

**Office of Enterprise Assessments Review of
Mine Safety, Stabilization, and Habitability
at the Waste Isolation Pilot Plant**



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Acronyms

bhp	Brake Horsepower
CAP	Corrective Action Plan
CBFO	Carlsbad Field Office
cfm	Cubic Feet per Minute
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EA	Office of Enterprise Assessments
FSR	Filter Self-rescuer
MSHA	Mine Safety and Health Administration
MVP	Mine Ventilation Plan
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NWP	Nuclear Waste Partnership, LLC
OFI	Opportunity for Improvement
POV	Pattern of Violation
SCSR	Self-contained Self-rescuer
S&S	Significant and Substantial
WIPP	Waste Isolation Pilot Plant
WSHP	Worker Safety and Health Program

**Office of Enterprise Assessments Review of Mine Safety, Stabilization, and Habitability at the
Waste Isolation Pilot Plant**

EXECUTIVE SUMMARY

The U.S. Department of Energy Office of Enterprise Assessments (EA) conducted an independent review of a number of aspects of mine safety, stabilization, and habitability at the Waste Isolation Pilot Plant (WIPP). EA also concurrently conducted a follow-up review of the WIPP Recovery Plan for Operating Diesel Equipment with Available Underground Airflows. EA performed the onsite portion of its review during November 18-20, 2014, and January 6-8, March 10-13, and June 9-12, 2015.

One of EA's highest priorities is to provide the necessary independent oversight to ensure that WIPP recovery is performed safely and in accordance with requirements. This review involved four of the seven key elements of the WIPP recovery strategy, including mine safety, mine stability, underground habitability, and elements of mine ventilation. EA selected aspects of these elements for review based on the type of work being performed underground and issues that may impact these functions. Since the underground workings at WIPP are now accessible, EA gave particular attention to ground control (maintaining the integrity of the mine entry roof, walls and floor), the operation of diesel equipment with the limited available airflows in the mine, and the status and condition of emergency escape and evacuation systems.

Nuclear Waste Partnership, LLC (NWP), the managing contractor at WIPP, has made considerable progress and improvement in mine safety, stabilization, and habitability over the period of this review. Underground operations, procedures, and mine safety systems showed significant enhancement in June 2015 compared to October 2014, when this review began. EA also observed improvements in the Carlsbad Field Office's oversight of NWP's priority and focus on mine safety issues. However, EA identified three areas of concern.

Adequate workplace examinations, which are essential to the safety of workers underground, are governed by Mine Safety and Health Administration (MSHA) regulations. Most of the NWP workplace examinations that EA observed were adequate, but those associated with the operation of the diesel-powered roof bolters did not meet the standard; roof bolting crews operating in the uncontrolled areas of the mine were not provided with toxic gas detection instrumentation to monitor the mine atmosphere. In the absence of this critical instrumentation, the workplace examinations conducted during each shift cannot be adequate.

Self-contained self-rescuers (SCSRs) are critical lifesaving equipment for miners' protection and are stored at various locations underground. The National Institute for Occupational Safety and Health/MSHA approval for WIPP SCSRs specifies that this equipment must be inspected every 90 days and that the inspections must meet requirements to maintain SCSRs in accordance with the manufacturer's approved service life plan. The SCSRs at WIPP have been inspected correctly, but not often enough (in some cases 130 days between inspections).

Finally, key NWP corrective actions relating to fire suppression associated with the February 2014 vehicle fire do not meet National Fire Protection Association standards in that not all diesel-powered equipment in the mine is protected by automatic fire suppression systems that shut down the equipment when the system is actuated.

EA will continue to follow up on these issues, including corrective actions for the two findings identified during this review.

Office of Enterprise Assessments Review of Mine Safety, Stabilization, and Habitability at the Waste Isolation Pilot Plant

1.0 PURPOSE

The U.S. Department of Energy (DOE) Office of Enterprise Assessments (EA) conducted an independent review of a number of aspects of mine safety, stabilization, and habitability at the Waste Isolation Pilot Plant (WIPP) and the conduct of ongoing recovery and rehabilitation efforts. EA performed the onsite portion of its review during November 18-20, 2014, and January 6-8, March 10-13, and June 9-12, 2015.

EA conducted a previous review of the WIPP Recovery Plan for Operating Diesel Equipment with Available Underground Airflows between June and October 2014 (report dated December 2014). At that time, conditions in the underground significantly limited the work that could be conducted and the ability to validate some aspects of the implementation of the recovery plan related to the use of diesel equipment underground. EA conducted a follow-up review of the implementation of the recovery plan regarding diesel equipment operation concurrently with this review.

2.0 SCOPE

This review looked at four of the seven key elements of the WIPP recovery strategy, including mine safety, mine stabilization, underground habitability, and elements of mine ventilation. EA selected aspects of these elements based on the type of work being performed underground and issues that may impact these functions. EA placed a significant focus on ground control (further described in Section 5.2), since routine ground control could not be performed while access to the underground workings was limited. For similar reasons, EA also placed significant focus on the operation of diesel equipment with the limited available airflows in the mine. As the number of workers permitted underground increased, the status and condition of emergency escape and evacuation systems became more critical and therefore were included in this review.

3.0 BACKGROUND

WIPP is the nation's only deep geologic repository for permanent disposal of defense-generated transuranic waste. WIPP is located in southeast New Mexico, about 26 miles from Carlsbad, and is managed by Nuclear Waste Partnership, LLC (NWP). Within DOE, the Office of Environmental Management's Carlsbad Field Office (CBFO) has primary responsibility for oversight of WIPP.

WIPP suspended operations on February 5, 2014, after a fire involving an underground vehicle. Nine days later, on February 14, 2014, a radiological release occurred underground, contaminating a portion of the mine that was primarily along the ventilation path from the location of the incident. Safety concerns related to the vehicle fire and the radiological release are being addressed in order to protect workers, the public, and the environment while the mine is being prepared to resume emplacing waste. NWP is systematically making the WIPP underground habitable for safe operations and protection of workers as critical mine safety and maintenance operations proceed.

EA has made it one of its highest priorities to provide the necessary independent reviews to ensure that WIPP recovery is performed safely and in accordance with requirements. The EA program is designed to enhance DOE safety and security programs by providing DOE and contractor managers, Congress, and other stakeholders with an independent evaluation of the adequacy of DOE policy and requirements and

the effectiveness of DOE and contractor line management performance in safety, security, and other critical functions as directed by the Secretary of Energy. The EA program is described in and governed by DOE Order 227.1, *Independent Oversight Program*, and EA implements the program through a comprehensive set of internal protocols, operating practices, inspector guides, and process guides. EA has identified mine safety, stabilization, habitability, and ventilation as key elements for this review.

4.0 METHODOLOGY

As identified in the Plan for the Independent Oversight Review of the Recovery at the Waste Isolation Pilot Plant, Office of Nuclear Safety and Environmental Assessments, June 2014, EA considered the current requirements that impact mine safety, stabilization, and habitability and met with appropriate responsible officials from the CBFO and NWP to gain an understanding of NWP's plans and operational limitations. EA compared NWP performance against 10 CFR 851, applicable Mine Safety and Health Administration (MSHA) regulations, and National Fire Protection Association (NFPA) and other consensus standards when appropriate. MSHA regulations are implemented by the NWP *WIPP Worker Safety and Health Program Description*, WP 15-GM.02, which implements Title 30 CFR, *Mine Safety and Health Administration*, Parts 47, 48, 49, 57, and 62, "Safety and Health Standards-Underground Metal and Nonmetal Mines."

The EA team examined key documents, such as system descriptions, work packages, procedures, manuals, analyses, policies, and numerous other documents, as well MSHA documents such as procedural manuals, policy memoranda, and inspection data systems. The team also interviewed key personnel responsible for developing and executing the associated programs; observed operating and maintenance activities; and walked down significant portions of the WIPP underground areas. The members of the EA review team, the Quality Review Board, and EA management responsible for this review are listed in Appendix A. A detailed list of the documents reviewed, personnel interviewed, and observations made during this review, relevant to the findings and conclusions of this report, is provided in Appendix B.

5.0 RESULTS

Activities examined by EA during the review are discussed below. The review criteria are shown in italics, followed by EA activities for the criteria. The criteria are based on DOE orders, DOE standards, and MSHA standards (30 CFR Parts 57, 48, and 49). Conclusions are summarized in Section 6, findings are identified in Section 7, opportunities for improvement (OFIs) are listed in Section 8, and items for EA follow-up are discussed in Section 9.

The EA review identified concerns in the following three areas:

- The adequacy of workplace examinations
- The examination of self-contained self-rescuers (SCSRs)
- Corrective actions related to diesel equipment fire suppression systems.

5.1 Mine Safety

Mine safety is paramount to the overall success of the recovery of WIPP and resumption of waste emplacement. EA reviewed various aspects of mine safety to determine whether the weaknesses in the WIPP safety programs identified during the accident investigation for the vehicle fire have been or are

being resolved. While significant progress has been achieved, EA identified deficiencies in some aspects of workplace examinations.

Adequate workplace examinations are essential to the safety of workers underground. MSHA regulations require all workplaces underground to be examined by a competent person to identify hazardous conditions and eliminate, mitigate, or correct hazardous conditions in a timely manner.

Criterion: *MSHA regulation in 30 CFR § 57.18002 requires that a competent person designated by the operator shall examine each working place at least once each shift for conditions which may adversely affect safety or health. The operator shall promptly initiate appropriate action to correct such conditions. A record that such examinations were conducted shall be kept by the operator for a period of one year, and shall be made available for review by the Secretary or his authorized representative. In addition, conditions that may present an imminent danger which are noted by the person conducting the examination shall be brought to the immediate attention of the operator who shall withdraw all persons from the area affected (except persons referred to in section 104(c) of the Federal Mine Safety and Health Act of 1977) until the danger is abated.*

The NWP Underground Services department conducts workplace examinations at WIPP by examining areas of the mine before workers begin work. These examinations include checking for adequate ventilation where diesel equipment will be operating, as well as making diesel exhaust gas checks where potential hazards may exist or develop. These initial shift or pre-shift examinations are supplemented with examinations by workers throughout the work shift, including pre-operational examinations of equipment. EA observed both types of workplace examinations. The Underground Services examinations were thorough and diligent, and EA's observations verified the adequacy of several pre-operational examinations.

EA identified one deficiency in the examination for potential hazards associated with the operation of the diesel-powered roof bolters. One of the most likely potential hazards underground is the accumulation of toxic atmospheres from the operation of diesel equipment, especially since the airflow available underground at WIPP is limited at this time. In November 2014, NWP equipped bolter crews with instrumentation to monitor the workplace atmosphere for gaseous diesel exhaust contamination. This practice remains in place for diesel roof bolters who work in radiation control areas, but not for other bolting crews. Also, in June 2015, EA observed that NWP no longer equips bolting crews with gas monitoring instrumentation when operating in the uncontrolled areas of the mine. NWP stated that this change in procedure was based on historical results and on Underground Services' practice of verifying the adequacy of ventilation rates for diesel operation, explaining that the work package would include the requirement to equip bolting crews with gas detectors in situations where diesel exhaust gases would need to be monitored.

Relying solely on ventilation rates is insufficient to address the hazard from diesel exhaust contamination that the workplace examinations were intended to identify. The minimum ventilation rate required by MSHA and NWP WIPP is 125 cubic feet per minute (cfm) per brake horsepower (bhp) for a properly operating, Environmental Protection Agency-certified diesel engine. National Institute for Occupational Safety and Health (NIOSH) Mining Research (formerly U.S. Bureau of Mines) has identified a number of minor variations in diesel engine operation parameters that significantly increase the production of diesel exhaust contaminants, including significantly increased production of carbon monoxide and diesel particulates from air filter clogging, restricted engine coolant flow, injection wearing or timing increases, and excessive fuel-to-air ratios. In addition, the research found significantly increased production of nitrogen dioxide from restricted engine coolant flow, advancing injection timing, and malfunctioning exhaust gas recirculation (EGR) valves or oxides of nitrogen after-treatments. Workplace gas sampling is intended to identify hazards that arise from such malfunctions, and these hazards are the same in both

radiation control areas and uncontrolled areas. In the absence of a process for ensuring that bolting crews always have instruments to identify the development of a hazardous condition, the shift examinations cannot be adequate (see **Finding F-WIPP-1**).

5.2 Mine Stabilization

A fundamental element of underground mining is maintaining the mine back (roof or ceiling of the mine entries), ribs (walls of the mine entries), and mine bottom (floor of the mine entries) open for safe travel through the mine entries. Collectively, these activities are referred to as ground control. There are two distinct but related aspects of ground control. The first involves the dimension of the entries (height and width) and supporting pillars, the appropriate characteristics of ground supports such as roof bolts (length, diameter, and strength), and other aspects of mine design that ensure the ground control system's integrity. The second aspect is the maintenance of the ground support systems with supplemental roof or rib bolting as needed to accommodate local conditions or abnormal geological conditions. EA reviewed both aspects of ground control.

5.2.1 NWP Ground Control Program

***Criterion:** 30 CFR §57.3203 Rock fixtures require the mine operator obtain a manufacturers' certification that the material was manufactured and tested in accordance with ASTM F432-95, "Standard Specification for Roof and Rock Bolts and Accessories" for rock bolts addressed by the standard. Bearing plates are required when necessary for effective ground support. When grouted fixtures can be tested by applying torque, the first fixture installed in each work place shall be tested to withstand 150 foot-pounds of torque. When other tensioned and nontensioned fixtures are used, test methods shall be established and used to verify their effectiveness.*

WIPP's robust ground control program has been in place since the site was initially designed. The design of the ground control systems was based on initial underground research and has evolved over time as underground conditions have been evaluated through routine monitoring throughout the mine to characterize actual performance and to improve forecasting of future performance of the underground excavations. EA reviewed the WIPP ground control program and recent geotechnical analysis reports; interviewed key staff responsible for program execution; and validated monitoring, the performance of the program, and compliance with requirements for ground support materials. The WIPP ground control systems are well designed and have proven effective in maintaining the structural integrity of the underground excavations.

5.2.2 Ground Support Systems Maintenance

Fundamental aspects of maintaining the installed ground support systems at WIPP include the identification of any need for supplemental roof or rib bolts due to loose materials or failure of previously installed bolts, strapping, or rib mesh fencing. Dislodged bolts may create a hazard if the remaining intact bolts cannot physically anchor the weight of the roof beam in a given length of entry to the strata above. In such a situation, supplemental bolting is needed to reduce the danger of a large area roof fall. If the local area of the roof or rib cracks or fractures between the installed bolts, the roof or rib may need supplemental support to reduce the danger of spalling or fractured roof or rib material becoming dislodged. Dislodged bolts can also present a danger if they are not removed or tethered to the meshing to keep them from falling and creating a hazard to workers in the area. EA evaluated these aspects of the WIPP ground control program through in-mine observation of ground conditions, observation of roof bolting activities, and analysis of the results of MSHA inspections.

Criterion: 30 CFR §57.3200 requires ground conditions that create a hazard to persons shall be taken down or supported before other work or travel is permitted in the affected area. Until corrective work is completed, the area shall be posted with a warning against entry and, when left unattended, a barrier shall be installed to impede unauthorized entry.

Criterion: 30 CFR §57.3306 requires ground support shall be used where ground conditions, or mining experience in similar ground conditions in the mine, indicate that it is necessary. When ground support is necessary, the support system shall be designed, installed, and maintained to control the ground in places where persons work or travel in performing their assigned tasks. Damaged, loosened, or dislodged timber use for ground support which creates a hazard to persons shall be repaired or replaced prior to any work or travel in the affected area.

EA's observation of NWP underground roof bolting activities verified conformance with applicable requirements for roof bolt materials and proper installation. Underground conditions have varied over EA's review period. In autumn 2014, EA observed that a significant number of areas needed supplemental bolting because the mine had not been accessible for ground support activities for some time. At that time, NWP was identifying areas needing supplemental support. However, NWP had not adequately posted or barricaded some areas to prevent entry, but had barricaded other areas with no clear indication or reporting of the rationale.

An adverse ground condition had developed in the E-140 entry near S-1950, an area that was heavily traveled. Concerns about the ground conditions increased when the 41-ton forklift needed to be moved from the area. The E-140 entry area contained a significant number of broken and dislodged bolts and sluffing ribs, so NWP barricaded a significant portion of the ribs in the E-140 entry. EA identified several concerns about NWP's resolution of these ground control concerns. First, the NWP staff working on the problem did not know the reason for barricading the ribs and there was no posting to warn other workers of the hazards condition present. A second concern was NWP's lack of understanding of the MSHA requirement (30 CFR §57.3460) that prohibits performing maintenance between machinery or equipment and ribs unless the area has been tested and, when necessary, secured. CBFO intervened, and NWP rectified the situation by applying the MSHA standards in this situation. NWP then successfully moved the forklift without incident. This was one of several examples EA noted in which CBFO identified a situation where NWP may not have given appropriate priority to a potential mine safety issue and CBFO's timely intervention corrected the situation.

EA made these observations in autumn 2014, shortly after the mine became accessible for conducting ground control evaluations and supplemental bolting. Subsequent observations underground have shown significant progress in rehabilitation of the ground conditions underground. Additionally, NWP has shown more attention to postings and warnings, which now provide an indication to warn of ground control and other hazards.

Analysis of the MSHA inspection results relative to ground control provide another indication of the adequacy of the WIPP programs for maintaining ground support systems in the mine. Records indicate that MSHA conducted five regular inspections of WIPP between June 10, 2014, and June 17, 2015, and issued 22 citations for violations of MSHA ground standards. These citations included 5 for failure to correct hazardous ground conditions, 16 for failure to maintain ground control, and 1 for failure to provide proper tools for scaling the roof or ribs.

Data from the MSHA Monthly Monitoring Tool for Pattern of Violation (POV) provides another indication of the performance of WIPP. These criteria are designed to measure enforcement data to identify mines that exhibit a "Pattern of Violations" that could significantly and substantially contribute to mine safety or health hazards. One criterion in the POV tool is the rate of Significant and Substantial

(S&S) citations per 100 inspection hours during the previous 12 months; S&S citations are those in which the violation significantly and substantially contributes to the cause and effect of a safety or health hazard in a coal or other mine. The MSHA data shows the following POV Monitoring Tool S&S citation rates since June 2014:

- 2nd Quarter 2014, an S&S citation rate of 38.2
- 3rd Quarter 2014, an S&S citation rate of 31.4
- 4th Quarter 2014, an S&S citation rate of 23.0
- 1st Quarter 2015, an S&S citation rate of 17.8
- 2nd Quarter 2015, an S&S citation rate of 12.7.

This data shows a significant downward trend in the number and rate of S&S citations being issued at WIPP. The overall results from the five MSHA inspections at WIPP provide further insight. MSHA's June 2014 inspection resulted in 52 citations (13 S&S); its September 2014 inspection, 18 citations (9 S&S); its December 2014 inspection, 31 citations (12 S&S); its March 2015 inspection, 15 citations (4 S&S); and its June 2015 inspection, 15 citations (6 S&S). Analysis of the data indicates that MSHA issued significantly fewer citations at WIPP in 2015 than in 2014, and the rates of citations show a significant trend of better safety performance. The number of ground control citations shows a similar downward trend. Overall, the data shows that the WIPP mine safety program has shown significant improvement in recent months.

5.3 Mine Habitability

EA reviewed recovery activities in progress that are associated with making the mine habitable. Items that EA examined include SCSRs, fire suppression systems on diesel powered equipment, and processes for mine escape and evacuation. Processes, procedures, and work practices involving these elements were included in the review. EA found that most of the reviewed systems, procedures, and practices were adequate and validated.

5.3.1 SCSR Program

Critical equipment for miners' protection underground includes emergency escape respirators. WIPP employs MSA model W65 filter self-rescuers (FSRs) carried by workers, supplemented with Ocenco SCSR EBA 6.5 SCSRs stored at various locations underground. The MSA FSRs are lightweight devices that workers are intended to carry at all times underground to protect them from carbon monoxide in case of a fire. The Ocenco SCSRs provide the wearer with a closed-circuit source of oxygen and isolate the wearer from irrespirable atmospheres from a fire. EA reviewed the underground storage and maintenance of the Ocenco SCSR units.

Criterion: *30 CFR §57.15030 requires that a 1-hour self-rescue device approved by MSHA and NIOSH under 42 CFR part 84 shall be made available by the operator to all personnel underground. Each operator shall maintain self-rescue devices in good condition.*

Criterion: *42 CFR §84.3 Respirators for mine rescue or other emergency use in mines requires that NIOSH and the Mine Safety and Health Administration (MSHA), U.S. Department of Labor, jointly review and issue certifications for respirators used for mine emergencies and mine rescue, including any associated service-life plans, users' manuals and other supporting documentation. Each certification for a respirator designed for mine rescue or other emergency use in mines shall include, as a condition of approval, any use limitations related to mine safety and health.*

Criterion: *The Ocenco Instruction Manual for the EBA 6.5 SCSR (Manual Number NH13747) Inspection guidelines are based on the deployment of the device. If the EBA 6.5 is carried daily it is to be inspected daily. If the EBA 6.5 is stored in accordance with an approved MSHA storage plan or stored in a protective storage container on a vehicle, it is to be inspected every 90 days.*

Criterion: *30 CFR §48.11 Hazard training requires miners be provided hands-on training in the complete donning of all types of self-contained self-rescue devices used at the mine, which includes assuming a donning position, opening the device, activating the device, inserting the mouthpiece, and putting on the nose clip. It also requires hands-on training in transferring between all applicable self-rescue devices.*

EA participated in the hands-on training for using and donning the MSA W65 FSR and the Ocenco model EBA 6.5 SCSR. NWP provides this training in new miner training and in the annual retraining required for each worker underground. The training is sufficient for a simple device like the MSA W65 FSR and meets the minimum MSHA standards for non-metal mines where the more complicated SCSR devices are not typically used. However, at WIPP, the vehicle accident investigation report noted that miners' difficulties with the SCSRs while evacuating the underground are similar to those that had been encountered in coal mines. NIOSH research and MSHA's experience with these devices in coal mines led to the conclusion that annual training was not sufficient to maintain workers' proficiency in donning and using SCSRs and MSHA revised the coal mine regulations accordingly (see **OFI-WIPP-2**).

EA examined and inspected SCSRs underground at several locations. All SCSRs examined met the inspection criteria established by Ocenco and approved by NIOSH. EA also examined the records of 15 randomly selected SCSRs to determine whether they were inspected in accordance with the NIOSH/MSHA approved service life plan for Ocenco EBA 6.5 SCSRs. Records before the vehicle fire indicated that these devices were inspected, but the frequency was significantly different from the requirements (up to four months between inspections, instead of every 90 days as required). For a more recent evaluation of the NWP inspection practices, EA examined the SCSR inspection records for the last two inspection periods. These records showed that stored SCSRs were still not inspected at 90-day intervals but at intervals that in some cases exceeded 130 days (see **Finding F-WIPP-2**).

5.3.2 NWP Corrective Actions Related to Diesel Equipment Fire Suppression

After the vehicle fire, a key element of mine habitability was to conduct operational checks of safety-related equipment in the mine, including fire suppression systems on diesel-powered equipment (a central concern identified in the accident investigation report). NWP included a corrective action for this issue to be completed 180 days after access to the underground resumed. EA reviewed the status of the implementation of this corrective action.

Criterion: *NFPA 122 Section 7.4 requires that diesel-powered equipment shall be protected by a fixed fire suppression system to suppress the largest anticipated fires in the protected areas, and that system shall have the following characteristics:*

- (1) Be listed or approved for the purpose*
- (2) Be automatically actuated by a fire detection system*
- (3) Have one manual actuator in the operator's compartment and at least one additional actuator accessible from the ground*
- (4) Be provided with an agent container and a network of agent distribution hoses or pipes with discharge nozzles*
- (5) Be provided with discharge nozzle blowoff caps or other suitable devices or materials to prevent the entrance of moisture, dirt, or other material into the piping*

- (6) *Have all system components secured and protected against damage, including abrasion and corrosion*
- (7) *Be installed so that the system actuation causes shut-down of the protected equipment*
- (8) *Permit up to a 30-second agent discharge delay*
- (9) *Include a standby source of power if electrical power is the only means of actuation*
- (10) *Have an installation and maintenance manual or owner's manual.*

Title 10 C.F.R. § 851, Appendix A, *Worker Safety and Health Functional Areas*, Section 2, Fire Protection, Subsection (b), states that an acceptable fire protection program must include sufficient fire protection criteria and procedures, analyses, hardware and systems, apparatus and equipment, and personnel to comprehensively ensure that workers are protected and that applicable building codes and NFPA codes and standards are met.

The NWP corrective action plan (CAP) was to evaluate the current underground mobile diesel-powered equipment automatic fire protection system and redesign it to be more reliable. Following that evaluation, a separate design plan was to be developed and issued. Not all diesel-powered equipment operating underground at WIPP is protected by fixed automatic fire suppression systems installed so that actuation causes shutdown of the equipment as required by NFPA 122.

While NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities* is a standard that has applicability to a mine such as WIPP, it is not identified as specifically applicable to WIPP in the Worker Safety and Health Program (WSHP). DOE G 440.1, *Worker Safety and Health Program for DOE (Including the National Nuclear Security Administration) Federal and Contractor Employees* provides guidance on acceptable means for complying with requirements. Section 6.4 states, “DOE managers should determine which standards are applicable to the site hazards and whether additional standards are needed for their workplaces and activities to control recognized hazards. If necessary to protect the safety and health of workers, managers must include such additional standards in their written WSHP” (see **OFI-CBFO-1**).

5.3.3 Mine Evacuation

Escape and evacuation from underground workings in the event of a mine fire or other emergency is vital to the safety of underground miners. Critical elements of mine escape and evacuation include pre-planned escape routes, designated escape routes marked so that miners can navigate even in smoke-filled entries, and miners’ routine participation in drills and exercises that simulate potential emergency conditions. EA reviewed the processes and procedures for underground escape and evacuation at WIPP to assess the adequacy of escape and evacuation plans and the results of drills and exercises.

Criterion: *30 CFR §57.11050 requires that every mine have two or more separate, properly maintained escapeways to the surface from the lowest levels which are so positioned that damage to one shall not lessen the effectiveness of the others.*

Criterion: *30 CFR §57.11051 requires that escape routes be inspected at regular intervals and maintained in safe, travelable condition; and marked with conspicuous and easily read direction signs that clearly indicate the ways of escape.*

Criterion: *30 CFR §57.4361 requires that mine evacuation drills shall be held at least every six months to assess the ability of all persons underground to reach the surface or other designated points of safety within the time limits of the self-rescue devices that would be used during an actual emergency. The evacuation drills shall be held for each shift at some time other than a shift change and involve all*

persons underground; involve activation of the fire alarm system; and include evacuation of all persons from their work areas to the surface or to designated central evacuation points.

The accident investigation for the vehicle fire identified a number of issues related to the processes, procedures, and conditions of the mine's escapeways. For example, some of the reflectors marking the direction of escapeways were obscured under the mesh fencing along the ribs and were spaced irregularly. These conditions still existed during the EA review in November 2014. EA also noted that other locations had very few reflectors along significant stretches of mine entries; for example, in E-140, there were only three reflectors from S-1000 to S-1600 (a distance of about 600 feet), and they were also behind the mesh fencing. Additionally, MSHA cited WIPP on December 16, 2014, for a violation of 30 CFR §57.11051, in that the escapeway direction was not marked at E-300/S-90. EA re-checked these situations underground on June 11, 2015, and found that both had been rectified. Reflectors are no longer obscured by the mesh fencing, and additional reflectors have been installed where needed.

MSHA regulations also require two distinct escapeways from all underground workplaces to the surface to ensure that if an event or situation (a mine fire, massive ground failure, or other situation that prevents travel) impacts the primary escapeway, personnel have a second, unimpeded escape path so they will not be trapped underground. A basic premise of this requirement is that escapeways must be routinely examined to ensure that they are passable. The E-300 entry serves as the secondary escapeway for large portions of the underground workings but is a radiological control area, so it may not be a viable secondary escapeway. During the review, a number of NWP officials confirmed that in an emergency, workers could cross the radiological control barriers if escape was cut off through the primary escapeway. However, there was considerable uncertainty within the underground workforce about whether this action would be permissible. CBFO identified this uncertainty and addressed it by requiring the inclusion of the information in the NWP pre-job briefs for those working in affected areas. NWP also noted this concern in the September 12, 2014, version of the WIPP Underground Escape and Evacuation Plan, which indicates that radiological control personnel will attempt to segregate potentially contaminated workers as they exit the underground, but that life safety and medical treatment always have the highest priority. Additionally, NWP is conducting ground control evaluations in the contaminated areas of the secondary escapeway to ensure that the entries are passable, as required by the regulations.

EA's discussions with NWP on this issue also revealed significant confusion about applying the escapeway requirements. NWP engineering officials indicated their belief that the 30 CFR §57.11050 requirement for two separate escapeways applies only to escape through mine shafts, not from working places. This is an example where training could be improved to improve worker proficiency and underground safety (see **OFI-WIPP-1**).

The MSHA regulations in 30 CFR §57.4361 require evacuation drills to be conducted at least every six months. NWP conducts drills in accordance with WP 12-ER3004, *WIPP Drills and Exercises Management Control Procedure*. EA reviewed the drill/exercise packages and the actual event packages for drill number DR-2014-106 (an underground fire response on October 15, 2014) and drill number DR-2014-126 (an underground radiological event evacuation on December 22, 2014). These drills successfully tested underground fire response, the underground warning systems, public address systems, mine phones, evacuation and egress, and accountability.

5.4 Follow-up on WIPP Recovery Plan for Operating Diesel Equipment

EA reviewed the WIPP Recovery Plan for Operating Diesel Equipment with Available Underground Airflows and issued a report dated December 2014 and the implementation of the NWP corrective actions relative to the EA finding related to the mine ventilation plan (MVP). The finding stated: "The current WIPP Ventilation Plan does not adequately reflect the mine ventilation system as currently configured or

the conditions and assumptions governing mine operations under the recovery plan.” The finding also referred to the MVP not addressing minimum ventilation rates for situations in which multiple diesel units are operated in the same split of air. While numerous NWP officials stated that in such cases the minimum for each specific piece of equipment would be added to determine the minimum ventilation, the MVP did not make those limitations and procedures clear. NWP responded that the WIPP MVP was being updated to include instructions, along with an example of how to determine the required airflow for multiple diesel unit operation. The revision was to be completed by February 9, 2015 (the revision, MVP revision 38, was issued on February 17, 2015).

Criterion: MSHA regulations in 30 CFR § 57.8520, Ventilation Plan, require a listing of the number and type of internal combustion engine units used underground, including make and model of unit, type of engine, make and model of engine, brake horsepower rating of engine, and approval number.

The MSHA regulations at 30 CFR 57.8520(e) require that the ventilation plan include the number and type of internal combustion engine units used underground, including make and model of unit, type of engine, make and model of engine, bhp rating of engine, and approval number. In addition, since Underground Services relies on the WIPP MVP to determine the necessary ventilation quantity for various diesel equipment in use underground, the December 2014 EA report also included a previous opportunity for improvement OFI-WIPP-2, which suggested updating Table 2 in the MVP to correct deficiencies and to clarify ambiguous entries that included the minimum ventilation rates. NWP responded that the WIPP MVP has traditionally included the gaseous ventilation rate for each piece of diesel equipment.

EA identified a potential issue on November 4, 2014, relating to the simultaneous operation of a roof bolter along with a Toyota forklift (WIPP Equipment Number 74-H-035). The MVP and reports from Underground Services indicated that this equipment required a 7500 cfm ventilation rate for exhaust dilution. However, this equipment has an 89 horsepower engine, and based on the NWP criteria, this ventilation rate should have been 11,200 cfm. EA informed NWP of the discrepancy, and the Ventilation and Underground Services Department reported that the error was corrected. This discrepancy also validated the need for accurate and up-to-date information in the MVP. On November 18 and 19, 2014, revision 36 of the MVP (dated November 15, 2013) was posted underground and was being used underground by Underground Services. Nevertheless, EA noted that the Toyota 74-H-035 forklift was underground on November 19, 2014, with a plate indicating that the equipment needed 7500 cfm to operate, instead of the 11,200 cfm actually needed to dilute the emissions. The plan was later updated to revision 37, dated December 2, 2014, and correctly listed the Toyota 74-H-035 forklift as requiring an 11,200 cfm ventilation rate.

EA’s observations underground on November 19, 2014, also identified four additional pieces of diesel equipment that were not included in the November 2013 MVP in effect at the time:

- Two S570 Bobcats numbers 120649 and 120652 located underground in W-30 between S-1600 and S-1950
- A S160 Bobcat located in the S-1600 cross cut
- A S750 Skid Steer (WIPP Equipment Number 74-H-042).

None of these pieces of diesel equipment were tagged out as required by the evaluation of the safety of the situation relative to diesel equipment maintenance checks. EA informed NWP of this discrepancy at the time of the observation. As noted, MVP revision 37, issued on December 2, 2014, did not include this equipment in the Table 2 list of diesel equipment underground.

Revision 38 of the WIPP MVP (February 17, 2015) added to Table 2 the four pieces of diesel equipment underground that were not in previous versions. In addition, the plan included a new Section 7.1, Minimum Ventilation Requirements, specifically stating that the MSHA certified rating for each piece of diesel equipment shall be used to determine minimum ventilation rates and that equipment not having an MSHA certification shall have 125 cfm/bhp. This section also includes instructions for adding the quantities for multiple diesel engines operating on the same split of air. EA's observations underground and discussions with Underground Services validated that this procedure was in place and applied.

6.0 CONCLUSIONS

Mine safety, stabilization, and habitability at WIPP have improved substantially over the period of this review. NWP underground operations, procedures, and mine safety systems showed considerable enhancement in June 2015 compared to November 2014, when this review began. NWP has established and implemented programs for mine safety, stabilization, and habitability that are mostly effective. EA also observed improvements in CBFO's oversight of the priority and focus that NWP affords to mine safety issues.

For the most part, NWP has established adequate and effective mine safety programs. Even though most of NWP's workplace examinations were adequate, some were insufficient to identify hazardous conditions and eliminate, mitigate, or correct the conditions in a timely manner. Substantial progress has been made and validated in rectifying issues and concerns related to the escape and evacuation systems at WIPP, which did not function adequately after the vehicle fire. However, although emergency escape self-rescuers were inspected correctly, the frequency of these inspections did not meet the limitations of the approval of the devices.

EA also identified substantial progress in NWP's efforts to replace or repair equipment that impacts safety. One area identified as inadequate was the fire suppression systems on the underground diesel equipment; NWP's plan for this corrective action falls short of the requirements of applicable NFPA standards.

This current review included a follow-up to the December 2014 EA review of the WIPP Recovery Plan for Operating Diesel Equipment with Available Underground Airflows. At the time of the December 2014 onsite review, the underground was not available for work involving the operation of diesel equipment. This current review focused on validating procedures and limitations identified in the previous report. While this review initially identified some continuing deficiencies, subsequent visits validated the proper and adequate implementation of practices and procedures and corrective actions from that review. Overall, NWP's priority and focus on mine safety related issues has dramatically improved during the time span of these reviews.

7.0 FINDINGS

As defined in DOE Order 227.1, *Independent Oversight Program*, findings are significant deficiencies or safety issues that warrant a high level of attention from management. If left uncorrected, findings could adversely affect the DOE mission, the environment, the safety or health of workers and the public, or national security. Findings may identify aspects of a program that do not meet the intent of DOE policy or Federal regulation. CAPs must be developed and implemented for EA findings. Cognizant DOE managers must use site- and program-specific issues management processes and systems developed in accordance with DOE Order 227.1 to manage these CAPs and track them to completion.

Nuclear Waste Partnership, LLC

Finding F-WIPP-1: Contrary to 30 CFR §57.18002, NWP does not provide workers with appropriate instrumentation to identify the development of a hazardous atmosphere from diesel exhaust contaminants and thus cannot ensure that adequate workplace examinations are conducted each shift whenever diesel-powered equipment is in operation.

Finding F-WIPP-2: NWP does not inspect SCSRs stored underground at the proper periodicity in accordance with the Ocenco EBA 6.5 Users' Manual, as approved by NIOSH, in accordance with 42 CFR Part 84.

8.0 OPPORTUNITIES FOR IMPROVEMENT

This EA review identified three OFIs. These potential enhancements are not intended to be prescriptive or mandatory. Rather, they are suggestions to assist site management in implementing best practices, or provide potential solutions to minor issues identified during the review. In some cases, OFIs address areas where program or process improvements can be achieved through minimal effort. It is expected that these OFIs will be evaluated by the responsible line management organizations and accepted, rejected, or modified as appropriate, in accordance with site-specific program objectives and priorities.

Nuclear Waste Partnership, LLC

OFI-WIPP-1: Consider conducting a training needs assessment to determine the appropriate training in underground mining regulations and practices for NWP staff responsible for functions and activities underground that require a working knowledge of the MSHA standards, as appropriate for the degree to which their responsibilities directly impact mine safety and health.

OFI-WIPP-2: Consider applying the NIOSH mining research to develop training on successful escape from mine fires using SCSRs. Consider adopting the content and frequency (quarterly) of the training provided to coal miners using SCSRs. This hands-on SCSR training for WIPP underground personnel would include:

- Instruction and demonstration of the use, care, and maintenance of the devices
- Complete donning and transfer from the MSA W-65 self-rescuer to the Ocenco EBA 6.5 SCSR
- How to recognize when the unit is not functioning properly and how to start and restart the unit
- Expectations for communications and controlling breathing and physical exertion.

Carlsbad Field Office

OFI-CBFO-1: Consider adding NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities* as specifically applicable to WIPP through the WIPP Worker Safety and Health Program in accordance with 10 CFR § 851, Appendix A, *Worker Safety and Health Functional Areas*, Section 2, Fire Protection and DOE G 440.1, *Worker Safety and Health Program for DOE (Including the National Nuclear Security Administration) Federal and Contractor Employees*.

9.0 ITEMS FOR FOLLOW-UP

A number of issues that EA identified during the initial site visits suggested that insufficient priority hindered timely correction of mine safety related issues. As the review progressed, EA noted improved performance and focus on mine safety. Future EA reviews should include observations to confirm continued improvement and focus. Accordingly, EA will:

- Continue to follow the results of MSHA inspections at WIPP and monitor trends for continued safety and health improvements
- Monitor the adequacy of escapeways and other life safety code elements underground as changes are made to the mine ventilation system and layout
- Validate the installation of fire suppression systems on diesel-powered equipment
- Validate the proper frequency of SCSR inspections.

Appendix A Supplemental Information

Dates of Review

Onsite Review: November 18-20, 2014, January 6-8, March 10-13, and June 9-12, 2015

Management

Glenn S. Podonsky, Director, Office of Enterprise Assessments
William A. Eckroade, Deputy Director, Office of Enterprise Assessments
Thomas R. Staker, Director, Office of Environment, Safety and Health Assessments
William E. Miller, Director, Office of Nuclear Safety and Environmental Assessments
Patricia Williams, Director, Office of Worker Safety and Health Assessments

Quality Review Board

William A. Eckroade
John S. Boulden III
Thomas R. Staker
William E. Miller
Karen L. Boardman
Michael A. Kilpatrick

Enterprise Assessments Site Lead

Jeff Snook

Enterprise Assessments Reviewer

Peter M. Turcic

Appendix B
Key Documents Reviewed, Interviews, and Observations

Documents Reviewed

- 30 CFR PART 48—Training and Retraining of Miners
- 30 CFR PART 49—Mine Rescue Teams
- 30 CFR PART 57—Safety and Health Standards for Underground Metal and Nonmetal Mines
- NH13747, Revision A, ECN 2384, September 7, 2001
- Corrective Action Plan, *CAP, NWP Haul Truck Fire Accident Investigation Board report, Rev-2*
- Ocenco, Inc., *Instruction Manual for EBA 6.5 60 Minute Self-Contained Self-Rescuer*, Manual No. NH13747
- WP Underground Escape and Evacuation Plan, Revision 27, September 12, 2014
- WP 12-ER3004, Revision 9, *WIPP Drills and Exercises*, December 19, 2013
- WP 12-4907, Revision 13, *Evacuation/Sheltering in Place*, October 15, 2013 WP 12-ER4911, Revision 13, *Underground Fire Response*, January 2, 2014
- WP 15-GM.02, Revision 8, *Worker Safety & Health Program Description*, September 9, 2013.
- WIPP Underground Escape and Evacuation Map
- WIPP Mine Ventilation Plan, Revision 36, November 2013
- WIPP Mine Ventilation Plan, Revision 37, December 2013
- WIPP Mine Ventilation Plan, Revision 38, February 2015
- WIPP Recovery Plan for Operating Diesel Equipment with Available Underground Airflows, December 2014
- DOE/WIPP-14-3516, Volume 1, *WIPP Geotechnical Analysis Report*, June 2014
- *MSHA Program Policy Manual Volume IV - Metal and Nonmetal Mines*

Interviews:

Nuclear Waste Partnership, LLC

- URS Corporation Senior Project Director
- Manager, Underground Operations Integration
- Process Equipment Engineer
- Process System Engineer
- Nuclear Safety subject matter expert
- Manager, Geotechnical and Mine Engineering
- Safety Superintendent

Carlsbad Field Office

- Facility System safety system oversight
- Mining Ops safety system oversight
- Waste Ops safety system oversight
- Facility Representative

Observations:

- Underground inspections (4)