From: Anthony Gaines
To: Trifiletti, Sue
Date: 03/24/2008 7:51:00 AM
Subject: Fwd: Decontamination and Decommissioning Plan

>>> Leonard Wert 03/20/2008 6:42 AM >>>
Here's Sabia's plan for cleanup.

>>> James Miller <Jmiller@sabiainc.com> 03/19/2008 6:31 PM >>>
Dear Mr. Collins,

In accordance with the provisions of Confirmatory Action Letter CAL No. 4-08-001, SABIA is submitting the attached work plan to your office for review and approval.

Please contact me if there are any questions.

James F. Miller
R.S.O.
SABIA, Inc.

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Subject: Fwd: Decontamination and Decommissioning Plan
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From: Anthony Gaines

Created By: ADG1@nrc.gov

Recipients
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BST1 (Sue Trifiletti)

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March 19, 2008

Attn: Mr. Elmo Collins, Regional Administrator
United States Nuclear Regulatory Commission
Nuclear Materials Licensing Branch
611 Ryan Plaza, Suite 400
Arlington, TX 76011-4005

Reference: Idaho Radioactive Materials License No. 11-27727-01 (handwritten correction: 7, ADG)
Reference: Confirmatory Action Letter CAL No. 4-08-001

Dear Mr. Collins:

In reference to the provisions of section 3 of your letter of March 4, 2008, SABIA, Inc. is submitting a decontamination and decommissioning plan. This plan has been prepared by Philotechnics of San Diego. This plan addresses all concerns and provisions as outlined in the Confirmatory Action Letter, and is hereby submitted to the Nuclear Regulatory Commission for your review.

Thank you for your prompt attention to this matter.

Sincerely,

James F. Miller

James F. Miller, R.S.O.

Radiological Work Plan
Sr-90 Decontamination Project

Prepared for:

Sabia, Inc.
2300 North Yellowstone Highway
Idaho Falls, ID 83402

March 19, 2008

Prepared By:

Philotechnics Ltd.
7676 Hazard Center Dr.
Suite 500
San Diego, CA 92108

Clinton Lingren **Sabia Inc., President and CEO**	**Jon Dillon** **Philotechnics Ltd., Regional Manager**

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Clinton Lingren
Sabia Inc., President and CEO

Jon Dillon
Philotechnics Ltd., Regional Manager

1.0 Introduction

Philotechnics Ltd. has provided professional health physics and radioactive material management services for twenty seven years. We are providing to Sabia, Inc. the following approach for the decontamination and final status survey of Bay 3 and Bay 4 at the Idaho Falls facility. The Radiological Work Plan is based on information in the confirmatory action letter issued by the Nuclear Regulatory Commission (NRC), Region IV on March 5, 2008 signed by Mr. Elmo E Collins and meetings with key Sabia personnel. The overall goal of the project is to contain the leaking Sr-90 sealed source and perform decontamination activities of all surfaces and/or removal of all contaminated materials affected. A Final Status Survey Report (FSSR) will be submitted to Sabia for purposes of obtaining NRC approval for the resumption of license operations.

2.0 Release Criteria

The radiological release criteria of NRC 10 Code of Federal Regulations (CFR) 20 Subpart E for unrestricted use will be used for releasing the facility. The specified criteria is that residual radioactivity results in a TEDE to an average member of the critical group that does not exceed 25 mrem per year and that the residual radioactivity has been released to levels that are as low as reasonably achievable (ALARA).

2.1 Default Screening Values

The default screening value for Sr-90 as referenced in NUREG 1757 Vol.2, Table H-1 is provided in Table 2.1.

Table 2.1 Default Screening Values for Nuclides of Concern

Nuclide	Emission Type	Total Activity $DCGL_W$ ($dpm/100cm^2$)	Removable Activity Limit ($dpm/100cm^2$)
Sr-90	Beta	8,700	870

Additionally, a reasonable effort shall be made to decontaminate any detectable contamination in support of the ALARA principle.

3.0 Technical Scope

Operations will be conducted in compliance with Philotechnics, Ltd. Commonwealth of Massachusetts Radioactive Material License number 56-0543 under a reciprocal agreement with the NRC. Philotechnics approach for this project will be to provide the qualified staff, on-site and off-site labor, materials, equipment and analytical services in accordance with industry standard practices, the provisions in Subpart E of 10 CFR 20 and the guidance provided in NUREG 1757 "Consolidated Decommissioning Guidance".

The project will be conducted according to the following work breakdown structure:

- **Pre-mobilization** – prepare project plans/procedures, develop survey packages and procure equipment and supplies
- **Mobilization** – mobilize personnel and equipment to the site
- **Characterization Survey** – perform and document field measurements; perform data entry, data verification, and statistical analysis
- **Remediation** – perform necessary remediation (e.g. flooring, fixed laboratory surfaces, equipment, etc.)
- **Remedial Action Surveys** - monitor the effectiveness of decontamination efforts and ensure that surrounding areas are not cross-contaminated from remediation actions
- **Final Status Surveys** – perform final status surveys
- **Demobilization** – ship equipment and supplies, demobilize personnel
- **Final Report** – preparation and submittal of final report

Surveys will be performed to characterize the radiological condition of the facility before any remediation is performed. Characterization surveys will be conducted by performing the appropriate combination of scan surveys, total activity measurements and removable contamination measurements. All survey data shall be documented on survey maps and associated data information sheets. Accessible surfaces, floors, sink traps, drains, exhaust vents, walls and equipment will be considered as impacted for purposes of the characterization survey.

The following sections detail the approach to performing safe and efficient decontamination activities in each warehouse bay. Site specific Radiological Work Permits (RWPs) will be developed in accordance with Philotechnics procedure HP-AC-03 – *Radiological Work Permits.*

3.1 Scope Item 1: Radiological Characterization

A characterization survey will be completed to confirm and supplement information provided by the NRC and Department of Energy Radiological Assistance Program (DOE RAP) team. Surveys will be completed in accordance with Philotechnics procedures HP-WM-01 – *Radiation Surveys* and HP-WM-02 Rev1 – *Contamination Surveys*. The survey will initiate in the corridor leading into the office areas of Bays 3 and 4; and continue into the facility to characterize floors, walls, ceilings, ventilation and equipment.

3.1.1 Establishment of Control Point

Initial decontamination efforts will be conducted to establish a control point for entering and exiting the facility. Employees will don and doff their personal protective equipment (PPE) in this area and a step off pad and frisker will be set up for workers leaving the controlled area. The survey will progress from the front (office areas) to the rear (roll up doors) of the facility.

Surveys will be conducted in a manner as not to disturb the high concentrations of contamination identified in Bay 3.

3.1.2 Initial Classification

Initially all surfaces and structures below two (2) meters in height will be categorized as Class I and above two meters in height categorized as Class II. If the survey results show contamination in excess of the established release criteria above two (2) meters, the area will be reclassified as Class I.

3.1.3 Characterization Survey Data

In areas where the characterization survey results indicate contamination is not present in excess of the release criteria, data from the survey may be used as part of the final status survey. For areas that are partially contaminated, the characterization survey data may be used as part of the final status survey measurements provided that 1) the data used is only from areas with contamination levels below the release criteria, and 2) decontamination work is controlled such that the survey location could not have become cross-contaminated.

3.2 Scope Item 2: Remediation

Remediation is the physical or chemical process of reducing and preventing the spread or potential exposure from contamination. Remediation options include the use of commercially available materials and/or equipment that will effectively remove radioactive materials from surface areas so that the contamination can be released or collected and properly disposed. Once the characterization surveys have been completed, remediation activities will take place.

3.2.1 Remediation Activities

The first goal of the remediation activities is to perform gross decontamination activities in Bay 3 to contain and isolate the leaking Sr-90 source and address higher level contamination issues that may potential affect normal decontamination efforts. Concurrent with these activities, the remediation will be completed in the office areas near the front of the facility. After the remediation has been successfully completed, the control point will be relocated inside the warehouse portion of the facility.

Decontamination activities will continue working from areas of lower contamination to areas of higher contamination. All radioactive material including sealed sources and gauges, with exception of the leaking Sr-90 source will decontaminated and moved to one corner of the warehouse and shielded so as not to interfere with survey measurements. For non-fixed materials, equipment, fixed surfaces and structures, a decision will be made by the Project Manager with input from Sabia personnel whether to attempt decontamination or if disposal as radioactive waste.

3.2.2 Decontamination Methodology

Initially floor and equipment decontamination will be completed using various standard decontamination methodologies. Conventional non-aggressive methods such as sticky rollers, electrostatic wipes, Maslinn mops, etc. will be used. Wet decontamination methods will be used when applicable; however, due to the porous nature of many surfaces the use will be only for specific items/areas so that contamination does not become trapped in the surface. For areas where more aggressive decontamination is required, concrete floor scabbling and/or scarifying could be used. Administrative and engineering controls shall be utilized, as necessary, to prevent the spread of contamination and the release of airborne contamination. Engineering controls such as containments, HEPA vacuums and portable HEPA ventilation systems shall be used, as appropriate.

Wall and ceiling decontamination activities shall be completed, as required, using conventional decontamination methodologies to the extent practical. In the event these methods are unsuccessful, more aggressive decontamination techniques may be performed such as demolition. Demolition would be performed following an engineering evaluation to ensure the structural integrity of the building is maintained. All remediation activities will be conducted in a manner to control the spread of contamination and keep personnel exposure ALARA.

3.2.3 Radioactive Waste

All radioactive waste generated during these activities shall be packaged in accordance with 49 CFR (B-25, super sacks, inter-modal, etc.) for shipment to a licensed waste processor for volume reduction and/or disposal as radioactive waste. The leaking Sr-90 source will require encapsulation on-site using a combination of a steel drum and concrete to meet transportation (49 CFR) and waste acceptance criteria for ultimate disposal.

3.3 Scope Item 3: Free-Release Surveys

All equipment and supplies inside facility Bays 3 and 4 will be appropriately surveyed and/or decontaminated before being released for unrestricted use. NRC risk-based building surfaces release criteria do not apply to materials (e.g. supplies, computers, shelving, etc.) and portable equipment that are removed from licensed facilities.

3.3.1 Unrestricted Release Limits (Materials & Equipment)

Impacted equipment and materials will be either decontaminated to meet the criteria specified in NRC Regulatory Guide 1.86, or disposed of as radioactive waste as per Philotechnics procedure HP-WM-05 – *Release of Material for Unrestricted Use*. Release limits specific to Sr-90 are indicated by bold text in Table 3.1.

Table 3.1 Acceptable Surface Contamination Levels

NUCLIDE [a]	AVERAGE [bc]	MAXIMUM [bd]	REMOVABLE [be]
U-nat, U-235, U-238 and associated decay products	5,000 dpm /100 cm^2	15,000 dpm /100 cm^2	1,000 dpm/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	**1,000 dpm/100 cm^2**	**3,000 dpm/100 cm^2**	**200 dpm/100 cm^2**
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm/100 cm^2	15,000 dpm/100 cm^2	1,000 dpm/100 cm^2

[a] Where surface contamination by both alpha and beta-gamma emitting nuclides exists, the limits established for alpha and beta-gamma emitting nuclides should apple independently.
[b] As used in the table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency and geometric factors associated with the instrumentation.
[c] Measurements of average contaminant should not be averaged over more than 1 m^2. For objects of less surface area, the average should be derived for each such object.
[d] The maximum contamination level applies to an area of not more than 100 cm^2.
[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

3.3.2 Exceeding Unrestricted Release Limits (Materials & Equipment)

Any materials or equipment that exceeds the limits in Regulatory Guide 1.86 will be identified and a decision will be made by the Project Manager and input from Sabia management whether to attempt decontamination procedures or to treat as radioactive waste. If decontaminated efforts are not successful, the item will be wrapped and disposed of as radioactive waste. Items with the potential for internal contamination or cannot be appropriately evaluated will be designated as potentially contaminated and treated as radioactive waste. Philotechnics shall not use any chemicals or reagents on-site that will cause a radioactive waste to become a mixed waste. In addition, should Philotechnics personnel identify any hazardous material; they will immediately stop work and notify the Project Manager.

Materials will be wrapped in plastic, containerized or verified free of external radioactive contamination prior to leaving any impacted area. Once the office area and front portion of Bay 4 is decontaminated, we expect to use it as a storage area for any items that meet the free release criteria. Any equipment and supplies failing to meet the release criteria will be placed into an appropriate waste container.

4.0 Project Personnel

All project personnel will be employees of Philotechnics, Ltd. and will perform work activities in accordance with Philotechnics' radioactive materials license, this Work Plan, project specific Radiological Work Permit(s) (RWPs), the Health and Safety Plan (HASP) and associated procedures. To meet security requirements, all supervisory staff will submit completed background checks and fingerprinting information to Sabia for review and approval for unescorted access to the facility.

4.1 Project Liaison

Jon Dillon is the Project Liaison. His primary responsibility will be to interact in conjunction with Sabia personnel and with the various agencies overseeing this project which include the NRC, DOE and Homeland Security. He has over 16 years of professional experience in the related fields of hazardous and radioactive waste management, nuclear safety compliance and radiological engineering. He has extensive experience managing radioactive materials programs for biomedical companies in California. Mr. Dillon has provided radiological oversight and engineering expertise for numerous decommissioning projects where the goal was the termination of an Nuclear Regulatory Commission or agreement state issued radioactive materials license in accordance with MARSSIM, and where applicable, the respective agreement's state criteria.

Mr. Dillon holds the following degrees and certifications:

- M.S., Radiological Health Physics, San Diego State University (1994)
- B.S., Physics, University of California at Riverside (1990)
- MARSSIM 40-hr Training Course, ORAU (2005)
- OHSA 40-Hour Certification for Proper Handling of Hazardous Materials
- OSHA 8-Hour Refresher Training (March 2007)

- Hazardous Materials Transportation Training to meet 49CFR172.704 (2005, 1998)
- UCSD Professional Certificate for Hazardous Materials Management (1999)

4.2 Project Manager

Frank Brown is the Project Manager. Mr. Brown was hired by Philotechnics in June 2002 and manages Philotechnics' Clairton, Pennsylvania office. He has been a Project Manager on countless projects including a multi-million dollar D&D project in South Boston. Frank is a member of the National Health Physics Society and has over 15 years experience in the health physics industry. Before working at Philotechnics, Frank was an Engineering Laboratory Technician in the United States Navy for 8 years.

Mr. Brown holds the following degrees and certifications:

- MARSSIM 40-hr Training Course, ORAU (2007)
- OHSA 40-Hour Certification for Proper Handling of Hazardous Materials
- 40-hour RSO Training

4.3 Radiological Engineer

Robert Trimble is the Radiological Engineer. He is an Environmental Health and Safety (EHS) professional with 14 years of experience in environmental health and safety, facilities management, information technology, and security. Mr. Trimble has provided radiological oversight and engineering expertise for several decommissioning projects where the goal was the termination of a NRC or agreement state-issued radioactive materials license in accordance with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), and where applicable, the respective agreement's state criteria.

Mr. Trimble holds the following degrees:

- M.S., Radiological Health Physics, San Diego State University (1994)
- B.S., Physics, Cal State Northridge (1992)
- MARSSIM 40-hr Training Course, ORAU (2006)
- OHSA 40-Hour Certification for Proper Handling of Hazardous Materials

4.4 Health Physics Technicians

Health Physics Technicians (HPTs) will be responsible, under the direction of the Project Manager and Radiological Engineer, for performing radiation surveys, decontamination and airborne radioactivity surveys. HPTs will meet the requirements of Philotechnics' Procedure HP-AD-04 – *Radiological Training Requirements*.

5.0 Training

All personnel subject to entering work areas shall receive job-specific training by the Project Manager in accordance with Philotechnics procedure – HP-AD-04 R0 – *Radiological Training Requirements*. This training will include review of the Health and Safety Plan (HASP), tasks, hazards, associated precautions, procedures, emergency egress routes and assembly areas. Each employee must receive orientation training and acknowledge these requirements by signing the attendance sheet before working on the site. The job-specific orientation must be revised for any additional hazards identified during the course of the project. Training requirements for supervisors and workers associated with the work activities addressed by this Work Plan include:

- *Safe Work Permits, Radiation Work Permits (RWP) and Lockout/Tagout:* This training will encompass the purpose, applicability, specific requirements and individual responsibilities associated with the issuance, use and termination of these permits.
- *Access Control Points:* Personnel, other than qualified HPTs, will be instructed in and required to demonstrate proper use of access control points. This will include the use of step off pads, monitoring requirements and records requirements associated with the use and maintenance of the access control point.
- *Waste Handling, Segregation and Packaging:* Personnel shall be instructed in the identification, segregation and handling of radioactive and non radioactive wastes. This will include radiation survey requirements, maintenance/storage and disposition of different waste streams
- *Employee Safety Concerns:* Project personnel shall receive training regarding the protocol for reporting and resolving safety issues. Emphasis shall be placed on the ability for any employee to stop work if he/she feels uncomfortable or that the work is progressing in an unsafe manner.

6.0 Radiological Controls

The following sections detail the administrative and engineering controls being implemented throughout the remediation project. Topics covered include radiation protection, PPE, respiratory protection, dosimetry, bioassays, air monitoring and contamination controls.

6.1 Radiation Protection

The leaking Sr-90 source was estimated to be approximately 63 mCi by Sabia personnel with maximum dose rates of 1 Rad/hour at 1 foot from unshielded source and removable contamination measurements on the order of 50,000 dpm/100 cm^2. The source and resulting contamination at the facility presents both potential external and internal exposure hazards to project employees. Specific administrative and engineering controls will be used to control contamination and ensure staff is adequately protected. The project will be performed using administrative controls to ensure that employee exposures are kept As Low As Reasonably Achievable (ALARA). Remote handing instruments such as tongs and grippers will be used to minimize extremity doses when handling high activity sources and thick gloves will be used to provide extremity shielding. Shielding will also be used when practical to reduce dose rates where possible.

6.2 Personal Protective Equipment

All workers who enter the impacted area will be required to wear personal protective equipment. Initially, workers will don two pair of Tyvek suits, respiratory protection, steel toe shoes, shoe covers, safety glasses and nitrile gloves. When working with high levels of Sr-90 materials, thick butyl gloves will be used to handle objects with beta dose rates in excess of 100 mR/hr in order to reduce the dose to the hands. As decontamination efforts are successful in reducing contamination levels, PPE may be reduced to single Tyvek suits, shoe covers, safety glasses and nitrile gloves based upon air sampling and contamination survey results.

6.3 Respiratory Protection

Powered Air Purifying Respirators (PAPR's) with combination organic vapor/HEPA filter cartridges will be required for all workers entering the impacted area until the removable contamination levels and airborne radioactive concentrations will not exceed 10% (0.10) of the Derived Air Concentration (DAC) for Sr-90 as defined in 10 CFR Part 20, Appendix B. The DAC for Sr-90 is 3E-9 uCi/ml. Air monitoring will be performed during decontamination activities to document airborne concentrations of Sr-90 from both fixed area locations and personnel monitoring.

6.4 Dosimetry

All workers who enter the impacted area will be required to wear dosimetry. At a minimum, a whole body thermoluminescent (TLD) badge and extremity TLDs (finger rings) worn on each hand will be required. Direct reading electronic dose dosimeters will also be used for staff working in areas exceeding 100 mR/hr.

6.5 Bioassays

All workers will participate in a bioassay program to measure internal exposures. A urine sample will be collected before and after decontamination activities have been performed. Philotechnics Corporate RSO will review all dose records.

6.6 Air Monitoring

Since we expect airborne radioactivity concentrations to initially be in excess of 0.10 DAC, air monitoring in accordance with Philotechnics' procedure HM-WM-03-ICN – *Workplace and Air Monitoring* will be performed. An Eberline LV-1, or equivalent fixed filter sampling device will be used to collect general area air samples. Lapel air samples will be used for collecting worker breathing zone air samples. The air filters will be counted on an alpha/beta planchet counter to calculate airborne concentrations.

6.7 Contamination Controls

Standard administrative controls, including access control, radiation area postings, training and PPE will be implemented to minimize personnel exposure and control spread of contamination. Engineering controls such as portable HEPA vacuums shall be used, as appropriate. Prior to any dismantlement activities, characterization surveys shall be performed on systems and components to ascertain radiological conditions. These surveys will provide information that ensures proper radiological controls are used to prevent the spread of radioactive material. All personnel directly involved in aggressive remediation activities will perform a whole body frisk prior to leaving the work area per contractor procedure HP-WM-04 – *Personnel Monitoring and Decontamination*. All remediation activities will be conducted in a manner to control the spread of contamination and keep personnel exposure ALARA.

7.0 Instrumentation

A detailed summary of the proposed instrumentation for this project has been outlined below. Topics covered include protocols for instrument calibration, daily functional checks and determination of counting times and minimum detectable concentrations.

7.1 Instrument Calibration

Laboratory and portable field instruments will be calibrated at least annually with National Institute of Standards and Technology (NIST) traceable sources and to radiation emission types and energies that will provide detection capabilities similar to the nuclides of concern.

7.2 Functional Checks

Functional checks will be performed at least daily when in use in accordance with Philotechnics procedure HP-IN-01 Rev. 1 – *Instrument Response Checks*. The background, source check and field measurement count times for radiation detection instrumentation will be specified by procedure to ensure measurements are statistically valid. Background readings will be taken as part of the daily instrument check and compared with the acceptance range for instrument and site conditions. If an instrument fails a functional check, all data obtained with the instrument since the last satisfactory check will be invalidated.

7.3 Determination of Counting Times and Minimum Detectable Concentrations

Minimum counting times for background determinations and counting times for measurement of total and removable contamination will be chosen to provide a minimum detectable concentration (MDC) that meets the Data Quality Objectives (DQOs) specified in this Plan. MARSSIM equations relative to building surfaces have been modified to convert to units of dpm/100cm^2. Count times and scanning rates are determined using the following equations in 7.3.1 and 7.3.2.

7.3.1 Static Counting

Static counting Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, from NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{static} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E_{tot} \cdot \frac{A}{100cm^2}} \quad \text{(Equation 7.3.1)}$$

Where:

MDC_{static} = minimum detectable concentration level in dpm/100cm^2

B_r = background count rate in counts per minute

t_b = background count time in minutes

t_s = sample count time in minutes

E_{tot} = total detector efficiency for radionuclide emission of interest (includes combination of 2π instrument efficiency and 0.25 surface efficiency for beta emitters less than 400 KeV or 0.5 for beta emitters greater than 400KeV and gamma emitters)

A = detector probe area in cm^2

7.3.2 Ratemeter Scanning

Scanning Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation which is a combination of MARSSIM equations 6-8, 6-9 and 6-10:

$$MDC_{scan} = \frac{d'\sqrt{b_i}\left(\frac{60}{i}\right)}{\sqrt{p} \cdot E_{tot} \cdot \frac{A}{100cm^2}} \quad \text{(Equation 7.3.2)}$$

Where:

MDC_{scan} = minimum detectable concentration level in dpm/100 cm^2

d' = desired performance variable (1.38)

b_i = background counts during the residence interval
i = observation interval
p = surveyor efficiency (0.5)
E_{tot} = total detector efficiency for radionuclide emission of interest (includes combination of instrument efficiency and 0.25 surface efficiency for beta emitters less than 400KeV or 0.5 for beta emitters greater than 400KeV and gamma emitters)
A = detector probe area in cm^2

7.3.3 Smear Counting

Smear counting Minimum Detectable Concentration at a 95% confidence level is calculated using the following equation, from NUREG 1507, Table 3.1 (Strom & Stansbury, 1992):

$$MDC_{smear} = \frac{3 + 3.29\sqrt{B_r \cdot t_s \cdot (1 + \frac{t_s}{t_b})}}{t_s \cdot E} \quad \text{(Equation 7.3.3)}$$

Where:
MDC_{smear} = minimum detectable concentration level in dpm/smear
B_r = background count rate in counts per minute
t_b = background count time in minutes
t_s = sample count time in minutes
E = instrument efficiency for radionuclide emission of interest

7.4 Counting Uncertainty

The counting uncertainty for both total and removable measurements will be calculated using equation 6-15 from MARSSIM:

$$\sigma = \sqrt{\frac{C_{s+b}}{T_{s+b}^2} + \frac{C_b}{T_b^2}} \quad \text{(Equation 7.4)}$$

Where:

σ = uncertainty
C_{s+b} = gross counts of the sample (cpm)
T_{s+b} = Sample time (minutes)
C_b = Gross background counts (cpm)
T_b = Background count time (minutes)

7.5 Instrumentation Specifications

The instrumentation used for the unrestricted release of the facility is summarized in the following tables. Table 7.1 lists the standard features of each instrument such as probe size and efficiency. Table 7.2 lists the typical operational parameters such as scan rate, count time, and the associated Minimum Detectable Concentrations (MDC). Alternate or additional instrumentation with similar detection capabilities may be utilized as needed for survey requirements.

Table 7.1 – Instrumentation Specifications

Detector Model	Detector Type	Detector Area	Meter Model	Window Thickness	Typical Total Efficiency
NE BP19DD IBP19DD	Beta Scintillation	100 cm^2	NE Electra NE Selectra	0.8 mg/cm^2	27 % (Sr-90)
Bicron RSO-50	Ion Chamber	N/A	Bicron	N/A	Calibrated to Cs-137
43-10-1	Alpha/Beta Scintillation	20.4 cm^2	Ludlum 2929	0.4 mg/cm^2	30% (Sr-90)

Table 7.2 – Typical Instrument Operating Parameters and Sensitivities

Measurement Type	Detector Model	Meter Model	Scan Rate	Count Time	Background (cpm)	MDC ($dpm/100cm^2$)
Surface Scans	BP19DD IBP19DD	NE Electra NE Selectra	5 cm/sec.	N/A	450	1,026 (Sr-90)
Total Surface Activity	BP19DD IBP19DD	NE Electra NE Selectra	N/A	1 min.	450	376 (Sr-90)
Removable Beta Activity	43-10-1	Ludlum 2929	N/A	1 min.	55	125 (Sr-90)
Dose Rate	Bicron	RSO-50	N/A	N/A	<0.5 mR/hr	N/A

8.0 Characterization Surveys

Characterization surveys will be conducted to establish the levels and extent of residual activity. This information will aid in determining final remediation methods and disposal options for the structures and components of the facility. Characterization surveys will consist of scan surveys with static measurements and removable contamination measurements (smears) of all accessible areas.

The purpose of scanning is to identify locations of elevated activity. Where elevated activity is identified, a static measurement and smear will be taken at the location of highest activity identified during the scan. The boundaries of the elevated areas will be marked to aid in locating the area for remedial actions.

Characterization surveys will be conducted under the same quality assurance criteria as final status surveys such that the data may be used as final status survey data to the maximum extent possible. For areas that are partially contaminated, the characterization survey data may be used as part of the final status survey measurements provided that 1) the data used is only from areas with contamination levels below the release criteria, and 2) decontamination work is controlled such that the survey location could not have become cross-contaminated.

9.0 Remedial Action Surveys

Remedial action surveys will be conducted in support of remediation activities to help determine when the area is ready for a final status survey and to provide updated estimates for final status survey planning. Remedial action surveys serve to monitor the effectiveness of decontamination efforts and ensure that surrounding areas were not cross-contaminated from remediation actions.

Remedial action surveys consisted of scan surveys, direct measurements and removable contamination measurements. These are conducted following remediation activities to establish the success or failure of the efforts to decontaminate the applicable survey area. Results of the survey are the decision basis for continued remediation or initiation of final status surveys.

10.0 Design and Performance of Final Status Surveys

A final status survey is performed to demonstrate that residual radioactivity in each survey unit satisfies the predetermined criteria for release for unrestricted use. The survey provides data to demonstrate that all radiological parameters do not exceed the established DCGLs. For these reasons, more detailed guidance is provided for this category of survey. For the final status survey, survey units represent the fundamental elements for compliance demonstration using the statistical tests.

10.1 Background Determination

The use of reference background areas or paired background comparisons is not necessary for the purposes of this plan. The best approach for this survey will be to determine compliance with the established DCGLs following subtraction of the mean of a reference material background. This decision is based on the guidance provided in Section 12 of NUREG-1505, "A Nonparametric Statistical Methodology for the Design and Analysis of Final Decommissioning Surveys". This section states that better precision is possible if the average of the measurements made on the reference material is subtracted from each measurement made on that material.

A reference background in counts per minute, for each instrument type on each material type, will be established by calculating the mean of multiple measurements. The established mean background values will be subtracted from the applicable survey gross measurement count rates (in cpm) to determine the net measurement count rate. The number of measurements required for each material type will be calculated for the Sign test.

10.2 Data Quality Objectives (DQO)

The Data Quality Objective Process as described in MARSSIM is used throughout the design and implementation of survey design. The following is a list of the major DQOs for the survey design described in this plan:

- Static measurements will be taken to achieve an MDC_{static} of less than 25% of the DCGL.
- Scanning will be conducted at a rate to achieve an MDC_{scan} of less than 50% of the DCGL.
- Individual measurements will be made to a 95% confidence interval.
- Decision error probability rates will initially be set at 0.05 for both α and β.
- The null hypothesis (H_0) and alternate null hypothesis (H_A) are that of NUREG 1505 scenario A:
  H_0 is that the survey unit does not meet the release criteria
  H_A is that the survey unit meets the release criteria
- Characterization surveys will be conducted under the same quality assurance criteria as final status surveys such that the data may be used as final status survey data to the maximum extent possible.

10.3 Area Classifications

Initially all surfaces and structures below two meters in height will be categorized as Class I and all surfaces and structures above two meters in height categorized as Class II. If the survey results show contamination in excess of the release criteria above 2 meters, the area will be reclassified as Class I.

10.3.1 Impacted Areas

Impacted areas are those areas that have potential residual radioactivity from licensed activities. Impacted areas are subdivided into Class 1, Class 2 or Class 3 areas. Class 1 areas have the greatest potential for contamination and therefore receive the highest degree of survey effort for the final status survey using a graded approach, followed by Class 2, and then by Class 3. Impacted sub-classifications are defined, for the purposes of this plan, as follows:

10.3.2 Class 1 Area

Areas with the highest potential for contamination, and meet the following criteria: (1) impacted; (2) potential for delivering a dose above the release criterion; (3) potential for small areas of elevated activity; and (4) insufficient evidence to support classification as Class 2 or Class 3.

10.3.3 Class 2 Area

Areas that meet the following criteria: (1) impacted; (2) low potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

10.3.4 Class 3 Area

Areas that meet the following criteria: (1) impacted; (2) little or no potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

10.4 Survey Units

A survey unit is a geographical area of specified size and shape for which a separate decision will be made whether or not that area meets the release criteria. A survey unit is normally a portion of a building or site that is surveyed, evaluated and released as a single unit. For the purposes of this plan, areas of similar construction and composition will be grouped together as survey units and tested individually against the release criteria and the null hypothesis to show compliance with the release criteria. Survey units will be homogeneous in construction, contamination potential and contamination distribution.

The number of discrete sampling locations needed to determine if a uniform level of residual radioactivity exists within a survey unit does not depend on the survey unit size. However, the sampling density should reflect the potential for small elevated areas of residual radioactivity. Survey units will be sized according to the potential for small elevated areas of residual radioactivity. Recommended maximum survey unit sizes for building structures, based on floor area, is Class 1: up to 100 m^2 , Class 2: 100 m^2 to 1000 m^2 and Class 3: no limit.

10.5 Surface Scans

Scanning is used to identify locations within the survey unit that exceed the investigation level. These locations are marked and receive additional investigations to determine the concentration, area and extent of the contamination. For Class 1 areas, scanning surveys are designed to detect all areas of elevated activity that are not detected by the measurements using the static sampling pattern.

The percentage of survey area scanned may be increased based on suspected elevated activity. For Class 2 survey units, the surfaces to be scanned will be those with the highest potential to contain residual contamination. Philotechnics does not anticipate any survey unit receiving a Class 3 classification, thus all survey units will be issued a Class 1 or Class 2 designation. However, for illustrative purposes Class 3 references have been included in this work plan.
If elevated activity is detected during the scan surveys the location shall be marked and total and removable surface activity measurements and will be taken to quantify the activity. However, total surface activity measurements are in addition to the static measurements required for the statistical test. Table 10.1 summarizes the percentage of accessible building structural surfaces to be scanned based on classification.

Table 10.1 – Scan Survey Coverage by Classification

Structure	Class 1	Class 2	Class 3
Floors	100%	70-90%	50%
Other Structures	100%	50%	25%

10.6 Total Surface Activity Measurements

Direct surveys (static measurements) will be taken on building surfaces and system internals to the extent practical in impacted areas utilizing instrumentation of the best geometry, based on the surface, at the survey location. Additionally, locations of elevated activity identified and marked during the scan survey will require direct survey measurements.

10.6.1 Determining the Number of Samples and Relative Shift

A minimum number of samples are needed to obtain sufficient statistical confidence that the conclusions drawn from the samples are correct. The number of samples will depend on the relative shift (the ratio of the concentration to be measured relative to the statistical variability of the contaminant concentration).

The minimum number of samples is obtained from MARSSIM tables or calculated using equations in Section 5 of MARSSIM.

The number of required samples will depend on the ratio involving the activity level to be measured relative to the variability in the concentration. The ratio to be used is called the Relative Shift (Δ/σ_S), and is defined in MARSSIM as:

$$\Delta / \sigma_S = \frac{DCGL - LBGR}{\sigma_S}$$

Where:

DCGL = derived concentration guideline level or release criterion
LBGR = concentration at the lower bound of the gray region. The LBGR is the average concentration to which the survey unit should be cleaned in order to have an acceptable probability of passing the test
σ_S = an estimate of the standard deviation of the residual radioactivity in the survey unit

10.6.2 Determination of Acceptable Decision Errors

A decision error is the probability of making an error in the decision on a survey unit by failing a unit that should pass (β decision error) or passing a unit that should fail (α decision error). MARSSIM uses the terminology α and β decision errors; this is the same as the more common terminology of Type I and Type II errors, respectively. The decision errors have been set at 0.05 for both Type I and Type II errors.

10.6.3 Determination of Number of Data Points (Sign Test)

The number of direct measurements for a particular survey unit, employing the Sign Test, is determined from MARSSIM Table 5.5, which is based on the following equation (MARSSIM equation 5-2):

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(SignP - 0.5)^2}$$

Where:

N	=	number of samples needed in the survey unit
$Z_{1-\alpha}$	=	percentile represented by the decision error α
$Z_{1-\beta}$	=	percentile represented by the decision error β
SignP	=	estimated probability that a random measurement will be less than the DCGL when the survey unit median is actually at the LBGR

Note: SignP is determined from MARSSIM Table 5.4

MARSSIM recommends increasing the calculated number of measurements by 20% to ensure sufficient power of the statistical tests and to allow for possible data losses. MARSSIM Table 5.5 values include an increase of 20% of the calculated value.

10.6.4 Determination of Sample Locations

Determination of Class 1 survey unit sample locations is accomplished by first determining sample spacing and then systematically plotting the sample locations from a randomly generated start location. The random starting point of the grid or pattern provides an unbiased method for obtaining measurement locations to be used in the statistical tests. Class 1 survey units have the highest potential for small areas of elevated activity, so the areas between measurement locations may be adjusted to ensure that these areas can be detected by scanning techniques.

Similar systematic spacing methods are used for Class 2 survey units because there is an increased probability of small areas of elevated activity. The use of a systematic grid or pattern allows the decision-maker to draw conclusions about the size of the potential areas of elevated activity based on the area between measurement locations.

Class 3 survey locations for surfaces and structures are determined from computer selected randomly generated x and y coordinates. Survey protocols for all classes are summarized in Table 10.2.

For Class 1 and Class 2 survey units where MARSSIM based surveys are not applicable (i.e. drains, ventilation system), representative sampling will be performed throughout each component or system. The Project Manager will use professional judgment as the basis for determining sample locations.

Sample locations will be determined such that the characterization survey will provide representative data to form suitable conclusions about the condition of each component or system in the facility.

Table 10.2 – Survey Sample Placement Overview

Survey Unit Classification		$DCGL_W$ Comparison	Elevated Measurement Comparison	Measurement Locations
Impacted	Class 1	Yes	Yes	Systematic random
	Class 2	Yes	N/A	Systematic random
	Class 3	Yes	N/A	Professional Judgment
Non-Impacted		None	None	None

In addition, totals surface activity measurements will be collected at each area of elevated activity identified during the scan surveys.

10.6.4.1 Determining Class 1 Sample Locations

In Class 1 survey units, the sampling locations are established in a unique pattern beginning with the random start location and the determined sample spacing. After determining the number of samples needed in the survey unit, sample spacing is determined from MARSSIM equation 5-8:

$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Where:

L = sample spacing interval
A = the survey unit area
N = number of samples needed in the survey unit

Maps will be generated of the survey unit's permanent surfaces included in the statistical tests and folded out in a 2-dimensional view. A random starting point is determined using computer-generated random numbers coinciding with the x and y coordinates of the total survey unit. A grid or pattern is plotted across the survey unit surfaces based on the random start point and the determined sample spacing. A measurement location is plotted at each line intersection of the plot.

10.6.4.2 Determining Class 2 Sample Locations

In Class 2 survey units, the sampling locations are established in a unique pattern beginning with the random start location and the determined sample spacing. After determining the number of samples needed in the survey unit, sample spacing is determined from MARSSIM equation 5-8:

$$L = \sqrt{\frac{A}{N}} \text{ for a square grid}$$

Where:

L	= sample spacing interval
A	= the survey unit floor area
N	= number of samples needed in the survey unit

Maps will be generated of the survey unit's permanent surfaces included in the statistical tests. Typically, a random starting point is determined using computer-generated random numbers coinciding with the x and y coordinates of the total survey unit. Then a grid or pattern would be plotted across the survey unit surfaces based on the random start point and the determined sample spacing.

10.6.4.3 Determining Class 3 Sample Locations

Class 3 survey units, sample locations will be determined based on the professional judgment of the Project Manager. The locations will then be plotted on the applicable survey map and surfaces of the survey unit.

10.7 Removable Contamination Measurements

Removable contamination measurements (smears) will be collected on all structural surfaces at each sample location. An area of approximately $100cm^2$ shall be wiped if possible. If an area of less than $100cm^2$ is wiped, a comment shall be added to the survey data sheet estimating the surface area wiped to allow for area correction of the results. Swabs may be used when system or component access points are not large enough to allow for a wipe of $100cm^2$, such as drain lines.

10.8 Survey Investigation Levels

Investigation levels are used to flag locations that require special attention and further investigation to ensure areas are properly classified and adequate surveys are performed. These locations are marked and receive additional investigations to determine the concentration, area and extent of the contamination. The survey investigation levels for each type of measurement are listed by classification in Table 10.3.

Table 10.3 – Survey Investigation Levels

Survey Unit Classification	Flag Direct Measurement or Sample Result When:	Flag Scanning Measurement Result When:	Flag Removable Measurement Result When:
Class 1	> DCGL	>DCGL	> DCGL
Class 2	> 75% of DCGL	> 75% of DCGL	> 75% of DCGL
Class 3	>MDC	>MDC	> MDC

10.9 Survey Documentation

A survey package will be developed for each survey unit containing the following:

- Survey Instruction Sheets
- General survey requirements
- Instrument requirements with associated MDCs, count times and scan rates
- Survey Maps
- Overview maps detailing survey locations and placement methodology
- Survey Data Sheets
- Signature of Data Collector and Reviewer

10.10 Data Validation

Field data will be reviewed and validated to ensure:

- Completeness of forms and the type of survey has correctly been assigned to the survey unit.
- The MDCs for measurements meet the established data quality objectives; independent calculations will be performed for a representative sample of data sheets and survey areas.
- Instrument calibrations and daily functional checks have been performed accurately and at the required frequency.

11.0 Data Quality Assessment and Interpretation of Survey Results

The statistical guidance contained in Section 8 of MARSSIM will be used to determine if areas are acceptable for unrestricted release, and whether additional surveys or sample measurements are needed.

11.1 Preliminary Data Review

A preliminary data review will be performed for each survey unit to identify any patterns, relationships or potential anomalies. Additionally, measurement data is reviewed and compared with the release criteria and investigation levels to identify areas of elevated activity and confirm the correct classification of survey units. If an area is misclassified with a less restrictive classification, the area will be upgraded and surveyed accordingly.

The following preliminary data reviews will be performed for each survey unit:

1. Calculations of the survey unit mean, median, maximum, minimum and standard deviation for each type of reading.
2. Comparison of the actual standard deviation to the assumed standard deviation used for calculating the number of measurements. If the actual standard deviation is greater than estimated, the minimum number of samples shall be calculated using the actual standard deviation to ensure a sufficient number of samples have been obtained.
3. Comparison of survey data with applicable investigation levels.

11.2 Determining Compliance

For Class 1 areas, if it is determined that all total activity results are less than the applicable release criterion, then no further statistical tests are required. If any of the total activity measurements are greater than the applicable release criteria, then the survey unit fails and the null hypothesis is not rejected.

In this survey design, calculations used to determine the minimum number of sample locations is based on the Sign Test. However, the Sign test will not be performed because the total activity release criterion is used as a maximum. If all measurements are less than the release criterion, performance of the Sign test is not necessary because the survey unit will pass the Sign test by definition.

For Class 2 and Class 3 areas, data results are initially compared to the investigation levels. These investigation levels are provided to help ensure that survey units have been properly classified. If all data results in Class 2 or 3 areas are less than the investigation levels, then the survey unit is determined to meet the release criterion. If these investigation levels are exceeded, then an investigation is performed to verify the initial assumptions for classification and determine the appropriate resolution (e.g., additional scans or survey unit reclassification).

Class 3 survey units, by definition, are not expected to contain residual activity above a small fraction of the release criteria. Therefore, if contamination is detected exceeding the release criteria, then reclassification is required. However, reclassification of the entire survey unit may or may not be appropriate. The area containing the residual activity may have been an isolated case and reclassification of the entire survey unit would be inappropriate. More appropriately, the affected portion of the survey unit may be separated and only that portion reclassified. The Radiological Engineer will evaluate the survey results, assign additional scan surveys, as appropriate and determine the appropriate course of action.

Removable contamination measurements will be compared directly to the applicable release criteria. No contingency is established for elevated removable contamination. If any removable contamination is detected which exceeds a removable contamination limit, then the survey unit is determined not to meet the release criterion. However, if all removable contamination measurements are less than the removable contamination limit, then compliance shall be determined based on total activity measurements.

Table 11.1 – Building Surfaces and Structures Data Compliance Overview

Classification	Survey Result	Conclusion
Class 1	• All measurements < release criteria	Survey unit meets release criterion
	• Any measurement > release criteria	Survey unit does not meet release criterion
Class 2	• All measurements < applicable investigation levels	Survey unit meets release criterion
	• Average > applicable investigation levels, and • All measurements < release criterion	Survey unit may meet release criterion. Perform evaluation of elevated activity and determine if additional surveys and/or reclassification are warranted.
	• Any measurement > release criteria	Survey unit does not meet release criterion
Class 3	• All measurements < applicable investigation levels	Survey unit meets release criterion
	• Average > applicable investigation levels, and • All measurements <release criteria	Survey unit may meet release criterion. Perform evaluation of elevated activity and determine if additional surveys and/or reclassification are warranted.
	• Any measurement >release criteria	Reclassify survey unit or portion of survey unit, if justification for splitting the survey unit is provided. Survey unit does not meet release criterion as it exists

12.0 Final Report

A Final Report summarizing D&D activities performed at the facility shall be prepared and submitted to the U.S. Nuclear Regulatory Commission. The guidance provided in NUREG 1727 will be used to prepare the final report. The Final Report will include, at a minimum:

- An overview of the results of the final status survey
- A summary of the DCGLs for the facility
- A discussion of any changes that were made in the FSS from what is proposed in this plan
- A description of the method by which the number of samples was determined for each survey unit
- A summary of the values used to determine the number of samples and a justification for these values
- The survey results for each survey unit including the following:
  - The number of samples taken for the survey unit;
  - A description of the survey unit, including (a) a map or drawing showing the reference system and random start systematic sample

locations for Class1 and 2 survey units and reference area, as applicable, the random locations shown for Class 3 survey units and reference areas, (b) discussion of remedial actions and unique features, and (c) areas scanned for Class 3 survey units and reference areas;

  - The measured sample concentrations, in units comparable to the screening values;
  - The statistical evaluation of the measured concentrations;
  - Judgmental and miscellaneous sample data sets reported separately from those samples collected for performing the statistical calculations;
  - A discussion of anomalous data including any areas of elevated activity detected during scan surveys that exceeded the investigation levels or any measurement locations in excess of the screening values; and
  - A statement that a given survey unit satisfies the screening values and the elevated measurement comparison if any sample points exceeded the screening values

- A description of any changes in initial survey unit assumptions relative to the extent of residual activity (e.g., material not accounted for during site characterization)
- A description of how ALARA practices were employed to achieve final activity levels.

13.0 References

13.1 General References

Philotechnics Radioactive Materials License Number 56-0543 (Commonwealth of Massachusetts) working under reciprocal agreement with the NRC

Philotechnics Procedures

HP-AD-04R0 Radiological Training Requirements;
HP-AC-03 Radiological Work Permits;
HP-1IN-01 Rev. 1 Instrument Response Checks;
HPOP-101 Operation of Ludlum 2929 Scaler;
HPOP-103 Operation of the Bicron Electra/Selectra;
HPOP-104 Operation of Ludlum Model 2221;
HP-WM-01 Radiation Surveys;
HP-WM-02 Contamination Surveys;
HP-WM-03 Workplace and Personnel Air Sampling;
HP-WM-05 Release of Material for Unrestricted Use.

13.2 Radiation Control References

Regulations

NRC Title 10 Code of Federal Regulations (CFR), Part 20

Technical Guidance Documents

International Organization of Standardization. ISO-7503-1, *Evaluation of Surface Contamination - Part 1: Beta Emitters (Maximum Beta Energy Greater Than 0.15 MeV) and Alpha Emitters*, First Edition 1988-08-01.

Oak Ridge Institute for Science and Engineering. 2001. *MARSSIM Overview.* January 19.

Termination of Operating Licenses for Nuclear Reactors. 1974. NRC Regulatory Guide 1.86. June.

U.S. Nuclear Regulatory Commission (NUREG). 1992. CR-5849, Manual for Conducting Radiological Surveys in Support of License Termination, Draft for Comment. June

———1995. 1505. A Nonparametric Statistical Methodology for the Analysis of Final Status Decommissioning Surveys.

———1995. 1506. Measurement Methods for Radiological Surveys in Support of New Decommissioning Criteria. August.

———1997. 1507. Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions. December.

———2001. 1575. Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Revision 2. June.

———2003. 1757, Vol. 2. Consolidated NMSS Decommissioning Guidance. Final Report.

———2000. 1727. NMSS Decommissioning Standard Review Plan, Final. September.