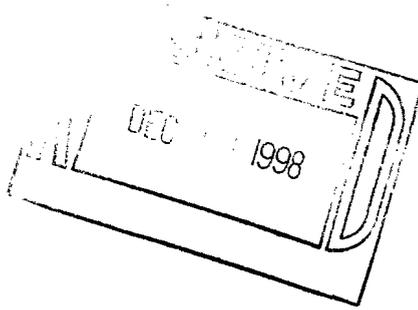


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**UNDERGROUND  
HAZARDOUS WASTE MANAGEMENT UNIT  
CLOSURE CRITERIA FOR THE  
WASTE ISOLATION PILOT PLANT  
OPERATIONAL PHASE**

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**Prepared for  
United States Department of Energy**

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**Table of Contents**

	<u>Page</u>
<b>1.0 Introduction</b> .....	1
<b>2.0 Performance Criteria - Unit Closure</b> .....	2
<u>2.1 Flammable Gas</u> .....	2
2.1.1 Occupational .....	2
2.1.2 Environmental .....	2
2.1.3 Discussion .....	3
<u>2.2 Volatile Organic Compounds</u> .....	3
2.2.1 Occupational .....	3
2.2.2 Environmental .....	3
2.2.3 No-Migration .....	4
2.2.4 Discussion .....	5
<u>2.3 Other Criteria</u> .....	6
<b>3.0 Design Criteria - Unit Closure</b> .....	6
<b>4.0 Quality Assurance/Quality Control</b> .....	7
<b>5.0 Monitoring</b> .....	7

**List of Appendices**

Appendix 1 - Design Parameters Guidance ..... 8

Appendix 2 - References ..... 9

**Underground Hazardous Waste Management Unit  
Closure Criteria for the Waste Isolation Pilot Plant  
Operational Phase**

## **1.0 Introduction**

The purpose of this paper is to provide guidance, performance criteria and design criteria, and definition of regulatory requirements specific to closure of portions of the underground facility where waste disposal operations are complete. "Closed portion", as defined in Title 40 Code of Federal Regulations (CFR) Part 260, Hazardous Waste Management System: General, means "...that portion of a facility which an owner or operator has closed in accordance with the approved facility closure plan and all applicable requirements." This paper is focused on operational phase closure requirements of Resource Conservation and Recovery Act (RCRA) Part B Permit Application, RCRA No-Migration Variance Petition, and 40 CFR 191 Subpart A, Environmental Standards for Management and Storage. Facility closure criteria specific to long-term performance will be developed through the Performance Assessment (PA) process. While operational and long-term closure design features are for the most part separate and discrete, some design features may prove to impact upon each other.

Section 1.0 describes the purpose and scope of this paper. Sections 2.0 and 3.0 identify performance criteria and design criteria, respectively. Section 2.0 also presents information for volatile organic compound (VOC)/flammable gas, and addresses occupational/environmental considerations. These two sections additionally describe the basis for criteria identified and the requisite level of supporting regulatory discussions. Sections 4.0 and 5.0 provide general guidance for Quality Assurance/Quality Control (QA/QC) and Monitoring aspects of closure.

Operational phase closure activities will focus on environmental performance standards established at WIPP, and the compliance of the panel closure system with those standards. Appendix 1 contains additional guidance on select design parameters.

Consideration has been given to the potential for migration of hazardous constituents through the soil, hydrologic, geologic and containing structures. During the operating phase of the Waste Isolation Pilot Plant (WIPP), no credible migration pathway for hazardous constituents or radionuclide contaminants has been identified, other than through airborne transport (WIPP Final Safety Analysis Report, Rev 0, May 1990,). Therefore, control of ambient mine air and its contents will sufficiently demonstrate compliance to the applicable environmental performance standards during the operational phase of the facility. The Operational Phase of disposal is planned to be complete 25 years after waste disposal begins, and final closure is planned to be complete within 10 years of disposal completion; the resulting duration for air pathway migration analysis will be 35 years.

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## 2.0 Performance criteria - Unit Closure

### 2.1 Flammable Gas

#### 2.1.1 Occupational

From a performance criteria standpoint, minimum occupational health requirements for repository operations are, in part, set forth in 30 CFR 57, Safety and Health Standards - Underground Metal and Non-Metal Mines, and DOE Order 5480.7A, Fire Protection.

#### 2.1.2 Environmental

Subpart C of 40 CFR 264 requires that: "Facilities must be designed, constructed, maintained and operated to minimize the possibility of a fire, explosion, or any unplanned sudden or non-sudden release of hazardous waste or hazardous waste constituents to air, soil or surface water which could threaten human health or the environment."

Subpart D of 40 CFR 264 requires that: "Each owner or operator must have a contingency plan for his facility. The contingency plan must be designed to minimize hazards to human health or the environment from fires, explosions, or any unplanned sudden or non-sudden release of hazardous waste or hazardous waste constituents to air, soil or surface water." Furthermore, 40 CFR 264.51 Subpart D, Paragraphs a and b, require that: "the provisions of the plan must be carried out immediately whenever there is a fire, explosion, or release of hazardous waste or hazardous waste constituents which could threaten human health or the environment."

### 2.1.3 Discussion

The purpose of many environmental regulations is to ensure that measures are taken to prevent the occurrence of accidents such as explosions or fires that could result in a release or a threat of release of hazardous constituents or radionuclide contaminants. These operational regulatory requirements are not aimed at regulating releases that could occur in the event of an accident, but are instead concerned with the prevention of that accident. Other portions of the operational regulations require that contingency plans be developed to address the occurrence of an accident. If it can be demonstrated that the consequence or likelihood of such an accident scenario is unlikely, the applicable regulatory requirements are limited to contingency planning.

In general the RCRA standards are designed to require waste management practices to prevent conditions that could lead to events threatening or causing releases. This design was emphasized during negotiations for the Test Phase No-Migration Determination, when the EPA (as prompted by the public) expressed concern over the potential buildup of flammable gases. The public argued that if a container exploded, there would be a release of hazardous constituents and possibly migration from the unit. A justified case must be made that, realistically, there will be no explosion or fire in a closed hazardous waste management unit that will result, in turn, in a loss of isolation between active areas and closed areas.

## 2.2 Volatile Organic Compounds

### 2.2.1 Occupational

Occupational hazards associated with VOCs during normal waste emplacement are expected to be mitigated through dilution by ventilation, incidental to current underground operations; a safety analysis must address this. Occupational exposures to VOCs will be managed in accordance with DOE Order 5480.10A, Contractor Industrial Hygiene Program.

### 2.2.2 Environmental

Subpart X of 40 CFR 264, Miscellaneous Unit, includes requirements that are applicable to owners and operators that treat, store, or dispose of hazardous waste in miscellaneous units. Since the WIPP underground waste management units are categorized as miscellaneous units, the environmental performance standards set forth in Subpart X, specifically in

264.601(c) (1) & (2), are applicable:

"Prevention of any release that may have adverse effects on human health or the environment due to the migration of waste constituents in the air, considering:

- (1) The volume and physical and chemical characteristics of the waste in the unit, including its potential for the emission and dispersal of gases, aerosols and particulates;
- (2) The effectiveness and reliability of systems and structures to reduce or prevent emissions of hazardous constituents to the air."

### 2.2.3 No-Migration

40 CFR 268.6 requires that a facility petition the EPA for a variance from the land disposal restrictions (LDR) if the hazardous waste to be disposed of in the land is not to be treated to LDR standards. The DOE has chosen not to treat the waste to be disposed of at WIPP, but instead to isolate it from the environment. Subsequently, the DOE must petition the agency for a variance from the restrictions, demonstrating to a reasonable degree of certainty that no-migration of hazardous constituents will occur beyond the unit boundary, above health-based levels, for as long as the waste remains hazardous.

Since there are many uncertainties in demonstrating no-migration, such as waste characterization analysis, model analysis, and so on, the EPA has granted no-migration variances for land disposal based on demonstrations being within one order-of-magnitude of health-based levels. The EPA stated in the Federal Register Final Notice to grant Exxon a variance (58 FR 40144):

"Nevertheless, EPA acknowledges that waste variability is a legitimate concern, particularly where modeled releases are within an order of magnitude of an HBL. Therefore, as a condition of today's decision, EPA is restricting the total mass of benzene that may be placed on the NSLTU to the amount used by Exxon in its modeling."

The EPA also stated in the Federal Register Final Notice to grant DOE a variance (55 FR 47700):

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"Nevertheless, even if these data underestimate the constituent concentrations by as much as an order of magnitude, the concentration of constituents at the unit boundary are still expected to be below health-based levels."

"The compliance point concentrations (with the carbon adsorption control device installed in the bin discharge system) are an order of magnitude below the level of regulatory concern for carbon tetrachloride and are two to seven orders of magnitude below any other level of regulatory concern."

Since the No-Migration standard does not apply at WIPP until a Hazardous Waste Management Unit (HWMU) is closed, the no-migration demonstration only applies to closed units. Subsequently, the main focus on demonstrating no-migration will be on the design of the HWMU closure system. A successful demonstration will show that releases from all closed HWMUs at no time will result in hazardous constituent levels within one order-of-magnitude of health-based levels at the WIPP Land Withdrawal Boundary.

#### 2.2.4 Discussion

A major thrust of environmental regulations is to ensure measures are taken to preclude accidents that would result in a release or a threat of release of hazardous constituents or radionuclide contaminants. These regulations are not aimed at regulating releases which could result from such an accident, only the prevention of that accident. Other portions of the regulations require contingencies should an accident occur. If it can be demonstrated that the consequence or likelihood of such an accident scenario is unlikely, the applicable regulatory requirements are limited to contingency planning.

The RCRA standards in general, are designed to require waste management practices that prevent conditions that could lead to accidental events which could threaten or cause release.

A closure system is expected to be designed to prevent the release of hazardous constituents at levels that could exceed health-based levels at the land withdrawal boundary. Appendix 1, Table B, provides average headspace concentrations and health-based levels of the nine hazardous constituents that make up more than 99% of the health-based risk.

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### 2.3 Other Criteria

Subpart A of 40 CFR 191 Environmental Standards for Management and Storage, specifically 191.03(b), for normal operations, stipulates that operations are to be conducted in a manner that provides reasonable assurance that the combined annual dose equivalent to any member of the public in the general environment shall not exceed 25 millirem to the whole body, and 75 millirem to any other critical organ.

Subpart A of 40 CFR 191 provides environmental radiation protection standards for the management and disposal of transuranic (TRU) waste for normal operations. Under 191.03(b), Standards, the requirements are presented such that a "reasonable assurance" be provided. This infers that the assurance provided by a closure system (if any is needed at all, from the standpoint of Subpart A) be considered in a safety analysis.

### **3.0 Design Criteria - Unit Closure**

Closure is the process of rendering a portion of the underground repository (a Hazardous Waste Management Unit) inactive and closed in accordance with approved facility closure plans. As stated in 40 CFR 264.113(b), Closure; Time Allowed for Closure: "The owner or operator must complete partial and final closure activities in accordance with the approved closure plan and within 180 days after receiving the final volume of hazardous wastes, or the final volume of non-hazardous waste...." The design goal is for a panel closure system that can be emplaced within 180 days. Final closure will also be required to address the radioactive aspects of the decontamination and decommissioning (D&D) activities.

The panel closure system performance should comply with environmental performance standards for the release of VOCs established at WIPP. The closure system design basis will consider migration mechanisms, such as creep closure, overpressure resulting from gas generation, differential pressures induced by the repository ventilation system, and diffusion of VOCs through the closure system.

The WIPP disposal phase operations are currently planned for 25 years, with an additional ten years allowed for shaft closures. Therefore, the initial operational phase closure system components will have a minimum design life of 35 years.

Closure system construction materials must be compatible with the expected long-term performance of the repository. The closure system will be designed in such a way as to not detract from the performance of long-term seals. The closure system materials should also be of substantial construction to isolate the active workings from the closed areas.

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Closure performance standards as cited from 264.111 require the following:  
"The owner or operator close the facility in a manner that:

- (a) Minimizes the need for further maintenance; and
- (b) Controls, minimizes or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of hazardous waste, hazardous constituents, ... or hazardous waste decomposition products ... to the atmosphere."

#### **4.0 Quality Assurance/Quality Control**

General facility design and construction control requirements apply to all design and construction activities involved in HWMU closures, including construction materials. A failure of a closure system component could result in stopping waste handling and disposal operations and increase the potential for contamination. The design class of the closure system will be determined in accordance with WIPP procedures and subsequent QA/QC requirements relative to that design class will apply.

#### **5.0 Monitoring**

Although the EPA may require monitoring at WIPP in a No-Migration Determination, no monitoring related to the closure system design is currently required for the submittal of the NMVP.

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**Appendix 1 - Design Parameters Guidance**

- An estimate of expected gas generation rates during the operational phase of the facility is being developed, or has been developed in the following document:

Brush, L.H. 1994. "Position Paper on Gas Generation in the Waste Isolation Pilot Plant," draft memorandum for internal WIPP review, September 6, 1994.

Table A - Gas Generation Rates in a Humid Environment (Brush, 1994)

Process	Minimum (moles/drum/year)	Best Estimate (moles/drum/year)	Maximum (moles/drum/year)
Microbial Degradation	0	0.1	1.0
Anoxic Corrosion	0	0	0.06
Total	0	0.1	1.06

- Best estimates of true rate of volumetric change in a closed area will be considered in the design process. At a minimum, volumetric change rate should be considered in terms of a potential driving force for hazardous constituents from the closed units during the operational phase.
- Preliminary average head space concentrations and current health-based levels of nine indicator hazardous constituents are provided in Table B.

Table B - Weighted Average Headspace Concentrations and Health-Based Levels (Head Space Data from RFP and INEL Data)

Chemical	Headspace Concentration (mg/m <sup>3</sup> )	Headspace Concentration (ppmv)	35 year Health-Based Level (HBL) for Air (µg/m <sup>3</sup> )
Carbon Disulfide	0.41	0.13	10.0
Carbon Tetrachloride	3625.77	568.0	0.13
Chlorobenzene	63.99	13.7	20.0
Chloroform	76.79	15.5	0.09
1,1-Dichloroethylene	48.68	12.1	0.4
Methyl Ethyl Ketone	241.73	80.8	1000.0
Methylene Chloride	3387.03	960.1	4.26
1,1,2,2-Tetrachloroethane	69.65	10.0	0.35
Toluene	105.51	27.6	400.0

## Appendix 2 - References

- Code of Federal Regulations Title 30, Part 57, *Safety and Health Standards - Underground Metal and Non-Metal Mines*
- Code of Federal Regulations Title 40, Part 191, *Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes*
- Code of Federal Regulations Title 40, Part 260, *Hazardous Waste Management System: General*
- Code of Federal Regulations Title 40, Part 260, Subpart X, *Miscellaneous Units*
- Code of Federal Regulations Title 40, Part 264.601, *Environmental Performance Standards*
- Code of Federal Regulations Title 40, Part 268.6, *Petitions to Allow Land Disposal of a Waste Prohibited Under Subpart C or part 268*
- U. S. Department of Energy, May 1990. *Final Safety Analysis Report for the Waste Isolation Pilot Plant*, WP 02-9.
- U. S. Department of Energy, DOE Order 5480.7A, *Fire Protection*
- U. S. Department of Energy, DOE Order 5480.10A, *Contractor Industrial Hygiene Program*
- U. S. Environmental Protection Agency (EPA), 1990. *Conditional No-Migration Determination for the Department of Energy Waste Isolation Pilot Plant (WIPP)*, Federal Register, Volume 55, No. 220, p. 47700, November 14, 1990, EPA Office of Solid Waste and Emergency Response, Washington, D. C.
- U. S. Environmental Protection Agency (EPA), 1990. *No-Migration Variance From Land Disposal Restrictions for Exxon Company, U.S.A., Billings, Montana, New South Land Treatment Unit*, Federal Register, Volume 58, No. 142, p. 40134, July 27, 1993, EPA Office Solid Waste and Emergency Response, Washington, D. C.
- Brush, L.H. 1994. *Position Paper on Gas Generation in the Waste Isolation Pilot Plant*, Draft, September 6, 1994.