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Periodic Confirmatory Measurement Protocol for the Waste Isolation Pilot Plant

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United States Department of Energy
Waste Isolation Pilot Plant

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ACRONYMS AND ABBREVIATIONS

AL	action level
Am	americium
CFR	*Code of Federal Regulations*
CH	contact-handled
DOE	U.S. Department of Energy
dpm	disintegrations per minute
EDE	effective dose equivalent
EPA	U.S. Environmental Protection Agency
FAS	fixed air sampler
HEPA	high-efficiency particulate air (filter)
MOU	Memorandum of Understanding
mrem	millirem
PCM	periodic confirmatory measurement
Pu	plutonium
Sr	strontium
WAC	Waste Acceptance Criteria
WHB	Waste Handling Building
WIPP	Waste Isolation Pilot Plant
WWIS	WIPP Waste Information System
yr	year

1.0 INTRODUCTION

This document describes the periodic confirmatory measurement (PCM) protocol that will be used to satisfy the requirements of the Memorandum of Understanding (MOU) between the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA). The MOU commits the Waste Isolation Pilot Plant (WIPP) to complying with Title 40 *Code of Federal Regulations* (CFR) Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities," until such time as the underground repository closure is complete. This program also satisfies the requirements of 40 CFR Part 191, Subpart A, "Environmental Standards for Management and Storage," for PCM sampling.

Title 40 CFR §61.93 requires sampling at release points which could cause an effective dose equivalent (EDE) in excess of 1% of the 10 millirem (mrem)/year (yr). Since during normal operations WIPP is not expected to release any radioactive materials other than naturally occurring elements, only PCMs are performed to verify the low emissions. If WIPP remains below 0.1 mrem per year, the dose limits in 40 CFR Part 191, Subpart A, will also be met.

Title 40 CFR Part 191, Subpart A, guidance requires monitoring or dose modeling for unplanned releases and/or accidents. This will be accomplished using the PCMs, in that WIPP will use all representative samples for the analysis of material released from the site. If necessary, fixed air sampler (FAS) filters and/or continuous air monitor filters in the area may be used to determine release levels. WIPP procedures and statements of work will provide analyses of filters during normal and off-normal events. In the unlikely event that representative samples are not available, a conservative estimate of release, based on all available information about the accident, will be used to perform dose calculations.

2.0 CLASSIFICATION OF RELEASE POINTS

Effluent air can be exhausted from three locations at the WIPP site: (1) the unfiltered exhaust from the underground repository sampled at Station A; (2) the normally filtered exhaust sampled at Station B, although when the mine ventilation system is used in maintenance, bypass, minimum, or reduced modes, Station B is redundant to Station A; and (3) the filtered exhaust from the Waste Handling Building (WHB) sampled at Station C. Current sampling locations and methods do not preclude the use of different sampling locations and/or methods in the future. Effluent from the underground is normally vented without filtration with Station A as the sampling point for the exhausted air. However, the effluent stream can be manually or automatically switched to filtration and Station B is then the sampling point for all air exhausted from the underground. Station A-3 sampler is automatically stopped when the exhaust is switched through the high-efficiency particulate air (HEPA) filters.

3.0 MEASUREMENT PROTOCOL

The radionuclides analyzed in the air effluent monitoring program are limited to plutonium-238 (^{238}Pu), $^{239/240}$Pu, americium-241 (^{241}Am), and strontium-90 (^{90}Sr) for contact-handled (CH) waste handling process, as determined, using the Summary Radionuclide Inventory, Table ES-5 from DOE/CAO-95-1121, *Transuranic Waste Baseline Inventory Report*. These elements constitute approximately 98% of the dose due to the average source term for CH waste. During accident analysis and recovery, the individual container constituents as listed in the WIPP Waste Information System (WWIS) database will be used to determine what radionuclides will be analyzed for in the samples collected during the event.

Filters will be analyzed for gross alpha and beta activity. The filters will be collected from each station as often as necessary to maintain the desired flow rate during normal working hours. For Station A, this is currently several times a day during underground mining activities. Station B and C filters are generally exchanged once a week. The filters are held for a minimum of three days prior to gross alpha and beta counting to allow for the decay of radon daughters. Action Levels are 10% of the value determined to expose the public to 0.1 mrem/yr. The calculations for determining the Action Levels can be found in Attachment 1, Action Level Calculations. The Action Level for alpha is 6 disintegrations per minute (dpm) per day and for beta is 567 dpm/day. Radionuclides $^{239/240}$Pu and ^{90}Sr have the most restrictive dose consequence for alpha and beta respectively.

The Action Levels are reflected in the Radiological Control WIPP Statement of Work and Data Quality Objectives for Analysis of RadCon Samples by WIPP Laboratories, and can be easily met by the counting method employed. The statement of work requires that if a filter exceeds the Action Levels it will be immediately radiochemically analyzed to determine what constituents are present and Radiological Control management will be notified and will determine what actions are required.

The representative sample filters will be composited and analyzed monthly or quarterly depending upon the frequency of filter changes from each station. Generally, Station A will be monthly and Stations B and C will be quarterly. PCMs used to verify compliance with the standards are derived from radiochemical analysis of the air filters as opposed to the results obtained from the gross alpha/beta counting. At a minimum, WIPP will use one filter sample from each station as the PCM sample each sample period.

Specific details of the measurement process can be found in the following documents:

- WP 12-RC.01, Quality Assurance Program Plan for Sampling Emissions of Radionuclides to the Ambient Air at the Waste Isolation Pilot Plant
- WP 12-HP3500, Airborne Radioactivity
- WP 12-HP4000, Emergency Radiological Control Responses

- WP 12-RE3004, Periodic Confirmatory Sampling, Reporting, and Compliance Activities

- Radiological Control WIPP Statement of Work and Data Quality Objectives for Analysis of RadCon Samples by WIPP Laboratories

4.0 EFFLUENT MONITORING DURING NORMAL ACTIVITIES

Approved and controlled operating procedures are used at the WIPP facility to ensure that uniform methods are used to collect, package, and transport FAS filters. The use of such procedures provides a means for demonstrating quality assurance of air emission data. Station A FAS filters are collected as needed each working shift to assure a representative sample. Station B FAS filters are collected weekly and at the end of each underground effluent filtration event, or as needed. Station C FAS filters are collected weekly, or as needed. Filters from all three stations are typically analyzed for ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Am, and ^{90}Sr. The periodic composite samples will be summed to obtain a total quantity for each radionuclide released from each effluent point. These values will be used as input into the CAP88-PC program.

5.0 EFFLUENT MONITORING DURING KNOWN OR SUSPECTED RELEASES

If there is a known or suspected release in the WHB, the Station C filter will be exchanged and the filter will be radiochemically analyzed, providing the information necessary to quantify the activity released to the environment.

If there is a known or suspected release in the underground, the air is diverted through Station B and the filters from Stations A and B will be collected and radiochemically analyzed to provide the information necessary to quantify the activity released to the environment. This value is added to the routine composite sample values, for a yearly release value during the development of the compliance report.

6.0 FLOW RATE MEASUREMENTS

The WHB and underground repository ventilation systems were analyzed to determine the location of the sampling probes for each sampling station to ensure representative samples are obtained. In 1988, the Energy Systems Laboratory of Texas A&M University conducted tests using scale models of the WIPP exhaust airflow systems to recommend the locations for the shrouded sampling probes for Stations A and B, and to determine the expected velocity and particle concentration profiles at these locations. The DOE subsequently published the results of these tests in the following documents: DOE/WIPP 88-024, *Tests of Model Waste Isolation Pilot Plant (WIPP) Exhaust Airflow Systems*; DOE/WIPP 89-026, *Evaluation of the Station A Effluent Monitoring System in the Underground Exhaust Ventilation System at the Waste Isolation Pilot Plant*; and DOE/WIPP 89-027, *Evaluation of the Station B Effluent Monitoring System in the Underground Exhaust Ventilation System at the Waste Isolation Pilot Plant*. The study recommended the Station A sampling probe be located 1.5 stack diameters (21 feet) upstream of, or below, the exhaust duct elbow, and the Station B sampling probe be

located 11.5 stack diameters (69 feet) downstream of the final fan discharge to the exhaust duct. Additional tests were conducted on the effluent sampling systems at both Stations A and B after the probes were installed. The tests confirmed the appropriateness of single-point sampling.

The sampling point for Station C was designed according to the methodology specified by the American National Standards Institute Document, N13.1-1969, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities*.

The effluent flow rates in the filtered and unfiltered exhaust from the underground are continuously measured and the data is continuously transmitted to the WIPP Central Monitoring System where they are displayed and recorded.

The effluent flow rate from the WHB is monitored and recorded continuously as part of the isokinetic sampling system for the exhaust stream. To ensure the accuracy of flow rate, the flow control system is calibrated annually against a series of Pitot tube measurements at the Station C sampling location.

Sampler flow rates at all three effluent release points can be read at the respective samplers and are controlled electronically. Stations A, B, and C sampler flow rates are recorded electronically.

The sampler flow calibrations and effluent mass flow calibrations for Stations A, B, and C are performed using approved site procedures.

7.0 SOURCE-TERM COMPUTATIONS

The annual source term for the three release points at WIPP is calculated by summing the composited filter values indicating routine releases plus any accidental release and accounting for sample time and total stack flow. The process for determining the source term is detailed in WP 12-RE3004.

8.0 DOSE ANALYSIS

The source-term results from the PCMs will be used as input to the approved CAP88-PC computer program, which models the release of radionuclides to the environment and estimates EDE to the public. Title 40 CFR §61.93(a) and EPA Guidance 402-R-97-001, *Guidance for the Implementation of EPA's Standards for Management and Storage of Transuranic Waste (40 CFR Part 191, Subpart A) at the Waste Isolation Pilot Plant*, Section 2.7.2, recommend the use of CAP88-PC or other approved procedures to calculate EDE to members of the public.

The appropriate meteorological, population, and source-term data will be input to the CAP88-PC program. The resulting EDE will be compared to 1% of the dose limits in 40 CFR Part 61, Subpart H; and 40 CFR Part 191, Subpart A, to determine whether PCM continues to be appropriate for each release point. In the event that the CAP88-PC calculation indicates an off-site EDE in excess of the regulatory limits, WIPP

will begin calculating and reporting monthly off-site doses until directed otherwise by the EPA.

9.0 REFERENCES

Memorandum of Understanding Between the U.S. EPA and the U.S. DOE Concerning the Clean Air Act Emission Standards for Radionuclides 40 CFR § 61, Including Subparts H, I, Q & T. Signed by Mary D. Nichols, EPA Assistant Administrator for Air and Radiation: September 29, 1994. Signed by Tara O'Toole, DOE Assistant Secretary for Environment, Safety, and Health, April 5, 1995.

Title 40 CFR Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities"

Title 40 CFR Part 191, Subpart A, "Environmental Standards for Management and Storage"

EPA 402-R-97-001, *Guidance for the Implementation of EPA's Standards for Management and Storage of Transuranic Waste (40 CFR Part 191, Subpart A) at the Waste Isolation Pilot Plant*

American National Standards Institute Document N13.1-1969, *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities*

DOE/CAO-95-1121, *Transuranic Waste Baseline Inventory Report*

DOE/WIPP 88-024, *Tests of Model Waste Isolation Pilot Plant (WIPP) Exhaust Airflow Systems*

DOE/WIPP 89-026, *Evaluation of the Station A Effluent Monitoring System in the underground Exhaust Ventilation System at the WIPP*

DOE/WIPP 89-027, *Evaluation of the Station B Effluent Monitoring System in the Underground Exhaust Ventilation System at the WIPP*

WP 12-HP3500, Airborne Radioactivity

WP 12-HP4000, Emergency Radiological Control Responses

WP 12-RC.01, Quality Assurance Program Plan for Sampling Emissions of Radionuclides to the Ambient Air at the Waste Isolation Pilot Plant

WP 12-RE3004, Periodic Confirmatory Sampling, Reporting, and Compliance Activities

Radiological Control WIPP Statement of Work and Data Quality Objectives for Analysis of RadCon Samples by WIPP Laboratories

Attachment 1 - Action Level Calculations

Action levels are the threshold concentration of an effluent at which an appropriate action is to be performed. Calculation of the potential to discharge radionuclide emission rates from point sources is determined for the WIPP. The action levels are calculated using a combination of the CAP88-PC computer model output data and site specific data for the maximally exposed individual (MEI). The MEI is assumed to be located at 300 meters from the WIPP release point.

The NESHAP regulations require that calculations be made at all release points which have the potential to discharge radionuclides into the air in quantities which could cause an effective dose equivalent (EDE) in excess of 1% of the standard. The three potential release points identified at WIPP (i.e., Stations A, B, and C) are modeled by CAP88-PC computer model as if they were located at the same release point. Filters from all three stations are routinely analyzed for ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Am, and ^{90}Sr. The FAS filters are initially analyzed for gross alpha and gross beta activity.

Site specific data such as the average temperature, five-year meteorological data, and precipitation are used to calculate the yearly activity of each of the five radionuclides in units of Curies per year (Ci/yr), for the MEI to receive an EDE of 0.1 mrem per year at 300 meters. For a single day of activity on a filter, the activity is converted from Curies per year to disintegrations per minute per day (dpm/day) using the ratio of exhaust shaft flow rate (cfm) and average flow rate through the filter (cfm).

Sum of Activity [Curies/Year]

Yearly Activity Released from Stack (Ci/Yr)		**Average Sample Flow (cfm)/Effluent Flow (cfm)**	**Sample Time (min/yr)/Period Time (min/yr)**	**Sum of Activity on FASs (Ci/yr)**
^{241} Am	1.90×10^{-4}	2 / 425,000	525,600 / 525,600	8.94×10^{-10}
^{238} Pu	2.20×10^{-4}	2 / 425,000	525,600 / 525,600	1.04×10^{-09}
$^{239/240}$ Pu	2.00×10^{-4}	2 / 425,000	525,600 / 525,600	9.41×10^{-10}
^{90}Sr	2.00×10^{-2}	2 / 425,000	525,600 / 525,600	9.41×10^{-08}
Column A1, A2, A3, A4		Column B	Column C	Column D1, D2, D3, D4

Formulas are A1 X B X C = D1; A2 X B X C = D2; A3 X B X C = D3, and A4 X B X C = D4.

Attachment 1 - Action Level Calculations

Conversion of the Sum of Activity from Curies per year to Disintegrations per day yields the following:

Sum of Activity [Disintegrations per day]

Sum of Activity on FASs (Ci/yr)		Conversion (dpm/Ci)/(day/yr)	FAS Activity Limit (dpm/day)
^{241} Am	8.94×10^{-09}	$(2.2 \times 10^{12}/1)/(365)$	5.39 ~ 5
^{238} Pu	1.04×10^{-09}	$(2.2 \times 10^{12}/1)/(365)$	6.24 ~ 6
$^{239/240}$ Pu	9.41×10^{-10}	$(2.2 \times 10^{12}/1)/(365)$	5.67 **~ 6 (alpha)**
^{90}Sr	9.412×10^{-08}	$(2.2 \times 10^{12}/1)/(365)$	**567 (beta)**
Column A1, A2, A3, A4		Column B	Column C1, C2, C3, C4

Formulas are A1 X B = C1; A2 X B = C2; A3 X B = C3, and A4 X B = C4.

Action Levels for alpha activity on the filter is 6 dpm per day. The beta activity on the filter is 567 dpm per day. The result of these calculations indicate that if WIPP releases these activities at these action levels for 365 days, WIPP has released an EDE equal to 1% of the 10 mrem per year.