ATTACHMENT A2

GEOLOGIC REPOSITORY

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TABLE OF CONTENTS

LIST OF TABLES

ATTACHMENT A2

GEOLOGIC REPOSITORY

A2-1 Description of the Geologic Repository

Management, storage, and disposal of transuranic (**TRU**) mixed waste in the Waste Isolation Pilot Plant (**WIPP**) geologic repository is subject to regulation under 20.4.1.500 New Mexico Administrative Code (**NMAC**). The WIPP geologic repository is mined within a bedded salt formation, which is defined in 20.4.1.100 NMAC (incorporating Title 40 of the Code of Federal Regulations (**CFR**) §260.10) as a Miscellaneous Unit. As such, hazardous waste management units within the repository are eligible for permitting and are regulated under 20.4.1.500 NMAC (incorporating 40 CFR Part 264, *Miscellaneous Units*). The underground Hazardous Waste Disposal Units (**HWDUs**) consist of eight currently excavated panels, known as Panels 1 through 8, and two planned panels, known as Panels 11 and 12. Each panel contains seven rooms and two access drifts. A typical disposal panel is depicted in Figure M-42.

As required by 20.4.1.500 NMAC (incorporating 40 CFR §264.601), the Permittees shall ensure that the environmental performance standards for a Miscellaneous Unit, which are applied to the underground HWDUs in the geologic repository, are met.

The Disposal Phase will consist of receiving contact-handled (**CH**) and remote-handled (**RH**) TRU mixed waste shipping containers, unloading and transporting the waste containers to the underground HWDUs, emplacing the waste in the underground HWDUs, and subsequently achieving closure of the underground HWDUs in compliance with applicable state and federal regulations.

The WIPP geologic repository is mined within a bedded-salt formation called the Salado Formation, which is 2,000 feet (**ft**) ((610 meters (**m**)) thick. The underground HWDUs (miscellaneous units) are located approximately 2,150 ft (655 m) beneath the ground surface. Transuranic mixed waste management activities underground will be confined to the southern portion of the 120-acre (48.6 hectare) mined area and the western portion of the 29.2-acre (11.8 hectares) mined area during the Disposal Phase. During the term of this Permit, disposal of TRU mixed waste is authorized in the HWDUs designated as Panels 7, 8, 11, and 12 (see Figure M-43). Panel 9 encompassed the four drifts that extended from the southernmost drift of Panels 4 and 5 to the northernmost drift of Panels 3 and 6 and has been closed, effectively also closing Panels 3, 4, 5, and 6. In the future, the Permittees may request Permit modifications to allow disposal of TRU mixed waste in other areas of the underground, one of which may be Panel 10, which encompasses the four drifts running from the point of closure of Panel 9 to the northernmost drift of Panels 1 and 8.

Panels 1 through 8, 11, and 12 consist of seven rooms and two access drifts each. Access drifts connect the rooms and have the same cross section (see Section A2-2a(3)). The closure system installed for each HWDU, after it is filled, will prevent anyone from entering the HWDU and will restrict ventilation airflow. The point of compliance for air emissions from the underground is defined in Permit Attachment N (Volatile Organic Compound Monitoring Plan). The point of compliance is the location where the concentration of volatile organic compounds (**VOCs**) in the air emissions from the underground HWDUs will be measured and then compared to the VOC action levels (10^{-5} for carcinogens and Hazard Index>1 for non-carcinogens) as required by Permit Part 4, Section 4.6.2.3.

Description of Four-Shaft Configuration

Four shafts connect the underground area with the surface. The Waste Shaft Conveyance headframe and hoist are located within the Waste Handling Building (**WHB**) and are used to transport containers of TRU mixed waste, equipment, and materials to the repository horizon. The Waste Hoist can also be used to transport personnel. The Air Intake Shaft and the Salt Handling Shaft provide ventilation to all areas of the mine except for the Waste Shaft Station. This area is ventilated by the Waste Shaft itself. The Salt Handling Shaft is also used to hoist mined salt to the surface and serves as the principal personnel transport shaft. The Exhaust Shaft serves as a common exhaust air duct (air pathway) for the mine. In some cases (such as during mining activities), the Salt Handling Shaft is used as an unfiltered exhaust shaft. The Salt Handling Shaft exhaust air comes from the North or Construction Circuits (i.e., areas of the underground that are not contaminated and do not need High-Efficiency Particulate Air (**HEPA**) filtration). The relationship between the WIPP surface facility, the four shafts, and the geologic repository horizon is shown on Figure M-44.

Description of Five-Shaft Configuration (with Shaft #5)

A fifth shaft, Shaft #5 (**S#5**), also connects the underground facility with the surface. The relationship between the WIPP surface facility, the five shafts, and the underground facility horizon is shown in Figure A2-2-S#5. With S#5 in use, the configuration of the shafts is as follows:

- Shaft #5 provides the majority of the intake air for the underground facility.
- The Air Intake Shaft provides the exhaust air pathway for the construction area of the underground facility.
- The Waste Shaft Conveyance headframe and hoist are located within the WHB and are used to transport containers of TRU mixed waste, equipment, and materials to the repository horizon. The waste hoist can also be used to transport personnel.
- The Waste Shaft provides intake air for the Waste Shaft Station.
- The Salt Handling Shaft provides a portion of the ventilation for the north area of the underground facility and is also used to hoist mined salt to the surface and serve as the principle personnel transport shaft.
- The Exhaust Shaft serves as a common exhaust air pathway for the north, disposal, and Waste Shaft Station areas of the underground facility.

The HWDUs identified as Panels 1 through 8, 11, and 12 (Figure M-43) provide room for up to 6,569,200 cubic feet (ft^3) (186,000 cubic meters (m^3)) of CH TRU mixed waste. The CH TRU mixed waste containers may be stacked up to three high across the width of the room.

Panels 4 through 8, 11, and 12 provide room for up to 138,950 ft^3 (3,935 m^3) of RH TRU mixed waste. Remote-handled TRU mixed waste may be disposed of in up to 730 boreholes per panel, subject to the limitations in Permit Part 4, Section 4.1.1.2.ii. These boreholes are drilled on nominal eight-foot centers, horizontally, about mid-height in the ribs of a disposal room. The thermal loading from RH TRU mixed waste shall not exceed 10 kilowatts per acre when averaged over the area of a panel, plus 100 feet of each of a panel's adjoining barrier pillars for Panels 4 through 8, and 150 feet of each of a panel's adjoining barrier pillars for Panels 11 and 12.

The WIPP facility is located in a sparsely populated area with site conditions favorable to isolation of TRU mixed waste from the biosphere. Geologic and hydrologic characteristics of the site related to its TRU mixed waste isolation capabilities are discussed in Addendum L1 of the WIPP Hazardous Waste Facility Permit Renewal Applications (DOE, 2009, 2020). Contingency and emergency response actions to minimize impacts of unanticipated events, such as releases of TRU mixed waste, are described in Permit Attachment D. The closure plan for the WIPP facility is described in Permit Attachment G.

A2-2 Geologic Repository Design and Process Description

A2-2a Geologic Repository Design and Construction

Compliance with the Permit ensures operations at the WIPP facility are safe and protective of human health and the environment.

As a part of the design validation process, geomechanical tests were conducted in Site and Preliminary Design Validation test rooms. During the tests, salt creep rates were measured. Separation of bedding planes and fracturing were also observed. Consequently, a ground-control strategy was implemented. The ground-control program at the WIPP facility mitigates the potential for roof or rib falls and maintains normal excavation dimensions, as long as access to the excavation is possible.

A2-2a(1) CH TRU Mixed Waste Handling Equipment

The following are the major pieces of equipment used to manage CH TRU waste in the geologic repository. A summary of equipment capacities, as required by 20.4.1.500 NMAC is included in Table A2-1.

Facility Pallets

The facility pallet is a fabricated steel unit designed to support seven-packs, three-packs, or four-packs of drums, standard waste boxes (**SWBs**), ten-drum overpacks (**TDOPs**), or a standard large box 2 (**SLB2**),. The facility pallet accommodates up to four seven-packs, four three-packs, or four four-packs of drums; two three-packs of shielded containers; four SWBs (in two stacks of two units); two TDOPs; or one SLB2. Loads are secured to the facility pallet during transport to the emplacement area. Facility pallets are shown in Figure M-21. Fork pockets in the side of the pallet allow the facility pallet to be lifted and transferred by forklift to prevent direct contact between TRU mixed waste containers and forklift tines. This arrangement reduces the potential for puncture accidents. WIPP facility operational documents define the operational load of the facility pallet to ensure that the rated load of a facility pallet is not exceeded.

Backfill

Magnesium oxide (**MgO**) is used as a backfill to provide chemical control over the solubility of radionuclides in order to comply with the requirements of 40 CFR §191.13. The MgO backfill is packaged appropriately for emplacement in the underground. Magnesium oxide is benign; therefore, should a backfill package be breached, no hazardous waste would result from a spill of backfill.

Typical backfill emplacement configurations are shown in Figure M-45. Some emplacement configurations may include the use of MgO emplacement racks, as shown in Figure M-45. The backfill emplacement process does not require additional operational considerations (e.g., ventilation flow and control) beyond those required for TRU mixed waste emplacement.

The Waste Shaft Conveyance

The hoist systems in the shafts and related shaft furnishings are designed to resist the dynamic forces of the hoisting system and to withstand a design-basis earthquake (**DBE**) of 0.1 g peak ground acceleration. Appendix D2 of the WIPP RCRA Part B Permit Application (DOE, 1997) provided an engineering design-basis earthquake report, which provides the basis for seismic design of WIPP facility structures. The Waste Hoist is equipped with a control system that detects malfunctions or abnormal operations of the hoist system (such as overtravel, overspeed, power loss, circuitry failure, or starting in a wrong direction) and triggers an alarm that automatically shuts down the hoist.

The Waste Hoist moves the Waste Shaft Conveyance and is a multirope, friction-type hoist. A counterweight is used to balance the Waste Shaft Conveyance. The Waste Shaft Conveyance (outside dimensions) is 30 ft (9 m) high by 10 ft (3 m) wide by 15 ft (4.5 m) deep and can carry a payload of 45 tons (40,824 kilograms (**kg**)). During loading and unloading operations, it is steadied by fixed guides. The hoist's maximum rope speed is 500 ft (152.4 m) per minute.

The Waste Shaft hoist system has two sets of brakes, with two units per set, plus a motor that is normally used to stop the hoist. The brakes are designed so that either set of brakes, acting alone, can stop a fully loaded conveyance under emergency conditions.

The Underground Waste Transporter

The underground waste transporter is a commercially available diesel-powered tractor. The trailer was designed specifically for the WIPP facility for transporting facility pallets from the Waste Shaft Conveyance to the underground HWDU. This transporter is shown in Figure M-46.

Underground Forklifts

Contact-handled TRU mixed waste containers loaded on slipsheets are removed from the facility pallets using forklifts with a push-pull attachment (Figure M-47) attached to the forklift-truck front carriage. The push-pull attachment grips the edge of the slipsheet (on which the waste containers sit) to pull the containers onto the platen. After the forklift moves the waste containers to the emplacement location, the push-pull attachment pushes the containers into position. The use of the push-pull attachment prevents direct contact between waste containers and forklift tines. Standard waste boxes and TDOPs may also be removed from the facility pallet by using forklifts equipped with special adapters for these containers. These special adapters prevent direct contact between SWBs or TDOPs and forklift tines. In addition, the low clearance forklift that is used to emplace MgO may be used to emplace waste if necessary.

A forklift is used to offload the SLB2 from the underground transporter and emplace the waste container in the waste stack.

A2-2a(2) Shafts

Four-Shaft Configuration

The WIPP facility uses four shafts: the Waste Shaft, the Salt Handling Shaft, the Air Intake Shaft, and the Exhaust Shaft. These shafts are vertical openings that extend from the surface to the repository level.

The Waste Shaft is located beneath the WHB and varies from 19 to 20 ft (5.8 to 6.1 m) in diameter. The Salt Handling Shaft, located north of the Waste Shaft beneath the salt handling headframe, varies from 10 to 12 ft (3 to 3.6 m) in diameter. Salt mined from the repository horizon is removed through the Salt Handling Shaft. The Salt Handling Shaft is the main personnel and materials hoist and also serves as a secondary supply air pathway for the underground areas. The Air Intake Shaft, northwest of the WHB, varies in diameter from 16 ft 7 inches (**in**) (4.51 m) to 20 ft 3 in. (6.19 m) and is the primary source of fresh air underground. The Exhaust Shaft, east of the WHB, varies from 14 to 15 ft (4.3 to 4.6 m) in diameter and serves as the exhaust air pathway for the underground air. In some cases, the Salt Handling Shaft may be used as an unfiltered exhaust shaft to ventilate areas of the underground that do not need filtration.

Five-Shaft Configuration (with S#5)

A fifth shaft, S#5, also extends from the surface to the repository level. The inside diameter of S#5 is approximately 26 ft (8 m). With S#5 in use, it is the primary source of fresh air to the underground facility. With S#5 in use, the ventilation functions of the existing shafts are as follows:

- Salt Handling Shaft serves as a secondary supply-air (intake air) pathway for the underground facility.
- The Waste Shaft serves as the supply-air (intake air) pathway for the Waste Shaft Station.
- The Air Intake Shaft serves as the exhaust air pathway for the construction area of the underground facility.
- The Exhaust Shaft serves as the exhaust air pathway for the north, disposal and Waste Shaft Station areas of the underground facility.

General Shaft Description

Openings excavated in salt experience closure because of salt creep, or time-dependent deformation at constant load. The closure affects the design of the openings discussed in this section. Underground excavation dimensions, therefore, are nominal because they change with time. The unlined portions of the shafts have larger diameters than the lined portions, which allows for closure caused by salt creep. Each shaft includes a shaft collar, a shaft lining, and a shaft key section. Permit Attachment G2 describes each shaft in detail including shaft construction, location of the shaft liners, shaft keys, water collection rings, and tubes.

Shafts and other underground facilities are, for all practical purposes, dry. Minor quantities of water (which accumulate in some shaft sumps) are insufficient to affect the waste disposal area. This water is collected, brought to the surface, and disposed of in accordance with current standards and regulations.

The Waste Shaft is protected from precipitation by the roof of the Waste Shaft Conveyance headframe tower. The Exhaust Shaft is configured at the top with a 14 ft- (4.3 m-) diameter duct that diverts air into the exhaust filtration system or to the atmosphere, as appropriate. The Salt Handling and Air Intake Shaft collars are open except for the headframes. Rainfall into the shafts is evaporated by ventilation air. Shaft #5 is covered to direct intake air into the underground facility using fans located on the surface. The fans are connected to the shaft via ducting and a plenum.

With S#5 in use, the Air Intake Shaft is converted to an exhaust shaft for Construction Circuit air by routing the air through a plenum and ducting to an unfiltered exhaust stack.

The Waste Hoist system in the Waste Shaft and Waste Shaft furnishings are designed to resist the dynamic forces of the hoisting system, which are greater than the seismic forces on the underground facilities. In addition, the Waste Shaft Conveyance headframe is designed to withstand the DBE. Maximum operating speed of the hoist is 500 ft (152.4 m) per minute. During loading and unloading operations, the Waste Hoist is steadied by fixed guides. The Waste Hoist is equipped with a control system that will detect malfunctions or abnormal operations of the hoist system, such as overtravel, overspeed, power loss, or circuitry failure. The control response is to annunciate the condition and shut the hoist down. Operator response is required to recover from the automatic shutdown. Waste Hoist operation is continuously monitored by the Central Monitoring System (**CMS**). A battery-powered transmitter/receiver allows communication between the Waste Shaft Conveyance and the hoist house.

The Waste Hoist has two pairs of brake calipers acting on independent brake paths. The hoist motor is normally used for braking action of the hoist. The brakes are used to hold the hoist in position during normal operations and to stop the hoist under emergency conditions. Each pair of brake calipers is capable of holding the hoist in position during normal operating conditions and stopping the hoist under emergency conditions. In the event of power failure, the brakes will set automatically.

The Waste Hoist is protected by a fixed automatic fire suppression system. Portable fire extinguishers are also provided on the hoist floor and in equipment areas.

A2-2a(3) Subsurface Structures

The subsurface structures in the repository, located at 2,150 ft (655 m) below the surface, include the HWDUs, the northern experimental areas, and the support areas. Appendix D3 of the WIPP RCRA Part B Permit Application (DOE, 1997) provided details of the underground layout. Figure M-48 shows the proposed waste emplacement configuration for the HWDUs.

The status of designated underground equipment, including fixed fire-protection systems, the ventilation system, and contamination-detection systems, are monitored by the CMS, located in the Support Building adjacent to the WHB. Backup power will be provided as discussed below. The subsurface support areas are constructed and maintained to conform to federal mine safety codes.

Underground Hazardous Waste Disposal Units (HWDUs)

During the terms of this and the preceding Permit, the final TRU mixed waste volumes emplaced in the repository will not exceed the maximum capacities listed in Permit Part 4, Table 4.1.1 for each HWDU. Contact-handled TRU mixed waste will be disposed of in underground HWDUs identified as Panels 1 through 8, 11, and 12. Remote-handled TRU mixed waste may be disposed of in Panels 4 through 8, 11, and 12.

Main entries and cross cuts in the repository provide access and ventilation to the HWDUs. The main entries link the shaft pillar/service area with the TRU mixed waste management area and are separated by pillars. Each of the underground HWDUs labeled Panels 1 through 8, 11, and 12 will have seven rooms. The locations of these HWDUs are shown in Figure M-43. The rooms in Panels 1-7 have nominal dimensions of 13 ft (4.0 m) high by 33 ft (10 m) wide by 300 ft (91 m) long and are separated by 100 ft (30 m) wide pillars. The rooms in Panel 8 have nominal dimensions of 16 ft (5.0 m) high by 33 ft (10 m) wide by 300 ft (91 m) long and are separated by 100 ft (30 m) wide pillars. The rooms in Panel 11 and Panel 12 will have nominal dimensions of 14 ft (4.3 m) high by 33 ft (10 m) wide by 300 ft (91 m) long and will be separated by 100 ft (30 m) wide pillars.

As currently planned, future Permits may allow disposal of TRU mixed waste containers in additional panels, one of which may be Panel 10 (Figure M-43). Disposal of TRU mixed waste in Panel 10 is prohibited under this Permit. The Permittees may request a Permit modification to allow disposal of TRU mixed waste in Panel 10 in the future, describing the condition of those drifts and the controls exercised for personnel safety and environmental protection while disposing of waste in these access drifts. These access drifts have the following nominal dimensions:

- The E-140 waste transport route south of the Waste Shaft Station is mined to be 25 ft wide nominally and its height ranges from about 14 ft to 20 ft
- The W-30 waste transport route south of S-700 is mined to be 20 ft wide nominally and its height is mined to at least 14 ft
- Other drifts that are part of the waste transport route are at least 20 ft wide and 14 ft high to accommodate waste transport equipment
- Other drifts (i.e. mains and cross-cuts) vary in width and height according to their function typically ranging from 14 ft to 20 ft wide and 12 ft to 20 ft high.

The layout of these excavations is shown on Figure M-43.

Underground Facilities Ventilation System

The underground facilities ventilation system provides a safe and suitable environment for underground operations during normal WIPP facility operations. The underground system is designed to provide control of potential airborne contaminants in the event of an accidental release or an underground fire.

The underground is divided into specific areas that are supported by different ventilation flows referred to as ventilation circuits. Consequently, the underground ventilation system is comprised of four separate circuits, as designated on Figure M-49: one serving the northern experimental areas (North Circuit), one serving the construction areas (Construction Circuit), one serving the waste disposal areas (Disposal Circuit), and one serving the Waste Shaft Station area (Waste Shaft Station Circuit). The air from the four circuits is recombined near the bottom of the Exhaust Shaft, which serves as a common exhaust route from the underground level to the surface. In some cases, the Salt Handling Shaft may be used as an unfiltered exhaust shaft (Figure M-50) to ventilate areas of the underground that do not need filtration.

With S#5 in use (Figure M-51), the Salt Handling Shaft serves as the secondary supply-air pathway for the underground facility while S#5 serves as the primary supply-air pathway for the underground facility. The Waste Shaft supplies the intake air for the Waste Shaft Station. The Air Intake Shaft provides the exhaust route for the Construction Circuit while the Exhaust Shaft provides the exhaust route for the North, Disposal, and Waste Shaft Station Circuits.

Underground Ventilation System Description

The underground ventilation system consists of centrifugal exhaust fans, two identical HEPA-filter assemblies arranged in parallel, isolation dampers, a filter bypass arrangement, two skid-mounted HEPA-filter assemblies arranged in parallel, and associated ductwork. The fans, connected by the ductwork to the underground exhaust shaft so that they can independently draw air through the Exhaust Shaft, are divided into three groups. One group consists of three main exhaust fans, two of which are utilized to provide the nominal airflow of 425,000 standard ft^3 per minute (**scfm**) throughout the WIPP facility underground during normal (unfiltered) operation. One main fan may be operated in the alternate mode to provide 260,000 scfm underground ventilation flow. These fans are located near the Exhaust Shaft. The second group consists of three filtration fans, and each can provide 60,000 scfm of airflow. These fans, located at the Exhaust Filter Building, can be operated in the filtration mode, where exhaust is diverted through HEPA filters, or in the reduced or minimum ventilation mode, where air is not drawn through the HEPA filters. The third group consists of two skid-mounted filtration fans and HEPA-filter assemblies, each of which can provide approximately 23,000 scfm of airflow. The skid-mounted filtration fan and HEPA-filter assemblies, referred to as the Interim Ventilation System (**IVS**) located south of the Exhaust Filter Building, are only operated in filtration mode, where exhaust is diverted through HEPA filters. In addition to the surface fans, an underground fan has been installed to ventilate areas in the North and Construction Circuits. This system is referred to as the Supplemental Ventilation System (**SVS**) and is used in conjunction with the IVS (as shown in Figure M-50). When this fan is operating, the Salt Shaft serves as an unfiltered exhaust shaft for the North and Construction Circuits. A portion of the airflow provided by the SVS to the Construction Circuit is also used to provide fresh air to the Disposal Circuit. In this case, the air from the Disposal Circuit will continue to be exhausted through the HEPA filtration system.

When the repository is configured to use five shafts, two fans located on the surface and connected via ducting and a plenum to S#5, supply the majority of the intake air to the underground facility. One fan operates at a time, while the idle fan is available as a back-up fan. The Salt Handling Shaft serves as a secondary air intake shaft for the north area and the Waste Shaft serves as the air intake shaft for the Waste Shaft Station area of the underground facility. The Air Intake Shaft serves as an unfiltered exhaust shaft for the construction area of the underground facility. The north, disposal, and Waste Shaft Station areas of the underground facility are exhausted through the Exhaust Shaft and the associated filtration system.

The underground mine ventilation is designed to supply sufficient quantities of air to the repository. During normal operating mode (simultaneous mining and waste emplacement operations), approximately 140,000 actual ft^3 (3,962 m^3) per min can be supplied to the panel area. This quantity can support the level of activity and the pieces of diesel equipment that are expected to be in operation.

At any given time during waste emplacement activities, there may be significant activities in multiple rooms in a panel. For example, one room may be receiving CH TRU mixed waste containers, another room may be receiving RH TRU mixed waste canisters, and the drilling of RH TRU mixed waste emplacement boreholes may be occurring in another room. The remaining rooms in a panel will either be completely filled with waste; be idle, awaiting waste handling operations; or being prepared for waste receipt. A minimum ventilation rate of 35,000 standard ft^3 (990 standard m^3) per minute is maintained in each active room when waste disposal is taking place and workers are present in the room. Based on calculations in Appendix D9 of the RCRA Part B Permit Application (DOE, 1997), this quantity of air is required to protect underground waste handling personnel working in an active disposal room. The remainder of the air is needed in order to account for air leakage through inactive rooms.

Air is routed into a panel from the intake side. Air is routed through the individual rooms within a panel using any of the following flow control devices: underground bulkheads, brattice-cloth barricades, bulkheads with doors or air regulators. Bulkheads are constructed by erecting framing of rectangular steel tubing and screwing galvanized sheet metal to the framing. Bulkhead members use telescoping extensions that are attached to framing and the salt which adjust to creep. Flexible flashing attached to the bulkhead on one side and the salt on the other completes the bulkhead installation. Where controlled airflow is required, a louver-style damper or a slide-gate (sliding panel) regulator is installed on the bulkhead. Personnel access is available through most bulkheads, and vehicular access is possible through selected bulkheads. Vehicle doors in the panel areas are not equipped with warning bells or strobe lights since these doors are to be used for limited periodic maintenance activities in the return air path. Flow is also controlled using brattice-cloth barricades. These consist of chain link fence that is bolted to the salt or attached to a structural member and covered with brattice cloth; and are used in instances where the only flow control requirement is to block the air. A brattice-cloth air barricade is shown in Figure M-52. Ventilation is maintained only in active rooms within a panel until waste emplacement activities are completed and the panel-closure system is installed. The air is routed simultaneously through the active rooms within the panel. The filled rooms are isolated from the ventilation system, while the active rooms that are actively being filled receive a minimum of 35,000 scfm of air when workers are present to assure worker safety. If an active room ventilation rate of 35,000 scfm cannot be met, actions as described in Permit Attachment O shall be taken during waste disposal operations when workers are present. After the rooms within a panel are filled, the panel will be closed using a closure system described Permit Attachment G and Permit Attachment G1.

Once a disposal room is filled and is no longer needed for emplacement activities, it will be barricaded against entry and isolated from the mine ventilation system. This may be accomplished by any of the following: by removing the air regulator bulkhead, closing bulkhead doors, constructing chain link/brattice-cloth barricades and, if necessary, constructing bulkheads at each end. A typical bulkhead is shown in Permit Attachment G1, Appendix G1-B. There is no requirement for air for these rooms since personnel and/or equipment will not be in these areas.

The ventilation path for the waste disposal side is separated from the construction (e.g., mining) side by means of air locks, bulkheads, and salt pillars. A pressure differential is maintained between the construction side and the waste disposal side to ensure that any leakage is towards the disposal side. The pressure differential is produced by the surface fans in conjunction with the underground air regulators.

Underground Ventilation Filtration System Description with Buildings 416 and 417

The Underground Ventilation Filtration System (**UVFS**) fans, which are part of the New Filter Building (**NFB**) (Building 416), provide enhanced ventilation in the underground, sufficient to allow concurrent mining and waste emplacement while in filtration mode (Figure M-53). The UVFS will provide filtered airflow through a surface mounted ventilation and filtration system. The intake duct to the surface ventilation and filtration facility is connected to the Exhaust Shaft. The exhaust from the underground will be directed to the salt-reduction system located in the Salt-Reduction Building (**SRB**) (Building 417).

Prior to passing through the NFB, air from the Exhaust Shaft may be directed through the SRB, which contains de-dusters, commonly used in the mining industry, and de-misters for salt dust and brine/water mist removal. The salt-reduction system consists of multiple parallel de-dusting units. The exhaust from the de-dusting units is directed to the filter supply manifold and then to the filtration units. The combination of the de-duster and de-mister has a water wash-down system that is connected to a water collection, treatment and sludge tank. The outlet of the water collection, treatment, and sludge tank is piped out of the SRB to an evaporative pond. Accumulated water and salt will be characterized and disposed of in accordance with WIPP facility standard operating procedures.

Differential-pressure instrumentation, located at each filter bank, will be provided with a high differential pressure alarm, which is monitored in the CMR. The exhaust from each of the filter banks is directed to a plenum which has a single duct that discharges to the environment through a stack.

Underground Ventilation Modes of Operation

When the repository is configured to use four shafts, the underground ventilation system is designed to perform under three types of operation: normal (the HEPA exhaust filtration system is bypassed), filtered (the exhaust is filtered through the HEPA filtration system) if radioactive contaminants are detected or suspected, or a combined mode in which the air in the Disposal Circuit is filtered and the air in the North and Construction Circuits is unfiltered. The possible modes of exhaust fan operation are as follows:

- Two main fans in operation
- One main fan in operation
- One filtration fan in filtered operation
- Two fans in filtered operation (one filtration fan and one IVS fan or two IVS fans)
- Three fans in filtered operation (one filtration fan and two IVS fans)
- One filtration fan in unfiltered operation
- Two filtration fans in unfiltered operation
- One main and One filtration fan in unfiltered operation
- Three fans in filtered operation (one filtration fan and two IVS fans exhausting through the Exhaust Shaft) and an underground SVS fan in operation (boosting fresh air into the mine causing the Salt Handling Shaft to serve as an unfiltered exhaust shaft for the North and Construction Circuits)

Underground Ventilation Filtration System Modes of Operation with Building 416

The UVFS, which includes the NFB, is designed to perform under two types of operation: filtered (the exhaust is filtered through the HEPA filtration system), and bypassed (the HEPA exhaust filtration system is bypassed).

For UVFS Filtration Mode

- One exhaust fan
- Two exhaust fans
- Three exhaust fans
- Four exhaust fans

For UVFS Bypass Mode

- One to four exhaust fans

Under some circumstances (e.g., power outages and maintenance activities), exhaust fan operation may be discontinued for short periods of time.

In the normal mode, two main surface exhaust fans, located near the Exhaust Shaft, provide continuous ventilation of the underground areas. In this mode, underground airflows join at the bottom of the Exhaust Shaft before discharge to the atmosphere. However, in some cases, the Salt Handling Shaft may be used as an unfiltered exhaust shaft to ventilate areas of the underground that do not need filtration.

Typically, outside air is supplied to the construction areas and the waste disposal areas through the Air Intake Shaft, the Salt Handling Shaft, and access entries. A small quantity of outside air flows down the Waste Shaft to ventilate the Waste Shaft Station. The ventilation system is designed to operate with the Air Intake Shaft as the primary source of fresh air. Under these circumstances, sufficient air is available to simultaneously conduct underground operations (e.g., waste handling, mining, experimentation, and support). Ventilation may be supplied by operating fans in the configurations listed in the above description of the ventilation modes.

An underground SVS fan, located in the S-90 drift, provides additional ventilation to the underground facility, as needed. The SVS ventilates the following:

- The North and Construction Circuits, exhausting through the Salt Handling Shaft and
- The disposal areas of the underground, exhausting through the Exhaust Shaft and through the filtration system

When the repository is configured to use five shafts, two intake fans located on the surface and connected to S#5 via ducting and a plenum, supply the majority of the intake air to the underground facility. The fans are designed to operate one fan at a time with the second fan available as a back-up fan. The fans have variable frequency drives that can adjust the intake flow at S#5 to meet the requirements of the underground ventilation filtration system and the Construction Circuit.

If the nominal flow of 425,000 scfm (12,028 m^3/min) is not available (e.g., only one of the main ventilation fans is available), underground operations may proceed; however, the number of activities that can be performed in parallel may be limited depending on the quantity of air available. Ventilation may be supplied by operating one or more of the filtration exhaust fans. To accomplish this, the isolation dampers will be opened, which will permit air to flow from the main exhaust duct to the filter outlet plenum or to the IVS. The filtration fans may also be operated to bypass the HEPA plenum. The isolation dampers of the filtration exhaust fan(s) to be employed will be opened, and the selected fan(s) will be switched on. In this mode, underground operations will be limited, because filtration exhaust fans cannot provide sufficient airflow to support the use of numerous pieces of diesel equipment.

If the nominal flow of 425,000 scfm (12,028 m^3/min) is not available because the facility is operating in filtration mode, the exhaust air will pass through HEPA-filter assemblies, with filtration fans operating (i.e., other fans are stopped). This system provides a means for removing the airborne particulates before they are discharged through the exhaust stack to the atmosphere. The filtration mode is activated manually or automatically if the radiation monitoring system detects abnormally high concentrations of airborne radioactive particulates (an alarm is received from the continuous air monitor in the exhaust drift of the active waste panel) or a waste handling incident with the potential for a waste container breach is observed. The filtration mode is not initiated by the release of gases such as VOCs.

If electrical power fails, the exhaust filter system is powered by backup diesel generators. Normal TRU mixed waste handling and related operations cease upon loss of electric power and are not resumed until normal electric power is returned. As specified in Permit Part 2, waste handling equipment will "fail safe," meaning that it will retain its load in the event of a power outage.

Electrical System

The WIPP facility uses electrical power supplied by the regional electric utility company. If there is a loss of power, TRU mixed waste handling and related operations will cease.

Backup, alternating current power will be provided on site by diesel generators. These units provide a high degree of reliability. Each of the diesel generators can carry predetermined equipment loads while maintaining additional power reserves. Predetermined loads include lighting and ventilation for underground facilities, lighting and ventilation for the TRU mixed waste handling areas, and the Air Intake Shaft hoist. The diesel generators can be brought online within 30 minutes either manually or from the control panel in the CMR.

Uninterruptible power supply (**UPS**) units are also online providing power to predetermined monitoring systems. These systems ensure that the power to the radiation detection system for airborne contamination, the local processing units, the computer room, and the CMR will always be available, even during the interval between the loss of off-site power and initiation of backup diesel generator power.

A2-2a(4) RH TRU Mixed Waste Handling Equipment

The following are the major pieces of equipment used to manage RH TRU mixed waste in the geologic repository. A summary of equipment capacities is included in Table A2-3.

The Facility Cask Transfer Car

The Facility Cask Transfer Car is a self-propelled rail car (Figure M-34) that operates between the Facility Cask Loading Room and the geologic repository. After the Facility Cask is loaded, the Facility Cask Transfer Car moves onto the Waste Shaft Conveyance and is then transported underground. At the underground Waste Shaft Station, the Facility Cask Transfer Car proceeds away from the Waste Shaft Conveyance to provide forklift access to the Facility Cask.

Horizontal Emplacement Machine or Functionally Equivalent Equipment

A horizontal emplacement machine (**HEM**) (Figure M-54), or functionally equivalent equipment, emplaces canisters into a borehole in a room wall of an underground HWDU. Once the canisters have been emplaced, the HEM then fills the borehole opening with a shield plug.

A2-2b Geologic Repository Process Description

RH TRU Mixed Waste Emplacement

The Facility Cask Transfer Car, loaded with a Facility Cask, is moved onto the Waste Shaft Conveyance and is lowered to the Waste Shaft Station underground. At the Waste Shaft Station underground, the Facility Cask is moved from the Waste Shaft Conveyance by the Facility Cask Transfer Car (Figure M-55). A forklift is used to remove the Facility Cask from the Facility Cask Transfer Car and to transport the Facility Cask to the Underground HWDU. There, the Facility Cask is placed on the HEM. The HEM is used to emplace the RH TRU mixed waste canister into the borehole. The borehole is visually inspected for obstructions prior to aligning the HEM and emplacement of the RH TRU mixed waste canister. The Facility Cask is moved forward to mate with the shield collar, and the transfer carriage is advanced to mate with the rear Facility

Cask shield valve. The shield valves on the Facility Cask are opened, and the transfer mechanism advances to push the canister into the borehole. After retracting the transfer mechanism into its housing, the shield valve(s) is closed. The transfer mechanism is moved to the rear, and the shield plug carriage containing a shield plug is placed on the emplacement machine cask carriage. The transfer mechanism is used to push the shield plug into the borehole, thereby completing the emplacement.

A shield plug is a concrete filled cylindrical steel shell (Figure M-56) approximately 61 in (155 cm) long and 29 in (74 cm) in diameter, made of concrete shielding material inside a 0.24 in-(0.61 cm)- thick steel shell with a removable pintle at one end. Each shield plug has integral forklift pockets and weighs approximately 3,750 pounds (**lb**) (1,700 kg). The shield plug is inserted with the pintle end closest to the HEM to provide the necessary shielding, limiting the borehole radiation dose rate at 11.8 in (30 cm) to less than 10 millirem per hour for a canister surface dose rate of 100 rem per hour . Additional shielding is provided at the direction of the radiological control technician based on dose rate surveys following shield plug emplacement. This additional shielding is provided by the manual emplacement of one or more shield plug supplemental shielding plates and a retainer (Figures M-56).

The amount of RH TRU mixed waste disposed in each panel is limited based on thermal and geomechanical considerations and shall not exceed 10 kilowatts per acre as described in Section A2-1. Remote-handled TRU mixed waste emplacement boreholes are drilled in the ribs of the panels at a nominal spacing of 8 ft (2.4 m) center-to-center, horizontally.

Figures M-40 and M-41 are flow diagrams of the RH TRU mixed waste handling process for the RH-TRU 72-B and CNS 10-160B casks, respectively.

CH TRU Mixed Waste Emplacement

A forklift or the facility transfer vehicle transports the loaded facility pallet to the conveyance loading room adjacent to the Waste Shaft. The facility transfer vehicle is driven onto the Waste Shaft Conveyance deck, where the loaded facility pallet is transferred to the Waste Shaft Conveyance, and the facility transfer vehicle is backed off. Containers of CH TRU mixed waste (55-gal (208-L) drums, SWBs, 85-gal (322-L) drums, 100-gal (379-L) drums, and TDOPs) or shielded containers can be handled individually, if needed, using the forklift and appropriate lifting attachments (e.g., drum handlers, parrot beaks).

The Waste Shaft Conveyance lowers the loaded facility pallet to the underground. At the Waste Shaft Station, the CH TRU underground transporter is backed up to the Waste Shaft Conveyance, and the facility pallet is transferred from the Waste Shaft Conveyance onto the transporter (see Figure M-46). The transporter is then used to move the facility pallet to the appropriate underground HWDU for emplacement. The underground waste transporter is equipped with a fire suppression system, rupture-resistant diesel fuel tanks, and reinforced fuel lines to minimize the potential for a fire involving the fuel system.

A forklift in the HWDU is used to remove the waste containers from the facility pallets and to place them in the waste stack using a push-pull attachment or, in the case of an SLB2, the SLB2 is lifted from the facility pallet and placed directly on the floor of the emplacement room. The waste will be emplaced room by room in Panels 1 through 8 and Panels 11 and 12. Each panel will be closed off from active ventilation when filled. If a waste container is damaged during the Disposal Phase, it will be immediately overpacked or repaired. Contact-handled TRU mixed waste containers are continuously vented. The filter vents allow aspiration, preventing internal pressurization of the container.

Once a waste panel has been mined and any initial ground control established, flow control devices are constructed to assure adequate control over ventilation during waste emplacement activities. The first room to be filled with waste is typically Room 7, which is the one that is farthest from the main access drifts. A ventilation control point is established for Room 7 either just outside the exhaust side of Room 6 or at the inlet side of Room 7. This ventilation control point consists of a flow control device (e.g., bulkhead with a ventilation regulator or brattice cloth). When RH TRU mixed waste canister emplacement is completed in a room, CH TRU mixed waste emplacement can begin in that room. Stacking of CH TRU mixed waste typically begins at the exhaust side of the room and proceeds down the access drift, through the room and up the intake access drift until the entrance of Room 6 is reached. At that point, a brattice-cloth and chain-link barricade and, if necessary, bulkheads will be installed. This process is typically repeated for Room 6, and so on until Room 1 is filled. At that point, the panel closure system is constructed.

The emplacement of CH TRU mixed waste into the HWDUs is typically in the order received and unloaded from the CH packaging. There is no specification for the amount of space to be maintained between the waste containers themselves, or between the waste containers and the walls. Containers are stacked in the best manner to provide stability for the stack (up to three containers high) and to make best use of available space. The space between the wall and the container ranges from 8 to 18 in (20 to 46 cm). This space is a function of disposal room wall irregularities, container type, and sequence of emplacement. Space is required over the stacks of containers to assure adequate ventilation for waste handling operations. A minimum of 16 in (41 cm) was specified in the Final Design Validation Report (Appendix D1, Chapter 12 of the WIPP RCRA Part B Permit Application (DOE, 1997)) to maintain airflow. Typically, the space above a stack of containers is 36 to 48 in. (90 to 122 cm). However, backfill material, consisting of bags of MgO, takes up 18 in (45 cm) of height. Figure M-48 shows a typical container configuration, although this figure does not mix containers on any row. Such mixing, while inefficient, is allowed to assure timely movement of waste into the underground. No aisle space is maintained for personnel access to emplaced waste containers. No roof maintenance behind stacks of waste is planned.

The anticipated schedule for the filling of each of the underground HWDUs known as Panels 1 through 8, 11, and 12, is shown in Permit Attachment G, Table G-1. Panel closure in accordance with the Closure Plan in Permit Attachment G and Permit Attachment G1 is estimated to require an additional 180 days following placement of the final waste in the panel.

Figures M-38 and M-39 are flow diagrams of the CH TRU mixed waste handling process.

A2-3 Waste Characterization

Transuranic mixed waste characterization is described in Permit Attachment C.

A2-4 Treatment Effectiveness

Transuranic mixed waste treatment, as defined in 20.4.1.100 NMAC (incorporating 40 CFR §260.10), for which a permit is required, is not performed at the WIPP facility.

A2-5 Maintenance, Monitoring, and Inspection

A2-5a Maintenance

A2-5a(1) Ground-Control Program

The ground-control program at the WIPP facility ensures that any room in a HWDU in which waste will be placed is sufficiently supported to assure waste disposal activities can be carried out safely. In addition, the Land Withdrawal Act (**LWA**) requires a regular review of roof-support plans and practices by the Mine Safety and Health Administration (**MSHA**). Ground control is performed in accordance with standard operating procedures that incorporate the requirements of 30 CFR Part 57, Subpart B.

A2-5b Monitoring

A2-5b(1) Groundwater Monitoring

Groundwater monitoring for the underground HWDUs is conducted in accordance with Permit Part 5 and Permit Attachment L.

A2-5b(2) Geomechanical Monitoring

The geomechanical monitoring program at the WIPP facility is an integral part of the ground-control program. Hazardous waste disposal units and drifts are monitored to provide confirmation of structural integrity. Geomechanical data on the performance of the repository shafts and excavated areas are collected as part of the geotechnical field-monitoring program. The results of the geotechnical investigations are reported annually in the Geotechnical Analysis Report (**GAR**). The report describes monitoring programs and geomechanical data collected during the previous year.

A2-5b(2)(a) Description of the Geomechanical Monitoring System

The Geomechanical Monitoring System (**GMS**) provides in situ data to support the continuous assessment of the design for underground facilities. Specifically, the GMS provides for:

- Early detection of conditions that could affect operational safety,
- Evaluation of disposal room closure that ensures adequate access,
- Guidance for design modifications and remedial actions, and
- Data for interpreting the behavior of underground openings, in comparison with established design criteria.

The instrumentation in Table A2-2 is available for use in support of the geomechanical program.

The minimum instrumentation for each of the ten panels is one borehole extensometer installed in the roof near the center of each disposal room. The roof extensometers monitor the dilation of the immediate salt roof beam and possible bed separations along clay seams. Additional instrumentation will be installed as conditions warrant.

Remote polling of the geomechanical instrumentation is performed at least once every month. This frequency may be increased to accommodate any changes that may develop.

The results from the remotely read instrumentation are evaluated after each scheduled polling. Documentation of the results are provided annually in the GAR.

Data from remotely read instrumentation are maintained as part of a geotechnical instrumentation system. The instrumentation system provides for data maintenance, retrieval, and presentation. The Permittees retrieve the data from the instrumentation system and verify data accuracy by confirming the measurements were taken in accordance with applicable instructions and equipment calibration is known. Next, the Permittees review the data after each polling to assess the performance of the instrument and of the excavation. Anomalous data will be investigated to determine the cause (instrumentation problem, error in recording, changing ground conditions). The Permittees calculate various parameters such as the change between successive readings and deformation rates. This assessment is reported to the Permittees' cognizant ground control engineer and operations personnel. The Permittees will investigate unexpected deformation to determine if remediation is needed.

The stability of an open panel excavation is generally determined by the rock deformation rate. The excavation may be unstable when there is a continuous increase in the deformation rate that cannot be controlled by the installed support system. The Permittees evaluate the performance of the excavation. These evaluations assess the effectiveness of the roof support system and estimate the stand-up time of the excavation. If an open panel shows the trend is toward adverse (unstable) conditions, the results will be reported to determine if it is necessary to terminate waste disposal activities in the open panel. This report of the trend toward adverse conditions in an open HWDU will also be provided to the Secretary of the NMED within seven (7) calendar days of issuance of the report.

Using data available on the New Mexico Oil Conservation Division (**OCD**) website, the Permittees shall provide a list of oil and gas production and salt water disposal wells within a one-mile perimeter outside the Land Withdrawal Act boundary that were listed as active by the OCD during the previous calendar year. This report will be provided annually in October.

The assessment and evaluation of the condition of WIPP repository excavations is an interactive, continuous process using the data from the monitoring programs. Criteria for corrective action are continually reevaluated and reassessed based on total performance to date. Actions taken are based on these analyses and planned utilization of the excavation. Because excavations are in a natural geologic medium, there is inherent variability from point to point. The principle adopted is to anticipate potential ground control requirements and implement them in a timely manner rather than to wait until a need arises.

A2-5b(3) Volatile Organic Compound Monitoring

The volatile organic compound monitoring for the WIPP Underground HWDUs will be conducted in accordance with Permit Part 4 and Permit Attachment N.

A2-5c Inspection

Inspections of the underground HWDUs are conducted in accordance with Permit Part 2 and Permit Attachment E.

References

DOE, 1997. Resource Conservation and Recovery Act Part B Permit Application, Waste Isolation Pilot Plant (WIPP), Carlsbad, New Mexico, Revision 6.5, 1997.

DOE, 2009. WIPP Hazardous Waste Facility Permit Amended Renewal Application, Carlsbad, New Mexico, September 2009.

DOE, 2020. WIPP Hazardous Waste Facility Permit Renewal Application, Carlsbad, New Mexico, March 2020.

TABLES

Table A2-1
CH TRU Mixed Waste Handling Equipment Capacities

Capacities for Equipment (lb)	
Facility Pallet	25,000
Facility Transfer Vehicle	26,000
Underground transporter	28,000
Underground forklift	12,000
SLB2 forklift	36,000
Maximum Gross Weights of Containers (lb)	
Seven-pack of 55-gal (208-L) drums	7,000
Four-pack of 85-gal (322-L) drums	4,500
Three-pack of 100-gal (379-L) drums	3,000
Ten-drum overpack	6,700
Standard waste box	4,000
Standard large box 2	10,500
Shielded container	2,260
Three-pack of shielded containers	7,000
Maximum Net Empty Weights of Equipment (lb)	
TRUPACT-II	13,140
HalfPACT	10,500
TRUPACT-III	43,600
Facility pallet	4,120

Table A2-2
Instrumentation Used in Support of the Geomechanical Monitoring System

Instrument Type	Features	Parameter Measured	Range
Borehole Extensometer	The extensometer provides for monitoring the deformation parallel to the borehole axis. Units suitable for up to 5 measurements anchors in addition to the reference head. Maximum borehole depths are 50 feet.	Cumulative Deformation	0-2 in
Borehole Television Camera	Closed circuit television may be used for monitoring areas otherwise inaccessible, such as boreholes or shafts.	Video Image	N/A
Convergence Points and Tape Extensometers	Mechanically anchored eyebolts to which a portable tape extensometer is attached.	Cumulative Deformation	2-50 ft
Convergence Meters	Includes wire and sonic meters. Mounted on rigid plates anchored to the rock surface.	Cumulative Deformation	2-50 ft
Rock Bolt Load Cells	Spool type units suitable for use with rock bolts. Tensile stress is inferred from strain gauges mounted on the surface of the spool.	Load	0-300 kips
Earth Pressure Cells	Installed between concrete keys and rock. Preferred type is a hydraulic pressure plate connected to a vibrating wire transmitter.	Lithostatic Pressure	0-1,000 pounds per square inch (**psi**)
Piezometer Pressure Transducers	Located in shafts and of robust design and construction. Periodic checks on operability required.	Fluid Pressure	0-500 psi
Strain Gauges	Installed within the concrete shaft key. Suitably sealed for the environment. Two types used:surface mounted and embedded.	Cumulative Deformation	0-3,000 microinches per inch (**µin/in**) (embedded) 0-2,500 µin/in (surface)

Table A2-3
RH TRU Mixed Waste Handling Equipment Capacities

Capacities for Equipment (lb)	
41-Ton Forklift	82,000
Maximum Gross Weights of RH TRU Containers (lb)	
RH TRU Facility Canister	10,000
55-gal (208-L) Drum	1,000
RH TRU Canister	8,000
Maximum Net Empty Weights of Equipment (lb)	
Facility Cask	67,700
Light Weight Facility Cask	48,450