

ATTACHMENT O
WIPP MINE VENTILATION RATE MONITORING PLAN

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ATTACHMENT O

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O-1 Definitions

Compliance with the mine ventilation requirements set forth in Permit Part 4 and Permit Attachment A2 requires the use and definition of the following terms:

Actual cubic feet per minute (acfm): The volume of air passing a fixed point in an excavation, normally determined as the product of the cross section of the excavation and the mean velocity of the air.

Standard cubic feet per minute (scfm): The actual cubic feet per minute passing a fixed point adjusted to standard conditions. In the Imperial measurement system, the standard condition for pressure is 14.7 pounds per square inch (**psi**) (sea level) and the standard condition for temperature is 492 degrees Rankine (freezing point of water or 32 degrees Fahrenheit). The greatest difference between acfm and scfm occurs in the summer when the pressure at the repository horizon is about 14.2 psi and the temperature is about 560 degrees Rankine (100 degrees Fahrenheit). Then

$$1 \text{ scfm} \times (560/492) \times (14.7/14.2) = 1.2 \text{ acfm}$$

A reasonably conservative conversion factor, therefore, is 1.2. Using this factor, 35,000 scfm is very nearly $35,000 \times 1.2$ or 42,000 acfm.

Restricted Access: If the required ventilation rate in an active room when waste disposal is taking place cannot be achieved or cannot be supported due to operational needs, access is restricted by the use of barriers, signs and postings, or individuals stationed at the entrance to the active disposal room when ventilation rates are below 35,000 scfm unless measures as described in Section O-3c(1) are implemented. Note: As provided in Section O-3c(2) entry to restricted access active rooms for the purpose of establishing normal ventilation is allowed.

Shift: Those work shifts when there is normal access to the Waste Isolation Pilot Plant (**WIPP**) underground.

Worker: Anyone who has normal access to the WIPP underground.

O-2 Objective

The objective of this plan is to describe how the ventilation requirements in the Permit will be met. This plan achieves this objective and documents the process by which the Permittees demonstrate compliance with the ventilation requirements by:

- Maintaining a minimum of 35,000 scfm of air through the active rooms when waste disposal is taking place and when workers are present in the rooms
- If an active room ventilation rate of 35,000 scfm cannot be met, actions as described in Section O-3c(1) shall be taken during waste disposal operations when workers are present.

1 This plan contains the following elements: Objective; Design and Procedures; Equipment
2 Calibration and Maintenance; Reporting and Record Keeping; Quality Assurance.

3 O-3 Design and Procedures

4 This section describes the four basic processes that make up the mine ventilation rate
5 monitoring plan:

- 6 • Test and Balance, a periodic re-verification of the satisfactory performance of the entire
7 underground ventilation system and associated components
- 8 • Monitoring of active room(s) to ensure a minimum flow of 35,000 scfm whenever waste
9 disposal is taking place and workers are present in the room
- 10 • If an active room ventilation rate of 35,000 scfm cannot be met, actions as described in
11 Section O-3~~be~~(1) shall be taken during waste disposal operations when workers are
12 present.

13 ~~• Verification of the total mine airflow~~

14 O-3a Test and Balance

15 O-3a(1) Test and Balance Process

16 The WIPP ventilation system and the underground ventilation modes of operation are described
17 in Permit Application A2-2a(3). The Permittees shall verify underground ventilation system
18 performance by conducting a periodic Test and Balance. The Test and Balance is a
19 comprehensive series of measurements and adjustments designed to ensure that the system is
20 operating within acceptable design parameters. The Test and Balance is an appropriate method
21 of verifying system flow because it provides consistent results based on good engineering
22 practices. The testing of underground ventilation systems is described in McPherson, 1993.
23 Once completed, the Test and Balance data become the baseline for underground ventilation
24 system operation until the next Test and Balance is performed.

25 The "Test" portion of the process shall involve measuring the pressure drop and air quantity of
26 every underground entry excluding alcoves or other dead end drifts. In addition, the tests shall
27 verify resistance curves for each of the main regulators, measure shaft resistance, and measure
28 main fan pressure and quantity. This is done at the highest achievable airflow to facilitate
29 accurate measurements. From these measurements the frictional resistance of the system is
30 determined.

31 Pressure shall be measured using the gage and tube method, which measures the pressure
32 drop between two points using a calibrated pressure recording device and pitot tubes. Pressure
33 drops across the shafts shall be measured by either calibrated barometers at the top and
34 bottom of shafts or the gage and tube method. Airflow shall be measured using a calibrated
35 vane anemometer to take a full entry traverse between system junctions. Fan pressure shall be
36 measured using a calibrated pressure recording device and pitot tube to determine both static
37 and velocity pressure components.

1 Multiple measurements shall be taken at each field location to ensure accurate results.
2 Consecutive field values must fall within $\pm 5\%$ to be acceptable. These data shall be verified
3 during the testing process by checking that:

- 4 • the sum of airflows entering and leaving a junction is equal to zero; and,
- 5 • the sum of pressure drops around any closed loop is equal to zero.

6 Once the measurements are taken, data shall be used to calculate the resistance of every
7 underground drift, as well as shafts and regulators using Atkinson's Square Law

$$8 \quad P = R \times Q^2$$

9 where the pressure drop of an entry (P) is equal to a resistance (R) times the square of the
10 quantity of air flowing (Q) through the circuit.

11 The "Balance" portion of the process shall involve adjusting the settings of the system fans and
12 regulators to achieve the desired airflow distribution in all parts of the facility for each mode of
13 operation. The system baseline settings for the current Balance shall be established from the
14 previous Test and Balance. Adjustments shall then be made to account for changes in system
15 resistance due to excavation convergence due to salt creep, approved system modifications, or
16 operational changes.

17 The Permittees shall use a commercially available ventilation simulator to process Test and
18 Balance field data. The simulator uses the Hardy-Cross Iteration Method (McPherson, 1993) to
19 reduce field data into a balanced ventilation network, including the appropriate regulator settings
20 necessary to achieve proper airflow distribution for the various operating modes. Once
21 balanced, the same simulator shall be used to evaluate changes such as future repository
22 development and potential system modification before they are implemented.

23 The Test and Balance process culminates in a final report which is retained on site. Following
24 receipt of the Test and Balance Report, the Permittees shall revise the WIPP surface and
25 underground ventilation system procedures to incorporate any required changes to the
26 ventilation system configuration. The Test and Balance data shall be used to adjust the
27 operating range of fan controls, waste tower pressure, auxiliary air intake tunnel regulator
28 settings, underground regulator settings, and door configurations. The model data and
29 procedure changes shall be used to establish normal configuration settings to achieve the
30 desired airflow in the underground. These settings shall then be modified by operations
31 personnel throughout the year to compensate for system fluctuations caused by seasonal
32 changes in psychrometric properties, and to meet specific operational needs. This ensures that
33 the facility is operated at the design airflow rate for each ventilation mode.

34 O-3a(2) Test and Balance Schedule

35 The Test and Balance is generally conducted on a 12- to 18-month interval, but in no case shall
36 the interval between consecutive Test and Balance performances exceed 18 months. This
37 interval is sufficient to account for changes in the mine configuration since over this period the
38 ventilated volume changes very little. The quality and maintenance of ventilation control
39 structures (e.g., bulkheads) is excellent, so leakage is small and relatively constant. Historic test
40 and balance results confirm that changes between test and balances fall within anticipated
41 values.

1 ~~O-3b~~ Total Mine Airflow

2 ~~O-3b(1)~~ Monitoring Total Mine Airflow

3 ~~The Permittees shall use the Central Monitoring Room Operator's (CMRO) Log to monitor total~~
4 ~~mine airflow. Run times for the various modes of operation shall be entered into the CMRO Log.~~
5 ~~For example, if the CMRO Log indicates that the ventilation system was configured for Alternate~~
6 ~~Mode (one main fan) at 8:00 am, and that this configuration was maintained until 11:30 am, a~~
7 ~~total of 3.5 hours of run time in Alternate Mode would be recorded. Run times are recorded to~~
8 ~~the nearest quarter hour. The CMRO shall record each time when the ventilation system~~
9 ~~configuration is changed, including periods when there is no ventilation.~~

10 O-3**be** Active Room Minimum Airflow

11 O-3**be**(1) Verification of Active Room Minimum Airflow

12 Whenever workers are present, the Permittees shall verify the minimum airflow through active
13 room(s) when waste disposal is taking place of 35,000 scfm at the start of each shift, any time
14 there is an operational mode change, or if there is a change in the ventilation system
15 configuration. If an active room ventilation rate of 35,000 scfm cannot be met, measures such
16 as those described below shall be taken during waste disposal operations when workers are
17 present.

18 Measures to allow waste emplacement in an active room when, under abnormal conditions,
19 35,000 scfm cannot be achieved will be prescribed in standard operating procedure(s)
20 described in Section 0-5c. These measures may include, but are not limited to, the following: the
21 adjustment of the volatile organic compound (VOC) immediately dangerous to life or health
22 (IDLH)-based action levels in the Permit, Section 4.6.3.2 (these adjustments are directly
23 proportional to the actual flow rate that is less than 35,000 scfm); or the use of personal
24 protective equipment (PPE) as described in Occupational Safety and Health Administration
25 (OSHA) Standard 29 CFR 1910.134.

26 Implementing measures taken at the WIPP facility regarding the 35,000 scfm ventilation rate
27 and associated details (i.e., date, start time, end time, and reason) will be recorded in the
28 Central Monitoring Room Operator's (CMRO) Log and reported to the New Mexico Environment
29 Department (NMED) as required by Section O-5a.

30 O-3**be**(2) Measurement and Calculation of the Active Room Airflow

31 The Permittees shall measure the airflow rate and use the room cross-sectional area to
32 calculate the volume of air flowing through a disposal room. The measurement of airflow shall
33 use a calibrated anemometer and a moving traverse (McPherson, 1993). Airflow measurements
34 shall be collected at an appropriate location, chosen by the operator to minimize airflow
35 disturbances, near the entrance of each active room. The excavation dimensions at the
36 measurement location are taken and the cross-sectional area is calculated. The flow rate is the
37 product of the air velocity and the cross-section area. The value shall be entered on a log sheet
38 and compared to the required minimum. The format and content of the log sheet may vary, but
39 will always contain the following data and information as applicable:

- 1 • Date
- 2 • Time
- 3 • Ventilation flow rate reading
- 4 • If the required minimum ventilation rate was achieved
- 5 • If the room was restricted
- 6 • If Section O-3~~be~~(1) measures will be implemented (implementing procedure and revision
7 number, if applicable)
- 8 • The reason for waste emplacement under 35,000 scfm ventilation rate, if applicable
- 9 • Signature

10 Working values are in acfm and the conversion to scfm is described in section O-1 above.
11 Measurements shall be collected, recorded, and verified by qualified operators.

12 The operator shall compare the recorded acfm value with the minimum acfm value provided at
13 the top of the log sheet. The airflow shall be re-checked and recorded whenever there is an
14 operational mode change or a change in ventilation system configuration. Once the ventilation
15 rate has been recorded and verified to be at least the required minimum, personnel access to
16 the room is unrestricted in accordance with normal underground operating procedures. If the
17 required ventilation rate cannot be achieved, or cannot be supported due to operational needs,
18 access to the room shall be restricted. Those periods when active disposal room access is
19 restricted shall be documented on the log sheet for that active disposal room. Entry to restricted
20 access active rooms for the purpose of establishing normal ventilation or for emplacing waste
21 under the conditions identified in Section O-3~~be~~(1) is allowed. Such entry shall be documented
22 on the log sheet including a reference to the SOP used.

23 ~~O-3d — Verification of Total Mine Airflow~~

24 ~~The Permittees shall perform a verification of the total mine airflow to ensure that rates~~
25 ~~established by the Test and Balance for various operational modes are reasonably maintained.~~
26 ~~These checks are identified in Permit Attachment E, Table E-1, and are performed as indicated~~
27 ~~in Table E-1.~~

28 O-4 Equipment Calibration and Maintenance

29 Equipment used for the periodic Test and Balance, ~~flow verification checks~~, and daily
30 verification of active disposal room flow rate shall be calibrated in accordance with appropriate
31 WIPP calibration and data collection procedures. Work performed by subcontractors shall also
32 be calibrated to an equivalent standard. Equipment shall be inspected before each use to
33 ensure that it is functioning properly and that the equipment calibration is current. Maintenance
34 of equipment shall be completed by qualified individuals or by qualified off-site service vendors.

35 Equipment used to conduct the Test and Balance, ~~Verification of Total Mine Airflow~~, and to
36 determine the airflow through the active disposal room(s) are provided in Table O-~~21~~.

1 O-5 Reporting and Recordkeeping

2 O-5a Reporting

3 The Permittees shall submit an annual report to NMED presenting the results of the data and
4 analysis of the Mine Ventilation Rate Monitoring Plan. In the years that the Test and Balance is
5 performed, the Permittees will provide a summary of the results in the annual report.

6 The Permittees shall evaluate compliance with the minimum ventilation rate for an active room
7 specified in Permit Section 4.5.3.2 on a monthly basis. The Permittees shall report to the
8 Secretary in the annual report specified in Permit Section 4.6.4.2 whenever the evaluation of the
9 mine ventilation monitoring program data identifies that the ventilation rate specified in Permit
10 Section 4.5.3.2 has not been achieved. The Permittees will identify the implementing measures
11 as described in Section O-3c(1) used to allow waste handling activities to proceed when the
12 35,000 scfm ventilation rate is not achieved. These implementing measures and associated
13 details (i.e., date, start time, end time, and reason) will be reported to NMED in the annual Mine
14 Ventilation Rate Monitoring Report required by this section.

15 The Permittees shall also notify NMED by e-mail within 15 calendar days of commencement of
16 waste emplacement operations taking place below 35,000 scfm. The notification shall include
17 the date, start time, end time, reason and implementing measure taken, as applicable. If the
18 Permittees have not completed the waste emplacement activity by the time of this notification, a
19 follow-up e-mail shall be provided within 15 calendar days to notify NMED of the end of the
20 waste emplacement activity and other relevant information not previously provided.

21 O-5b Recordkeeping

22 The Permittees shall retain the following information in the Operating Record:

- 23 • The CMRO Log documenting the ventilation system operating mode.
- 24 • Active disposal room log sheet documenting the ventilation flow rate readings and
25 applicable information listed in Section O-3c(2).
- 26 • The flow verification check and associated documentation.

27 These records will be maintained in the facility Operating Record until closure of the WIPP
28 facility.

29 O-5c Standard Operating Procedure Applicable to Abnormal Operating Conditions for Active
30 Room Ventilation Flow Rate

31 The abnormal operating conditions procedure provides instructions necessary to evaluate VOC
32 concentrations in an adjacent filled room prior to commencing waste emplacement operations in
33 an active disposal room when workers are present at a reduced active room ventilation flow
34 rate. Abnormal conditions that may prevent 35,000 scfm from being met, may include, but are
35 not limited to, barometric pressure changes, maintenance activities, and equipment
36 malfunctions. VOC data in the adjacent filled room are collected and analyzed in accordance
37 with Permit Part 4, Section 4.6.3. Adjusted VOC action levels are prescribed at a maximum of
38 5,000 scfm increments (e.g., 30,000 scfm, 25,000 scfm, 20,000 scfm, 15,000 scfm, and 10,000

1 scfm) to provide a means of assessment. When the measured flow rates falls between the
2 increment values in the SOP, the lower flow rate is used for determining the adjusted VOC
3 action level. The validated VOC monitoring data are compared to the action levels prescribed in
4 the standard operating procedure and a decision flow path is provided to the Facility Shift
5 Manager, or designee, to determine applicable actions.

6 These actions include, but are not limited to, commencing waste emplacement operations at a
7 reduced active room ventilation flow rate based on the adjusted VOC action levels, commencing
8 waste emplacement operations at a reduced active room ventilation flow rate with the use of
9 PPE as described in OSHA standard 29 CFR 1910.134, or restricting access to the active
10 disposal room until the ventilation flow rate requirements of Permit Part 4, Section 4.5.3.2. are
11 met. As stated in the abnormal operating conditions procedure, implementing measures taken
12 at the WIPP facility are recorded in the CMRO Log and reported to NMED as required by
13 Section O-5a.

14 O-6 Quality Assurance

15 Quality assurance associated with the Mine Ventilation Rate Monitoring Plan shall comply with
16 the requirements of the WIPP Quality Assurance Program Description (**QAPD**). The Permittees
17 shall verify the qualification of personnel conducting ventilation flow measurements. The
18 instrumentation used for monitoring active disposal rooms shall be calibrated in accordance with
19 the applicable provisions of the WIPP procedures. The ventilation simulation software programs
20 shall be controlled in accordance with the WIPP QAPD and WIPP computer software quality
21 assurance plans.

22 Data generated by this plan, as well as records, and procedures to support this plan shall be
23 maintained and managed in accordance with the WIPP QAPD. Nonconformance or conditions
24 adverse to quality as identified in performance of this plan will be addressed and corrected as
25 necessary in accordance with applicable WIPP Quality Assurance Procedures.

26

REFERENCES

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McPherson, M. J., 1993. *Subsurface Ventilation and Environmental Engineering*, Chapman & Hall, London, First Edition.

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TABLES

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**TABLE O-4
 VENTILATION OPERATING MODES AND ASSOCIATED FLOW RATES**

MODE OF OPERATION	FLOW RATE (SCFM) NOMINAL DESIGN VALUES
NORMAL (TWO MAIN FANS)	425,000
ALTERNATE (ONE MAIN FAN)	260,000
MAINTENANCE BYPASS [PARALLEL OPERATION OF MAIN FAN(S) AND FILTRATION FAN(S)]	260,000 TO 425,000
REDUCED (TWO FILTRATION FANS)	120,000
MINIMUM (ONE FILTRATION FAN)	-60,000
FILTRATION (ONE FILTRATION FAN OR ONE IVS FAN)	-60,000 OR 23,000
FILTRATION (ONE FILTRATION FAN AND ONE IVS FAN OR TWO IVS FANS)	83,000 OR 43,000
FILTRATION (ONE FILTRATION FAN AND TWO IVS FANS)	106,000

**TABLE O-21
 Mine Ventilation Rate Testing Equipment**

Equipment Used to Conduct Test	Ventilation Test Performed		
	Test and Balance	Active Disposal Room(s)	Flow Verification Check
Calibrated Anemometer	X	X	
Calibrated Differential Pressure Sensor	X		
Pitot Tubes	X		✘
Tubing	X		✘
Temperature Sensing Device	X		✘
Relative Humidity Sensor	X		✘
Calibrated Barometers	X		✘
Electronic Manometer	X		✘

