EGG-WM--9196

DE91 001887

TEST PLAN
FOR
PERSONNEL PROTECTIVE EQUIPMENT BUBBLE SUIT
DECONTAMINATION FEASIBILITY TEST

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May 1990

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Prepared for the
U. S. Department of Energy
Idaho Operations Office
Under DOE Contract No. DE-AC07-76ID01570

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TEST PLAN
FOR
PERSONNEL PROTECTIVE EQUIPMENT BUBBLE SUIT
DECONTAMINATION FEASIBILITY STUDY

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TEST PLAN
PERSONNEL PROTECTIVE EQUIPMENT BUBBLE SUIT
DECONTAMINATION FEASIBILITY TEST

1. INTRODUCTION

This test plan defines the details for performing a study to determine the feasibility of using a shower based system to decontaminate personnel protective equipment (PPE) bubble (encapsulation) suits worn by personnel as they are egressing a mixed-TRU contamination zone. The testing will be performed using an EPA rated Level A fully encapsulating suit. The person directly involved in the suit contamination and shower processes will be provided with Level A protection. This test plan provides a description of the test apparatus, provides details of the tests to be performed, defines the sampling procedures and controls, and defines the analytical methods for the samples collected. The test plan also discusses the data management and the reporting of the test result and the quality assurance and safety requirements for the study.

1.1 Background

The buried mixed-TRU waste cleanup operations will require personnel to enter contaminated zones to maintain equipment and to perform special case tasks. During entry, personnel must be protected from hazardous materials and TRU contamination; and therefore, must wear PPE. The primary contaminants, of concern for personnel during these activities are alpha-emitting radionuclides, primarily Pu-239 and Am-241. It is anticipated that these contaminants will be mobilized with the dust generated during the cleanup activities and the PPE will become covered with loose contaminants. As a result, there is risk of personnel contamination and uptake during the removal of the PPE. This risk could be reduced if the PPE is decontaminated prior to removal.

1.2 Objectives of a Decontamination Station

The primary objective of a decontamination station is to minimize the risk of alpha-emitting radionuclide contamination and uptake by personnel as the PPE are being removed. The secondary objective of a decontamination station is to minimize the risk of contamination spread from the contaminated zone to the clean area.

1.3 Scope of the Study

Two types of shower system will be tested in this study:

1. a drench shower based system and
2. a multi-nozzle based shower system.

After prerequisite and simulated scoping tests are performed to establish protocol and set test parameters, the general approach to the decontamination tests is to perform the following general steps:

1. Contaminate the PPE suit with dust containing low concentrations of Pu-239 and Am-241
2. Measure the PPE suit contamination levels prior to decontamination
3. Decontaminate the suit using the shower based system
4. Measure the PPE suit contamination levels after decontamination
5. Dry the suit using a towel, and
6. Measure the suit contamination levels after the suit is towelled dry.

These tests are primarily feasibility tests rather than design optimization tests. Therefore, parameters such as flow rates and time in the shower will be chosen following the scoping tests and prior to testing with contaminated soil.

1.4 Objectives of the Study

The objective of the study is to evaluate the feasibility of using a shower based system for eliminating loose contamination on the PPE and for establishing an effective transition zone between the contaminated and clean areas. Suit contamination samples will be collected as outlined in section 1.3 for both types of shower systems and analyzed to obtain data for quantitative evaluation of the effectiveness (decontamination factors) of each shower system. Visual observations will be made to qualitatively observe the effectiveness of the shower systems to remove the contaminated dust especially in critical areas such as the zippers, head region and upper body regions of the suit. Other observations include the effectiveness of the shower to be an effective transition zone between contaminated and clean areas, the time for decontamination, secondary waste generated, and other baseline data useful in designing a shower based decontamination system.

2. ORGANIZATIONAL RESPONSIBILITIES

The general organization and responsibilities of ERP are described in the Management Plan for Environmental Restoration Project, EG&G-WM-8676⁽¹⁾ and the Data Collection Quality Assurance Plan, EG&G-WM-8220⁽²⁾. The project-specific responsibilities and job descriptions are listed below for key organizations associated with investigations described in this test plan. The organizational structure is depicted in Figure 2.1.

The contamination control system engineer is responsible for ensuring that the data are obtained within the framework provided by this test plan. In addition, he will ensure that the data are defensible. The system engineer identifies the need for experimental work and integrates control of contamination with other retrieval features.

The quality assurance (QA) officer is responsible for reviewing the test plan, reviewing the Statement of Work (SOW), auditing the field and laboratory activities, and reporting to the ERP manager.

The Environmental Restoration Program Independent Data Integrity Review Committee (EIRC) is responsible for reviewing the data and test plan and any supporting data needed to determine if the data meets the objectives of the study.

The health physicist (HP) support is responsible for radiological monitoring of the test setup area at TRA (Test Reactor Area) and issuing of green tags for radiologically clean equipment and hardware leaving TRA. The HP will assist personnel with monitoring of the area and will verify that all personnel are wearing proper dosimetry and protective equipment during the testing activities. The HP's responsibilities include: (1) maintaining the calibration of all radiological instruments and maintaining calibration log books, (2) sounding the alarm in the event of a radioactive release, (3) conducting radiological surveys of data collection equipment before and following decontamination procedures, (4) notifying appropriate emergency personnel on the event of a release, fire or explosion, and (5) assign proper

Figure 2.1 Organizational Responsibilities for PPE Decontamination Feasibility Study.

File: ORG

3. TEST DESCRIPTION

This section describes the apparatus used to perform the studies. The overall test apparatus is schematically shown in Figure 3.1 and consists of three major subsystems:

1. Suit contamination apparatus
2. Shower decontamination apparatus, and
3. Step-off pad area.

As shown in Figure 3.1, the three subsystems are integrally connected to minimize the probability of contamination spread from the contamination chamber to the room. This section also discusses the laboratory instruments used to support the field testing.

3.1 Suit Contamination Apparatus

A schematic of the apparatus used to contaminate the suit is shown in Figure 3.2. The suit contamination chamber is approximately 4-feet wide, 5-feet deep, and 8-feet high fabricated primarily from Plexiglas to allow visual access inside the chamber. Dust is generated using two dust generators. The two generators are initially mounted in the center of the front and back walls at approximately two feet above the floor. The dust generator consists of a soil bed to provide a bed to place the contaminated soil and a soil mobilizer to provide the driving force to mobilize the contaminated soil. The soil bed is a V-shaped Plexiglas tray approximately 6-inch wide x 12-inch long x 8-inch high. At the bottom of the bed is the soil mobilizer. The mobilizer consists of a perforated dacron tube pressurized with plant air. The tube has both radial and lateral perforations which allows the escape of the pressurized air, creating the driving force to mobilize the contaminated soil in the test bed.

Figure 3.1 Overall Test Apparatus Setup.

File: SETUP

Figure 3.2 Contamination Chamber Test Apparatus.

A ventilation system is attached to the side wall opposite the doorway. The ventilation system provides a negative internal pressure within the contamination chamber to prevent contamination spread outside the test apparatus. High efficiency particulate air (HEPA) filters are used in the ventilation system to prevent contamination of the room air.

Total dust loadings (average time-integrated dust concentration levels) in the chamber are sampled using three high volume (Hi-Vol) samplers with 2-inch particulate filters operated at 2 cubic feet per minute (cfm).

3.2 Shower Decontamination Apparatus

A schematic of the shower decontamination apparatus is shown in Figure 3.3. The chamber is nominally 4-feet wide, 4-feet deep, and 8-feet high fabricated primarily of Plexiglass to allow visual access inside the chamber. The bottom of the chamber has a drain with a gravity collection system for the potentially contaminated water from the showering process. Two types of shower are provided for testing:

1. Drench shower
2. Multi-nozzle shower

3.3 Step-Off Pad Area

The step-off pad area is shown in Figure 3.1. It consists of a 6-foot by 6-foot, minimum, roped-off area with blotting paper on the floor. The area is used to take smear samples of the suit, provide a suit dry-off area, and for doffing the PPE.

3.4 Laboratory Instruments and Equipment

The laboratory instruments and equipment used to support the suit contamination and shower decontamination systems, as a minimum, shall meet the requirements listed below.

File: SHOWER

Figure 3.3 Shower Decontamination Apparatus.

1. Suit contamination dust generator air flow rates - accuracy of $\pm 10\%$ of reading over the range of 5 to 10 cfm.
2. Suit contamination dust generator line pressure - accuracy of $\pm 10\%$ of reading over the range of 25 to 35 psig.
3. Shower apparatus water flow rate - accuracy of $\pm 10\%$ of reading over the range of 10 to 70 gallons per minute (gpm).
4. Shower apparatus water line pressure - accuracy of $\pm 10\%$ of reading over the range of 5 to 50 psig.
5. Hi-Vol sampler air flow rate - accuracy of $\pm 2\%$ of reading at 2 cfm.
6. Stop watch - accuracy of ± 1 second.
7. Vacuum gage - accuracy of ± 0.2 inches of water over the range of 0 to 1.0 inches of water.

Information on each laboratory instrument and equipment used in the test shall be recorded in the log book per requirements of section 4.1.1.

4. SEQUENCE OF TEST EVENTS

This section discusses the sequence of test events. Prior to performing the decontamination tests with contaminated soils, prerequisite tests are performed to verify proper operation of the equipment and establish parameters for the equipment. Simulated scoping test runs are performed to set test parameters, standardize test protocol, train personnel, and identify and resolve any hardware/procedural problems.

4.1 Prerequisites

The prerequisites shall be completed prior to performing the simulated scoping tests described in Section 4.2.

4.1.1 Apparatus Setup and Checkout

The following checkouts shall be completed:

1. Record the calibration data for all laboratory instruments used in the test. As a minimum, include:
 - a. Instrument type
 - b. Instrument serial number
 - c. Calibration expiration date
 - d. Location and application of use
 - e. Name of person recording data
 - f. Date data is recorded.
2. Set parameters to generate a uniform dust cloud within the contamination system chamber.
 - a. Fill each dust generator approximately 1.5 inch deep with INEL spreading area soil that has been dried by ambient air in shallow trays to approximately 8% moisture content by weight.
 - b. Turn the ventilation system on and regulate to establish a 0.1 to 0.5 inches water column vacuum in the chamber.

- Initially set the air flow rate and line pressure to approximately 6 cfm and 30 psig for each dust generator.
- c. Adjust the settings of the dust generators and the ventilation system and, if necessary, the location of each generator such that visually the dust cloud in the contamination chamber is uniform and a negative pressure is maintained within the chamber.
 - d. Record the settings and final locations of each generator and the ventilation system.
3. Checkout the drench shower system.
 - a. Check the shower system for proper operation.
 - b. Determine the flowrate and line pressure and record the results:
 - i. shower type
 - ii. flow rate and method used to determine (i.e., flowmeter or volume/time measurements)
 - iii. Line pressure.
 4. Repeat (3) for the multi-nozzle shower system.

4.1.2 Test Run Prerequisites

The following appropriate prerequisites shall be completed prior to each test run:

1. Verify that each Hi-Vol sampler has been cleaned and loaded with a clean, preweighed filter with results recorded in the log book.
2. The encapsulation suit shall be clean and dry prior to donning.
3. The HP shall assign proper protective clothing, dosimetry, and detail any specific precautions prior to test runs involving contaminated soils.

4. An SWR shall be issued prior to performing tests with contaminated soils.
5. One person shall collect all of the smear samples for a test run to minimize variations in the sample collection. If practical, one person should collect the smear samples for the entire test.
6. The test apparatus shall be cleaned as required to satisfy the sample control objectives, reference section 6.1.
7. The ventilation system shall be turned-on prior to initiating the dust generator.

4.2 Simulated Scoping Test Runs

Simulated scoping test runs shall be performed using INEL spreading area soil (not contaminated with TRU radionuclides) that has been dried with ambient air by exposure to the atmosphere in shallow trays. The purpose of the simulated scoping tests is to train personnel, set test parameters, and establish sampling protocol to standardize data collection, and to identify and resolve any procedural/hardware problems.

The simulated scoping test runs shall consist of the following general steps:

1. Contaminate the suit using the contamination apparatus. After all prerequisites have been satisfied, the test equipment has been made ready, and the PPE equipment has been donned, the wearer should enter the center of the contamination chamber. Hi-Vol samples shall be obtained to document the uniformity of the dust concentration in the chamber and the uniformity of the dust generation among test runs. Initially the dust generators will be turned on for 4 minutes to contaminate the suit. At the end of each 1/4 of the total run time, the wearer shall rotate 90 degrees clockwise. All observation shall be recorded in the log book.

2. Sample the suit using smears per section 5.1. These samples shall be controlled with pregravimetric and postgravimetric analyses required for each sample. The samples may also be used as field blanks. The final test run protocol (i.e., run time, dust generator settings, sampling protocol, etc.) shall be established to provide an equivalent dust loading on the suit which will yield a minimum of 10 pCuries of Pu/sample when the Pu spiked soil is used for testing (e.g., 20 mgsoil/sample if a 500pCi/g source term is used for section 4.3 and 4.4 tests).
3. Shower the encapsulation suit using either the drench shower or the multi-nozzle shower. The simulated tests in the drench shower and the multi-nozzle shower shall be performed to establish protocol for the wearer during the shower process and to set the shower time, and finalize the flow rate for the test runs. Initially the wearer will stand in the center of the shower with his arms loosely to his side. The shower shall be operated for one minute at the flow rate established in Section 4.1.1. All observations shall be documented in the log book as well as the established protocol and the time and the flowrate for the shower process to be used during the contamination tests.
4. Sample the suit using simulated smear swipes. These samples are to be collected to obtain experience and to establish protocol for sample collection; the samples do not need to be controlled or analyzed.
5. Dry the suit using towels. After the samples have been taken, the wearer shall be dried by a second person using a cloth towel. The protocol used to dry the wearer shall be documented along with the time required.
6. Sample the suit repeating step 4.

4.3 Drench Shower Test Runs

Using the INEL spreading area soil contaminated with Rocky Flats Plant (RFP) TRU soil (source term), two complete test runs shall be performed. The protocol and test parameters established in the prerequisites tests shall be used. Hi-Vol samples shall be obtained for each suit contamination test run to document the uniformity of the dust concentration in the chamber and the uniformity of the dust generated among test runs. Actual run time of the dust generators must be recorded. Smear samples shall be taken as required by Section 5.2 and controlled as required by Section 6. Details of the test runs shall be documented in the log book.

4.4 Multi-Nozzle Shower Test Runs

Two complete test runs shall be performed using the multi-nozzle shower using the requirements discussed in Section 4.3.

5. SAMPLING PROCEDURES

All sampling shall be performed by smear sampling the encapsulation suit exterior at the locations and times described below. The actual smear sampling shall be consistently performed using protocol established during the simulated scoping tests, reference section 4.2. The sample preparations, packing and shipping, and chain of custody are discussed in Section 6. The analytical procedures for the samples are discussed in Section 7.

5.1 Simulated Scoping Suit Contamination Sampling

For each contamination apparatus setup and checkout test run used to establish the run times and settings for the dust generator (reference section 4.2.1), four smear samples shall be collected after the suit is contaminated and prior to the showering process for gravimetric analysis. Samples shall be collected at the following locations:

1. top of the head (H)
2. chest area (C)
3. back area (B), and
4. front leg area (L).

Reference Table 5.1 for the nomenclature for the test run sampling locations.

The filters from each of the Hi-Vol samplers shall also be collected for gravimetric analysis.

5.2 Shower Test Sampling

Spatial and temporal samples shall be collected for each drench and multi-shower decontamination run. Smear samples for both gravimetric and Pu analysis shall be collected:

1. After the suit is contaminated in the contamination chamber (C)
2. After the suit is decontaminated with the shower system (D), and
3. After the suit is towelled dry (T).

The tests are performed to maintain symmetry about the suit's vertical centerline plane. To reduce the area to be sampled, only half of the suit is sampled after contamination. Each half of the suit has been divided into 40 regions as shown in Figure 5.1. Eight random samples shall be collected from 8 of the regions after the suit is contaminated and after the shower process and samples shall be taken from three regions after the suit is towelled dry. The locations for the sample collection after the suit is contaminated and after the suit is towelled dry have been determined using a random number table. The sampling locations after the shower are the mirror locations of the pre-shower locations. Tables 5.2 and 5.3 define the sampling locations for each test run and each time of sampling during the test run.

Hi-Vol samples shall be taken at the discretion of the test engineer. If the samples are taken, the filters from each Hi-Vol sampler shall be collected for both gravimetric and Pu analysis.

Table 5.1 Suit contamination simulated test run sampling locations.

<u>Test Run</u>	<u>Sample Location</u>	<u>Sample I. D.</u>
R1	H	R1H
	C	R1C
	B	R1B
R2	H	R2H
	C	R2C
	B	R2B
.	.	.
.	.	.
.	.	.

FIGURE 5.1 Encapsulation Suit Grid Layout.

Table 5.2 Sample locations for the drench shower test runs.

<u>Test Run</u>	<u>Temperal</u> <u>Designation</u>	<u>Grid Location</u> ^(a)	Sample I. D.
D1	C	C17	D1C17
		C33	D1C33
		C20	D1C20
		C36	D1C36
		C06	D1C06
		C05	D1C05
		C19	D1C19
		C13	D1C13
	D	D17	D1D17
		D33	D1D33
		D20	D1D20
		D36	D1D36
		D06	D1D06
		D05	D1D05
		D19	D1D19
		D13	D1D13
	T	C01	D1T01
		C26	D1T26

<u>Test Run</u>	<u>Temperal Designation</u>	<u>Grid Location^(a)</u>	Sample I. D.
		C10	D1T10
D2	C	C10	D2C10
		C04	D2C04
		C39	D2C39
		C36	D2C36
		C19	D2C19
		C06	D2C06
		C40	D2C40
		C38	D2C38
	D	D10	D2D10
		D04	D2D04
		D39	D2D39
		D36	D2D36
		D19	D2D19
		D06	D2D06
		D40	D2D40
		D38	D2D38
	T	C29	D2T29
		C16	D2T16

<u>Test Run</u>	<u>Temperal</u> <u>Designation</u>	<u>Grid Location</u> ^(a)	Sample I. D.
		C21	D2T21

^(a) Reference Figure 5.1 for grid location.

Table 5.3 Sample locations for the multi-nozzle shower test runs.

<u>Test Run</u>	<u>Temperal Designation</u>	<u>Grid Location</u> ^(a)	<u>Sample I. D.</u>
MN1	C	C22	MN1C22
		C29	MN1C29
		C09	MN1C09
		C17	MN1C17
		C38	MN1C38
		C06	MN1C06
		C05	MN1C05
		C24	MN1C24
	D	D22	MN1D22
		D29	MN1D29
		D09	MN1D09
		D17	MN1D17
		D38	MN1D38
		D06	MN1D06
		D05	MN1D05
		D24	MN1D24
	T	C21	MN1T21
		C23	MN1T23

<u>Test Run</u>	<u>Temperal Designation</u>	<u>Grid Location^(a)</u>	<u>Sample I. D.</u>
MN1	C	C22	MN1C22
		C14	MN1T14
D2	C	C09	MN2C09
		C21	MN2C21
		C04	MN2C04
		C16	MN2C16
		C29	MN2C29
		C38	MN2C38
		C06	MN2C06
		C19	MN2C19
	D	D09	MN2D09
		D21	MN2D21
		D04	MN2D04
		D16	MN2D16
		D29	MN2D29
		D38	MN2D38
		D06	MN2D06
		D19	MN2D19
	T	C36	MN2T36

<u>Test Run</u>	<u>Temperal Designation</u>	<u>Grid Location</u> ^(a)	<u>Sample I. D.</u>
MN1	C	C22	MN1C22
		C39	MN2T39
		C10	MN2T04

^(a) Reference Figure 5.1 for grid location.

6. SAMPLE CONTROL

6.1 Sample Contamination Control

To minimize probability of smear sample and Hi-Vol filter contamination, clean gloves shall be worn on the hand(s) handling the samples. Each sample shall be maintained in its appropriate sealed sample container prior to analysis. One person shall collect all of the smear samples for a test run to minimize variations in the sample collection. If practical, one person should collect the smear samples for the entire test.

The test apparatus shall be decontaminated between runs, as determined in the prerequisites and simulated test runs to satisfy the following objectives:

1. Maintain good housekeeping practices and safe working conditions
2. Allow visual observation of the testing, and
3. Minimize probability of sample contamination.

6.2 Sample Preparation

Prior to sample collection, a gravimetric analysis (section 7.1) shall be performed for each smear sample and each Hi-Vol filter. Each smear sample and filter shall be individually bagged in a sealed sample container and tagged with the appropriate sample identification number.

6.3 Sample Custody

Sample custody shall be maintained by using sample labels and a log book.

6.3.1 Smear Sample Label

Labels shall be completed in indelible ink and affixed to the sample container prior to or at the time of the first gravimetric analysis. Sample labels shall, as a minimum, contain the following information:

1. Sample identification number
2. Sample swipe date/time, and
3. Sampling person.

6.3.2 Hi-Vol Filter Label

Labels shall be completed in indelible ink and affixed to the filter container prior to or at the time of the first gravimetric analysis. Sample labels shall, as a minimum, contain the following information:

1. Test run and location of Hi-Vol sampler identification
2. Sample collection date/time
3. Run duration, and
4. Person collecting filter.

6.3.3 Log Book

In general, a log book shall be kept during the field test operations documenting observations, anomalies, problems and solutions, decisions, etc. The date, type of test, person making the entry should be logged in the book. Record names of personnel performing the test, visiting personnel, any equipment failures and maintenance performed and the equipment decontamination performed. The test setup and test operations shall also be documented with

photographs and with videos. As a minimum, specific data included in the log book shall include:

1. Document the Pu contaminated soil source term including the average value of the Pu concentration and standard deviation. Also document the sample values or reference the document with the values tabulated.
2. Any changes in the test set-up from the original sketches and discussion of why the changes were necessary.
3. All prerequisite setup parameters as required per section 4.1 including instrumentation information, dust generator parameters, and shower parameters.
4. Set parameters for dust generator and shower for each test run and the actual time the dust generator is activated and the actual time the shower is on.
5. Information for each sample collected per sections 6.3 requirements.
6. Observations for each test run on contamination, shower, towel-off effectiveness, visual examinations of the suit.

7. ANALYTICAL PROCEDURES

Each smear sample and Hi-Vol filter shall be analyzed to determine pre-sampling and post-sampling weight. The Pu content of the smear samples and the Hi-Vol filters shall be determined by either Radiochemical Plutonium Analysis or by Alpha Liquid Scintillation Spectrometry for all test runs using Pu in the source term.

7.1 Gravimetric Analysis

All gravimetric analysis shall be performed by preweighing and postweighing the samples on a balance with an accuracy of ± 0.1 mg. The samples shall be dried in a desiccator prior to weighing.

7.2 Radiochemical Plutonium Analysis

Determination of Pu content of the samples using the radiochemical analysis is performed by using radiochemical separations followed by analysis of the separated fraction using alpha spectrometry. The sample is placed into solution with a high temperature fusion followed by acid dissolution. Following a barium sulfate precipitation, the solid is dissolved in alkaline ethylenediaminetetraacetic acid (EDTA) and precipitated as $\text{Ce}(\text{OH})_2$ for alpha spectrometry. Samples can also be precipitated as neodymium fluoride using the same technique. Each sample shall be analyzed to provide results with an accuracy of ± 10 fCi/sample (± 10 femtoCurie/sample).

7.2 Plutonium Analysis by Alpha Liquid Scintillation Spectrometry

Analysis of plutonium collected on the sample is accomplished by radiochemical separation and alpha liquid scintillation spectroscopy. The sample is put into solution by acid dissolution in a microwave digestion system in pressurized Teflon vessels. The Pu is extracted to an organic

reagent containing the scintillant or light producing substance. This is counted directly by a photomultiplier tube in a specially designed liquid scintillation counter. Each sample shall be analyzed to provide results with an accuracy of ± 10 fCi/sample.

8. DATA MANAGEMENT AND ANALYSIS

Results and analysis will be reported in an EG&G informal report. The primary quantitative analysis will center around a comparison of Pu contamination on the smear samples for pre-shower, post-shower, and post-towel dry periods. Qualitative results will be based on observations of the effectiveness of the shower to remove the contaminated dust especially in critical areas such as the zippers, head region and upper body regions of the suit. Other observations which will be discussed include the effectiveness of the shower to be an effective transition zone between contaminated and clean areas, the time for decontamination, secondary waste generated, and other baseline data useful in designing a shower based decontamination system.

9. QUALITY ASSURANCE TO ASSESS DATA PRECISION AND ACCURACY

The experiments will be performed a minimum of two times to determine reproducibility of the tests. Several routine procedures are used to assess the data precision and accuracy.

9.1 Standard and Blank Preparation

Many of the requirements for quality assurance in evaluating the tests have been discussed in Sections 4, 5, 6, and 7. These include sampling procedures, sample control, equipment, analytical procedures, protocol for performing the tests.

The calibration blank, standard, and method blanks can help in finding reagent and apparatus contamination and interferences. Differences in background count rates for different blanks help locate contamination and interference problems. The smaller the standard deviation in the background count rates for each type of blank the better the procedure. The matrix background is the sum of all the contributions to the background including contributions from the instrument electronics, any preparation reagents, the glassware, and the soil itself.

9.2 Statistical Uncertainties

All values are reported with statistical counting uncertainty. This is roughly the difference of the peak from a perfect gaussian shape. At a minimum the count time must be sufficient to bring this uncertainty below 50%. This value is calculated from the peak area at the 90% confidence level as

$$\text{Percent Uncertainty} = (1.65)(S_g)/(\text{Area})(100)$$

where:

$$S_g = [G + (N/2)(N/2)(1/K)(B_1 + B_2)]^{1/2}$$

G = gross counts in the peak

N = number of channels in the peak

K = number of end points, four

B₁ = averaged height of background on the left

B₂ = averaged height of background on the right

Area = total counts in the region of interest minus the background area.

9.3 Duplicates and Spikes

Duplicate and spiked samples are routinely analyzed to verify an analytical technique. A duplicate is two aliquots of the same sample treated the same throughout laboratory analytical procedures. For each set of duplicates a replicate percent difference (RPD) is calculated as:

$$\text{RPD} = (D_1 - D_2)/(D_1 + D_2)(200)$$

where:

D₁ = first result

D₂ = second result.

The standard control limit set by the EPA for standard trace metals analysis is for RPD to be less than 25%. A spiked sample is prepared by adding a known amount of an analyte (like Pu) to a known volume of sample, and may be analyzed to test for any matrix effects. For each spike a percent recovery (%R) is calculated as:

$$\%R = (SSR - SR)/(SA)(100)$$

where:

SSR = spiked sample result

SR = Sample result

SA = spiked added.

Recoveries between 75 and 125% indicate that the matrix is not interfering by enhancing or detracting from the determined concentrations of analytes.

Closeness of laboratory duplicate and spiked sample results indicate the precision and matrix effects associated with the laboratory operations but not sample collection, preservation or storage. The quality of these latter operations can be assessed by collecting duplicate samples or spiking samples at the source. Quality assurance measures for sampling include special container or coupon washing, verification of contamination free filters and smears, proper sample packaging and preservation, chain of custody control and prompt analysis.

10. SAFETY, TRAINING, AND LOGISTICS

Safety is of utmost concern with all experiments. It is the policy of EG&G, Idaho to take every practical precaution to protect the health of the employees. Three types of safety and training concerns are emphasized: radiological, laboratory, and waste management.

10.1 Radiological Safety and Training

Radiological safety and conformance to the EG&G Idaho Radiological Controls Manual⁽³⁾ will be assured by consulting the on-duty HP prior to experiments using radioactive materials. Subsections of the Radiological Controls Manual that apply to this Test Plan include:

Chapter 3, Airborne radioactivity limits, HEPA Filter Requirements, Monitoring for Airborne Radioactivity

Chapter 4, Enclosure for Containing Contamination and Severe Measurements

Chapter 8, Constant Air Monitors, Instrument Calibration and Control, Selection and Installation of CAMS

Chapter 11, Continuous Availability of Health Phys Personnel, Inspecting Radiological Work, Planning Radiological Work, Radiation Worker Training, Radiological Controls, Review and Approval.

10.2 Laboratory Safety and Training

Laboratory safe practices are described in the Standard Practices Manual⁽⁵⁾, Science and Technology Department, Section 2. Subsections that apply to this test plan in General Laboratory Practices include:

1.5 Eye Protection and Protective Clothing

1.6 Laboratory Safety

1.8 Laboratory Hood Use

1.10 Hydrofluoric Acid Use.

Subsections that apply to Site Laboratory Practices include:

2.4 Radioactive Materials Handling

2.5 Glove Box Use

2.7 Laboratory Radiological Training.

10.3 Waste Management Practices and Training

Waste Management practices are prescribed in the Safety Manual⁽⁴⁾ Section 15 and Laboratory Section 2 of the Standard Practices Manual⁽⁵⁾. Subsections of laboratory practices that apply to this test plan include:

- 1.1 Non-Radioactive Chemical Waste Disposal
- 1.3 Chemical Lab Inventory
- 1.4 Chemical Spill Control
- 2.9 Handling and Storage of Hazardous Waste in Satellite Accumulation Areas.

Pertinent Safety Manual Waste Management practice subsections include:

- 2. Incinerable Low-Level Radioactive Waste
- 3. Compatible Low-Level Radioactive Waste
- 9. Transuranic Waste
- 15.1 Routine Solid Waste Collection and Handling.

11. REFERENCES

1. Management Plan for Environmental Restoration Project, EG&G-WM-8676.
2. Data Collection Quality Assurance Plan, EG&G-WM-8220.
3. EG&G Idaho Radiological Controls and Safety Manual.
4. EG&G Idaho Safety Manual.
5. Standard Practices Manual, Science and Technology Department.

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