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WIPP PREPARATIONS FOR RESTART OF OPERATIONS IN LATE 2016

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Abstract

After more than 14 years of successful operation the Waste Isolation Pilot Plant (WIPP) in southeastern New Mexico experienced two unrelated events that halted operations temporarily. These were operational mishaps, accidents, and had no bearing on the suitability of the WIPP geology or on deep geologic disposal. The WIPP repository permanently isolates defense-origin transuranic (TRU) waste and TRU mixed waste (TRU with a hazardous waste component) from the biosphere by placing it 655 meters below the ground surface into a bedded salt formation that has been stable for ~250 million years. The two unrelated mishaps were a truck fire, and an independednt release from a waste drum mistakenly loaded with chemically incompatible materials that underwent a runaway reaction that produced heat and gas causing radioactive aerosol materials to be spewed into the underground, some very small fraction of which became detectable on the surface. Thorough investigations were done to determine root causes and to recommend corrective actions. The truck fire issue and the release issue had common elements in terms of identifying physical system and safety culture improvement needs. Before the repository can again operate it must (1) Enhance the ventilation system; (2) Upgrade the fire protection system; (3) Assure a habitable work environment, which includes improving both the radiological work environment and re-establishing mine stability; (4) Enhance emergency response and communications capability, and (5) Assure readiness to resume operations (physical systems and worker-qualification and safety-culture readiness). The repository is undergoing readiness reviews at this time, involving external expert reviews of both documentation and operational exercises. WIPP expects to again dispose of waste late in 2016.

1. Introduction

The US has one operating deep geologic repository, the Waste Isolation Pilot Plant (WIPP). WIPP is located in the Chihuahuan Desert of south-eastern New Mexico, about 42 km southeast of the city of Carlsbad. Its purpose is to permanently isolate defence-related transuranic (TRU) and TRU mixed waste (TRU waste with hazardous chemical content). WIPP opened in 1999 and safely disposed of waste until February of 2014 when two unrelated events occurred in the underground, a truck fire and a radiation leak from a drum. More than two years have been spent recovering the facility and upgrading it, and also upgrading its safety basis and the workforce safety-culture. WIPP is to start emplacing waste again before the end of this calendar year, at a limited pace because of airflow considerations, but an upgraded ventilation system, which will take several years to design, procure and install, will allow WIPP to return to full operations by 2020.

2. Accident Investigation Board Findings and Recommendations

An independent Accident Investigation Board (AIB) thoroughly investigated all aspects of the two February 2014 incidents and ruled both as “preventable” and made recommendations at many organizational levels for changes that would help assure there are processes in place to prevent repetition of the errors that led to the fire and radiation release incidents [1,2,3]. In terms of forensics that allowed a more precise determination of the cause of the runaway reaction that led to the underground release, the AIB was assisted by a scientific team of scientists from the US national laboratories called the Technical Assessment Team [4].

The three AIB reports contained numerous recommendations for physical, organizational and cultural changes. All recommendations were carefully addressed, and many will need care and attention to stay addressed. For example, upgrading the safety culture to assure a viable safety conscious work environment is not a one-time accomplishment, it is a continuous process until the operational phase of the repository is completed.

At a very high level this is what needs to be accomplished before WIPP can re-open to permanently dispose of TRU once again:

(1) The ventilation system must be enhanced;

(2) The fire protection system must be upgraded;

(3) The habitability of the work environment must be assured, which includes improving both the radiological work environment and re-establishing mine stability;

(4) The emergency response and communications capability must be enhanced, and

(5) Readiness to resume operations must be assured (including physical systems, worker-qualification programs, and safety-culture viability).

3. Progress on the Road to Operational Recovery

3.1 Ventilation Enhancement

Habitability in any underground space is strongly dependent on air quality. The WIPP ventilation system worked well in terms of providing air for mining, research and waste disposal activities. Then came the 2014 radiation release event and the system was shifted, automatically, into “filtration mode.” With air being filtered as it exits the underground, the flow of air is very limited, about one-seventh of the usual underground air flow, allowing only one or two pieces of diesel equipment to function underground at one time, and curtailing the number of personnel that can work underground at the same time.

The current system is called the Underground Ventilation System (UVS) and as long as it is running in filtration mode it can support some recovery activities, ground control activities, and limited maintenance work. The total underground airflow is 60,000 cubic feet per minute (60 Kcfm), or 28 cubic meters per second (m3/s). This is insufficient airflow to allow waste emplacement operations.

In order to allow waste emplacement to occur, an Interim Ventilation System (IVS) was installed to work in conjunction with the UVS to supports waste operations and to allow additional diesel operated equipment including ground control machinery. IVS is to add 54 Kcfm (25 m3/s) for a combined total of 114 Kcfm (54 m3/s). Figure 1 shows the IVS tied into the UVS to add supplemental flow through new filter banks.

Figure 1. Interim Ventilation System is tied into the Underground Ventilation System to supplement total airflow

A Supplemental Ventilation System (SVS) was also installed to support limited mining activities, and to provide additional air to the north area of the mine where there is a maintenance shop and an experimental area. SVS adds about 70 Kcfm (33 m3/s). Figure 2 shows the SVS, a single fan that draws additional air into the underground and exhausts it without going through the waste disposal area of the repository,

Figure 2. The Supplemental Ventilation System, a fan and additional louvers and baffles to increase airflow through the north part of the mine

Finally, in order to be able to resume full-scale operations a new Permanent Ventilation System (PVS) is to be built to support resumption of full pre-incident operations levels including simultaneous waste handling, mining, ground control and research activities. The PVS is targeting 540 Kcpm (255 m3/s). The process for procuring the detailed design and construction of the PVS is expected to take through 2020. The PVS will include the construction of an additional vertical shaft for exhausting unfiltered air from the underground, this will allow it to enhance both contaminated area (filtered) and uncontaminated area (unfiltered) airflow.

The original WIPP concept was to start clean and stay clean. Now that this is no longer the case, air will be filtered if it comes through the current waste disposal areas until such time as these panels are closed and sealed off. The PVS will allow unfiltered air to be used to support mining of new panels and emplacement of waste into those panels. The goal is to stay clean from that point forward.

3.2 Fire Protection System and Underground Emergency Response Capability Enhancement

New fire suppression and emergency response equipment has been obtained and tested. Figure 3 shows some of this new equipment ready for use in the underground. In addition, however, and in direct response to AIB recommendations, a robust combustibles control program is in place and being exercised as a matter of daily business practice.

Figure 3. New fire suppression and emergency response equipment in the underground

Automatic fire suppression systems have been installed on liquid fueled equipment and higher risk areas of the underground. Also, additional visual emergency egress strobes and reflectors have been added to enhance personnel egress safety in case of fire or other emergency.

Equipment and markers are not enough, however, and training has been enhanced to emphasize survival during an emergency, plus emergency drills and exercises have been held to ensure personnel are trained to safely evacuate when needed. A new underground personnel accountability system has been installed that allows two-way communication, one-button emergency notification without either dialing numbers or calling separate responder entities, and real-time continuous tracking of every underground employee.

3.3 Underground Habitability Restoration

The salt formation at the depth of the repository is under considerable lithostatic pressure and deforms plastically to attempt to fill in any void spaces. This is one of the most attractive qualities of using salt as a host rock, eventually it encapsulates the waste in rocksalt, a barrier that is impermeable to water. During the operational phase, however, it presents a well-known and readily coped with maintenance problem: keeping the excavations open and assuring no rock falls occur. During the recovery from the February 2014 events there was limited opportunity to keep up the routine maintenance of the mined openings, since then a program of catch-up rock bolting was set in motion as underground access was re-established. Limited airflow hampered that effort until two new hybrid rock bolters were purchased. They move from location to location using diesel power, but they do their bolting using electric power, thus allowing multiple activities while bolting is in progress. Figure 4 shows a new hybrid bolter in action.

Figure 4. A hybrid (diesel and electric) bolting machine conserves breathable air while bolting, allowing more simultaneous underground recovery activity

Another aspect of underground habitability is assuring worker risk avoidance though exposure control. The type of equipment shown in Figure 5, and being used to assure worker safety when entering a contaminated area, can be reduced by cleaning that area, reducing the level of contamination and hence the risk of exposure.

Figure 5. Underground worker being outfitted for work in a contamination area

Over time, respiratory-protection requirements have been reduced area by area thanks to a methodic radiological contamination mitigation progress. Contamination mitigation was achieved using water spray to remove surface contamination into the fractures of the salt-rock walls and the floor. Although the contaminants are still in place, they are no longer mobile with airflow or easily remobilized by human activity. In areas with significant traffic potential the material washed into the floor was overlain by a colored brattice-cloth and a layer of crushed salt.

3.4 Emergency Response Capability Enhancement

A new, state of the art, offsite (meaning not at the WIPP site itself where the emergency is likely to be) Emergency Operations Center became operational in late 2015. Its enhanced data and communications equipment will assure timely flow of necessary information between responders and key stakeholders Personnel assigned duties in this facility in case of an emergency have been trained to perform their duties through exercises designed to test system and personnel readiness to perform appropriately in case of an emergency. Figure 6 shows such an exercise in progress.

The previous Emergency Operations Center was located at the WIPP site, which created a difficulty since the release-event prevented personnel from coming on-site to take their place in that facility. Training requirements and drills were conducted prior to the events, but the expanded and revised Documented Safety Analysis for the facility, and its new implementing procedures, have created a more rigorous safety approach and assurance system.

Figure 6. A simulated emergency drill in the new Emergency Operations Center

3.5 Reviews of Readiness to Assume Operations

As a US Department of Energy Hazard Category II Nuclear Facility WIPP is obligated to, and welcomes the opportunity to, demonstrate its readiness to assume operations. Readiness will be addressed in three activity-phases.

The first phase is the contractor practicing its new work processes and procedures with the equipment they have been used to using for years. Figure 7 shows personnel reviewing new procedures standing by very familiar equipment.

Figure 7. Shows personnel reviewing new operating procedures looking at familiar waste container components

This phase of the recovery process is called Integrated Cold Operations. It involves eight weeks during which workers will practice using new equipment, procedures and processes for receipt, downloading and placement of waste. To demonstrate readiness to do waste handling work the waste handlers will use empty containers and conduct drills and exercises on scenarios designed to test knowledge and develop proficiency.

Two additional phases are both Operational Readiness Reviews (ORRs). ORRs are meant to be hard. They are performed by an independent team. They are intense. Every element of every operation is evaluated as if it were the real thing. The bar is set very high.

ORRs are designed to determine the level of readiness of workers, the plant and processes necessary for resumption of waste emplacement. The contractor, Nuclear Waste Partnership LLC, will conduct an ORR using external experts to aid their judgment of readiness.

Once the contractor is satisfied, the DOE will then conduct its own ORR, bringing in its own independent experts to conduct the tests and observe the operations.

Once DOE is satisfied that the plant is ready, operations resume. These activities have been scheduled and are progressing. WIPP re-opening is anticipated later this calendar year.

4. Conclusions

For an up to date look at the scope of our recovery activities and a rather complete description of the February 2014 events and their analyses please go to the WIPP Recovery website [5]. It includes a link to a statement that emphasizes that these two incidents were operational and therefore do *not* call into question the idea of deep geologic disposal, or the use of rock-salt as a repository host rock. Although WIPP operated safely for almost 15 years prior to these two incidents, the investigations of causes and contributing factors suggested that both the physical system and the work culture had deteriorated with time. Physically there was always a future to which to defer maintenance while shipments were arriving. Culturally it was very difficult to maintain a viable safety-conscious work environment, a safety culture, with an excellent safety record for almost 15 years. As WIPP looks toward operating again in 2017 and putting this operational hiatus behind us, the challenge will be to maintain the requisite worker-level safety culture and to interrupt, if needed, waste emplacement in order to perform critical preventive maintenance on equipment. In addition WIPP will keep abreast of promising deep geologic repository technology developments (such as the recently purchased hybrid bolters) to enhance operational efficiency and safety.

5. References

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[5] Waste Isolation Pilot Plant (WIPP) Recovery. www.wipp.energy.gov