and categorization protocols to be in full compliance with DOE O 151.1C and then provide training for all applicable personnel. **JON 6**: NWP and CBFO need to improve the content of site-specific EALs to expand on the information provided in the standard EALs contained in DOE O 151.1C. **JON 7**: NWP and CBFO need to develop and implement an Incident Command System (ICS) for the EOC/CMR that is compliant with DOE O 151.1C and is capable of assuming command and control for all anticipated emergencies.

Conclusion (CON)	Judgments of Need (JON)
CON 4: Actions to be taken by the Operator in the event of a U/G vehicle fire were not clear. There were inconsistencies between procedures and training for fire response that led to an ineffective response to the salt haul truck fire.	**JON 8**: NWP needs to review procedures and ensure consistent actions are taken in response to a fire in the U/G. **JON 9**: NWP, CBFO and DOE need to clearly define expectations for responding to fires in the U/G, including incipient and beyond incipient stage fires.
CON 5: NWP and CBFO failed to ensure that training and drills effectively exercised all elements of emergency response to include practical demonstration of competence, e.g., donning of self-rescuers and SCSRs, U/G personnel response to a fire, use of portable fire extinguishers, EOC roles, classification and categorization, notifications and reporting, and allowance of unescorted access for over 500 personnel, etc.	**JON 10**: NWP and CBFO need to develop and implement a training program that includes hands-on training in the use of personal safety equipment, e.g., self-rescuers, SCSRs, portable fire extinguishers, etc. **JON 11**: NWP and CBFO need to improve and implement an integrated drill and exercise program that includes all elements of the ICS, including the MRT, First Line Initial Response Team (FLIRT) and mutual aid; unannounced drills and exercises; donning of self-rescuers/SCSRs; and full evacuation of the U/G. **JON 12**: NWP needs to evaluate and improve their criteria for granting unescorted access to the U/G such that personnel with unescorted access to the underground are proficient in responding to abnormal events.
CON 6: NWP preventive and corrective maintenance program did not prevent or correct the buildup of combustible fluids on the salt haul truck.	**JON 13**: NWP management needs to reevaluate and modify the approach to conducting preventative and corrective maintenance on all U/G vehicles such that combustible fluids are effectively managed to prevent the recurrence of fires.
CON 7: NWP and CBFO management is not adequately considering overall facility impact with regard to operations, emergency response, and maintenance, which affects the safety posture of the facility, e.g., salt haul truck combustible build-up, conversion of the automatic fire suppression system to manual, removal of the automatic fire detection capability, not using fire resistant hydraulic fluid, discontinued use of the vehicle wash	**JON 14**: NWP and CBFO need to develop and implement a rigorous process that effectively evaluates: • changes to facilities, equipment, and operations for their impact on safety, e.g., plant operations review process; • impairment and corresponding compensatory measures on safety-related equipment; and • the impact of different approaches in

Conclusion (CON)	Judgments of Need (JON)
station, chaining of ventilation doors and an out-of-service regulator and fans, inoperable mine phones, and other non-waste-handling related equipment.	maintaining waste-handling and non-waste-handling equipment. **JON 15**: NWP needs to determine the extent of this condition and develop a comprehensive corrective action plan to address identified deficiencies.
CON 8: NWP and CBFO management have not effectively managed the quantity and duration of out-of-service equipment.	**JON 16**: NWP needs to develop and implement a process that ensures comprehensive and timely impact evaluation and correction of impaired or out-of-service equipment. **JON 17**: CBFO needs to ensure that its contractor oversight structure includes elements for comprehensive and timely evaluation and correction of impaired or out-of-service equipment.
CON 9: NWP management has allowed less than acceptable rigor in the performance of equipment inspections, resulting in the operation of U/G equipment in unacceptable condition.	**JON 18**: NWP needs to develop and reinforce clear expectations regarding the performance of rigorous equipment inspections in accordance with manufacturer recommendations, established technical requirements; corrective action; and trending of deficiencies.
CON 10: NWP did not ensure the Baseline Needs Assessment (BNA) addressed requirements of DOE O 420.1C and Mine Safety and Health Administration (MSHA) with the results completely incorporated into implementing procedures.	**JON 19**: NWP needs to ensure that all requirements of DOE O 420.1C and MSHA are addressed in the BNA, with the results completely incorporated into implementing procedures and the source requirements referenced, and that training consistent with those procedures is performed.
CON 11: NWP and CBFO management did not make conservative or risk-informed decisions with respect to developing and implementing the fire protection program. There is inadequate fire engineering analysis due to a lack of integration with ventilation design and operations, and U/G operations, for recognizing, controlling, and mitigating U/G fires.	**JON 20**: NWP and CBFO need to perform an integrated analysis of credible U/G fire scenarios and develop corresponding response actions that comply with DOE and MSHA requirements. The analysis needs to include formal disposition regarding the installation of an automatic fire suppression system in the mine.
CON 12: NWP and CBFO have failed to take appropriate action to correct combustible loading issues that were	**JON 21**: NWP and CBFO need to review the combustible control program and complete corrective actions that demonstrate compliance

Conclusion (CON)	Judgments of Need (JON)
identified in previous internal and external reviews.	with program requirements. These issues remain unresolved from prior internal and external reviews.
CON 13: NWP and CBFO have allowed housekeeping to degrade and other conditions to persist that potentially impede egress.	**JON 22**: NWP and CBFO need to evaluate and address deficiencies in housekeeping to ensure unobstructed egress and clear visibility of emergency egress strobes, reflectors, SCSR lights, etc.
CON 14: NWP has not fully developed an integrated contractor assurance system that provides assurance that work is performed compliantly, risks are identified, and control systems are effective and efficient.	**JON 23**: NWP needs to develop and implement a fully integrated contractor assurance system that provides DOE and NWP confidence that work is performed compliantly, risks are identified, and control systems are effective and efficient.
CON 15: CBFO failed to adequately establish and implement line management oversight programs and processes to meet the requirements of DOE O 226.1B and hold personnel accountable for implementing those programs and processes.	**JON 24**: CBFO needs to establish and implement an effective line management oversight program and processes that meet the requirements of DOE O 226.1B and hold personnel accountable for implementing those programs and processes.
CON 16: CBFO management does not have adequate communication processes to ensure awareness of issues that warrant attention from all levels of the DOE staff.	**JON 25**: CBFO needs to accelerate the implementation of a mechanism for all levels of CBFO staff to document, communicate, track, and close issues both internally and with NWP. **JON 26**: The CBFO Site Manager needs to institutionalize and communicate expectations for the identification, documentation, reporting, and correction of issues.
CON 17: DOE HQ failed to ensure that CBFO was held accountable for correcting repeatedly identified issues involving fire protection, maintenance, emergency management, work planning and control, and oversight.	**JON 27**: DOE HQ needs to ensure that repeatedly identified issues related to safety management programs (SMPs) are confirmed closed and validated by the local DOE office. This process should be considered for application across the DOE complex and include tracking, closure, actions to measure the effectiveness of closure (line management accountability), and trending to identify precursors and lessons learned. **JON 28**: DOE HQ should enhance its required oversight to ensure site implementation of the emergency management policy and requirements

Conclusion (CON)	Judgments of Need (JON)
	are consistent and effective. Emphasis should be placed on ensuring ICSs are functioning properly and integrated exercises are conducted where personnel are evacuated.
CON 18: DOE HQ failed to ensure CBFO was provided with qualified technical resources to oversee operation of a Hazard Category 2 Facility in a mine.	**JON 29**: DOE HQ needs to develop and implement a process for ensuring that technical expertise is available to provide support in the unique area of ground control, underground construction, and mine safety and equipment. **JON 30**: DOE HQ needs to assist CBFO with leveraging expertise from MSHA, in accordance with the DOE/MSHA Memorandum of Understanding (MOU), in areas of ground control, underground construction, and mine safety where DOE does not have the expertise. **JON 31**: DOE HQ needs to re-evaluate resources (i.e., funding, staffing, infrastructure, etc.) applied to the WIPP project to ensure safe operations of a Hazard Category 2 Facility.
CON 19: The Office of Environmental Management Consolidated Business Center (EMCBC) and CBFO failed to ensure support services as described in the Service Level Agreement were provided.	**JON 32**: EMCBC and CBFO need to develop and implement clear expectations and a schedule for EMCBC to provide support in the areas of regulatory compliance, safety management systems, preparation of program procedures and plans, quality assurance, lessons learned, contractor assurance, technical support, DOE oversight assistance, etc.
CON 20: There are elements of the CONOPS program that demonstrate a lack of rigor and discipline commensurate with operation of a Hazard Category 2 Facility.	**JON 33**: NWP and CBFO need to evaluate and correct weaknesses in the CONOPS program and its implementation, particularly with regard to flow-down of requirements from upper-tier documents, procedure content and compliance, and expert-based decision making.
CON 21: NWP and CBFO did not analyze and disposition differences between waste-handling and non-waste-handling vehicles for similar hazards and impacts, e.g., allowing a truck in this condition to be at the waste face.	**JON 34**: NWP and CBFO need to identify and control the risk imposed by non-waste-handling equipment, e.g., combustible buildup, manual vs. automatic fire suppression system, fire-resistant hydraulic oil, etc., or treat waste-handling equipment and non-waste-handling equipment the same.

CON 22: NWP and CBFO management allowed a culture to exist where there are differences in the way waste-handling equipment and non-waste-handling equipment are maintained and operated.	**JON 35**: NWP and CBFO management need to examine and correct the culture that exists regarding the maintenance and operation of non-waste-handling equipment.
Positive Statement: All supervisors and employees in the U/G actively used the mine phone to alert other workers of the fire and the need to evacuate before the evacuation alarm was sounded. **Positive Statement**: Workers assisted other workers during the evacuation, including helping them to don self-rescuers and SCSRs. **Positive Statement**: Personnel in the U/G exhibited detailed knowledge of the underground and ventilation splits. **Positive Statement**: NWP on-site medical response was effective in treating personnel.	