

**The February 2014 Accidents at WIPP - 15024  
(What Happened and What We Know About Why)**

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**ABSTRACT**

With almost 15 years of successful and safe operations, the WIPP facility was suddenly shutdown in February 2014 due to two unrelated accidents underground. A fire burned the front tires and engine of a salt haul truck, creating significant soot and forced evacuation of the mine. A second unrelated incident occurred 9 days later when at least one drum of non-compliant waste from Los Alamos National Laboratory burst, introducing airborne radioactivity into the underground ventilation air. Some radioactivity was released to the atmosphere at the surface. Bioassay showed that 22 workers received low internal doses, with no long-term adverse health effects expected for these employees. Independent environmental monitoring indicated very low levels off-site and dose reconstruction modeling indicated no members of the public were exposed.

Comprehensive accident investigations resulted in significant planned changes to enhance safety management programs at WIPP, and a recovery plan was developed. In addition to safety management program augmentation, recovery involves new and enhanced underground ventilation systems and decontamination of affected areas underground. Resumption of initial waste disposal operations is scheduled for early in FY16, with a return to normal operations (17 shipments per week) within about three years.

**INTRODUCTION**

WIPP was legislatively authorized in 1979, following a long and rich US history of planning for permanent isolation of all long-lived radioactive wastes from the production of nuclear weapons in a deep geologic salt formation. Constructed during the 1980's, the facility was ready for disposal operations in 1988. Two decades passed from WIPP authorization to operation, with waste acceptance limited to only defense-related Transuranic (TRU) waste. Full scale shipping and emplacement began March 1999. Numerous descriptions of the history, design, operation and regulatory oversight of WIPP have been published over the years, and are not repeated here. An excellent overview was published in Radwaste Solutions Magazine (May/June 2009), which devoted the entire issue to WIPP in recognition of the facility's tenth operating anniversary. For a detailed look at WIPP and its many attributes, along with a complete description of its operation, the reader is encouraged to review that issue [1].

With almost 15 years of successful and safe operations, the WIPP facility was suddenly shutdown in February 2014 due to two unrelated accidents underground. To understand the significant impact these events caused, it is important to remember that WIPP (like any deep geologic repository for waste disposal) is first and foremost, a mine. One of the most important factors in safe operations is the underground ventilation system, which is designed, maintained, and operated to meet or exceed the criteria specified by 30 CFR Part 57, Safety and Health Standards Underground Metal and Nonmetal Mines, and the New Mexico Mine Safety Code for

mines. The ventilation system must also meet the requirements of the WIPP Hazardous Waste Facility Permit, issued by the New Mexico Environment Department (NMED).

Air is supplied to the underground horizon, at 667 meters below the surface, through the waste shaft, the salt handling shaft, and the air intake shaft, and is pulled up through a single fourth shaft by exhaust fans located on the surface. Normally, this ventilation is substantial, and is discharged to the atmosphere at the surface without being filtered. However, an important part of the nuclear safety systems at WIPP is the ability to filter air from the underground through a standby high-efficiency particulate air (HEPA) filtration system, also at the surface. This switch to filtration is an automatic response in the event that airborne radioactivity is detected downstream of the waste emplacement areas underground. Airborne radioactivity levels are measured by continuous air monitors placed in the underground and in the ventilation system.

The underground ventilation system currently consists of six exhaust fans (three main fans in the normal flow path and three smaller fans in the filtration flow path), two identical HEPA filter assemblies arranged in parallel, and associated ductwork. Underground ventilation is divided into four separate flow paths supporting the waste disposal area, the construction area, the north area, and the waste shaft station. Figure 1 graphically displays the flow of air in the existing underground ventilation system.

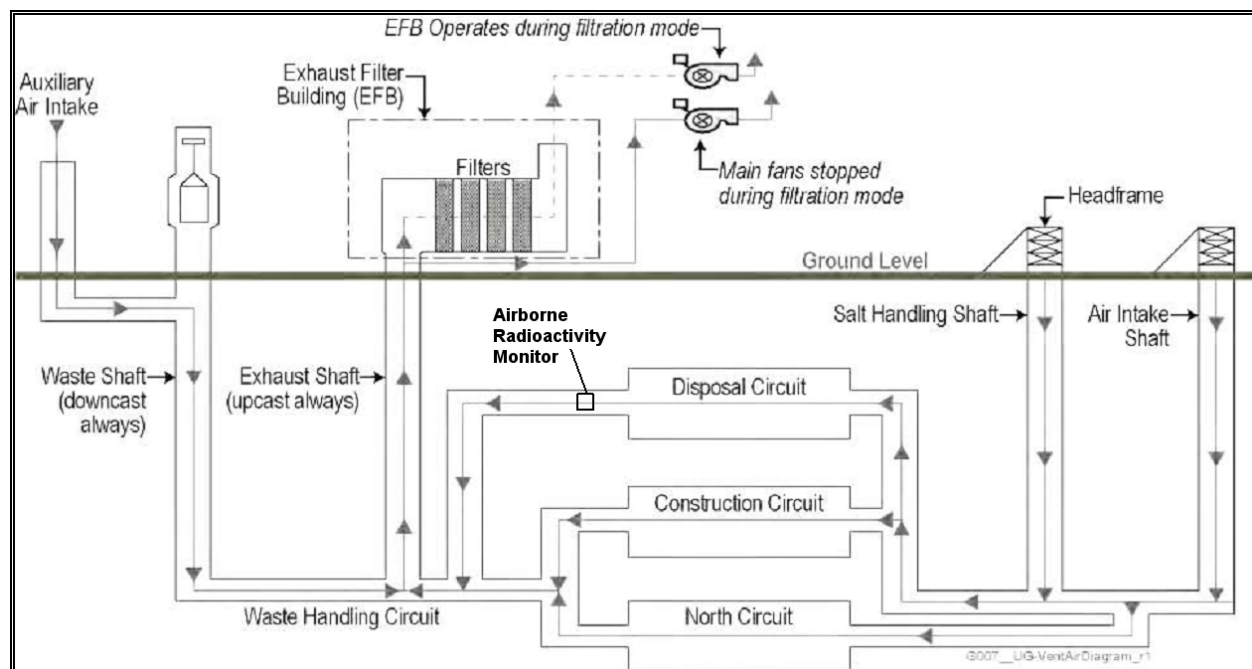


Fig. 1 WIPP Underground Ventilation System—Current Configuration

## THE TWO INCIDENTS AT WIPP IN FEBRUARY 2014

WIPP waste disposal operations were suspended on February 5, 2014, following a fire involving an underground vehicle. Nine days later, on February 14, 2014, a radiological event occurred underground at WIPP, contaminating a portion of the mine primarily along the ventilation path downstream from the location of the incident in a recently opened waste disposal room. Airborne radioactivity reached the surface and a small amount bypassed the HEPA filtration system, which was detected outside the facility boundary. This section summarizes (1) what is known about what happened during the two events based on the investigations conducted to date,

(2) the Department's ongoing response to the incidents, and (3) the effects on the WIPP facility. Figure 2 shows a schematic of the WIPP underground layout and where the two incidents occurred. Waste emplacement in Panel 6 had been completed about 3 weeks before the fire event, and emplacement activities had switched to Room 7 of Panel 7, which only contained 24 rows of waste containers when the incidents happened.

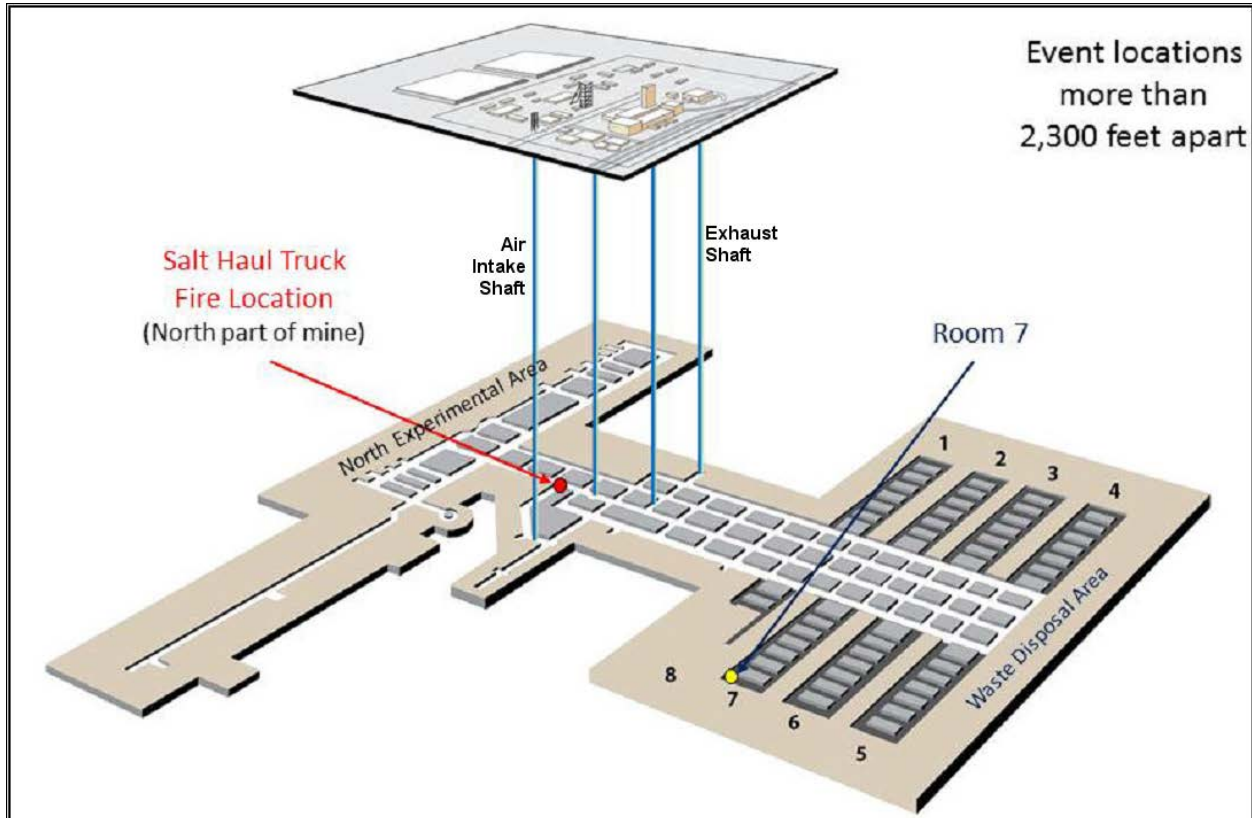


Fig. 2 Location of the Two Incidents at WIPP in February 2014

The underground fire involved a salt haul truck, a diesel-powered vehicle used to move mined salt from the underground. There were 86 people in the underground at the onset of the fire; all evacuated from the mine safely. Six personnel were evaluated for smoke inhalation and released from a local hospital the day of the underground fire. One employee continues to be treated for smoke inhalation as a result of the fire.

The fire burned the engine compartment of the salt haul vehicle and consumed the front tires, which contributed significantly to the amount of smoke and soot in the area of the fire. The vehicle caught fire directly in front of the primary air intake drift as it split to flow both north and south, thereby affecting the entire underground. The high ventilation flow at this unique location fanned the flames, which impinged on the downwind mine walls and caused decrepitation of the adjacent salt ribs. More significant with regard to the longer term recovery, the fire resulted in heavy smoke damage in the immediate area, and to mechanical and electrical equipment and systems throughout the underground. Soot was deposited on the mine's walls, shafts, and underground equipment, including the waste hoist tower, which is used to transport TRU waste containers to the underground for disposal. Soot trapped by the HEPA filtration system augmented the need to replace the filters, which was eventually completed in June 2014. In

summary, the soot and smoke from the fire adversely affected key equipment and facilities of the WIPP repository, and required a widespread cleanup effort throughout the underground.

Nine days later, on February 14, 2014, at 11:14 pm, a continuous air monitor detected a radiological release in the underground. As designed, the underground ventilation system automatically switched to HEPA filtration and the damper was manually opened and adjusted to achieve designated airflow. The airflow was reduced from 12,000 cubic meters per minute to 1,700 m<sup>3</sup> per minute. No employees were in the underground at the time. The continuous air monitor was located immediately downstream and outside Panel 7.

Redirection of ventilation through the HEPA filters is designed to protect aboveground workers at the site and the public in the surrounding areas by minimizing radiation releases to the environment. However, slightly elevated levels of airborne radioactive concentrations were subsequently detected outside the WIPP facility due to leakage through closed ventilation filter bypass dampers. Particulate samples of effluent downstream of the HEPA filters indicated a total release to the atmosphere over several days of about 4E7 Bq.

Actions were taken immediately following the incident to stabilize the facility and to determine the extent of impact to WIPP personnel, the public, and the environment. Activities included radiological surveys across the WIPP site and adjacent areas, as well as collection and analysis of environmental and personnel bioassay samples. Surface radioactivity samples from equipment and structures across the facility showed no detectable levels. However, subsequent bioassay tests showed that 22 workers received internal dose as a result of the release, each with a total lifetime exposure of less than 100 micro Sievert, which is equivalent to the exposure resulting from a single chest x-ray. All follow-up tests were below minimum detectable concentrations. No long-term adverse health effects are expected for these employees.

In addition, air samples were collected by the independent Carlsbad Environmental Monitoring and Research Center (CEMRC), operated by New Mexico State University from locations downwind of WIPP surface facilities. These were subsequently analyzed via sensitive radiochemistry methods, and small, but measurable levels of radioactive particulate were identified. These small levels were reported within a few days of the event in the media, and resulted in substantial public interest. Subsequent dose reconstruction modeling showed that if there had been members of the public present, immediately downwind of the surface facilities overnight during the event, their maximum dose would have been less than about 30 micro Sievert. No members of the public were exposed to these low levels.

Other WIPP recovery actions followed as part of the initial incident response. On March 6, two ventilation system dampers that were known to have allowed a small amount of the radioactive material to bypass the HEPA filters were sealed with a high-density foaming material. Periodic air sampling of the HEPA filtered exhaust was conducted and publicized on the WIPP recovery website. Soil, surface water, sediment, animal, and vegetation sampling were performed. The only detectable levels were from opportunistic samples of rainwater runoff from structures immediately adjacent to the release point several weeks after the event. Although detectable, levels were below drinking water standards, and were seen only once.

In response to stakeholder requests, the Department initiated a comprehensive public outreach and communications strategy that included weekly town hall meetings, upgrading the WIPP

recovery website, starting WIPP Update email notifications, and conducting regular, formal and informal discussions with WIPP's regulators.

## **ACCIDENT INVESTIGATIONS**

On February 7, 2014, the Department appointed an Accident Investigation Board (AIB) to determine the cause of the fire incident and to develop recommendations for corrective actions to prevent recurrence. The AIB is an independent entity that performs a rigorous accident investigation and prepares associated investigation reports in accordance with established Department requirements, i.e., DOE Order 225.1B, Accident Investigations. The results of the fire accident investigation were released in an extensive report issued March 13, 2014 (DOE 2014a). The report is available at: <http://www.wipp.energy.gov/Special/AIB%20Report.pdf>.

The AIB report identified 10 contributing causes and 35 areas where the Department and WIPP's management and operating contractor would be required to evaluate processes or procedures and develop and implement corrective actions [2]. The report cited weaknesses in the fire protection, emergency management, maintenance, and oversight by DOE. DOE and the WIPP's management and operating contractor developed corrective action plans responding to the AIB report, the key elements of which are outlined in the Recovery Plan discussed in subsequent sections. Implementation of the corrective actions is well underway.

On February 27, 2014, the Department appointed a second AIB to determine the cause of the radiological release and to develop recommendations for corrective actions. This second AIB used a two-phased approach. The first phase focused on the response to the radioactive material release, including related exposure to aboveground workers and the response actions, while the second phase, which is ongoing, is evaluating the cause of the underground radiological release event.

The first phase is complete, and the results are documented in the comprehensive report issued April 24, 2014 (DOE 2014b) [3]. According to the Phase 1 report, the cumulative effect of inadequacies in ventilation system design and operability compounded by degradation of key safety management programs and safety culture resulted in the release of a minimal amount of radioactive material from the underground to the environment. The Phase 1 report is at: [http://www.wipp.energy.gov/Special/AIB\\_Final\\_WIPP\\_Rad\\_Release\\_Phase1\\_04\\_22\\_2014.pdf](http://www.wipp.energy.gov/Special/AIB_Final_WIPP_Rad_Release_Phase1_04_22_2014.pdf).

It identified eight contributing causes and 47 areas of improvement for the Department and the WIPP management and operating contractor. The report cited deficiencies in the response to the event and in the areas of nuclear safety, maintenance, radiological protection and controls, emergency management, safety culture and oversight. The corrective action plans being developed to address the findings of the Phase 1 report are currently in the final stages of approval. The key elements of the corrective action plans are outlined in the Recovery Plan described below, and implementation of the corrective actions is ongoing.

Phase 2 of the AIB investigation of the radiological release is in process and focuses on the cause of the radiological release. The AIB will provide its findings when the investigation is complete, currently expected by the end of calendar year 2014.

To complement the AIB investigation, the DOE Deputy Under Secretary for Management and Performance chartered a Technical Assessment Team (TAT) to perform a comprehensive,

independent scientific review of the mechanisms and chemical reactions that may have resulted in the release of radioactivity. Primary review areas include site assessment and sampling, analysis and characterization, TRU drum processes and practices and evaluation of potential reaction mechanisms and chemistry. Led by the Savannah River National Laboratory, the TAT is comprised of experts from, Pacific Northwest National Laboratory, Sandia National Laboratories, Oak Ridge National Laboratory; and Lawrence Livermore National Laboratory. Los Alamos National Laboratory (LANL) is separately performing an extensive review of its own TRU program and is sharing the results with the TAT. The Technical Assessment Team coordinates with the AIB.

In May 2014, efforts to examine waste in Panel 7, Room 7 (using video cameras extended out on a long boom to view from above) identified that a waste container originating from LANL had been breached. Following identification of the waste container, samples were obtained underground, and analyses of those samples and other analytical and investigative work continues by both the AIB and the Technical Assessment Team. To date, only one breached drum has been identified, however, a more complete video camera inspection of Panel 7, Room 7 will be initiated in January 2015. A photograph taken in May 2014 of the breached drum is shown in Figure 3. Also shown is a schematic reconstruction of all waste containers in Room 7 of Panel 7, identifying all containers from the same waste stream. The waste stream of interest originated from repackaging nitrate salts by mixing with an organic-based absorbent to eliminate residual neutralized acidic liquids. This oxidizer and fuel combination was subsequently (post incident) found to exhibit the characteristic of ignitability under provisions of the Resource Conservation and Recovery Act.

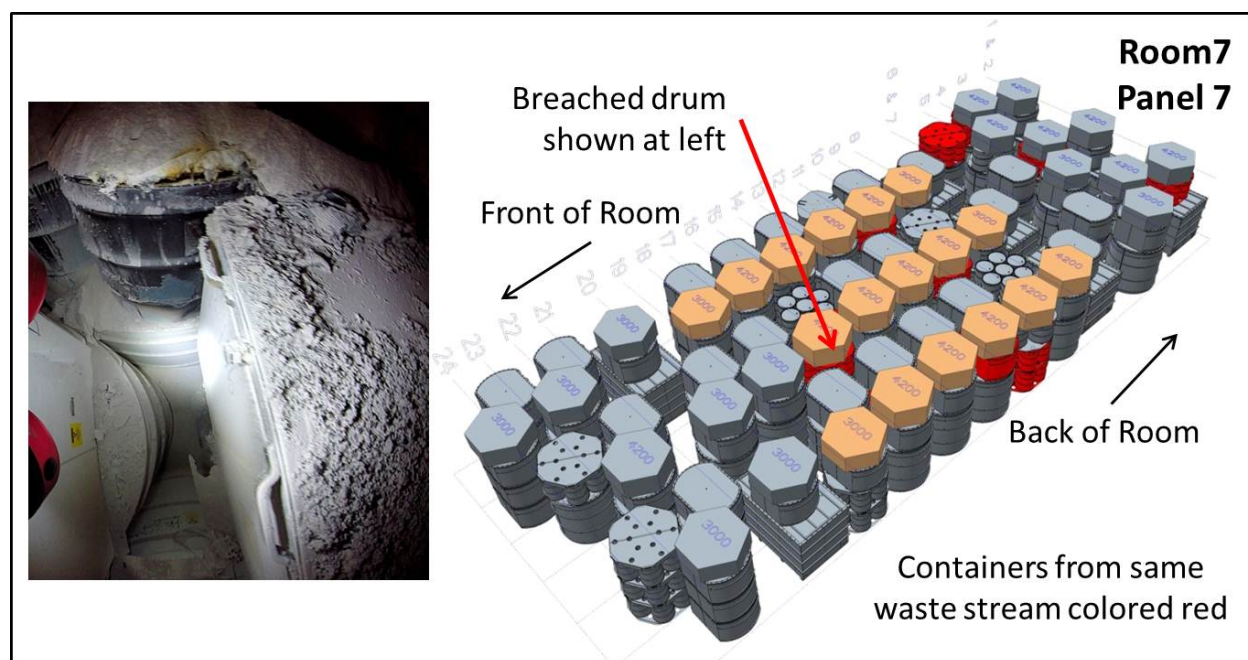


Fig. 3 Photo of breached drum and schematic of its location within Panel 7 Room showing containers of the same waste stream from LANL. Orange hexagonal symbols represent plastic bags (containing granular chemical backfill) that melted as a result of the exothermic reaction that was the source of released radioactivity.

LANL self-reported this non-compliance to the NMED believing that they:

“...failed to conduct an adequate hazardous waste determination for the nitrate salt-bearing wastes with regard to EPA Hazardous Waste Number (HWN) D001 (ignitability characteristic). The Permittees' prior waste characterization activities for these legacy (pre-1991) wastes were based on the best available information at the time the wastes were managed, and included extensive reviews of available information; however, recent analytical testing has shown that these wastes carry HWN D001 as an oxidizer.” [4]

In response to these findings, the DOE Inspector General Office (IG) initiated a special inquiry to determine whether LANL appropriately managed the remediation and repackaging of waste shipped to WIPP [5]. The IG review identified several major deficiencies in LANL's procedures for the development and approval of waste packaging and remediation techniques that may have contributed to the radiological event. Of particular concern, the IG found that not all waste management procedures at LANL were properly vetted through the established procedure revision process nor did they conform to established environmental requirements. The IG recommended immediate action was necessary to ensure that these matters were addressed and fully resolved before TRU waste operations were resumed, or, for that matter, before future mixed radioactive hazardous waste operations were initiated.

## **EFFECTS OF THE RELEASE INCIDENT**

As a result of the radiological event, portions of the WIPP underground and the existing surface mounted ventilation system are radiologically contaminated. Comprehensive surveys are ongoing to determine the extent of the contamination, although it is expected that most of the underground will be free of contamination. Based on the ventilation flow and radiological surveys to date, it is anticipated that only Panel 7 and the exhaust drifts and shaft may be potentially contaminated.

Since the radiological release, the underground ventilation system has operated in filtration mode through two parallel HEPA filter banks with an air flow rate of 1,700 m<sup>3</sup> per minute of filtered air. This is significantly lower than the normal, unfiltered rate of 12,000 m<sup>3</sup> per minute. Air is exhausted through the filter banks by one of three available exhaust fans. This HEPA filtration system provides a means for removing the airborne particulates that may contain radioactive and hazardous waste contaminants in the reduced exhaust flow before they are discharged through the exhaust port to the atmosphere. The HEPA filtration system is designed for one exhaust fan to operate at a time at 1,700 m<sup>3</sup> per minute. The other two fans serve as back-up and are rotated into service. This low flow can only support limited underground operations.

The current limited ventilation constrains the number of personnel and activities that can be conducted in the underground at any time. Operations impacted include activities that produce exhaust or fumes (e.g., diesel engines for roof bolters, fork lifts, salt haul trucks, underground construction vehicles) and create underground dust (e.g., mining, roof bolting, vehicle movements, movement of salt).

The radiological event released a small amount of contamination to the environment, which was detected and announced on February 19, 2014 by the Carlsbad Environmental Monitoring & Research Center. The announcement noted that all of the radiation levels detected were very low and were well below any level of public and environmental hazard. Later results showed that the released low levels of radioactivity decreased significantly after the event, and the analyses

continue to reflect that the air around the WIPP site is safe, posing no risk to the environment or the public.

## **REGULATORY COMPLIANCE**

WIPP is regulated under numerous requirements, including those of the Environmental Protection Agency and the New Mexico Environment Department, and both agencies were closely involved in the response to the February 2014 incidents and DOE's planned recovery.

NMED issued Administrative Orders following the incidents that required DOE to submit plans for isolating the waste containers that were similar to the nitrate salt waste stream from LANL. No similar waste is stored in the waste handling building at the surface, but there are drums of similar waste with nitrate salts treated with organic-based absorbent in both Panel 7 and Panel 6. DOE developed a plan for the isolation of Panel 6 and of Room 7 of Panel 7 from ventilation pursuant to the administrative orders, and these activities are high priority as part of the overall recovery plan.

Lifting the Administrative Orders will require resumption of inspections and monitoring for the aboveground and underground Permit requirements; closing Panel 6 and Panel 7, Room 7; the NMED inspection of the surface and underground; and approval of any required permit modifications requests necessary to resume operations. DOE will submit proper notices and modification requests for activities that deviate from the current permit, such as permit modification requests to address the changes planned for the ventilation system as described in subsequent sections.

In December 2014, the NMED issued an Administrative Compliance Order which assessed a fine of approximately \$17M in response to cited violations of their permit for WIPP operations. Negotiations between DOE and NMED to reach a final settlement are ongoing at the time this paper was written.

## **RECOVERY OBJECTIVES**

The recovery and resumption of TRU waste disposal operations at WIPP are central to the Department's national clean-up mission. A Recovery Plan was developed, which details the steps to achieve restart and support DOE's mission requirements, as well as commitments to the public, the community, generator sites, and their host states [6]. The objective is to resume emplacing waste in WIPP in the first quarter of the calendar year 2016. Safety, health, and protection of the public, the workers, and the environment are DOE's highest priorities. Every stage of recovery will be supported by rigorous regulatory compliance and robust upgrades to nuclear safety, fire protection, and emergency management documentation, procedures, and training. These will be validated in accordance with Departmental directives through the conduct of Operational Readiness Reviews at the contractor and federal levels. At all stages of recovery, the Department will communicate openly, early, and frequently with the public, stakeholders, and regulators.

When disposal operations resume, the first wastes to be disposed of will be the site-derived waste from the recovery actions and the containers currently stored in the Waste Handling Building at WIPP. Once these containers have been safely disposed of, WIPP will begin receiving wastes



from waste generator sites. The number of shipments that can be processed will increase as supported by ventilation improvements and equipment.

It is envisioned that the initial waste will be emplaced into the contaminated area, e.g., Panel 7 first, followed by emplacement in the drifts between Panels 2 through 4 and 5 through 7 (see Figure 2). Over time, as areas are decontaminated and other contaminated areas are closed off, the majority of operations will take place in the clean parts of the facility.

Increasing ventilation capacity is a principal requirement for safe underground operations, as it supports worker safety, mining, and waste emplacement. Since the radiological event, it is necessary to operate the existing underground ventilation system in filtration mode, which is inadequate to support operations in both the “clean” and contaminated underground areas. The ventilation levels must be increased to support the recovery of WIPP and resume waste emplacement and, eventually, full disposal operations and concurrent mining operations. The recovery strategy calls for ventilation to be increased in three phases. The ongoing first phase is the installation of two skid-mounted fans on the associated HEPA filter units, which will increase the ventilation flow from 1,700 m<sup>3</sup> per minute to 3,200 m<sup>3</sup> per minute and allow redundancy for fan maintenance.

Currently to change out HEPA filters, the entire ventilation system must be shut down, and, therefore, no workers will be permitted underground during the exchange. The boost in ventilation flow will also allow increased activities that require diesel engines, such as roof bolting. The second phase is the supplemental ventilation system, which will reconfigure the underground with bulkheads, ventilation regulators in the bulkheads, and supplemental fans. This will boost the air available at low cost, and will allow for a further increase of activities that create fumes and dust, especially very limited mining and initial waste operations. The third phase, consists of a new permanent ventilation system and the construction of a supporting exhaust shaft and two associated drifts. This last phase will restore WIPP to its pre-incident airflow capacity for simultaneous mining and waste emplacement operations, and may take several years to achieve.

Another key to the recovery strategy is to address the deficiencies identified in the AIB reports and other assessments prior to commencing operations. No waste emplacement will occur before corrective actions are closed, and preparedness and competencies validated with Operational Readiness Reviews. An Operational Readiness Review is a disciplined, systematic, documented examination of facilities, equipment, personnel, procedures, and management control systems to verify that a facility can be operated safely within its approved safety envelope as defined by the facility safety basis.

The existing workforce plays a key role in the recovery strategy. Rather than hire new workers trained to work in radiologically contaminated environments, the current workforce is being trained to perform work in uncontaminated and contaminated environments and to minimize skills mix imbalances. Maintaining the ability of workers to perform recovery functions, in addition to their normal WIPP operations responsibilities, is a Department priority. For example, waste handlers and miners will be performing recovery scope, including soot cleaning and decontamination until waste emplacement and mining resume.

## **RECOVERY STRATEGY**

The AIB identified elements of Safety Management Programs involved in the February 2014 events or in the response to the events that were noncompliant. DOE and the Management and Operating Contractor at WIPP developed a set of corrective and compensatory actions in response to both events. However, there are three Safety Management Programs—emergency management, fire protection, and radiological readiness and safety—that are key to existing recovery activities as well as resumption of waste emplacement activities:

- **Emergency Management**—The Emergency Management Program is being enhanced to improve response to site incidents and emergencies. The program is being restructured to align with current and changing needs in accordance with the National Incident Management System and the Incident Command System. The restructuring includes updates to the emergency management policies, plans, and procedures, as well as changes to equipment and facilities. Training, drills and validation exercises are being conducted. The program will be verified to align with DOE requirements and the revised Documented Safety Analysis. After successful implementation, the compensatory measures will be removed. This enhanced program will be in place prior to the start of operations.
- **Fire Protection**—The Fire Protection Program is being enhanced to include upgrades to underground fire protection equipment, better controls on combustible loading, improved scheduling of maintenance to manage fire protection controls, new fire protection equipment, changes to the engineering review of fire loading and maintenance regime, and inclusion of greater probability of fires in the safety analysis. These actions are designed to protect the safety of workers and equipment and prevent another fire from occurring in the underground. This enhanced program will be in place prior to the start of operations.
- **Radiological Readiness and Safety**—A comprehensive program to address the need to operate in both an uncontaminated and a contaminated environment has started. The program complies with 10 CFR Part 835, Occupational Radiation Protection, and DOE-STD-1128-2008, Good Practices for Occupational Radiation Protection in Plutonium Facilities. Immediate interim actions were instituted to address gaps. Trained radiation control personnel from other sites were brought to WIPP to augment the staff, mentor personnel, and provide support to new radiological activities. Training and drills conducted on the new procedures and processes have begun and will continue as this enhanced program is maintained in place prior to the start of operations.

## **DECONTAMINATION**

Decontamination is a key element of the WIPP Recovery Plan. The radiological release incident may change WIPP from a “clean” nuclear facility to one that will require simultaneous operations in contaminated and uncontaminated areas for an extended period. Panel 7, the exhaust drift, and the exhaust shaft are contaminated, but the degree is not yet known. Also, there may be additional areas that are contaminated due to the flow path of the exhaust during the incident and afterwards. This affects WIPP’s concept of operations and the required knowledge and training of the WIPP workforce.

A key element of the strategy for recovery is to not decontaminate areas of WIPP where decontamination is technically challenging or would be overly costly or delay the return to

operations. The strategy is to separate the contaminated areas from the balance of the underground, and operate WIPP with both contaminated and clean areas.

A vast majority of the underground is expected to not have been affected by the radiological event. Comprehensive surveys are being conducted to confirm mine conditions. For areas with elevated levels that are expected to be used long-term (e.g., Panel 7), decontamination options are being evaluated. Alternatively, appropriate protective equipment and procedures will be utilized.

Preliminary studies have been performed to determine the relative effectiveness of various methods of decontamination of the WIPP underground. The decontamination of salt surfaces has not been well documented in the current available literature. New processes have been designed and tested using actual WIPP salt material, as well as other materials, including both surrogate contaminants and americium contamination.

Of the methods tested (dry brushing, vacuum cleaning, water washing (spray misting), strippable coatings, and mechanical grinding), the most practical seems to be fresh-water spray. This is expected since the repository is mined in a salt formation, and salt is readily soluble. The method essentially dissolves the top layer, upon which surface contaminants are deposited (whether the contamination itself is soluble or not). Effectiveness is very high, and it is easy and rapid to deploy. This decontamination method is clearly preferable over conventional techniques employed on engineered surfaces from a usability perspective.

All contaminated areas are in the process of being properly marked and barricaded to prevent access. The first step for decontamination is to test the effectiveness of fresh-water spray as a method of removing contamination. Research shows that water spray will release contamination from the surface and either carry it as runoff into the floor porosity, or wick it into the rock via capillary flow, where it is trapped within the interstitial grain boundaries. The water tends to drive the contamination deeper in the salt. At this point, it is thought that this will be an effective method for fixing contamination in Panel 7, Rooms 1 through 6, and other areas of the mine where contamination may be present. It may be necessary to spray a fixative over some areas with high potential for contact with heavy equipment. The fixative could be colored to help monitor any potential damage to the coating. The purpose of these decontamination activities is to affix radioactive contamination and prevent airborne entrainment; it is not to remove all contamination in the affected areas. Decontamination activities will be initiated upon completion of preliminary and in-mine tests and is expected to begin in mid-fiscal year 2015.

## **VENTILATION**

Airflow is the major limitation to recovery operations for a significant portion of the recovery schedule. This means that many underground recovery activities, especially those involving diesel equipment, will need to be conducted in series, rather than concurrently, until additional ventilation capacity is obtained. Work will be conducted in a manner that efficiently sequences activities on multiple shifts to optimize the use of available airflow. Based on the current reduced ventilation flow under HEPA filtration (1,700 m<sup>3</sup> per minute), at most only two pieces of underground diesel equipment can be operated simultaneously while maintaining adequate airflow conditions for personnel and the active waste emplacement panel. Parallel activities will be limited to activities that do not exceed air quality or underground ventilation limits.

The first phase in augmenting filtered ventilation to the underground will provide an additional capacity of 1,500 m<sup>3</sup> per minute, for a total of about 3,200 m<sup>3</sup> per minute. The HEPA skid and fan unit final designs have been completed and were released to the subcontractors for manufacture in August 2014, with planned operation by April 2015.

The second phase, or supplemental ventilation system, reconfigures the mine itself using bulkheads, overcasts, airlocks, and bulkhead ventilation regulators augmented with supplementary underground fans to provide additional flow through the mine. The combined interim and supplemental ventilation systems will provide 5,100 m<sup>3</sup> per minute. Supplemental ventilation for clean areas of the mine, including mining operations, will be obtained by using one of the existing shafts as an exhaust shaft for radiologically uncontaminated air. Once in place, this second phase will provide sufficient ventilation flow to support limited waste emplacement operations.

The third phase will be to design and construct a new permanent underground ventilation system capable of providing 12,000 m<sup>3</sup> per minute airflow, restoring the facility back to full, unrestricted operation. This will provide the ventilation required to simultaneously conduct mine stability activities, mining, maintenance, waste emplacement, and research and development activities. Table I lists the airflow rates for the different configurations.

TABLE I. Ventilation air flow rates for different configurations before and after recovery

Ventilation Configuration	Total airflow (cubic meters per minute)
Standard operations (prior to February 2014)	12,000
WIPP Permit requirement	7,400
HEPA filtration mode	1,700
1 <sup>st</sup> phase: Interim skid-mounted fans	3,200
2 <sup>nd</sup> phase: Supplemental ventilation	5,100
3 <sup>rd</sup> phase: Permanent (new exhaust shaft)	12,000

Replacement of the HEPA filtration system pre-filters was completed in June 2014. The need for future replacement of the pre-filters to support ongoing recovery activities will continue to be evaluated.

## EFFECTS ON WASTES GENERATORS AT OTHER DOE SITES

DOE is continuing to characterize and certify TRU waste at the Idaho National Laboratory, Oak Ridge National Laboratory, the Savannah River Site, and Argonne National Laboratory for eventual shipment to WIPP. Waste continues to be generated at the Hanford site and Lawrence Livermore National Laboratory. DOE is carefully evaluating and analyzing the impacts on storage requirements and commitments with state regulators at the generator sites. These efforts will inform decisions related to the availability of storage for certified TRU waste until waste shipments to WIPP can resume.

A discussion of the impacts of the February incidents on the TRU waste programs at LANL is beyond the scope of this paper.

In parallel with the ongoing AIB Phase 2 investigation into the direct cause and contributing causes of the release, generator site certification programs are being assessed to ensure the

programs certify waste meeting the WIPP Waste Acceptance Criteria. After issuance of the AIB Phase 2 report, the need for any additional corrective actions will be assessed and implemented at generator sites. All waste generators will have rigorous characterization, treatment, and packaging processes and procedures in place to ensure compliance with WIPP Waste Acceptance Criteria. DOE has surveyed the TRU waste generator sites and evaluated their waste stream documentation and determined that there are no other waste containers having the specific characteristics of the Los Alamos National Laboratory nitrate salt waste stream.

## **CONCLUSIONS**

The February 2014 salt truck fire and radiological release events were significant. While no harm to workers, public or the environment resulted, these events could be considered as a “wake up call. Almost fifteen years of performing routine operations day after day without any challenging events eroded the WIPP nuclear safety culture. Nuclear safety assurance requires continual questioning attitudes on the part of all workers, whether at WIPP or in the pipeline that ships waste to WIPP for permanent disposal. The challenge is to actively and consistently promote continual improvement in operational safety and efficiency.

The WIPP underground will be systematically made habitable for safe operations and protective of workers with resumption of critical mine safety and maintenance. Operations will include simultaneous activities in contaminated and uncontaminated sections of the mine. Ventilation will be increased in phases back to its pre-incident airflow capacity, the mine will be surveyed and made habitable for workers, and the workforce will be retrained for contaminated operations and cross-trained for recovery activities.

The schedule to commence waste emplacement operations is the first quarter of calendar year 2016, with the intent to incrementally increase waste emplacement operations over time. Options are being explored to determine if some actions can be accelerated.

The Department is committed to ensuring the safety and continued progress of the TRU waste programs at the generator sites in order to fulfill our commitments to the host states. The Department is continuing to characterize and certify TRU waste for eventual shipment to WIPP, and the generator sites are continuing to store TRU waste safely on-site until WIPP operations are resumed.

The Recovery Plan is intended to provide reasonable confidence for resumption of WIPP disposal operations by: (1) safely isolating the waste of concern; (2) initial closure of the affected waste disposal panels; (3) responding to weaknesses identified by the Accident Investigation Board reports through comprehensive upgrades to programs, procedures, and training; (4) upgrading equipment, infrastructure, and facilities; and (5) ensuring that waste generators have rigorous characterization, treatment, and packaging processes and procedures and that all waste meets WIPP Waste Acceptance Criteria.

The Department is committed to resuming WIPP operations as a critical part of the environmental cleanup program, and will continue to work with regulators, community partners in New Mexico, TRU waste generators, and other stakeholders around the country to ensure that this is done safely and efficiently. WIPP will recover, and become an even more robust and safer facility than before.

## **REFERENCES**

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