Final Report:
Final Status Survey of St. Albans Veterans Administration Extended Care Center Facility – Queens, New York

Prepared for:

Stone and Webster Inc.
100 Technology Drive Center
Stoughton, Massachusetts 02072

Prepared by:

Cabrera Services, Inc.
809 Main Street
E. Hartford, CT 06108

March 2002

U.S. ARMY CORPS OF ENGINEERS

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
JACOB K. JAVITS FEDERAL BUILDING
NEW YORK, N.Y. 10278-0090

REPLY TO
ATTENTION OF

Formerly Used Defense Sites Project Office
190 State Highway 18, Suite 202
East Brunswick, NJ 08816

SUBJECT: Final Report: Final Status Survey of St. Albans VA Medical Hospital, Queens
C02NY0763

March 6, 2002

Mr. Todd Jackson
Nuclear Regulatory Commission Region I
475 Allendale Rd
King of Prussia, PA 19406

Dear Todd;

This letter is to formalize the submittal of the subject report. Per our telephone conversation on March 1, 2002, you do not have any revisions for the Draft Final submitted on January 9, 2002, so we now consider this report as a "Final". Attached is the cover sheet for the final report to replace the previous cover sheet of the draft final. I would appreciate a letter from NRC stating your concurrence.

It's been a pleasure working with you on this project and I hope to have this opportunity again. If you have any questions or need additional information, please do not hesitate to contact me at (732) 435-0079 or toll free at (877)607-0580

Sincerely,

Luz O. Spann-LaBato, P.E.
Project Manager

Encl.

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
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NEW YORK, N.Y. 10278-0090

REPLY TO
ATTENTION OF

Formerly Used Defense Sites Project Office
190 State Highway 18, Suite 202
East Brunswick, NJ 08816

SUBJECT: Draft Final Report: Final Status Survey of St. Albans VA Medical Hospital, Queens C02NY0763

January 9, 2002

Mr. Todd Jackson
Nuclear Regulatory Commission Region I
475 Allendale Rd
King of Prussia, PA 19406

Dear Mr. Jackson;

Enclosed is the subject report for your review and approval. Please forgive the delay but as I explained to you earlier, some of the circumstances were beyond my control. If you have any comments on this report, please let me know so we can address these prior to issuing a final report.

If you have any questions or need additional information, please do not hesitate to contact me at (732) 435-0079.

Sincerely,

Luz O. Spann-LaBato, P.E.
Project Manager

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E. Hartford, CT 06108

December 2001

Executive Summary

Cabrera Services, Inc. (CABRERA), under contract to Stone and Webster Engineering Corporation, performed final status surveys on portions of the St. Albans Veterans Administration Extended Care Center Facility (VAECC), located in Queens, New York. CABRERA also provided daily radiological support services during the field remediation phase of the project. The Final Status Survey (FSS) was performed in accordance with guidance as outlined in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) and Stone and Webster documents "Work Plan for Decontamination and Decommissioning" and "Sampling and Analysis Plan for Decontamination and Decommissioning."

The VAECC facility was operated as a Naval Hospital providing nuclear medicine services under an NRC license until 1973. The affected area of the facility has been locked and inactive since radioactive contamination in excess of NRC release criteria was found by previous surveys. The radionuclide of concern (ROC) at the site is strontium-90 (Sr-90).

A FSS was performed in accordance with MARSSIM and approved Stone and Webster Work Plans. The Derived Concentration Guideline Level (DCGL) for Sr-90, established by WESTON for the U.S. Department of the Army, New England District, Corps of Engineers, was 8,700 dpm/100 cm^2 for concrete surfaces remaining in place (MADONIA). In addition, a soil contamination DCGL limit was set at 11 pCi/g using RESRAD with the review and approval of the US NRCto address potential contamination surrounding removed drainage piping.

The FSS consisted of scans using a beta scintillator, static measurements at discrete locations, transferable contamination measurements at the same discrete locations, and collection and analysis of soil samples from areas adjacent to locations where piping was removed and soil was exposed. Scan surveys were provided for 100% of reasonably accessible floor areas and wall areas up to a height of 2 meters.

The results of the FSS show Sr-90 residual activity may be present This FSS conclude that Sr-90 activity levels are well below the respective DCGL of 8,700 dpm/100 cm^2 of total and 870 dpm/100 cm^2 of transferable activity on the walls and floors of affected areas at the site. Soil sample results also establish that residual Sr-90 concentration in affected site soils are well below the respective DCGL of 11 pCi/g. The DCGLs presented above meet the requirements of 10CFR20 Subpart E regulation dose requirements which limit dose to an average member of the critical group to 25 millirem in any one year.

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

Acronym or Abbreviation	Definition
DCGL	Derived Concentration Guideline
DOD	Department of Defense
DQO	Data Quality Objectives
EPA	Environmental Protection Agency
FSS	Final Status Survey
HSA	Historical Site Assessment
LBGR	Lower Bound Gray Region
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimum Detectable Concentration
NRC	Nuclear Regulatory Commission
ROC	Radionuclides of Concern
SSHP	Site Safety and Health Plan
SU	Survey Unit
TLD	Thermo Luminescent Dosimeter
VAECC	St. Albans Veterans Administration Extended Care Center Facility

1.0 INTRODUCTION

This report presents the results of radiological surveys that were conducted in accordance with the Work Plan and provides an analysis of the final status survey data using Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) statistical tests and guidance. Final status survey results are presented in Section 6.0.

2.0 BACKGROUND AND SITE DESCRIPTION.

The Veteran's Administration Extended Care Center (VAECC) facility is a fifteen building complex located on approximately a 55-acre site at 179th Street and Linden Boulevard in Queens, New York. Only Building 90 and Tunnel 45, which connects the subsurface levels of Building 90 to Building 91, have been impacted by the D&D activities.

The VAECC facility was operated as a Naval Hospital prior to its acquisition by the Veteran's Administration (VA). The Naval Hospital provided nuclear medicine services under a NRC license, which included several amendments. NRC licensed activities ended with the termination of Nuclear Regulatory Commission (NRC) license # 31-00076-06 on December 31, 1973. In 1976, the St. Albans facility was transferred from the Navy to the VA. The VA did not hold a radioactive materials license at the St. Albans facility. In May of 1992 the USACE, while performing a review of former Department of Defense (DOD) sites, visited the St. Albans facility and identified areas of elevated radioactivity. In July of 1992, Teledyne Isotopes performed survey work at the St. Albans facility and recommended an expanded survey and decontamination of other rooms in the report titled "Radiation Safety Survey for VA Medical Center Queens, NY, July 1992" (Teledyne Isotopes, 1992). In September 1997, Ogden Environmental and Energy Services Co., Inc, (Ogden) surveyed the nuclear labs and the ejector pit located adjacent to Tunnel 45 and identified radioactive contamination in excess of NRC release criteria in effect at that time (NEA). The Ogden report concluded the scope of the survey needed to be expanded.

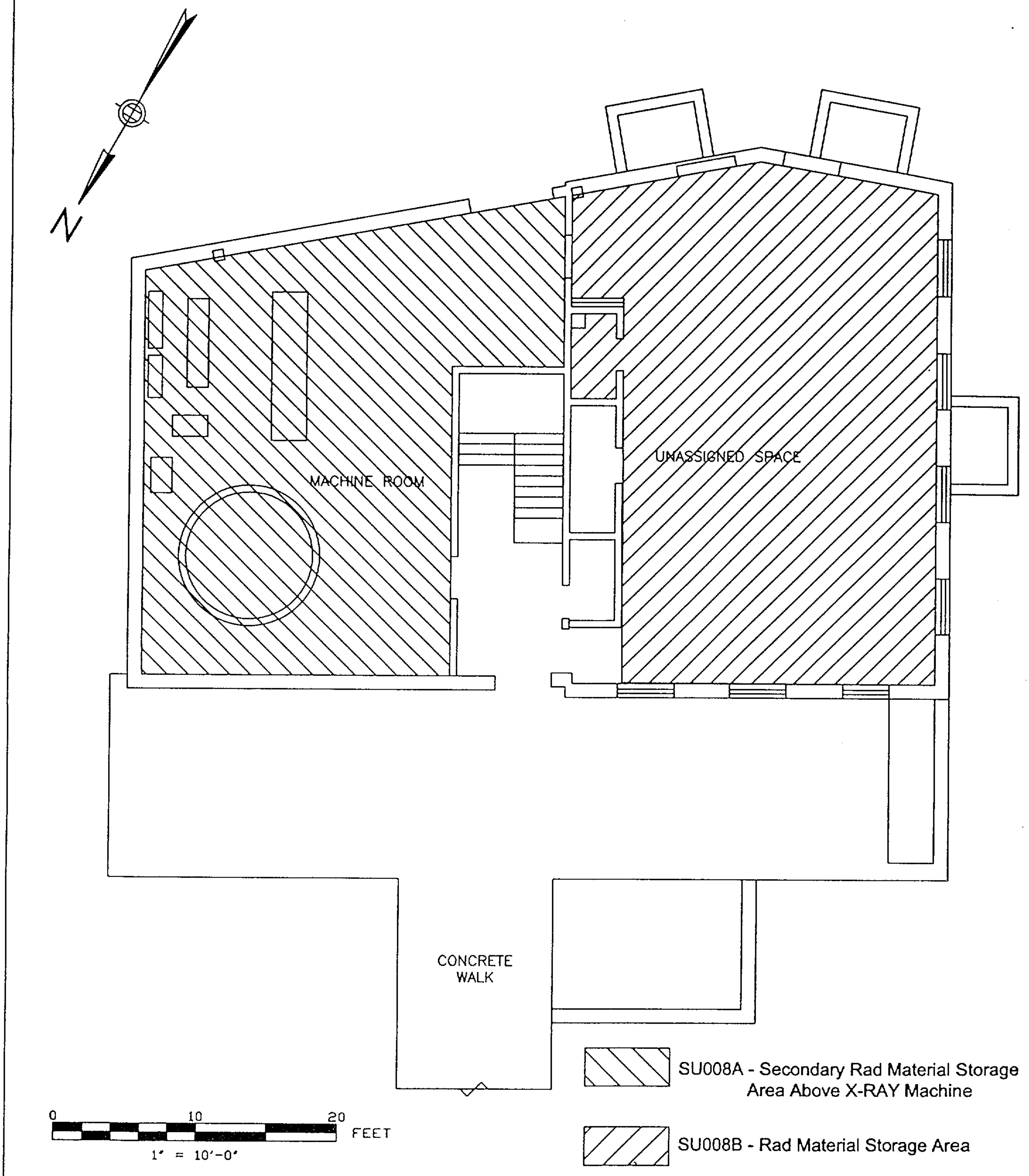
Stone & Webster prepared a records review report (HSA, 1998) for the USACE, chronicling the use of radioactive materials at the St. Albans facility. The Stone & Webster report identified areas in Buildings 64, 90 and 91, which needed to be characterized and remediated to support unrestricted use of the St. Albans facility.

In 1999, Roy F. Weston Company, Inc. (Weston), conducted characterization surveys of Buildings 64, 90 and 91 (Weston, 1999a). Previous characterization of the buildings divided areas into logical survey units (SU). Based on the previous characterization efforts and small-scale decontamination activities, data demonstrate that all SUs in Buildings 64 and 91 (Weston, 1999b) met the DCGL criteria for the FSS. The Weston surveys included Carbon 14, Tritium and Strontium as radionuclides of concern. The 1999 radiological surveys conducted by Weston concluded that Carbon 14 and Tritium were not present and that strontium 90 is the only identified isotope of concern remaining at St. Albans. The Women's Bathroom (SU003) on the basement floor and the ground floor (SU008) of Building 90 met the requirements for the FSS. SUs 001, 002 and 004 (located in the Building 90 basement) contained contamination that required remediation, followed by a comprehensive FSS (Weston, 1999b).

Table 2-1

Survey Unit Summary

SURVEY UNIT #	DESCRIPTION	MARSSIM CLASS	DECON-TAMINATION REQUIRED	FINAL STATUS SURVEY COMPLETE
SU 001A	Nuclear Medicine Laboratory (High and Low Level Lab)	CLASS 1	Y	Y
SU 001B	Nuclear Medicine Laboratory (Corridor and Count Room)	CLASS 1	Y	Y
SU 002	Ejector Pit	CLASS 1	Y	Y
SU004	Men's Toilet	CLASS 1	Y	Y
SU005	Basement Level Building 90	CLASS 2	N	Y
SU 008A	Ground Level Building 90 (RMA Storage)	CLASS 2	N	Y
SU 008B	Ground Level Building 90	CLASS 3	N	Y



ST. ALBANS VETERANS
ADMINISTRATION EXTENDED CARE CENTER
QUEENS, NEW YORK

STONE & WEBSTER
a Shaw Group Company
STOUGHTON, MASSACHUSETTS

FIGURE 2-2
BUILDING 90
GROUND LEVEL

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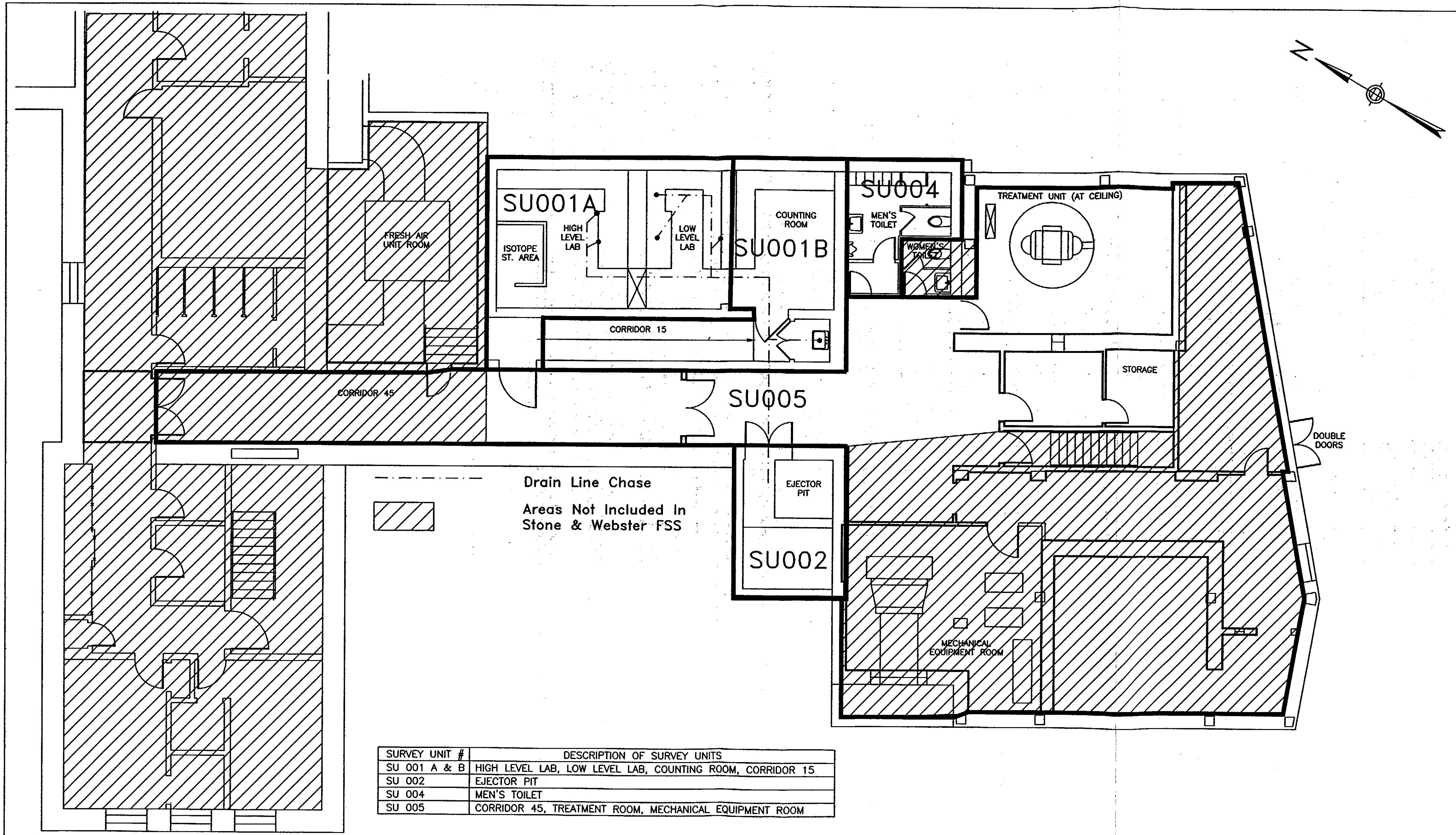

SURVEY UNIT #	DESCRIPTION OF SURVEY UNITS
SU 001 A & B	HIGH LEVEL LAB, LOW LEVEL LAB, COUNTING ROOM, CORRIDOR 15
SU 002	EJECTOR PIT
SU 004	MEN'S TOILET
SU 005	CORRIDOR 45, TREATMENT ROOM, MECHANICAL EQUIPMENT ROOM

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FIGURE 2-1
BUILDING 90
Survey Unit Locations

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Table 2-2

Survey Units Surveyed by Weston

SURVEY UNIT #	DESCRIPTION	MARSSIM CLASS	DECON-TAMINATION REQUIRED	FINAL STATUS SURVEY COMPLETE
SU 003	Womens Toilet	Class 1	No	Yes
SU 006	Maintenance Shop and Stairwell	Class 3	No	Yes
SU 007	Audiology, Speech Pathology	Class 3	No	Yes
*SU 008	Ground Level Building 90	Class 3	No	No
**SU 005	Balance of Basement in Building 90	Class 1	Sub-unit 501did not meet DCGL	No
SU 009	Incinerator	Class 3	No	Yes

*Area used to transport contaminated materials must be surveyed following remediation. See Table 2-1 above.

** SU 005 reported in sub-units – Complete details in Weston 12/99

3.0 RADIONUCLIDE OF CONCERN (ROC)

The historical review of past radiological usage and radiological survey reports indicate that Strontium-90 (Sr-90) is the only isotope of concern. Sr-90 is typically present in metallic or oxide forms. It has a half-life of approximately 28 years and is a beta source. It is both a skin- and internal-dose hazard. The Site Health and Safety Plan (SSHP) provides for measures to mitigate radiological hazards.

4.0 REMEDIATION ACTIVITIES

Prior to remediation, SU001, SU002 and SU004 at the VAECC had been found to contain residual levels of Sr-90 greater than the derived concentration guideline level (DCGL) as stated in Section 5.1. These areas have undergone remediation and subsequent Final Status Survey (FSS). Pipes in SU005 were removed during remediation activities and a FSS of SU005 was subsequently performed. For the most part, remediation activities occurred prior to the FSS; however, after the bulk of remediation activities were performed, additional remediation of several small areas occurred based upon scan results. Remediation did occur on a small scale in some areas while final status survey continued. As areas were remediated and the FSS began, remediation was started in other nearby areas. Control and surveillance measures were adopted to avoid the potential of cross-contamination between FSS and remediation areas. Such control and surveillance measures during remediation activities included plastic sheeting placed over walls and entry points in each room being remediated, where necessary, and a HEPA filtered air monitoring system, which provided a negative pressure atmosphere inside each room. Results of smear surveys performed during remediation activities showed no activity in excess of background. Results of external monitoring, performed using thermo luminescent dosimetry (TLDs), showed no detectable activity for shallow and extremity doses for each worker.

Total surface Sr-90 contamination monitoring was performed with a Ludlum 2224 scaler/rate –meter with Ludlum Model 43-89 alpha-beta scintillator in accordance with standard operating procedures as presented in Appendix A of the Site Safety and Health Plan (SSHP), the Radiation Protection Plan (RPP). Removable Sr-90 contamination smears were analyzed with a Ludlum Model 2929 and Model 43-10-1 sample counter.

Remedial activities were performed in order to reduce contamination to a small fraction of the 8,700 dpm/100 cm^2 total DCGL and 870 dpm/100 cm^2 transferable contamination DCGL as follows:

In SU001, mastic was sampled for asbestos content; all debris and remaining furniture were removed; contaminated concrete was removed; remaining ductwork was removed; contaminated drain lines and soil were removed; and contaminated asbestos tile in Corridor 15 was removed.

In SU002, contaminated hardware was removed; contaminated drain lines and soil were removed; the pipe under Tunnel 45 was removed; and the contaminated drain line connecting SU001 and SU002 was removed.

In SU004, the internal contents of restroom were removed and contaminated ceramic floor tiles were removed.

Materials removed during the remediation process were surveyed and segregated as necessary to ensure that materials with levels of radioactivity greater than 200 dpm/100 cm^2 removable activity or 1,000 dpm/100 cm^2 (as per NRC Regulatory Guide 1.86) were treated as contaminated waste.

5.0 FINAL STATUS SURVEY DESIGN

The FSS of the VAECC was designed and performed using MARSSIM guidance. The radionuclide of concern is Sr-90, which emits beta radiation upon undergoing radioactive decay. Contamination in the building was assumed to be at or near the surface of walls, floors and penetrations. During remediation activities, contamination penetrated some surfaces up to several centimeters. Surface scans were performed with the knowledge that residual contamination would be greatest at the outermost layers of affected surfaces. Soil below floor structures (e.g., pipes) removed during remedial activities was considered potentially contaminated and soil samples were collected at these locals for offsite laboratory Sr-90 analysis.

Radiologically impacted areas at the VAECC were divided into four Class 1 survey units (SUs 001A, 001B, 002 and 004), two Class 2 survey units (SUs 005 and 008A), and one Class 3 survey unit (SU008B). Sr-90 surface scans were performed over reasonable accessible floor areas and wall areas up to a height of 2 meters. For the purpose of this report, the phrase "reasonable accessible" is defined to mean not requiring disassembly of fixed items that are not being removed and which a Ludlum 43-89 probe could not fit. SU008A was originally specified as a Class 3 survey, however, scoping surveys presented data, which supported a reclassification of SU008A as a Class 2 survey unit. The methods used for selection of survey unit areas and relevant calculations (e.g., number of sample points, grid spacing) are described in Section 5.2.

Following remediation, surface scans were performed at a speed of 1 to 3 inches per second over 100% of reasonably accessible areas of the floor and of walls up to 2 meters above the floor in each survey unit. Results were recorded and locations exceeding investigation levels stated in Section 5.1 were reported to management (i.e., Stone & Webster), investigated, and, when appropriate, remediated further. Following any additional decontamination, scanning was repeated to demonstrate effectiveness of the removal actions. A scoping survey scan of some remaining areas (i.e., upper wall and ceiling) in Class 1 and certain Class 2 areas was also performed. Scan minimum detectable concentrations (Scan MDCs) are reported in Appendix C to this report.

Following surface scanning, static 1-minute measurements were performed for at least 14 systematic, pre-determined points per survey unit and recorded by the surveyor. Scans and static measurements were performed using a Ludlum Model 2221 (or Ludlum Model 2224) scaler/ratemeter coupled to a Ludlum 43-89 probe. Shielded measurements were performed by placing the detector against a wooden jig equal in length and width to the face of the detector. The wooden jig has a low background activity allowing for conservative final activity results to be reported. This shielded measurement provides a gamma background correction for the calculation of Sr-90 surface activity concentrations. It should be noted that the structures being surveyed, especially wall surveys, varied in material consistency and, therefore, in background beta activity. Since no beta surface corrections or background subtraction due to the naturally occurring beta components of the material being scanned were made, the resultant scan and static measurements are conservative. Equations for static measurement MDC calculations are reported in Appendix D to this report.

A smear survey was also performed at each static measurement point for transferable activity analysis. A Ludlum Model 2929/43-10-1 alpha/beta sample counter was used on-site to analyze smear activity. Scan and smear counting instrumentation was efficiency calibrated using a Sr-90 NIST traceable source with results reported in disintegrations per minute of Sr-90 per 100 cm^2.

5.1 DCGLs Established

The DCGLs for the St. Albans facility were established using the 64132 Federal Register Notice, Volume 63, No. 222, dated November 18, 1998. Weston incorporated an alteration to the DCGLs in a letter to the USACE dated May 15, 2000 and subsequently approved by the NRC in a letter to the VA dated June 20, 2000 (MADONIA). The building surface contamination investigation level presented in Table 5-1 was set by management at the onset of field activities. Table 3-1 summarizes these DCGLs.

Table 5-1 DCGLs to be Applied at VAECC

Isotope	Soil DCGL (pCi/g)***	Building Surface (total activity)** DCGL (dpm/100 cm^2)*	Building Surface Transferable Activity DCGL (dpm/100 cm^2)*	Building Surface (total activity) Investigation Level (dpm/100 cm^2)*
Sr- 90	11	8,700	870	2,000

*dpm/100 cm^2—disintegrations per minute per one hundred square centimeters

** total activity = Gross activity

***pCi/g—Picocurie per gram

5.2 Final Status Survey Unit Classification and Calculations

A site reference coordinate system was designed to ensure all sample and measurement locations are spatially identified such that each location is reliably reproducible. Computer assisted design (CAD) was utilized to layout survey unit dimensions by rooms and to aid in the development of the FSS locations. The individual survey units were broken down based upon logical room units and initial levels of contamination.

5.2.1 Survey Unit Classification

Survey units in impacted areas under MARSSIM are broken into three classes (i.e., Class 1, 2 and 3). Impacted areas at the VAECC were divided into four Class 1 survey units (SU001A, 001B, 002 and 004), two Class 2 survey units (SU005 and 008A), and one Class 3 survey unit (SU008B). SU008A was originally specified as a Class 3 survey, however, early scoping surveys presented data, which supported a reclassification of SU008A as a Class 2 survey unit. A triangular grid pattern was chosen for each survey unit.

An area is classified as a Class 1 survey unit if contaminant concentrations exist above the DCGLs. Past data indicates that SU001, 002 and 004 meet this criterion and therefore these areas have been designated as Class 1 survey units. The suggested maximum survey unit size for a Class 1 survey unit is 100 m^2. Therefore, due to the size of SU001, it has been divided into two survey units, SU001A and SU001B.

Sampling Survey Unit Maps are presented in Appendix B to this report.

5.2.2 Survey Reference System

A reference coordinate system was used to provide a level of reproducibility consistent with the objective of the survey. A random-start triangular grid pattern was referenced to each survey unit, a random starting point selected and the starting point grid coordinates of all locations within the survey unit were identified.

5.2.3 Limits on Decision Errors

Decisions based on survey results can often be reduced to a choice between "yes" or "no," such as evaluating whether or not a survey unit meets the release criterion. When viewed in this way, two types of incorrect decisions, or decision errors, are identified:

- Type I - incorrectly deciding that the answer is "yes" when the true answer is "no,"
- Type II - incorrectly deciding the answer is "no" when the true answer is "yes."

The distinctions between these two types of errors are important for two reasons: (1) the consequences of making one type of error versus the other may be very different, and (2) the methods for controlling these errors are different and involve tradeoffs. For these reasons, the decision maker should specify acceptable levels for each type of decision error.

A Type I decision error occurs when the null hypothesis is rejected when it is true, and is sometimes referred to as a false positive error. The probability of making a Type I decision error, or the level of significance, is denoted by alpha (α). Alpha reflects the amount of evidence the decision maker would like to see before abandoning the null hypothesis, and is also referred to as the *size* of the test.

A Type II decision error occurs when the null hypothesis is accepted when it is false. This is sometimes referred to as a false negative error. The probability of making a Type II decision error is denoted by beta (β). The term ($1-\beta$) is the probability of rejecting the null hypothesis when it is false, and is also referred to as the *power* of the test.

Using MARSSIM, the following limits on α and β have been established:

- Type I error - $\alpha = 0.05$. This implies that 5 percent (%) of the time the SU could be released even if the release criterion is exceeded. (Results in small but increased risk to the public.)

- Type II error - $\beta = 0.05$. This implies that 5% of the time even though the release criterion is not exceeded the SU will fail. (Results in unnecessary cleanup cost.)

5.2.4 Estimation of Relative Shift

The *Lower Bound of the Gray Region* (LBGR) is selected during the DQO process along with the target values for α and β. The *width* of the gray region, equal to (DCGL - LBGR), is a parameter that is central to the nonparametric tests discussed in MARSSIM. It is also referred to as the *shift*, Δ. The absolute size of the shift is actually of less importance than the *relative shift* - Δ/σ, where σ is an estimate of the standard deviation of the measured values in the survey unit. The estimated standard deviation, σ, includes both the real spatial variability in the quantity being measured, and the precision of the chosen measurement method. The relative shift, Δ/σ, is an expression of the resolution of the measurements in units of measurement uncertainty. Expressed in this way, it is easy to see that relative shifts of less than one standard deviation, $\Delta/\sigma < 1$, will be difficult to detect. On the other hand, relative shifts of more than three standard deviations, $\Delta/\sigma > 3$, are generally easier to detect. The number of measurements that will be required to achieve given error rates, α and β, depends almost entirely on the value of Δ/σ.

The minimum number of sample locations required is dependent on the distribution of site residual radionuclide concentrations relative to the DCGL and acceptable decision error limits (α and β), which are established in the previous section. The relative shift describes the relationship of site residual radionuclide concentrations to the DCGL and is calculated using the following equation, from MARSSIM.

$$\Delta/\sigma = \frac{\text{DCGL - LBGR}}{\sigma}$$

Where: DCGL = the derived concentration guideline (i.e., release limit)

LBGR = concentration at the lower bound of the gray region. The LBGR is the concentration to which the survey unit must be cleaned in order to have an acceptable probability of passing the statistical tests. The LBGR effectively becomes the survey's action level.

σ = an estimate of the standard deviation of the concentration of residual radioactivity in the survey unit (which includes real spatial variability in the concentration as well as the precision of the measurement system)

For this project, an LBGR = ½ DCGL has been established. During project planning, it was assumed that, following remediation, Sr-90 residual activities would be significantly less than the DCGL. If the assumed σ value is 1450 dpm/100cm^2 or less, the relative shift is calculated to be greater than 3. We will assume then that the σ value is, at most, 1450 dpm/100cm^2 and that the relative shift is at least 3. Following the FSS, data results will be reduced for each survey unit and with a standard deviation of less than 1450 dpm/100cm^2, the relative shift should calculate to greater than 3.

5.2.5 *Number of Data Points*

A statistical test may be used, if necessary to determine whether portions of the site are suitable for release for unrestricted use. The minimum number of systematic measurement locations required in each survey unit for the statistical test is determined using the following equation, from MARSSIM.

$$N = \frac{1}{2} \times \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{3(P_r - 0.5)^2}$$

Where: N = the minimum number of measurement locations per survey unit

$Z_{1-\alpha}$ = the percentile represented by the decision error α (Type I)

$Z_{1-\beta}$ = the percentile represented by the decision error β (Type II)

P_r = the probability that a random measurement from the survey unit exceeds a random measurement from the background reference area by less than the DCGL when the survey unit median is equal to the LBGR above background (based on relative shift)

The acceptable percentile values are $Z_{1-\alpha} = Z_{1-\beta} = 1.645$ (from Table 5.2 in MARSSIM). The relative shift is greater than 3, allowing the P_r value to be set at 1 as per MARSSIM, Section 5.5.2.3.

The Final Decommissioning Plan states eleven (11) data points per survey unit were required. However, based on MARRISM (Section 5.5.2.2), the number of sampling points should be increased by at least 20% in order to attain the desired power for statistical testing as well as to allow for any possible lost or unusable data points. This increased the number of data points to at least 14 points in each survey unit.

5.2.6 *Additional Samples to Meet EMC Criterion*

MARSSIM states that, for Class 1 areas, a dose area factor must also be used to evaluate the magnitude by which the concentration within a small area of elevated activity can exceed the $DCGL_w$ while maintaining compliance with the release criterion. The following formula is listed in section 5.5.2.4 of MARSSIM for determining the necessary scan sensitivity when incorporating the area factor:

Scan MDC (required) = ($DCGL_w$) x (Area Factor)

If the actual scan MDC is greater than the required scan MDC, additional samples are required to ensure that the dose-based criterion is satisfied.

The area factor is determined based on specific regulatory agency guidance and is some value greater than one. The calculated Scan MDC as presented in Appendix C for the plastic scintillator detector in use at the VAECC is 788 dpm/100 cm^2 for concrete material and 839 dpm/100 cm^2 for brick material. These values are well below the DCGL of 8,700 dpm/100 cm^2. An additional area factor multiplier would only increase required Scan MDC value. As such, the number of at least 14 samples per survey unit established in the previous section will suffice and no additional samples are required to meet the EMC criterion.

5.2.7 Grid Spacing

The grid spacing for the triangular grid is estimated as follows:

$$L = \sqrt{\frac{A}{0.866 \times n}}$$

Where: A = the surface area in the survey unit, and

n = the number of sample points per survey unit

The calculated L value for each survey unit is presented on Attachment 1 to this report.

5.3 Instrument Selection and Survey Techniques

Radiological instruments were available to scan equipment, personnel, and clothing for radiological contamination and for performing the FSS. This equipment included Geiger-Mueller detectors, beta scintillation probes, smear sample counter, a microrem meter, and other instrumentation connected to appropriate rate/scaler meters.

Scans were performed at a speed of 1 to 3 inches per second. General instrumentation survey techniques are presented in the operating procedures, which are attached as Appendix F to this report.

5.3.1 Field Instruments

A Ludlum Model 177 coupled to Ludlum Model 44-9 alpha/beta/gamma probe was used to radiologically release equipment and materials.

Ludlum Model 9 and Ludlum Model 19 meters were used to survey exposure levels at the VAECC.

A Ludlum Model 2221 scaler/ratemeter coupled to a Ludlum Model 43-89 alpha/beta scintillator probe and a Ludlum Model 2224 scaler/ratemeter coupled to a Ludlum 43-89 alpha/beta scintillator probe were used for performing surface scans.

The 4-inch cast iron pipe in the ejector pit was characterized using an AEES, Inc. PSR-4 proportional probe gas flow detector. The PSR-4 is designed to navigate multiple 90° pipe bends and traverse internal welds while maintaining a centered position. The probe utilizes P-10 gas fed through a C series combination gas and high voltage cable. The detector is covered with a single wrap of 0.8 mg/cm^2 mylar.

The PSR-4 (screened, ruggedized) probe uses a screen to minimize mylar window damage, and large spring-loaded rollers to guide and center the probe within the pipe. The large rollers allow for near zero insertion force while pushing the detector through the pipe. A plumber's flat snake with four-inch measurements was used to push the PSR-4 while measuring the location of the detector within the pipe. The instrument used to provide characterization data for the cast iron pipe is a detector appropriate for the energy and type of radiation to be detected. In addition, the instrument response and MDC is low enough to provide reasonable assurance that the established DCGLs levels may be achieved in the field.

The MDC expression from Table 3-1 of NUREG-1507 "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", December 1997, based on 95 % confidence, and 1-minute count and background time is:

$$MDC = C \times \left(3 + 4.65\sqrt{B}\right)$$

Where,

C = Detector Efficiency, dpm/count

B = Background Count - 1 Minute, counts

The following table provides calculated MDCs for several background values assuming the manufacturer's efficiency of 6% for ^{90}Sr/^{90}Y.

Radionuclide	Manufacturer's Detector Efficiency, (DPM/CPM)	Background, (CPM)	MDC Result (DPM/100cm^2)
Sr-90/Y-90	16.67	100	825
Sr-90/Y-90	16.67	150	999
Sr-90/Y-90	16.67	200	1146
Sr-90/Y-90	16.67	250	1275

5.3.2 Smear/Air Counting Instruments

A Ludlum Model 2929/43-10-1 alpha/beta sample counter was used to perform analysis of smear and air samples.

5.3.3 Environmental Air Sampling

A LV-1 low volume air sampler coupled to an isokinetic nozzle was used for airborne particulate measurements being discharged to the environment. All ventilation air discharged to the environment passed through a HEPA filtration system for essentially 100% total particulate capture. No gas or vapor releases were caused during the remediation process.

5.4 Instrument Calibration

Current calibration records were kept on site for review and inspection (included as Appendix G to this report). The records include, at a minimum, the following:

- name of the equipment
- equipment identification (model and serial number)
- manufacturer
- date of calibration
- calibration due date

Instrumentation was maintained and calibrated to manufacturers' specifications to ensure that required traceability, sensitivity, accuracy and precision of the equipment/instruments were maintained. Instruments were calibrated at a facility possessing appropriate NRC and/or Agreement State licenses for performing calibrations using National Institutes of Standard Technology (NIST) traceable sources. Scanning and smear counting instrumentation were efficiency calibrated using a Sr-90 NIST traceable source. Daily source checks were performed for all radiological survey instrumentation used at the VAECC. Control charts and relevant data are presented in Appendix E to this report.

5.5 Operating Procedures

Standard operating procedures for radiological survey instrumentation are referenced in Section 5.3 of this report. Other operating procedures can be found in Appendix F to this report.

6.0 SURVEY RESULTS

6.1 Survey Unit 001A

A Class 1 Final Status Survey was performed in Survey Unit 001A. Following are the 100% direct scan results, the direct static measurement results, and the results of any smear surveys taken in Survey Unit 001A.

6.1.1 Direct 100% Scan Results

A direct beta scan survey was performed in Survey Unit 001A on 100% of reasonably accessible floor areas and wall areas up to a height of 2 meters. Residual activity was identified at levels above background. Based on the beta scan results, the highest residual activity identified in Survey Unit 001A was approximately 2,700 dpm/100 cm^2. Survey results are presented in Appendix A for reference.

6.1.2 Direct Static Measurement Results

Direct static measurements of Sr-90 surface contamination results for Survey Unit 001A ranged from 75 to 406 dpm/100 cm^2. These results are well below the release limit of 8,700 dpm/100 cm^2. Survey results are presented in Appendix A for reference.

6.1.3 Smear Survey Results

Transferable surface contamination results for Survey Unit 001A range from 0 to 36 dpm/100 cm^2. These results are below the transferable contamination release limit of 870 dpm/100 cm^2 (i.e., 10% of the 8,700 dpm/100 cm^2 release limit). Survey results are presented in Appendix A for reference.

6.2 Survey Unit 001B

A Class 1 Final Status Survey was performed in Survey Unit 001B. Following are the 100% direct scan results, the direct static measurement results, and the results of any smear surveys taken in Survey Unit 001B.

6.2.1 Direct 100% Scan Results

A direct beta scan survey was performed in Survey Unit 001B on 100% of reasonably accessible floor areas and wall areas up to a height of 2 meters. Residual activity was identified at levels above background. Based on the beta scan results, the highest residual activity identified in Survey Unit 001B was approximately 4,200 dpm/100 cm^2. Survey results are presented in Appendix A for reference.

6.2.2 Direct Static Measurement Results

Direct static measurements of Sr-90 surface contamination results for Survey Unit 001B ranged from 37 to 433 dpm/100 cm^2. These results are well below the release limit of 8,700 dpm/100 cm^2. Survey results are presented in Appendix A for reference.

6.2.3 *Smear Survey Results*

Transferable surface contamination results for Survey Unit 001B range from 0 to 36 dpm/100 cm^2. These results are below the transferable contamination release limit of 870 dpm/100 cm^2 (i.e., 10% of the 8,700 dpm/100 cm^2 release limit). Survey results are presented in Appendix A for reference.

6.3 Survey Unit 002

A Class 1 Final Status Survey was performed in Survey Unit 002. Following are the 100% direct scan results, the direct static measurement results, and the results of any smear surveys taken in Survey Unit 002.

6.3.1 *Direct 100% Scan Results*

A direct beta scan survey was performed in Survey Unit 002 on 100% of reasonably accessible floor areas and wall areas up to a height of 2 meters. Residual activity was identified at levels above background. Based on the beta scan results, the highest residual activity identified in Survey Unit 002 was approximately 4,800 dpm/100 cm^2. Survey results are presented in Appendix A for reference.

6.3.2 *Direct Static Measurement Results*

Direct static measurements of Sr-90 surface contamination results for Survey Unit 002 ranged from 85 to 401 dpm/100 cm^2. These results are well below the release limit of 8,700 dpm/100 cm^2. Survey results are presented in Appendix A for reference.

6.3.3 *Smear Survey Results*

Transferable surface contamination results for Survey Unit 002 range from 0 to 45 dpm/100 cm^2. These results are below the transferable contamination release limit of 870 dpm/100 cm^2 (i.e., 10% of the 8,700 dpm/100 cm^2 release limit). Survey results are presented in Appendix A for reference.

6.4 Survey Unit 004

A Class 1 Final Status Survey was performed in Survey Unit 004. Following are the 100% direct scan results, the direct static measurement results, and the results of any smear surveys taken in Survey Unit 004.

6.4.1 Direct 100% Scan Results

A direct beta scan survey was performed in Survey Unit 004 on 100% of reasonably accessible floor areas and wall areas up to a height of 2 meters. Residual activity was identified at levels above background. Based on the beta scan results, the highest residual activity identified in Survey Unit 004 was approximately 2,200 dpm/100 cm^2. Survey results are presented in Appendix A for reference.

6.4.2 Direct Static Measurement Results

Direct static measurements of Sr-90 surface contamination results for Survey Unit 004 ranged from 64 to 1,223 dpm/100 cm^2. These results are well below the release limit of 8,700 dpm/100 cm^2. Survey results are presented in Appendix A for reference.

6.4.3 Smear Survey Results

Transferable surface contamination results for Survey Unit 004 range from 0 to 27 dpm/100 cm^2. These results are below the transferable contamination release limit of 870 dpm/100 cm^2 (i.e., 10% of the 8,700 dpm/100 cm^2 release limit). Survey results are presented in Appendix A for reference.

6.5 Survey Unit 005

A Class 2 Final Status Survey was performed in Survey Unit 005. Following are the 100% direct scan results, the direct static measurement results, and the results of any smear surveys taken in Survey Unit 005.

6.5.1 Direct 100% Scan Results

A direct beta scan survey was performed in Survey Unit 005 on 100% of reasonably accessible floor areas and wall areas up to a height of 2 meters. Residual activity was identified at levels above background. Based on the beta scan results, the highest residual activity identified in Survey Unit 005 was approximately 1,200 dpm/100 cm^2. Survey results are presented in Appendix A for reference.

6.5.2 Direct Static Measurement Results

Direct static measurements of Sr-90 surface contamination results for Survey Unit 005 ranged from 21 to 1,661 dpm/100 cm^2. These results are well below the release limit of 8,700 dpm/100 cm^2. Survey results are presented in Appendix A for reference.

6.5.3 Smear Survey Results

Transferable surface contamination results for Survey Unit 005 range from 0 to 44 dpm/100 cm^2. These results are below the transferable contamination release limit of 870 dpm/100 cm^2 (i.e., 10% of the 8,700 dpm/100 cm^2 release limit). Survey results are presented in Appendix A for reference.

6.6 Survey Unit 008A

Due to initial scoping results, Survey Unit 008A was reclassified in the field to a Class 2 survey unit and subsequently surveyed as a Class 2 survey unit. Following are the 100% direct scan results, the direct static measurement results, and the results of any smear surveys taken in Survey Unit 008B.

6.6.1 Direct 100% Scan Results

A direct beta scan survey was performed in Survey Unit 008A on 100% of reasonably accessible floor areas and wall areas up to a height of 2 meters. Residual activity was identified at levels above background. Based on the beta scan results, the highest residual activity identified in Survey Unit 008A was approximately 4,000 dpm/100 cm^2. Survey results are presented in Appendix A for reference.

6.6.2 Direct Static Measurement Results

Direct static measurements of Sr-90 surface contamination results for Survey Unit 008A ranged from 150 to 3,884 dpm/100 cm^2. These results are well below the release limit of 8,700 dpm/100 cm^2. Survey results are presented in Appendix A for reference.

6.6.3 Smear Survey Results

Transferable surface contamination results for Survey Unit 008A range from 0 to 29 dpm/100 cm^2. These results are below the transferable contamination release limit of 870 dpm/100 cm^2 (i.e., 10% of the 8,700 dpm/100 cm^2 release limit). Survey results are presented in Appendix A for reference.

6.7 Survey Unit 008B

A Class 3 Final Status Survey was performed in Survey Unit 008B. Following are the 100% direct scan results, the direct static measurement results, and the results of any smear surveys taken in Survey Unit 008B.

6.7.1 Direct 100% Scan Results

A direct beta scan survey was performed in Survey Unit 008B on 100% of reasonably accessible floor areas and wall areas up to a height of 2 meters. Residual activity was not identified at levels significantly above background. Survey results are presented in Appendix A for reference.

6.7.2 Direct Static Measurement Results

Direct static measurements of Sr-90 surface contamination results for Survey Unit 008B ranged from 35 to 165 dpm/100 cm^2. These results are well below the release limit of 8,700 dpm/100 cm^2. Survey results are presented in Appendix A for reference.

6.7.3 *Smear Survey Results*

Transferable surface contamination results for Survey Unit 008B range from 0 to 13 dpm/100 cm^2. These results are below the transferable contamination release limit of 870 dpm/100 cm^2 (i.e., 10% of the 8,700 dpm/100 cm^2 release limit). Survey results are presented in Appendix A for reference.

6.8 Soil Analysis Survey Results

Soil samples were collected from pipe trench areas where cast iron and stainless steel piping was removed in Survey Units 001A, 001B and 005. Locations were selected for soil sampling based on proximity to pipe connection points or other potential leakage points and as per Stone & Webster guidance. In these three survey units, a potential existed for the migration of Sr-90 contamination into soil due to the cutting and removal operation of potentially contaminated pipes. The collected soil samples were sent to an off-site laboratory for Sr-90 concentration analysis. The DCGL in soil for Sr-90 is 11 pCi/g as referenced in Section 5.1. A map of soil sample locations is presented in Appendix B.

6.8.1 *Survey Unit 001A Soil sample Results*

Reported soil sample concentrations of Sr-90 in Survey Unit 001A range from 0.05 ± 0.39 pCi/g (MDC of 0.67 pCi/g) to 6.81 ± 0.89 pCi/g (MDC of 0.60 pCi/g). These results are well below the DCGL of 11.0 pCi/g. Soil sample results are presented in Appendix A for reference.

6.8.2 *Survey Unit 001B Soil sample Results*

Reported soil sample concentrations of Sr-90 in Survey Unit 001B range from 0.05 ± 0.41 pCi/g (MDC of 0.71 pCi/g) to 6.60 ± 1.40 pCi/g (MDC of 0.60 pCi/g). These results are well below the DCGL of 11.0 pCi/g. Soil sample results are presented in Appendix A for reference.

6.8.3 *Survey Unit 005 Soil sample Results*

Reported soil sample concentrations of Sr-90 in Survey Unit 005 range from -0.02 ± 0.35 pCi/g (MDC of 0.62 pCi/g) to 0.47 ± 0.40 pCi/g (MDC of 0.65 pCi/g). These results are well below the DCGL of 11.0 pCi/g. Soil sample results are presented in Appendix A for reference.

6.9 Surveys in Ejector Pit Room & Drum Storage

Work was performed in the Ejector Pit Room to measure the contamination levels inside the four-inch cast iron pipe in the wall. The work area was set-up to minimize the spread of contamination on the walls and floor. Smear surveys performed after the completion of work showed all levels to be at or below background. (See Table 7.9) Also, the four radioactive waste drums kept in the closet on the top level were removed from this area and placed on a herculite lay-down area. These drums were awaiting truck transport to a disposal site. A direct frisk of the drum storage and lay-down areas indicated no smearable contamination levels after these drums were removed from the building. (See Table 7.8)

6.10 Ejector Pit Cast Iron Pipe Characterization

This pipe is in the concrete wall of the ejector pit room. The pipe is located approximately 9 feet above the lower floor elevation in the ejector pit room on the wall opposite the room entrance. The pipe travels underground to an outside storm sewer manhole approximately 100 feet from building 90. Activities associated with the 4-inch cast iron pipe are limited to characterization of the internal surfaces of the pipe. No radioactive material was intentionally removed from the cast iron pipe inner surfaces and no volumetric samples were collected.

Based upon probe and pipe geometry, the PSR-4 probe field of view is 3.75 inches of interior pipe surface. The total interior pipe surface area is: π x 4" x 2.54 cm/in x 3.75" x 2.54 cm/in = 304 cm^2. The calculated efficiency for the PSR-4 probe is 4.6%. (See Attachment A) This efficiency is multiplied by the Building Surface Contamination DCGL (8700 dpm/100 cm^2) to yield 400 cpm/100 cm^2. Since the surface area is 304 cm^2, the cpm value becomes 1216, (400 x 3.04). This counts per minute value of 1216 is for both Strontium-90 and the Yttrium-90 daughter. The PSR-4 probe with the Ludlum 2221 meter will provide radioactivity response readings in cpm. Therefore, the critical value for Sr-90 is 2432 cpm.

The presence of naturally occurring radon/thoron radioactivity caused much more difficulty than anticipated in trying to acquire accurate readings using the PSR-4 probe. Readings in the ejector pit area as well as in an office room in another building found radon/thoron levels to be in the range of 8000 cpm – 10,000 cpm. The combination of concrete walls and floors together with the PSR-4's thin mylar window are significant factors in these high background values. Before conducting pipe readings, the PSR-4 was taken outside to allow for "natural purging" of the detector. The count data in Attachment B describe the background readings at specific times. A significant decrease is seen from the reading @ 1240 hrs (6099 cpm) versus the value @ 1315 hrs (3051 cpm). This is a result of the probe being in the cast iron pipe and not in the ambient atmosphere where the high readings were detected.

Note: After the characterization survey was completed, the PSR-4 detector was sent back to the vendor. The vendor stated that the probe was working properly.

Survey Technique

The instrument used in the pipe characterization was calibrated to a ^{90}Sr source of known strength in geometry similar to the expected probe positioning within the cast iron pipe. The probe was setup in accordance with the manufacturer instructions and guidance (See Attachment C).

One-minute instrument readings were taken every 4 inches using a Ludlum 2221 scaler/ratemeter utilized in integrate mode. Four inches is consistent with the approximate field of view of the probe within the cast iron pipe. Count times were chosen to assure MDC and desired sensitivity is achieved. Results were converted to the same measurement units as the site DCGL (dpm/100cm^2).

Provisions were made to measure up to fifty feet of pipe. However, several 45-degree bends and possible internal obstructions prevented measurements of the full pipe length. The total length of pipe characterized was about 20 feet from the point of entry. At selected distances, duplicate readings were taken to determined consistency of measurements.

PSR-4 / LUdlum 2221 count data

Attachment B shows the one-minute gross count data using the PSR-4/Ludlum 2221 arrangement. For Instrument readings No. 1 & 2, the net count results are computed by subtracting 6099 (background value @ 1240 hrs.) from the gross count value. For Instrument readings No. 3 thru No. 8, the net counts are computed by subtracting 3537 (background value @ 1' mark) from the gross count value. For the remaining instrument readings, the net counts are determined by subtracting 3051 (background value @ 3' mark) from the gross count value. The background readings were very high during the initial measurement process due to the concentration of natural radon/thoron daughters. An attempt was made to reduce this concentration by locating fans in the ejector pit area. However, use of this engineering control was marginally successful in reducing radon/thoron concentrations.

Duplicate readings were taken at Instrument Reading No.'s 3, 4, 9 and 36 (last four readings in Attachment B). Good correlation is noted for Readings No. 9 & 36, (985 vs. 880 and -103 vs. -103). Poor correlation is seen for the other two Readings. The poor correlation is likely due to the rapid decay in radon/thoron daughters contributing to the probe reading.

The first 45° pipe bend occurred at about six feet in. The second 45° bend was between 18.5 and 19 feet. The PSR-4 detector was removed from the pipe at this point since it could not be maneuvered any further.

Conclusion of Cast Iron Pipe Characterization

The critical value has been determined to be 2432 counts/minute value for Sr-90. All counts/minute values in Attachment B are below this number. Therefore, the contents of this cast-iron pipe do not contain radioactive material above the DCGL.

7.0 STATISTICAL EVALUATION OF FINAL STATUS SURVEY RESULTS

Statistical evaluation of final status survey data is not presented in this report due to scan, static measurement and soil sample results being well below the relevant DCGL for each result. A statistical evaluation (e.g., the Sign Test) would have been performed if some sample results were found to be greater than the relevant DCGL for each result. The ranges, averages, resulting standard deviation and relative shift calculations are included for all surface scan and static measurement results in the following tables and all results are presented in Appendix A to this report. The relative shift value with respect to FSS data results is presented for each Survey Unit at the bottom of each of the following tables. Each relative shift result is greater than 3 and, therefore, follows the assumptions made in establishing the FSS design. Previous details concerning the assumptions made for relative shift with respect to this FSS can be found in Section 5.2.4 of this report.

7.1 Data Reduction Tables

7.1.1 Table 7-1 Survey Unit 001A

SURVEY UNIT 001A		
	DIRECT MEASUREMENT TOTAL SURFACE CONTAMINATION	TRANSFERABLE SURFACE CONTAMINATION
Sample Designation	**dpm/100cm²**	**dpm/100cm²**
1A-1	294	0
1A-2	208	0
1A-3	144	18
1A-4	278	0
1A-5	299	0
1A-6	176	0
1A-7	224	3
1A-8	272	36
1A-9	406	4
1A-10	304	0
1A-11	315	0
1A-12	337	0
1A-13	75	0
1A-14	128	0
1A-15	342	15
1A-16	326	0
Average	258	5
Standard Deviation	90	10
Relative Shift	**48**	**434**

7.1.2 Table 7-2 Survey Unit 001B

SURVEY UNIT 001B		
	DIRECT MEASUREMENT TOTAL SURFACE CONTAMINATION	TRANSFERABLE SURFACE CONTAMINATION
Sample Designation	**dpm/100cm²**	**dpm/100cm²**
1B-1	433	36
1B-2	321	21
1B-3	246	1
1B-4	337	0
1B-5	203	0
1B-6	353	0
1B-7	171	0
1B-8	208	0
1B-9	299	33
1B-10	363	0
1B-11	192	0
1B-12	278	0
1B-13	187	1
1B-14	37	0
1B-15	214	0
1B-16	128	6
1B-17	187	0
Average	244	6
Standard Deviation	98	12
Relative Shift	**44**	**366**

7.1.3 Table 7-3 Survey Unit 002

SURVEY UNIT 002		
	DIRECT MEASUREMENT TOTAL SURFACE CONTAMINATION	TRANSFERABLE SURFACE CONTAMINATION
Sample Designation	**dpm/100cm^2**	**dpm/100cm^2**
2-1	342	10
2-2	267	4
2-3	299	0
2-4	262	37
2-5	144	0
2-6	118	21
2-7	390	5
2-8	401	12
2-9	85	0
2-10	353	45
2-11	187	0
2-12	337	10
2-13	294	7
2-14	176	0
2-15	118	0
2-16	337	0
2-17	166	26
2-18	294	13
Average	254	11
Standard Deviation	101	14
Relative Shift	**43**	**322**

7.1.4 Table 7-4 Survey Unit 004

SURVEY UNIT 004		
	DIRECT MEASUREMENT TOTAL SURFACE CONTAMINATION	TRANSFERABLE SURFACE CONTAMINATION
Sample Designation	**dpm/100cm^2**	**dpm/100cm^2**
4-1	978	0
4-2	791	8
4-3	107	0
4-4	304	0
4-5	337	0
4-6	288	27
4-7	919	8
4-8	892	0
4-9	214	0
4-10	908	0
4-11	1026	0
4-12	64	0
4-13	876	0
4-14	1223	0
Average	638	3
Standard Deviation	394	7
Relative Shift	**11**	**588**

7.1.5 Table 7-5 Survey Unit 005

SURVEY UNIT 005		
	DIRECT MEASUREMENT TOTAL SURFACE CONTAMINATION	TRANSFERABLE SURFACE CONTAMINATION
Sample Designation	**dpm/100cm^2**	**dpm/100cm^2**
5-1	1661	25
5-2	43	2
5-3	203	8
5-4	1512	44
5-5	1432	0
5-6	321	0
5-7	262	0
5-8	1186	16
5-9	1132	0
5-10	294	5
5-11	139	0
5-12	21	0
5-13	1218	0
5-14	524	0
5-15	598	7
5-16	134	6
5-17	1245	0
Average	701	7
Standard Deviation	582	12
Relative Shift	**7**	**365**

7.1.6 *Table 7-6 Survey Unit 008A*

SURVEY UNIT 008A		
	DIRECT MEASUREMENT TOTAL SURFACE CONTAMINATION	TRANSFERABLE SURFACE CONTAMINATION
Sample Designation	**dpm/100cm²**	**dpm/100cm²**
8A-1	347	6
8A-2	230	13
8A-3	214	12
8A-4	491	13
8A-5	481	22
8A-6	491	24
8A-7	342	8
8A-8	3884	10
8A-9	224	11
8A-10	363	22
8A-11	353	18
8A-12	214	6
8A-13	150	0
8A-14	283	29
8A-15	278	12
Average	556	14
Standard Deviation	927	8
Relative Shift	**5**	**567**

7.1.7 Table 7-7 Survey Unit 008B

SURVEY UNIT 008B		
	DIRECT MEASUREMENT TOTAL SURFACE CONTAMINATION	TRANSFERABLE SURFACE CONTAMINATION
Sample Designation	dpm/100cm^2	dpm/100cm^2
8B-1	72	0
8B-2	115	6
8B-3	51	0
8B-4	35	0
8B-5	78	1
8B-6	165	0
8B-7	49	0
8B-8	58	2
8B-9	51	13
8B-10	134	1
8B-11	113	12
8B-12	126	7
8B-13	136	0
8B-14	103	0
Average	92	3
Standard Deviation	40	5
Relative Shift	**107**	**921**

7.1.8 Table 7.8 Survey of Drum Closet Storage Area

Sample Number	Location	**Direct Scan Total Surface Contamination (dpm/100 cm^2)**	**Removable Surface Contamination (dpm/100 cm^2)**
1	Back Wall	336	10
2	Left Wall	386	0
3	Front Wall	429	0
4	Door	13	7
5	Floor	205	0
6	Right Wall	327	0

Date: July 18, 2001 Surveyor: Steve Sagaties

Direct Scan: Instrument Used L2224; # 162426/ 43-89 Scintillation Probe # 171386

Instrument Efficiency: 0.336

Removable Contamination: Instrument Used L2929; # 163827

Instrument Efficiency: 0.459

7.1.9 Table 7.9 Contamination Survey of Ejector Pit Room After PSR-4Pipe Analysis

Sample Number	Location	Direct Scan Total Surface Contamination (dpm/ 100 cm^2)	Removable Surface Contamination (dpm/ 100 cm^2)
1	Floor by Ladder	0	6
2	Center of Floor		18
3	Northwest Corner of Floor	57	0
4	Front Wall: Left		14
5	Front Wall: Under Pipe		0
6	Front Wall: Under Pipe (By Floor)	0	0

Date: July 18, 2001   Surveyor: Steve Sagaties

Direct Scan: Instrument Used L2224; # 162426/ 43-89 Scintillation Probe # 171386

Instrument Efficiency: 0.336

Removable Contamination: Instrument Used L2929; # 163827

Instrument Efficiency: 0.459

8.0 SUMMARY

Remediation activities performed at the VAECC sufficiently reduced Sr-90 residual contamination to levels below the relevant DCGLs as planned. As shown by the final status survey surface scan and static measurement results, surface contamination levels of Sr-90 activity in impacted areas of Survey Units 001A, 001B, 002, 004, 005, 008A and 008B are well below the DCGL of 8,700 dpm/100 cm^2. As shown by the final status survey soil sample results, soil contamination levels of Sr-90 residual activity in impacted soils of Survey Units 001A, 001B and 005 are also well below the DCGL of 11 pCi/g.

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Attachment 1:

Grid Spacing – L Values

ATTACHMENT 1

GRID SPACING

SURVEY UNIT	AREA, m^2	NUMBER OF DATA POINTS, n_{EA}	GRID SPACING, L, m	ROUNDED SPACING, m
1a	82	14	2.6	2.6
1b	105	14	2.9	2.9
2	65	14	2.3	2.3
4	36	14	1.7	1.7
5	214	14	4.2	4.2
8a	187	14	3.9	3.8
8b	168	14	3.7	3.5

Attachment A
Determination of PSR–4 Detector Efficiency

Appendix A: Determination of PSR 4 Detector Efficiency

Instrument reading No.	1.25" diameter Sr 90 Source Center Location wrt to PSR4 center of active area @ radial distance 2.25 inches from detector axis centerline	Gross Counts (1 Minute)	Net Counts (1 Minute)	Adjustment for measured beta dose reduction with 25 mg/cm^2 plastic sheeting source holder	Measured 1 minute count rate adjustment for source counts at calibration distance of 1 inch vs detector to-surface distance of 0.75 inches to inner pipe wall in field	Adjusted Net Counts (1 minute)	Adjusted Net Counts per square cm source area (cts/cm^2)	Total Net Counts for area within detector "field of view" on pipe inner wall of 3.75" (CPM)	Sr-90 Source DPM for equivalent of 23.75cm2 (equivalent to 3 - 1.25" diameter sources)	Efficiency, CPM/DPM
1	center	254	191.2	1.16	1.44	319	40.30	656.00	14232	0.046
2	1.25" left	163	100.2	1.16	1.44	167	21.12			
3	1.25" right	165	102.2	1.16	1.44	170	21.54			
4	2.5" left	72	9.2	NA	NA	NA	NA			
5	2.5" right	74	11.2	NA	NA	NA	NA			

Background Start (CPM):	62.8
Background End (CPM):	

By:	H. W. Siegrist	Date:	07/05/2001
Reviewed By:		Date:	

Instrument:	Ludlum 2221	Calibration Du	12/26/2001
Serial No:	81301		
Probe:	PSR-4		
Serial No:	78575 16336 9		

Attachment B
PSR-4 Count Data in Cast Iron Pipe

Appendix B: PSR-4 Count Data in Cast Iron Pipe

Instrument reading No.	Probe leading edge Location from Pipe Penetration Opening, inches	Gross Counts (1 Minute)	Net counts	Instrument reading No.	Probe leading edge Location from Pipe Penetration Opening, inches	Gross Counts (1 Minute)	Net counts	Instrument reading No.	Probe leading edge Location from Pipe Penetration Opening, inches	Gross Counts (1 Minute)
1	4	6173	74	51	204	2217	-834			
2	8	6387	288	52	208	2081	-970			
3	12	5488	1951	53	212	2221	-830			
4	16	5325	1788	54	216	1927	-1124			
5	20	3720	183	55	220	2081	-970			
6	24	3421	-116	56	224	2061	-990			
7	28	3583	46	57	228					
8	32	3879	342	58	232					
9	36	4036	985	59	236					
10	40	4058	1007	3 (QA)	12	3833	296			
11	44	4326	1275	4 (QA)	16	3772	235			
12	48	4508	1457	9 (QA)	36	3931	880			
13	52	4312	1261	36 (QA)	144	2948	-103			
14	56	4115	1064							
15	60	3726	675							
16	64	3988	937							
17	68	3924	873							
18	72	3628	577							
19	76	4061	1010							
20	80	4315	1264							
21	84	4156	1105							
22	88	4160	1109							
23	92	4277	1226							
24	96	4106	1055							
25	100	3790	739							
26	104	3451	400							
27	108	3725	674							
28	112	3186	135							
29	116	3083	32							
30	120	2978	-73							
31	124	3319	268							
32	128	3407	356							
33	132	3088	37							
34	136	3076	25							
35	140	2931	-120							
36	144	2948	-103							
37	148	3072	21							
38	152	2854	-197							
39	156	2740	-311							
40	160	2545	-506							
41	164	2335	-716							
42	168	2603	-448							
43	172	2707	-344							
44	176	2618	-433							
45	180	2437	-614							
46	184	2604	-447							
47	188	2469	-582							
48	192	2155	-896							
49	196	2101	-950							
50	200	2130	-921							

Background Start 1240 hrs:	6099	Background 1' mark:		3537	Instrument:			Calibration Due
Background End 1440 hrs:	2810	Background 3' mark:		3051	Serial No:			
					Probe:			
Surveyed By:	Henry W. Siegrist		Date:	07/18/2001	Serial No:			
Reviewed By:			Date:					
RWP#								

Attachment C
PSR-4 Instrument Guidelines

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General Information

The **PSL-4** Proportional Probe is a gas flow detector used in 4" piping systems. This design will navigate multiple 90^0 pipe bends, hurtle internal welds while maintaining center position. The probe has a near **Zero** insertion force with a "push" through concept, thus simplifying the survey techniques. Gas flow is fed through the cable and connector. The unit is equipped with a quick disconnect port for use with the **Model FT** insertion device (optional). Two versions are available: the **PSL** (screen less) and the **PSR** (screen ruggedized). Ruggedized units are outfitted for class level piping systems and/or harsh environments.

Concept

The PSL series of pipe probes were developed for survey of straight run pipe with (2-3) 90^0 bends where the pipe conditions were seamless welded pipe with welded connections. The ability to insert the probe into a length of up to 25' in steel pipe was first developed to survey electrical conduits and small air ducts at environmental remediation sites. The success of these probes was tested and found to be usable in other conditions as well. {i.e., drain line entry ports in floors and sinks, wall penetrations for electrical pipe chases, water lines with mild sediment build up, etc.}

Additionally were the observations of the accessability and limitations of the probe within certain pipe compositions. Examples are:

Seamless welded pipe defines the interior surface as having a relatively smooth inner surface. Some pipes contain an inner bead at the joint where the rolled edges meet. The probe design was able to navigate these conditions as long as the user does not attempt to rotate the probe when inserted. Tracking was observed to be straight and with minimal drag. However; some drag may be observed in pipes where the seam weld is large. At welded connections the probe was able to hurtle the interior welds bead with ease.

Electrical EMT conduits were comprised with straight pipe using compression fitting couplings and sweeping 90^0 bends, . Minimal restrictions were experienced at insertion depths of >50'. The use of electrical pulling soaps (used to lubricate cables during installations) creates a risk of dirt build up and may leave the pipe interior dirty. Thus some probe extractions found the probe to be covered with an oily like substance on the rollers.

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Air ventilation Ducts of 4" or smaller were observed to have directional limitations. The internal fittings of air ducts require one end of the duct pipe to be tapered in order to insert into the adjoining duct pipe. This creates a reduced chance of withdrawal of the probe when the survey is complete. Often times it was required to remove the probe at the far end and withdrawal the cable from the insertion end. These internal tapered edges create too large of a hurtle for the probe rollers. On a good note, was the ability of the probe to pass by dents and kinks in the duct surfaces.

PVC was the most limiting composition for standard probes. The probe will navigate straight runs with ease. The probes (at the joints in PVC piping) are not capable of passing over these hurtles with the use of small rollers. Larger rollers were used for applications of PVC. Probe insertion and navigating the probe through the bends was accomplished with 3/4" rollers.

Probe usage

Probe navigating is performed by use of the centering legs and a fish tape. The concept of the probe is to use the 8 spring loaded rollers to center the detector within the pipe. The rollers create a near zero friction and with the use of the fish tape, the probe is pushed into the pipe. The self-centering nature of the design will allow for the probe to orbit through the pipe. This orbital motion may be observed by installing the probe into a short piece of pipe (sized accordingly) and noticing the angles of view as the probe is varied along the pipe axis. See figure one.

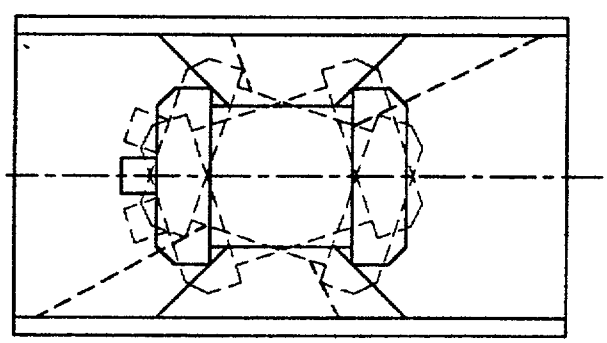

Figure 1

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This orbital motion allows the probe to conform to obsticals while it maintains a fairly constant centering position. The fields of view (angle of view) may vary during insertion. The area of view (internal surface area of the pipe) should remain consistent. The larger 3" and 4" probe tend to center lower in the pipe due to the additional weight of the probe. Future designs are being evaluated to reduce the probes weight.

Connection is as follows: connect the C series gas/HV cable to the probe and the opposite end to the gas feed connector block. The BNC connection of the connector block goes to the electronics box. Connect the P-10 gas supply to the connector block. Note.. The use of standard cable is not possible, unless they are adapted for passage P-10 gas. The quick disconnect fitting of the probe is a sealed port and will not accept gas. Connect the fish tape to this port. Wrap the coax around this fish tape as insertions begin. Wrapping the coax will reduce drag by the cable which helps to assist probe insertion.

Operating

Specifications

High Voltage (nominal operating) ---1800	Volts	
Mylar Density (aluminized)--------- 0.8	mg/cm² (single wrap)	
Length (including connector) -------- 4.5	Inches	
Diameter (without centering springs)- 2.5	Inches	
Input Sensitivity Range------------- 5-10	Milli Volts	
Nominal Efficiencies (4π)	At ¾" Geometry	
TH-230 – ≈ 2.0	%	
TC-99 — ≈ 3.5	%	
SRY-90 —	≈ 6.0 %	
PB-210 — ≈ 5.5	%	
Average Background ------------- 150-180	Counts/min	
Active Area---------------------- 66	Cm²	
Weight -------------------------- 1.3	LBS	
Operating Gas--------------------- P-10	@ 50 cc/min flow rate	

Used with **Model TR** Transport Rig or Customer owned electronics with Option **GP-1** Gas Purge Fitting.

Cable lengths range from 5' to 50' increments.

Optional **Model FT** insertion Device

The connections on the PSL series probes are a "C" series connector and a quick disconnect fitting. The Quick Disconnect must be understood to be a connection for the fish tape only, NOT a gas connection. The P-10 gas is fed through the coax cable. Not all applications require the use of a fish tape to insert the probe. {i.e., vertical runs or pipes where gravity will assist insertion} Therefore, the design utilizes the coax to feed the gas, thus reducing the need for the fish tape in some applications.

The gas flow rate is 50 cc/min. Purge time is 30-45 minutes at 50 cc/min. The purge time may be shortened by increasing the P-10 flow rate to 100 cc/min.

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At the normal operating voltage, a random arc may occur. This may be heard audibly at times. Numerous testing efforts to prevent this occurrence found the cause to be associated to the design of the probe. The internal surface of the detector is cylindrical with the anode wires situated at 30 degree angles to the inner cylinder. The distance at the center of the anode wire is in closer geometry to the cylindrical surface than that of the two end points of the anode wire. Since the charged field developed across the anode wire is exposed to a curved geometry, the risk of random arcing is at a higher possibility at the closer geometry areas along the anode wire. The effects of these arc's were also found to have a minimal contribution to the overall counts. The effects were determined to be less than 3 additional counts per arc.

In cases where the arcing adds large amounts of counts to the display, is an indication of detector over-voltage.

The detector is covered with a .8 mg/cm/sq mylar, single wrap.

Testing the probe stability was performed over months of background count rate monitoring and efficiency testing. Numerous tests were conducted for 10 minute count runs and the averages deduced from 2 hour testing intervals. Test results show the average probe background to be 165 cpm in a 10-15 μR background. Increases in back ground counts were observed when the probe reached a physical temperature of >95 degrees.

Plateau; high voltage adjustments may be required for large changes in elevations (atmospheric pressure). Calibration from the manufacturer is 900'. The input sensitivity is recommended between 5-10 millivolts.

Operating characteristics of the probe is a gas flow, proportional concept. The ability to retrieve alpha and beta results from proportional probes may be enhanced with the use of dual detection electronics such as the LMI 2224 rate meter scale. The dual channel 2224 produces independent alpha and beta display results at a single operating voltage. When a single channel piece of electronics is used, an operating voltage for each isotope will be required.

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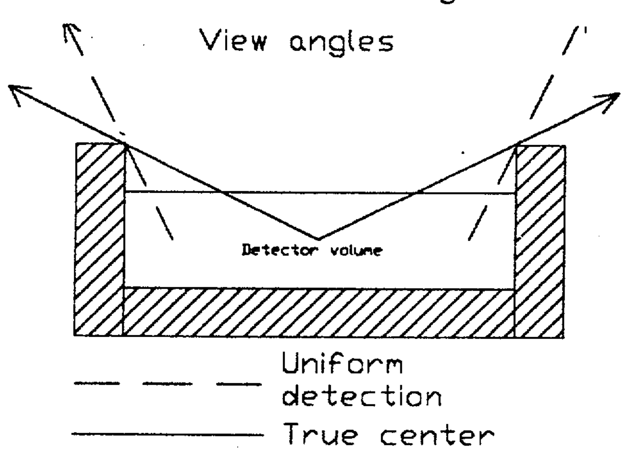
Interpretation of data, Disclaimer

AEES Inc. developed this approach to pipe detection to satisfy a need at a remediation site, for the access to the interior surfaces of cylindrical objects only. The principles for proportional detection were applied in the design to make this effort to survey cylindrical objects possible. The interpretation of the resulting data can produce an sizable task to analyze; if not kept to the basics. The amount of possible interpretations for: detection area in cm^2 vs probe geometry, the detector view angles with respect to theoretical detector center, pipe surface area vs orbital angle and respective view angles and the source calibration methods has forced AEES Inc. to require the end users organization to determine the applicable factors in interpreting the resulting data.

AEES Inc. has been involved in probe manufacture for many years and has determined that several factors should be held to a basic approach.

Theoretical center of detector has a direct basis for the view angles of the probe. The angle of view will be dependent on issues like "incident angle of detection". At which point does a event go missed because the angle of the interaction to the detector surface; was to large. If a true center of the probe were used the angles of view would be large. If a uniform detection plane is used (equal detection across the internal volume of the detector) then the angles of view would be smaller. Since proportional probes poses near equal efficiencies across the face of the detectors (when properly calibrated), it can be assumed that the detection properties are as effective near the detector edges as well as the center. AEES Inc. classifies a proportional probe as having uniform detection qualities. View angles could then be smaller and more defining to areas of 100 cm^2.



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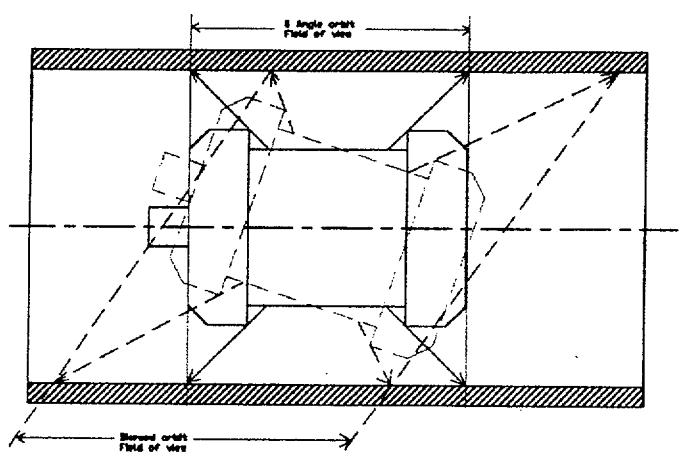
Pipe surface area vs orbital angle and respective view angles could result in "surface area of detection" variations. AEES Inc. recommends an average value be assessed and used as a constant value.



Calibration methods are defined by the end user. The availability of cylindrical sources is now becoming more addressed by source manufacturers as more probes of these types are being designed. Currently; however, they are limited and costly. Flexible sources are available from some source manufacturers. AEES has not yet found a source supplier whom can produce sources as we deem appropriate for our design; thus at present, AEES utilizes flat sources positioned in a source jig where the average surface area of the source is held at a 3/4" geometry. The reported efficiency values are determined without area correction factors.

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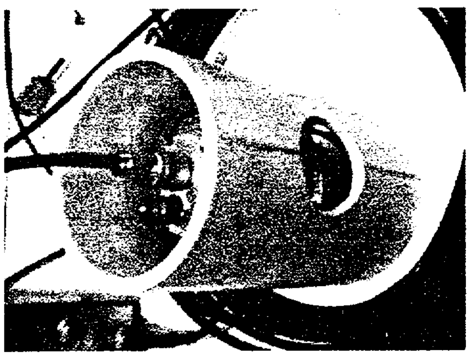
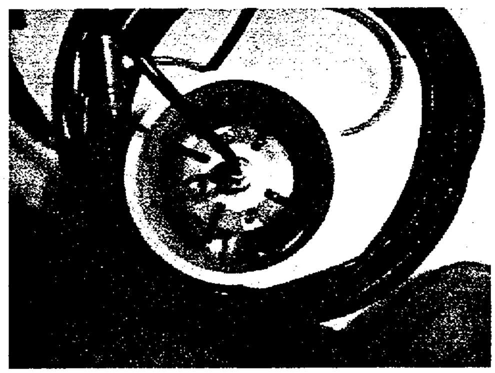
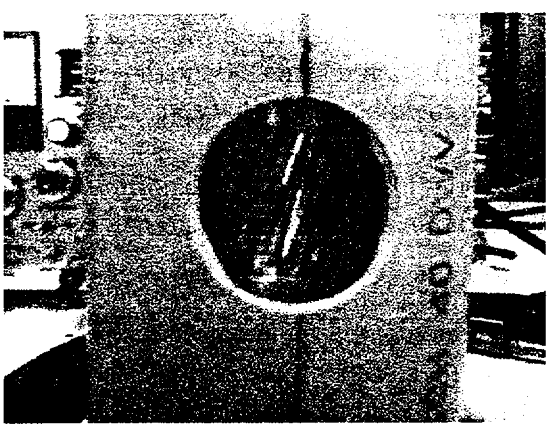
Below are some photos displaying the probe.





Source calibration / check jig.



Orient the probe such that the source location is centered in the window of the probe.

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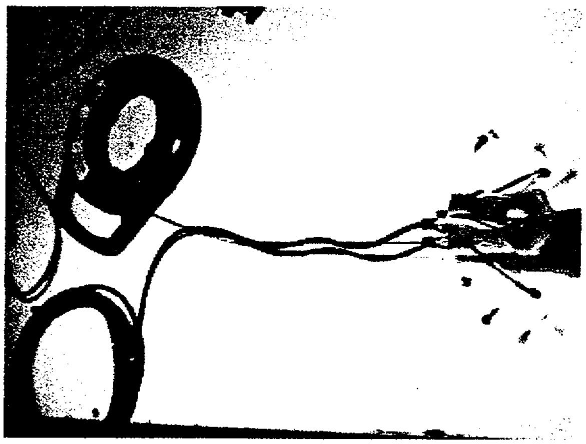
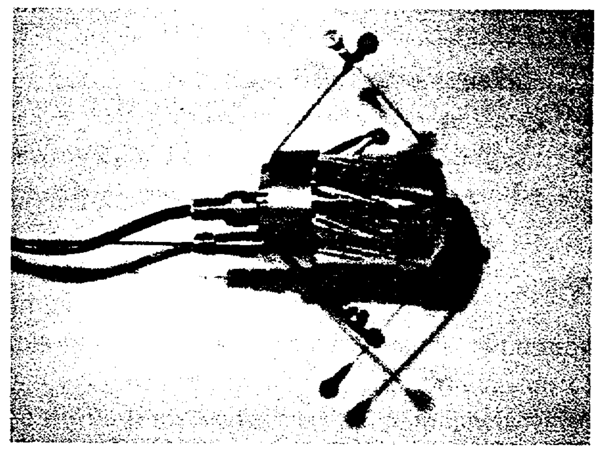
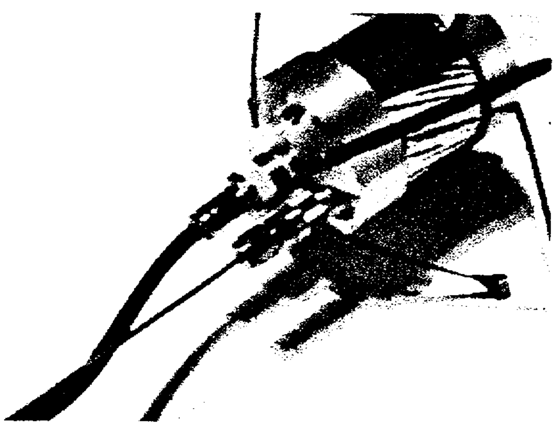
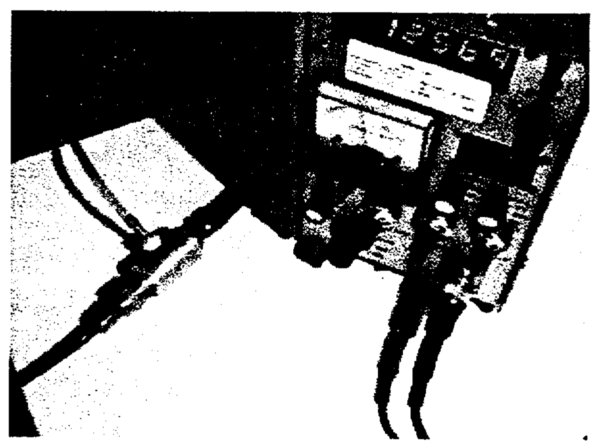




Probe connection to the coax and fish tape.





Probe connection and coax cable gas connection.

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Insertion method.

Grasp the four roller legs (of the connector end) with the thumb and index finger. Spring the four legs together and load them into the pipe end. Then insert the probe into the pipe. It is recommended that the coax (at least) be attached to the probe at time of insertion. In cases where the inner surface is smooth or slick, the probe may roll out of reach.

Appendix A:

Survey and Soil Sample Results Data Packages

ST. ALBANS FINAL STATUS SURVEY SUMMARY SHEET

SURVEY UNIT 1A (High Level and Low Level Labs & Isotope Storage Area)

		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	Surface	Ambient Background[1]	Count	DPM/100cm²	Background (cpm)	Sample Count (2 min)	DPM/100cm²
1A-1	Wall	104	159	294	83.1	158	0
1A-2	Wall	94	133	208	83.1	149	0
1A-3	Wall	115	142	144	83.1	184	18
1A-4	Wall	101	153	278	83.1	142	0
1A-5	Wall	106	162	299	83.1	162	0
1A-6	Floor	98	131	176	83.1	156	0
1A-7	Wall	112	154	224	83.1	169	3
1A-8	Wall	106	157	272	83.1	201	36
1A-9	Floor	114	190	406	83.1	170	4
1A-10	Floor	112	169	304	83.1	153	0
1A-11	Wall	101	160	315	83.1	165	0
1A-12	Wall	98	161	337	83.1	141	0
1A-13	Floor	103	117	75	83.1	155	0
1A-14	Wall	121	145	128	83.1	162	0
1A-15	Wall	97	161	342	83.1	181	15
1A-16	Wall	99	160	326	83.1	143	0
Date:	1/8/01						
Surveyor:	Edmond Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

Instrument Used: L2221 serial # 161581 / 43-89 scintillation probe # 0508
Instrument Efficiency: 0.1872

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

LOCATION DESIGNATION	DESCRIPTION OF LOCATION
1A-1	High Level Lab northwest corner on wall 0.48 meters above floor
1A-2	High Level Lab west wall 0.61 meters above floor
1A-3	High Level Lab west wall 0.61 meters above floor
1A-4	High Level Lab north wall 1.78 meters above floor
1A-5	High Level Lab south wall 0.3 meters above floor
1A-6	High Level Lab floor west side
1A-7	High Level Lab northeast corner on partition between high & low level labs 0.48 meters above floor
1A-8	High Level Lab south wall 1.6 meters above floor
1A-9	High Level Lab floor south side
1A-10	High Level Lab floor north side
1A-11	High Level Lab east partition between high & low level labs 1.78 meters above floor
1A-12	High Level Lab south wall 0.3 meters above floor
1A-13	Low Level Lab floor east side
1A-14	Low Level Lab west partition wall between high & low level labs 0.48 meters above floor
1A-15	Low Level Lab east partition wall between low level lab & counting room 1.0 meters above floor
1A-16	Low Level lab north wall 1.78 meters above floor

ST. ALBANS FINAL STATUS SURVEY REPLICATE SUMMARY SHEET							
SURVEY UNIT 1A (High Level and Low Level Labs & Isotope Storage Area)							
		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	Surface	Ambient Background[(1)]	Count	DPM/100cm^2	Background (cpm)	Sample Count (2 min)	DPM/100cm^2
1A-5XD	Wall	153	233	352	82.65	179	14
1A-9XD	Floor (Soil)	215	284	303	82.65	185	20
1A-15XD	Wall	179	222	189	82.65	143	0
Date:	01/16/01						
Surveyor:	Edmond Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

Instrument Used: L2224 serial # 162420 / 43-89 scintillation probe # PR-171381
Instrument Efficiency: 0.2275

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

ST. ALBANS FINAL STATUS SURVEY SUMMARY SHEET

SURVEY UNIT 1B (Counting Room, Wash Room & Corridor 15)

Location Designation	Surface	1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS: Ambient Background[1]	1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS: Count	DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY: DPM/100cm²	SR-90 BETA SMEAR RESULTS, COUNTS: Background (cpm)	SR-90 BETA SMEAR RESULTS, COUNTS: Sample Count (2 min)	TRANSFERABLE SR-90 SURFACE ACTIVITY: DPM/100cm²
1B-1	Floor	105	186	433	83.2	201	36
1B-2	Wall	101	161	321	83.2	187	21
1B-3	Wall	112	158	246	83.2	167	1
1B-4	Wall	116	179	337	83.2	165	0
1B-5	Wall	98	136	203	83.2	145	0
1B-6	Floor	102	168	353	83.2	159	0
1B-7	Wall	112	144	171	83.2	132	0
1B-8	Wall	114	153	208	83.2	142	0
1B-9	Wall	103	159	299	83.2	198	33
1B-10	Floor	127	195	363	83.2	139	0
1B-11	Floor	108	144	192	83.2	141	0
1B-12	Wall	115	167	278	83.2	153	0
1B-13	Wall	107	142	187	83.2	167	1
1B-14	Floor	94	101	37	83.2	156	0
1B-15	Floor	107	147	214	83.2	152	0
1B-16	Wall	115	139	128	83.2	172	6
1B-17	Wall	84	119	187	83.2	159	0
Date:	1/9/01						
Surveyor:	Edmond Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

Instrument Used: L2221 serial # 161581 / 43-89 scintillation probe # 0508
Instrument Efficiency: 0.1872

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

ST. ALBANS FINAL STATUS SURVEY REPLICATE SUMMARY SHEET

SURVEY UNIT 1B (Counting Room, Wash Room & Corridor 15)

Location Designation	Surface	1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS: Ambient Background[1]	1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS: Count	DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY: DPM/100cm²	SR-90 BETA SMEAR RESULTS, COUNTS: Background (cpm)	SR-90 BETA SMEAR RESULTS, COUNTS: Sample Count (2 min)	TRANSFERABLE SR-90 SURFACE ACTIVITY: DPM/100cm²
1B-6XD	Floor	166	272	466	82.65	153	0
1B-15XD	Floor	155	235	352	82.65	160	0
1B-17XD	Wall	158	167	40	82.65	162	0
Date:	01/16/01						
Surveyor:	Edmond Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

Instrument Used: L2224 serial # 162420 / 43-89 scintillation probe # PR-171381
Instrument Efficiency: 0.2275

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

LOCATION DESIGNATION	DESCRIPTION OF LOCATION
1B-1	Corridor 15 floor near entrance from corridor 45
1B-2	Corridor 15 north wall (near entrance from corridor 45) 1.65 meters above floor
1B-3	Corridor 15 south wall 0.4 meters above floor
1B-4	Corridor 15 north wall 0.2 meters above floor
1B-5	Corridor 15 south wall 1.85 meters above floor
1B-6	Corridor 15 floor
1B-7	On south side of partition wall between counting room & low level lab 1.04 meters above floor
1B-8	Corridor 15 north wall 1.65 meters above floor
1B-9	Corridor 15 south wall 0.4 meters above floor
1B-10	Counting room floor southwest corner
1B-11	Counting room floor northwest corner 0.18 meters from partition wall
1B-12	On east side (narrow portion bet. corridor & counting room) of corridor 15 north wall 0.2 meters above floor
1B-13	Corridor 15 southeast corner on south wall 1.85 meters above floor
1B-14	Corridor 15 floor washroom (formerly w/sink)
1B-15	Counting room floor east side
1B-16	Counting room northeast corner on north wall 0.76 meter above floor
1B-17	Counting room south wall next to entrance between counting room & corridor 15, 1.65 meters above floor

ST. ALBANS FINAL STATUS SURVEY SUMMARY SHEET							
SURVEY UNIT 2 (Ejector Pit room)							
		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	Surface	Ambient Background[(1)]	Count	DPM/100cm²	Background (cpm)	Sample Count (2 min)	DPM/100cm²
2-1	Floor	116	180	342	82.5	175	10
2-2	Wall	110	160	267	82.5	169	4
2-3	Wall	109	165	299	82.5	164	0
2-4	Wall	107	156	262	82.5	201	37
2-5	Floor	110	137	144	82.5	141	0
2-6	Floor	104	126	118	82.5	185	21
2-7	Wall	116	189	390	82.5	170	5
2-8	Floor	115	190	401	82.5	177	12
2-9	Underside of Entry Level Floor	109	125	85	82.5	134	0
2-10	Wall	114	180	353	82.5	209	45
2-11	Floor	101	136	187	82.5	125	0
2-12	Floor	98	161	337	82.5	175	10
2-13	Floor	105	160	294	82.5	172	7
2-14	Wall	118	151	176	82.5	153	0
2-15	Underside of Entry Level Floor	108	130	118	82.5	157	0
2-16	Wall	102	165	337	82.5	165	0
2-17	Wall	110	141	166	82.5	190	26
2-18	Wall	105	160	294	82.5	178	13
Date:	1/12/01						
Surveyor:	Edmund Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

Instrument Used: L2221 serial # 161581 / 43-89 scintillation probe # 0508
Instrument Efficiency: 0.1872

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

ST. ALBANS FINAL STATUS SURVEY REPLICATE SUMMARY SHEET

SURVEY UNIT 2 (Ejector Pit room)

		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	Surface	Ambient Background[1]	Count	DPM/100cm²	Background (cpm)	Sample Count (2 min)	DPM/100cm²
2-6XD	Floor	159	206	207	82.65	178	13
2-8XD	Floor	180	293	497	82.65	173	8
2-10XD	Wall	158	227	303	82.65	148	0
Date:	01/16/01						
Surveyor:	Edmond Young						

[1] Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

Instrument Used: L2224 serial # 162420 / 43-89 scintillation probe # PR-171381
Instrument Efficiency: 0.2275

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

LOCATION DESIGNATION	DESCRIPTION OF LOCATION
2-1	Ejector Pit lower level west wall 1.78 meters above floor
2-2	Ejector Pit lower level northwest corner on west wall 1.78 meters above floor
2-3	Ejector Pit entry level floor on west wall 1.78 meters above floor
2-4	Ejector Pit lower level southwest corner of south wall 1.85 meters above floor
2-5	Ejector Pit lower level southwest corner of floor
2-6	Ejector Pit lower level west side of floor
2-7	Ejector Pit lower level northwest corner on north wall 0.89 meters above floor
2-8	Ejector Pit entry level floor next to west wall on floor
2-9	Ejector Pit lower level underside of entry level floor 1.58 meters from north wall
2-10	Ejector Pit lower level south wall 0.70 meters above floor
2-11	Ejector Pit lower level east side of floor
2-12	Ejector Pit lower level northeast corner of floor
2-13	Ejector Pit entry level floor next to railing on floor
2-14	Ejector Pit entry level floor on north wall 0.13 meters above floor
2-15	Ejector Pit lower level underside of entry level floor 0.43 meters from north wall
2-16	Ejector Pit lower level southeast corner on east wall 1.28 meters above floor
2-17	Ejector Pit lower level east wall 1.28 meters above floor
2-18	Ejector Pit entry level floor on east wall 1.28 meters above floor

ST. ALBANS FINAL STATUS SURVEY SUMMARY SHEET

SURVEY UNIT 4 (Men's Toilet)

Location Designation	Surface	1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS: Ambient Background[(1)]	1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS: Count	MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY: DPM/100cm²	SR-90 BETA SMEAR RESULTS, COUNTS: Background (cpm)	SR-90 BETA SMEAR RESULTS, COUNTS: Sample Count (2 min)	TRANSFERABLE SR-90 SURFACE ACTIVITY: DPM/100cm²
4-1	West Wall	140	323	978	83	166	0
4-2	West Wall	149	297	791	83	174	8
4-3	West Wall	134	154	107	83	156	0
4-4	West Floor	128	185	304	83	148	0
4-5	West Floor	137	200	337	83	124	0
4-6	North Wall	136	190	288	83	192	0
4-7	South Wall	128	300	919	83	174	27
4-8	East Wall	131	298	892	83	154	8
4-9	North Floor	134	174	214	83	166	0
4-10	North Wall	142	312	908	83	160	0
4-11	South Wall	124	316	1026	83	160	0
4-12	East Wall	131	143	64	83	134	0
4-13	East Wall	128	292	876	83	136	0
4-14	East Wall	130	359	1223	83	160	0
Date:	12/07/00						
Surveyor:	Edmond Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

Instrument Used: L2221 serial # 161581 / 43-89 scintillation probe # 0508
Instrument Efficiency: 0.1872

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

SEP 05 2001 12:34PM HP LASERJET 3200

ST. ALBANS FINAL STATUS SURVEY REPLICATE SUMMARY SHEET

SURVEY UNIT 4 (Men's Toilet)

Location Designation	Surface	1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS: Ambient Background(1)	1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS: Count	DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY: DPM/100cm²	SR-90 BETA SMEAR RESULTS, COUNTS: Background (cpm)	SR-90 BETA SMEAR RESULTS, COUNTS: Sample Count (2 min)	TRANSFERABLE SR-90 SURFACE ACTIVITY: DPM/100cm²
4-4XD	West Floor	197	258	268	82.65	153	0
4-6XD	North Wall	199	271	316	82.65	151	0
4-14XD	East Wall	216	401	813	82.65	168	3

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Date: 01/16/01
Surveyor: Edmond Young

Direct Scan:
Instrument Used: L2224 serial # 162420 / 43-89 scintillation probe # PR-171381
Instrument Efficiency: 0.2275

Removable Contamination:
Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

LOCATION DESIGNATION	DESCRIPTION OF LOCATION
4-1	Southwest corner of west wall 0.94 meters above floor
4-2	Middle of west wall 0.94 meters above floor
4-3	Northwest corner of west wall 0.94 meters above floor
4-4	Floor south side near entrance
4-5	Floor north side
4-6	Northwest corner of north wall 0.41 meters above floor
4-7	Southeast corner on east wall of entrance 0.34 meters above floor
4-8	Northeast corner on east wall of entrance 0.34 meters above floor
4-9	Floor near north wall
4-10	North wall 1.26 meters above floor
4-11	South wall next to former stall area 1.04 meters above floor
4-12	East wall of entrance 1.81 meters above floor
4-13	East wall of former stall area 0.15 meters above floor
4-14	East wall of former stall area 1.62 meters above floor
4-15	Ceiling ventilation grate west side
4-16	Ceiling ventilation grate east side

ST. ALBANS FINAL STATUS SURVEY SUMMARY SHEET

SURVEY UNIT 5 (Corridor 45, Treatment Unit & Associated Equipment Room, and Foyer at Foot of Stairs)

Location Designation	Surface	1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
		Ambient Background[(1)]	Count	DPM/100cm²	Background (cpm)	Sample Count (2 min)	DPM/100cm²
5-1	Wall (1/10/01)	120	431	1661	80.45	185	25
5-2	Wall (1/10/01)	115	123	43	80.45	163	2
5-3	Floor (1/10/01)	108	146	203	80.45	169	8
5-4	Wall (1/10/01)	112	395	1512	80.45	204	44
5-5	Wall (1/10/01)	119	387	1432	80.45	141	0
5-6	Floor (1/10/01)	103	163	321	80.45	159	0
5-7	Floor (1/12/01)	115	164	262	82.5	150	0
5-8	Wall (1/12/01)	120	342	1186	82.5	181	16
5-9	Wall (1/12/01)	118	330	1132	82.5	147	0
5-10	Wall (12/27/00)	116	171	294	81.3	167	5
5-11	Floor (12/27/00)	108	134	139	81.3	158	0
5-12	Floor (1/12/01)	98	102	21	82.5	150	0
5-13	Wall (1/12/01)	124	352	1218	82.5	165	0
5-14	Wall (12/27/00)	105	203	524	81.3	152	0
5-15	Floor (12/27/00)	103	215	598	81.3	169	7
5-16	Floor (1/12/01)	111	136	134	82.5	171	6
5-17	Wall (1/12/01)	116	349	1245	82.5	165	0

Date: 12/27/00, 1/10/01, & 1/12/01

Surveyor: Edmond Young

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

Instrument Used: L2221 serial # 161581 / 43-89 scintillation probe # 0508

Instrument Efficiency: 0.1872

Removable Contamination:

Instrument Used:

Instrument Efficiency: 0.486

ST. ALBANS FINAL STATUS SURVEY REPLICATE SUMMARY SHEET

SURVEY UNIT 5 (Corridor 45, Treatment Unit & Associated Equipment Room, and Foyer at Foot of Stairs)

Location Designation	Surface	1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS: Ambient Background[1]	1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS: Count	DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY: DPM/100cm^2	SR-90 BETA SMEAR RESULTS, COUNTS: Background (cpm)	SR-90 BETA SMEAR RESULTS, COUNTS: Sample Count (2 min)	TRANSFERABLE SR-90 SURFACE ACTIVITY: DPM/100cm^2
5-3XD	Floor	196	220	105	82.65	147	0
5-6XD	Floor	170	209	171	82.65	173	8
5-8XD	Wall	271	550	1226	82.65	147	0
Date:	01/16/01						
Surveyor:	Edmond Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

Instrument Used: L2224 serial # 162420 / 43-89 scintillation probe # PR-171381
Instrument Efficiency: 0.2275

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

LOCATION DESIGNATION	DESCRIPTION OF LOCATION
5-1	Corridor South Wall opposite entrance to lab
5-2	Not accessible - use door to lab entrance 0.59 meters above right hand lower corner of door
5-3	Corridor 45 floor
5-4	Corridor South Wall next to ejector pit entrance
5-5	Corridor North Wall opposite ejector pit entrance
5-6	Corridor 45 floor
5-7	Foyer floor next to shield wall outside entrance to x-ray treatment room
5-8	X-ray treatment room west wall 0.81 meters above floor
5-9	X-ray treatment room south wall 1.5 meters above southwest corner of floor
5-10	X-ray control room north wall 0.15 meters above floor
5-11	X-ray control room floor
5-12	X-ray treatment room floor
5-13	X-ray treatment room north wall 0.5 meters above floor
5-14	X-ray control room south wall 1.85 meters above southeast corner of floor
5-15	X-ray control room floor
5-16	X-ray treatment room floor
5-17	X-ray treatment room south wall 1.5 meters above southeast corner of floor

ST. ALBANS FINAL STATUS SURVEY SUMMARY SHEET

SURVEY UNIT 8A (Drum Storage Above Machine Room)

		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	Surface	Ambient Background[1]	Count	DPM/100cm^2	Background (cpm)	Sample Count (2 min)	DPM/100cm^2
8A-1	Wall	178	243	347	79.55	165	6
8A-2	Wall	179	222	230	79.55	172	13
8A-3	Wall	138	178	214	79.55	171	12
8A-4	Wall	183	275	491	79.55	172	13
8A-5	Floor	160	250	481	79.55	180	22
8A-6	Floor	124	216	491	79.55	182	24
8A-7	Wall	150	214	342	79.55	167	8
8A-8	Floor	126	853	3884	79.55	169	10
8A-9	Floor	120	162	224	79.55	170	11
8A-10	Floor	118	186	363	79.55	180	22
8A-11	Wall	187	253	353	79.55	177	18
8A-12	Wall	190	230	214	79.55	165	6
8A-13	Wall	132	160	150	79.55	147	0
8A-14	Wall	182	235	283	79.55	187	29
8A-15	Wall	188	240	278	79.55	171	12
Date:	1/25/01						
Surveyor:	Edmund Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

Instrument Used: L2221 serial # 161581 / 43-89 scintillation probe # 508
Instrument Efficiency: 0.1872

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

ST. ALBANS FINAL STATUS SURVEY SUMMARY SHEET							
SURVEY UNIT 8A (Drum Storage Above Machine Room)							
		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	Surface	Ambient Background[1]	Count	DPM/100cm²	Background (cpm)	Sample Count (2 min)	DPM/100cm²
8A-9XD	Floor	124	188	281	79.55	160	1
8A-10XD	Floor	161	205	193	79.55	165	6
8A-13XD	Wall	150	190	176	79.55	172	13
Date:	1/26/01						
Surveyor:	Edmund Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

Instrument Used: L2221 serial # 162420 / 43-89 scintillation probe # 171381
Instrument Efficiency: 0.2275

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

LOCATION DESIGNATION	DESCRIPTION OF LOCATION
8A-1	X-ray shield wall outside surface
8A-2	X-ray shield wall outside surface
8A-3	X-ray shield wall outside surface
8A-4	North wall 0.9 meters above floor in northeast corner
8A-5	East floor next to X-ray shield wall
8A-6	Southeast corner on floor near wall
8A-7	South wall 1.73 meters above floor
8A-8	North portion of floor 1.0 meter from wall
8A-9	Center of room on floor
8A-10	South portion of floor near wall
8A-11	Wall on south side of room behind stairs to lower level 0.9 meter above floor
8A-12	Wall on east side stairs to lower level, north corner 0.33 meter above floor
8A-13	Wall on east side stairs to lower level, south corner 0.33 meter above floor
8A-14	South wall 0.26 meters above floor
8A-15	Wall in southwest corner of room 1.15 meters above floor

ST. ALBANS FINAL STATUS SURVEY SUMMARY SHEET

SURVEY UNIT 8B (RadMaterial Storage Area)

		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	**Surface**	**Ambient Background[1]**	**Count**	**DPM/100cm²**	**Background (cpm)**	**Sample Count (2 min)**	**DPM/100cm²**
8B-1	Wall	124	159	72	79.55	150	0
8B-2	Floor	131	187	115	79.55	165	6
8B-3	Floor	149	174	51	79.55	141	0
8B-4	Floor	157	174	35	79.55	132	0
8B-5	Wall	165	203	78	79.55	160	1
8B-6	Floor	129	209	165	79.55	150	0
8B-7	Floor	155	179	49	79.55	155	0
8B-8	Floor	164	192	58	79.55	161	2
8B-9	Floor	152	177	51	79.55	172	13
8B-10	Wall	162	227	134	79.55	160	1
8B-11	Floor	130	185	113	79.55	171	12
8B-12	Floor	141	202	126	79.55	166	7
8B-13	Floor	132	198	136	79.55	153	0
8B-14	Wall	175	225	103	79.55	155	0
Date:	1/25/2001 (scan) and 1/26/01 (smear)						
Surveyor:	Edmund Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

Instrument Used: L2221 serial # 161581 / 43-89 scintillation probe # 0508
Instrument Efficiency: 0.1872

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

ST. ALBANS FINAL STATUS SURVEY REPLICATE SUMMARY SHEET

SURVEY UNIT 8B (RadMaterial Storage Area)

		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	**Surface**	**Ambient Background[1]**	**Count**	**DPM/100cm²**	**Background (cpm)**	**Sample Count (2 min)**	**DPM/100cm²**
8B-1XD	Wall	182	203	92	79.55	167	8
8B-3XD	Floor	167	196	127	79.55	141	0
8B-8XD	Floor	172	210	167	79.55	156	0
Date:	1/26/01						
Surveyor:	Edmund Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

Instrument Used: L2224 serial # 162420 / 43-89 scintillation probe # PR-171381
Instrument Efficiency: 0.2275

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

LOCATION DESIGNATION	DESCRIPTION OF LOCATION
8B-1	North wall 1.65 meters above floor in northeast corner
8B-2	Northeast side of floor near doorway
8B-3	East side of floor next to wall
8B-4	Southeast side of floor near doorway
8B-5	On south wall 1.86 meters above the floor
8B-6	North portion of floor next to wall
8B-7	North middle section of floor
8B-8	South middle section of floor
8B-9	South portion of floor near wall
8B-10	North wall 1.66 meters above floor in northwest corner
8B-11	Northwest side of floor near wall
8B-12	West side of floor near wall
8B-13	Southwest side of floor near wall
8B-14	On south wall 1.84 meters above the floor

SEVERN TRENT SERVICES

STL St. Louis
13715 Rider Trail North
Earth City, MO 63045

Tel 314 298 8566
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ANALYTICAL REPORT

PROJECT NO. VA

St. Albans

Lot #: F1A080114

Tim Taylor

Stone & Webster Engineering Co
245 Summer Street
Boston, MA 02210

SEVERN TRENT LABORATORIES, INC.

Ron Martino
Project Manager

February 5, 2001

Case Narrative
LOT NUMBER: F1A080114

This report contains the analytical results for the 23 samples received under chain of custody by STL St. Louis on January 8, 2001. These samples are associated with your St. Albans project.

All applicable quality control procedures met method-specified acceptance criteria.

This report is incomplete without the case narrative. All results are based upon sample as received, wet weight, unless noted otherwise.

Observations/Nonconformances

Reference the chain of custody and condition upon receipt report for any variations on receipt conditions and temperatures of samples on receipt.

There were no anomalies with this analysis.

METHODS SUMMARY

F1A080114

PARAMETER	ANALYTICAL METHOD	PREPARATION METHOD
STRONTIUM 90 Sr90-Y90 cal	DOE 7500-SR MOD	

References:

DOE "DOE METHODS FOR EVALUATING ENVIRONMENTAL AND WASTE MANAGEMENT SAMPLES" OCTOBER 1994 US DEPARTMENT OF ENERGY

SAMPLE SUMMARY

F1A080114

WO #	SAMPLE#	CLIENT SAMPLE ID	SAMPLED DATE	SAMP TIME
DTCW5	001	SA5SS301XX	01/03/01	15:0(
DTCW8	002	SA5SS302XX	01/03/01	15:0(
DTCW9	003	SA5SS303XX	01/03/01	15:0(
DTCXA	004	SA5SS302XD	01/03/01	15:0(
DTCXC	005	SA1SS312XX	01/03/01	15:0(
DTCXD	006	SA1SS313XX	01/03/01	15:0(
DTCXE	007	SA1SS314XX	01/03/01	15:0(
DTCXF	008	SA1SS315XX	01/03/01	15:0(
DTCXG	009	SA1SS314XD	01/03/01	15:0(
DTCXH	010	SA1SS301XX	01/03/01	15:0(
DTCXJ	011	SA1SS302XX	01/03/01	15:0(
DTCXK	012	SA1SS303XX	01/03/01	15:0(
DTCXL	013	SA1SS304XX	01/03/01	15:0(
DTCXM	014	SA1SS305XX	01/03/01	15:0(
DTCXN	015	SA1SS306XX	01/03/01	15:0(
DTCXP	016	SA1SS307XX	01/03/01	15:0(
DTCXQ	017	SA1SS308XX	01/03/01	15:0(
DTCXR	018	SA1SS309XX	01/03/01	15:0(
DTCXV	019	SA1SS310XX	01/03/01	15:0(
DTCXW	020	SA1SS311XX	01/03/01	15:0(
DTCX0	021	SA1SS301XD	01/03/01	15:0(
DTCX1	022	SA1SS309XD	01/03/01	15:0(
DTCX2	023	SA1SS311XD	01/03/01	15:0(

NOTE(S):

- The analytical results of the samples listed above are presented on the following pages.
- All calculations are performed before rounding to avoid round-off errors in calculated results.
- Results noted as "ND" were not detected at or above the stated limit.
- This report must not be reproduced, except in full, without the written approval of the laboratory.
- Results for the following parameters are never reported on a dry weight basis: color, corrosivity, density, flashpoint, ignitability, layers, odor, paint filter test, pH, porosity pressure, reactivity, redox potential, specific gravity, spot tests, solids, solubility, temperature, viscosity, and weight.

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA5SS301XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-001
Work Order: DTCW5
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC DOE 7500-SR MOD				pCi/g	7500-SR MOD			
Strontium 90	-0.02	U	0.35	0.62	01/23/01	01/31/01	1023234	100

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.
Bold results are greater than the MDC

U Result is less than the sample detection limit.

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA5SS302XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-002
Work Order: DTCW8
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	**DOE 7500-SR MOD**			**pCi/g**	**7500-SR MOD**			
Strontium 90	0.04	U	0.42	0.72	01/23/01	01/31/01	1023234	100

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

U Result is less than the sample detection limit.

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA5SS303XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-003
Work Order: DTCW9
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	**DOE 7500-SR MOD**			**pCi/g**	**7500-SR MOD**			
Strontium 90	0.47	U	0.40	0.65	01/23/01	01/31/01	1023234	100

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

U Result is less than the sample detection limit.

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA5SS302XD

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-004
Work Order: DTCXA
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g	7500-SR MOD			
Strontium 90	-0.07	U	0.31	0.54	01/23/01	01/31/01	1023234	100

NOTE (S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

U Result is less than the sample detection limit.

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS312XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-005
Work Order: DTCXC
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g	7500-SR MOD			
Strontium 90	1.27		0.47	0.59	01/23/01	01/31/01	1023234	100

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.
Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS313XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-006
Work Order: DTCXD
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	**DOE 7500-SR MOD**			**pCi/g**	**7500-SR MOD**			
Strontium 90	0.33	U	0.36	0.60	01/23/01	01/31/01	1023234	100

NOTE (S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

U Result is less than the sample detection limit.

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS314XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-007
Work Order: DTCXE
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g	7500-SR MOD			
Strontium 90	2.14		0.59	0.57	01/23/01	01/31/01	1023234	100

NOTE (S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS315XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-008
Work Order: DTCXF
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g	7500-SR MOD			
Strontium 90	0.05	U	0.41	0.71	01/23/01	01/31/01	1023234	100

NOTE (S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

U Result is less than the sample detection limit.

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS314XD

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-009
Work Order: DTCXG
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD		pCi/g		7500-SR MOD			
Strontium 90	6.6		1.4	0.6	01/23/01	01/31/01	1023234	100

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS301XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-010
Work Order: DTCXH
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g	7500-SR MOD			
Strontium 90	1.07		0.47	0.66	01/23/01	01/31/01	1023234	100

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.
Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS302XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-011
Work Order: DTCXJ
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	**DOE 7500-SR MOD**			**pCi/g**	**7500-SR MOD**			
Strontium 90	0.20	U	0.39	0.66	01/23/01	01/31/01	1023234	97

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

U Result is less than the sample detection limit.

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS303XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-012
Work Order: DTCXK
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g	7500-SR MOD			
Strontium 90	1.84		0.56	0.62	01/23/01	01/31/01	1023234	100

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.
Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS303XX DUP

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-012X
Work Order: DTCXK
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g	7500-SR MOD			
Strontium 90	1.76		**0.54**	0.61	01/23/01	01/31/01	1023234	100

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.
Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS304XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-013
Work Order: DTCXL
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g	7500-SR MOD			
Strontium 90	2.34		0.60	0.51	01/24/01	02/01/01	1024214	89

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS305XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-014
Work Order: DTCXM
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)		MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g		7500-SR MOD			
Strontium 90	0.98		0.42		0.57	01/24/01	02/01/01	1024214	80

NOTE (S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.
Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS306XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-015
Work Order: DTCXN
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g	7500-SR MOD			
Strontium 90	0.68		0.39	0.59	01/24/01	02/01/01	1024214	79

NOTE (S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS307XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-016
Work Order: DTCXP
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g	7500-SR MOD			
Strontium 90	0.72		0.42	0.64	01/24/01	02/01/01	1024214	79

NOTE (S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS308XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-017
Work Order: DTCXQ
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g	7500-SR MOD			
Strontium 90	1.69		0.48	0.47	01/24/01	02/01/01	1024214	90

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS309XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-018
Work Order: DTCXR
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g	7500-SR MOD			
Strontium 90	6.81		0.89	0.60	01/24/01	02/02/01	1024214	88

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS310XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-019
Work Order: DTCXV
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC DOE 7500-SR MOD			pCi/g		7500-SR MOD			
Strontium 90	4.23		0.95	0.56	01/24/01	02/02/01	1024214	89

NOTE (S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS311XX

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-020
Work Order: DTCXW
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD		pCi/g		7500-SR MOD			
Strontium 90	4.6		1.0	0.6	01/24/01	02/01/01	1024214	74

NOTE (S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.
Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS301XD

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-021
Work Order: DTCX0
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD		pCi/g		7500-SR MOD			
Strontium 90	0.05	U	0.39	0.67	01/24/01	02/01/01	1024214	71

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

U   Result is less than the sample detection limit.

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS309XD

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-022
Work Order: DTCX1
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g	7500-SR MOD			
Strontium 90	3.27		**0.81**	0.63	01/24/01	02/01/01	1024214	79

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.

Bold results are greater than the MDC

STONE & WEBSTER ENGINEERING CORPORATION

Client Sample ID: SA1SS311XD

Quanterra, Inc. - Radiochemistry

Lab Sample ID: F1A080114-023
Work Order: DTCX2
Matrix: SOLID

Date Collected: 01/03/01 1500
Date Received: 01/08/01 0910

Parameter	Result	Qual	Total Uncert. (2 σ+/-)		MDC	Prep Date	Analysis Date	Batch #	Yld %
SR-90 BY GFPC	DOE 7500-SR MOD			pCi/g		7500-SR MOD			
Strontium 90	1.03		0.40		0.52	01/24/01	02/01/01	1024214	86

NOTE (S)

Data are incomplete without the case narrative.

MDC is determined by instrument performance only.
Bold results are greater than the MDC

METHOD BLANK REPORT

Quanterra, Inc. - Radiochemistry

Client Lot ID: F1A080114
Matrix: SOLID

Parameter	Result	Qual	Total Uncert. (2 σ+/-)	MDC	Prep Date	Lab Sample ID Analysis Date	Batch #	Yld %
SR-90 BY GFPC	**DOE 7500-SR MOD**		**pCi/g**	**7500-SR MOD**		**F1A230000-234B**		
Strontium 90	-0.05	U	0.35	0.61	01/23/01	01/31/01	1023234	100
SR-90 BY GFPC	**DOE 7500-SR MOD**		**pCi/g**	**7500-SR MOD**		**F1A240000-214B**		
Strontium 90	-0.11	U	0.43	0.75	01/24/01	02/02/01	1024214	88

NOTE(S)

Data are incomplete without the case narrative.

MDC is determined using instrument performance only
Bold results are greater than the MDC

U Result is less than the sample detection limit.

DUPLICATE EVALUATION REPORT

Quanterra, Inc. - Radiochemistry

Client Lot ID: F1A080114
Work Order #: DTAC
Matrix: SOLID

Date Sampled: 01/02/00
Date Received: 01/05/01

Parameter		SAMPLE Result		Total Uncert. (2σ +/-)	% Yld	DUPLICATE Result		Total Uncert. (2 σ +/-)	% Yld	QC Sample ID Precision	
SR-90 BY GFPC	**DOE 7500-SR**	**pCi/g**			**7500-SR MOD**					**F1A050206-007**	
Strontium 90		-0.05	U	0.34	87	0.16	U	0.34	90	367	%RPD
		Batch #:		1024214 (Sample)		1024214 (Duplicate)					
SR-90 BY GFPC	**DOE 7500-SR**	**pCi/g**			**7500-SR MOD**					**F1A080114-012**	
Strontium 90		1.84		0.56	100	1.76		0.54	100	4	%RPD
		Batch #:		1023234 (Sample)		1023234 (Duplicate)					

NOTE(S)

Data are incomplete without the case narrative.
Calculations are performed before rounding to avoid round-off error in calculated results

U Result is less than the sample detection limit.

Laboratory Control Sample Report

Quanterra, Inc. - Radiochemistry

Client Lot ID: F1A080114
Matrix: SOLID

Parameter	Spike Amount	Result	Total Uncert. (2σ+/-)	MDC	% Yld	% Rec	Lab Sample ID / QC Control Limits
SR-90 BY GFPC	**DOE 7500-SR MOD**	**pCi/g**		**7500-SR MOD**			**F1A230000-234C**
Strontium 90	9.83	5.8	1.2	0.6	100	59	49 - 126
	Batch #:	1023234		**AnalysisDate**	01/31/01		
SR-90 BY GFPC	**DOE 7500-SR MOD**	**pCi/g**		**7500-SR MOD**			**F1A240000-214C**
Strontium 90	9.83	11.4	2.4	0.8	76	116	49 - 126
	Batch #:	1024214		**AnalysisDate**	02/02/01		

NOTE(S)

MDC is determined by instrument performance only
Calculations are performed before rounding to avoid round-off error in calculated results

Appendix B:

Survey and Soil Sample Location Maps

SURVEY UNIT 1A (High Level and Low Level Labs & Isotope Storage Area)				
SOIL SAMPLE DESIGNATION	COLLECTION LOCATION DESCRIPTION	Sr-90 ACTIVITY CONCENTRATION (pCi/g)	TOTAL UNCERTAINTY +/- 2 σ (pCi/g)	MDC (pCi/g)
SA1SS301XX	Stainless steel piping trench below high level lab sink	1.07	0.47	0.66
SA1SS302XX	Stainless steel piping trench under high level lab fume hood drain north end	0.20	0.39	0.66
SA1SS303XX	Stainless steel piping trench under high level lab fume hood drain south end	1.84	0.56	0.62
SA1SS304XX	Stainless steel piping trench below low level lab sink northwest corner	2.34	0.60	0.51
SA1SS305XX	Stainless steel piping trench below UST area	0.98	0.42	0.57
SA1SS306XX	Stainless steel piping trench junction of low level sink and UST drain lines	0.68	0.39	0.59
SA1SS307XX	Stainless steel piping trench below low level lab sink northeast corner	0.72	0.42	0.64
SA1SS308XX	Stainless steel pipe trench beneath low level lab cabinet area	1.69	0.48	0.47
SA1SS309XX	Cast Iron piping trench beneath emergency shower drain area	6.81	0.89	0.60
SA1SS310XX	Stainless steel/cast iron common trench approximately 4 ft east of emergency shower drain	4.23	0.95	0.56
SA1SS311XX	Stainless steel/cast iron common trench approximately 8 ft east of emergency shower drain	4.60	1.00	0.60
SA1SS301XD	Stainless steel piping trench below high level lab sink - Duplicate	0.05	0.39	0.67
SA1SS309XD	Cast Iron piping trench beneath emergency shower drain area - Duplicate	3.27	0.81	0.63
SA1SS311XD	Stainless steel/cast iron common trench approximately 8 ft east of emergency shower drain	1.03	0.40	0.52

SURVEY UNIT 1A (High Level and Low Level Labs & Isotope Storage Area)		
Map Locator	**SOIL SAMPLE DESIGNATION**	**COLLECTION LOCATION DESCRIPTION**
A	SA1SS301XX	Stainless steel piping trench below high level lab sink
B	SA1SS302XX	Stainless steel piping trench under high level lab fume hood drain north end
C	SA1SS303XX	Stainless steel piping trench under high level lab fume hood drain south end
D	SA1SS304XX	Stainless steel piping trench below low level lab sink northwest corner
E	SA1SS305XX	Stainless steel piping trench below UST area
F	SA1SS306XX	Stainless steel piping trench junction of low level sink and UST drain lines
G	SA1SS307XX	Stainless steel piping trench below low level lab sink northeast corner
H	SA1SS308XX	Stainless steel pipe trench beneath low level lab cabinet area
I	SA1SS309XX	Cast Iron piping trench beneath emergency shower drain area
J	SA1SS310XX	Stainless steel/cast iron common trench approximately 4 ft east of emergency shower drain
K	SA1SS311XX	Stainless steel/cast iron common trench approximately 8 ft east of emergency shower drain
L	SA1SS301XD	Stainless steel piping trench below high level lab sink - Duplicate
M	SA1SS309XD	Cast Iron piping trench beneath emergency shower drain area - Duplicate
N	SA1SS311XD	Stainless steel/cast iron common trench approximately 8 ft east of emergency shower drain

LOCATION DESIGNATION	DESCRIPTION OF LOCATION
1A-1	High Level Lab northwest corner on wall 0.48 meters above floor
1A-2	High Level Lab west wall 0.61 meters above floor
1A-3	High Level Lab west wall 0.61 meters above floor
1A-4	High Level Lab north wall 1.78 meters above floor
1A-5	High Level Lab south wall 0.3 meters above floor
1A-6	High Level Lab floor west side
1A-7	High Level Lab northeast corner on partition between high & low level labs 0.48 meters above floor
1A-8	High Level Lab south wall 1.6 meters above floor
1A-9	High Level Lab floor south side
1A-10	High Level Lab floor north side
1A-11	High Level Lab east partition between high & low level labs 1.78 meters above floor
1A-12	High Level Lab south wall 0.3 meters above floor
1A-13	Low Level Lab floor east side
1A-14	Low Level Lab west partition wall between high & low level labs 0.48 meters above floor
1A-15	Low Level Lab east partition wall between low level lab & counting room 1.0 meters above floor
1A-16	Low Level lab north wall 1.78 meters above floor

ST. ALBANS FINAL STATUS SURVEY REPLICATE SUMMARY SHEET							
SURVEY UNIT 1A (High Level and Low Level Labs & Isotope Storage Area)							
		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	Surface	Ambient Background[1]	Count	DPM/100cm^2	Background (cpm)	Sample Count (2 min)	DPM/100cm^2
1A-5XD	Wall	153	233	352	82.65	179	14
1A-9XD	Floor (Soil)	215	284	303	82.65	185	20
1A-15XD	Wall	179	222	189	82.65	143	0
Date:	01/16/01						
Surveyor:	Edmond Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

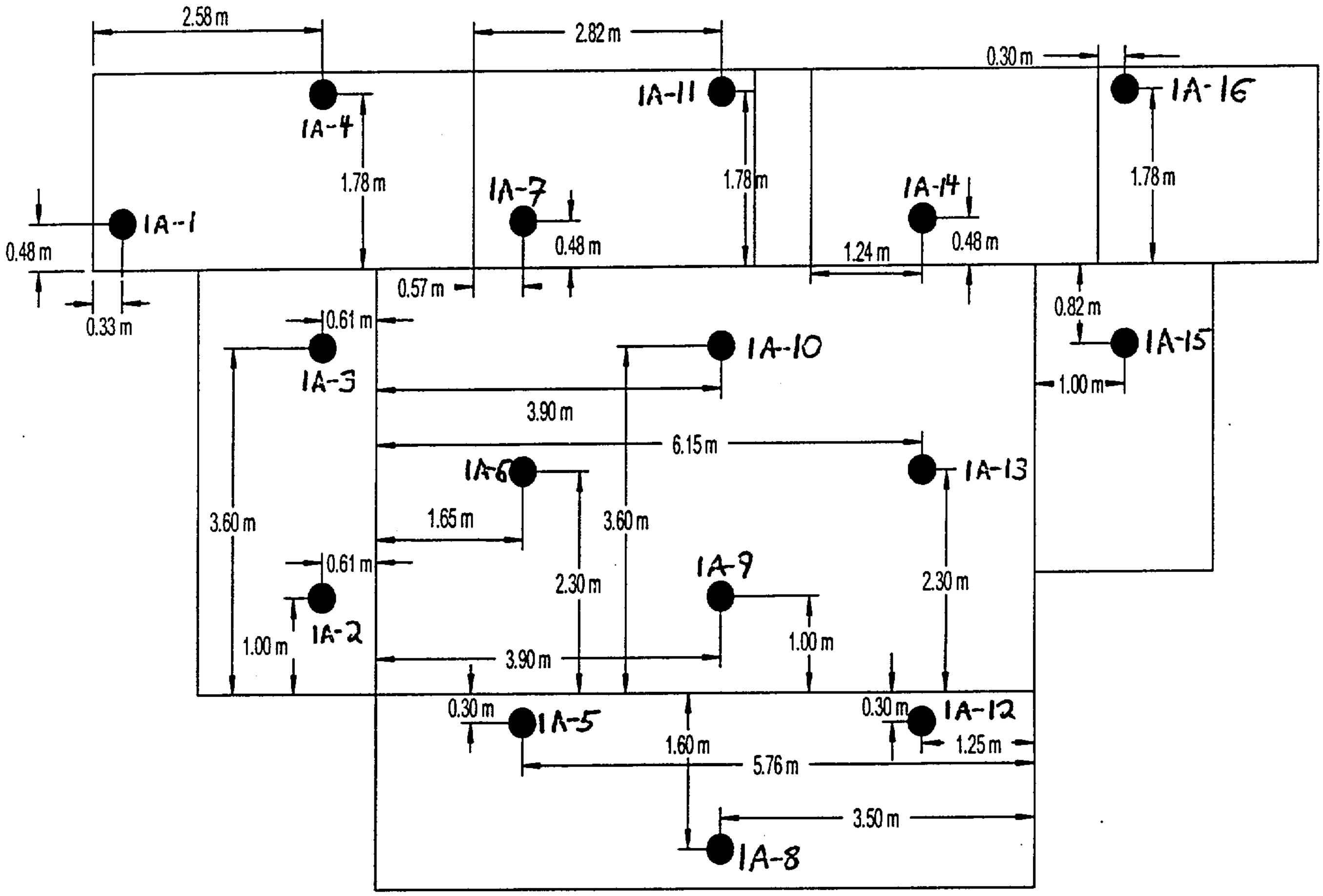
Instrument Used: L2224 serial # 162420 / 43-89 scintillation probe # PR-171381
Instrument Efficiency: 0.2275

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

HIGH LEVEL AND LOW LEVEL LABS & ISOTOPE STORAGE AREA

Survey Unit 1A



SURVEY UNIT 1B (Counting Room, Wash Room & Corridor 15)		
Map Locator	SOIL SAMPLE DESIGNATION	COLLECTION LOCATION DESCRIPTION
O	SA1SS312XX	Stainless steel/cast iron common trench approximately 12 ft east of emergency shower drain
P	SA1SS313XX	Stainless steel/cast iron common trench crossing corridor 15 ramp north side
Q	SA1SS314XX	Stainless steel/cast iron common trench crossing corridor 15 ramp south side
R	SA1SS315XX	Cast iron common trench piping trench beneath distillation sink area in closet
S	SA1SS314XD	Stainless steel/cast iron common trench crossing corridor 15 ramp south side - Duplicate

SURVEY UNIT 1B (Counting Room, Wash Room & Corridor 15)				
SOIL SAMPLE DESIGNATION	COLLECTION LOCATION DESCRIPTION	Sr-90 ACTIVITY CONCENTRATION (pCi/g)	TOTAL UNCERTAINTY +/- 2 σ (pCi/g)	MDC (pCi/g)
SA1SS312XX	Stainless steel/cast iron common trench approximately 12 ft east of emergency shower drain	1.27	0.47	0.59
SA1SS313XX	Stainless steel/cast iron common trench crossing corridor 15 ramp north side	0.33	0.36	0.60
SA1SS314XX	Stainless steel/cast iron common trench crossing corridor 15 ramp south side	2.14	0.59	0.57
SA1SS315XX	Cast iron common trench piping trench beneath distillation sink area in closet	0.05	0.41	0.71
SA1SS314XD	Stainless steel/cast iron common trench crossing corridor 15 ramp south side - Duplicate	6.60	1.40	0.60

LOCATION DESIGNATION	DESCRIPTION OF LOCATION
1B-1	Corridor 15 floor near entrance from corridor 45
1B-2	Corridor 15 north wall (near entrance from corridor 45) 1.65 meters above floor
1B-3	Corridor 15 south wall 0.4 meters above floor
1B-4	Corridor 15 north wall 0.2 meters above floor
1B-5	Corridor 15 south wall 1.85 meters above floor
1B-6	Corridor 15 floor
1B-7	On south side of partition wall between counting room & low level lab 1.04 meters above floor
1B-8	Corridor 15 north wall 1.65 meters above floor
1B-9	Corridor 15 south wall 0.4 meters above floor
1B-10	Counting room floor southwest corner
1B-11	Counting room floor northwest corner 0.18 meters from partition wall
1B-12	On east side (narrow portion bet. corridor & counting room) of corridor 15 north wall 0.2 meters above floor
1B-13	Corridor 15 southeast corner on south wall 1.85 meters above floor
1B-14	Corridor 15 floor washroom (formerly w/sink)
1B-15	Counting room floor east side
1B-16	Counting room northeast corner on north wall 0.76 meter above floor
1B-17	Counting room south wall next to entrance between counting room & corridor 15, 1.65 meters above floor

ST. ALBANS FINAL STATUS SURVEY REPLICATE SUMMARY SHEET

SURVEY UNIT 1B (Counting Room, Wash Room & Corridor 15)

		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	Surface	Ambient Background[1]	Count	DPM/100cm^2	Background (cpm)	Sample Count (2 min)	DPM/100cm^2
1B-6XD	Floor	166	272	466	82.65	153	0
1B-15XD	Floor	155	235	352	82.65	160	0
1B-17XD	Wall	158	167	40	82.65	162	0
Date:	01/16/01						
Surveyor:	Edmond Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

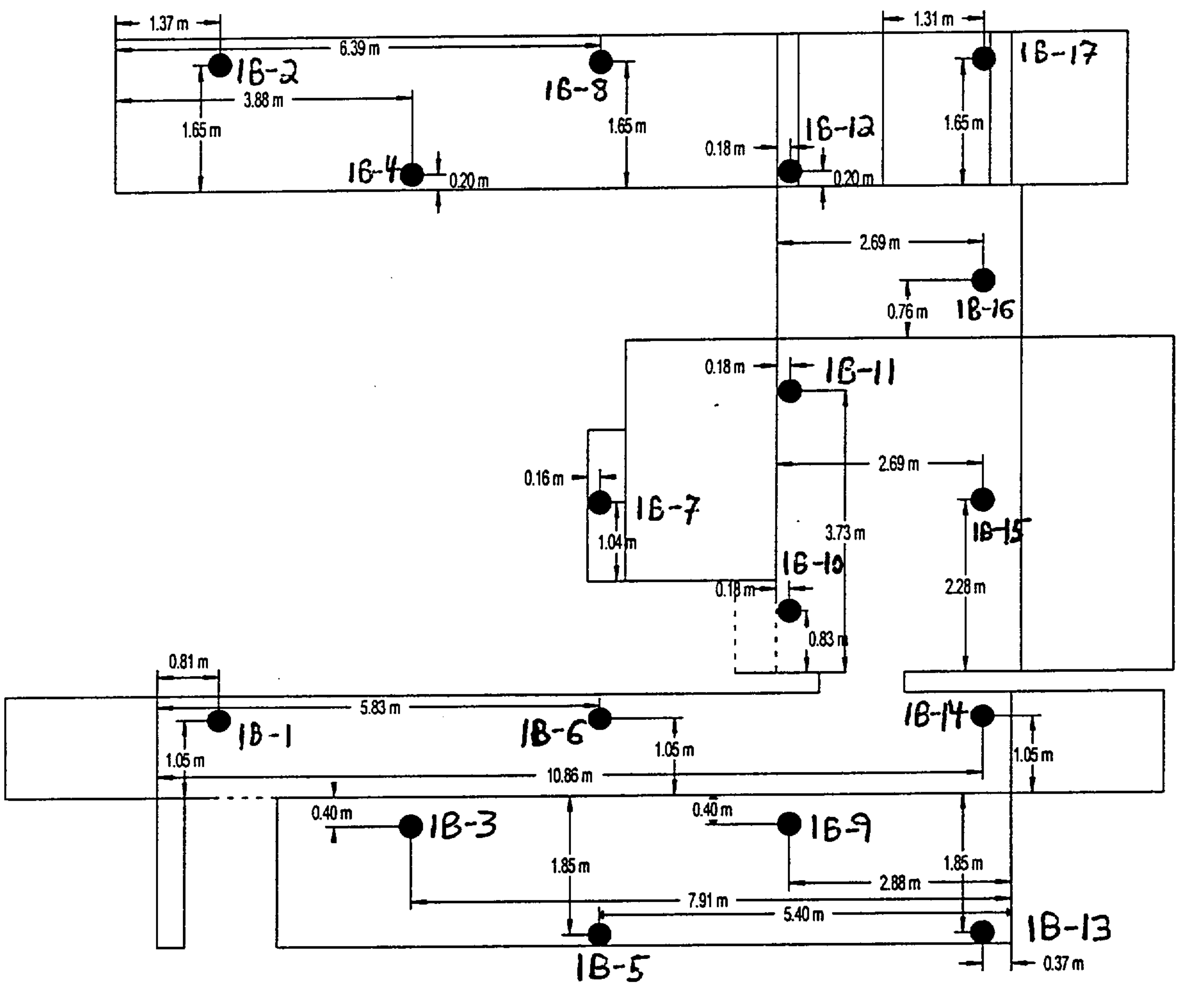
Instrument Used: L2224 serial # 162420 / 43-89 scintillation probe # PR-171381
Instrument Efficiency: 0.2275

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

COUNTING ROOM, WASH ROOM
& CORRIDOR 15

Survey Unit 1B



LOCATION DESIGNATION	DESCRIPTION OF LOCATION
2-1	Ejector Pit lower level west wall 1.78 meters above floor
2-2	Ejector Pit lower level northwest corner on west wall 1.78 meters above floor
2-3	Ejector Pit entry level floor on west wall 1.78 meters above floor
2-4	Ejector Pit lower level southwest corner of south wall 1.85 meters above floor
2-5	Ejector Pit lower level southwest corner of floor
2-6	Ejector Pit lower level west side of floor
2-7	Ejector Pit lower level northwest corner on north wall 0.89 meters above floor
2-8	Ejector Pit entry level floor next to west wall on floor
2-9	Ejector Pit lower level underside of entry level floor 1.58 meters from north wall
2-10	Ejector Pit lower level south wall 0.70 meters above floor
2-11	Ejector Pit lower level east side of floor
2-12	Ejector Pit lower level northeast corner of floor
2-13	Ejector Pit entry level floor next to railing on floor
2-14	Ejector Pit entry level floor on north wall 0.13 meters above floor
2-15	Ejector Pit lower level underside of entry level floor 0.43 meters from north wall
2-16	Ejector Pit lower level southeast corner on east wall 1.28 meters above floor
2-17	Ejector Pit lower level east wall 1.28 meters above floor
2-18	Ejector Pit entry level floor on east wall 1.28 meters above floor

ST. ALBANS FINAL STATUS SURVEY REPLICATE SUMMARY SHEET

SURVEY UNIT 2 (Ejector Pit room)

Location Designation	Surface	1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
		Ambient Background[1]	Count	DPM/100cm^2	Background (cpm)	Sample Count (2 min)	DPM/100cm^2
2-6XD	Floor	159	206	207	82.65	178	13
2-8XD	Floor	180	293	497	82.65	173	8
2-10XD	Wall	158	227	303	82.65	148	0
Date:	01/16/01						
Surveyor:	Edmond Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

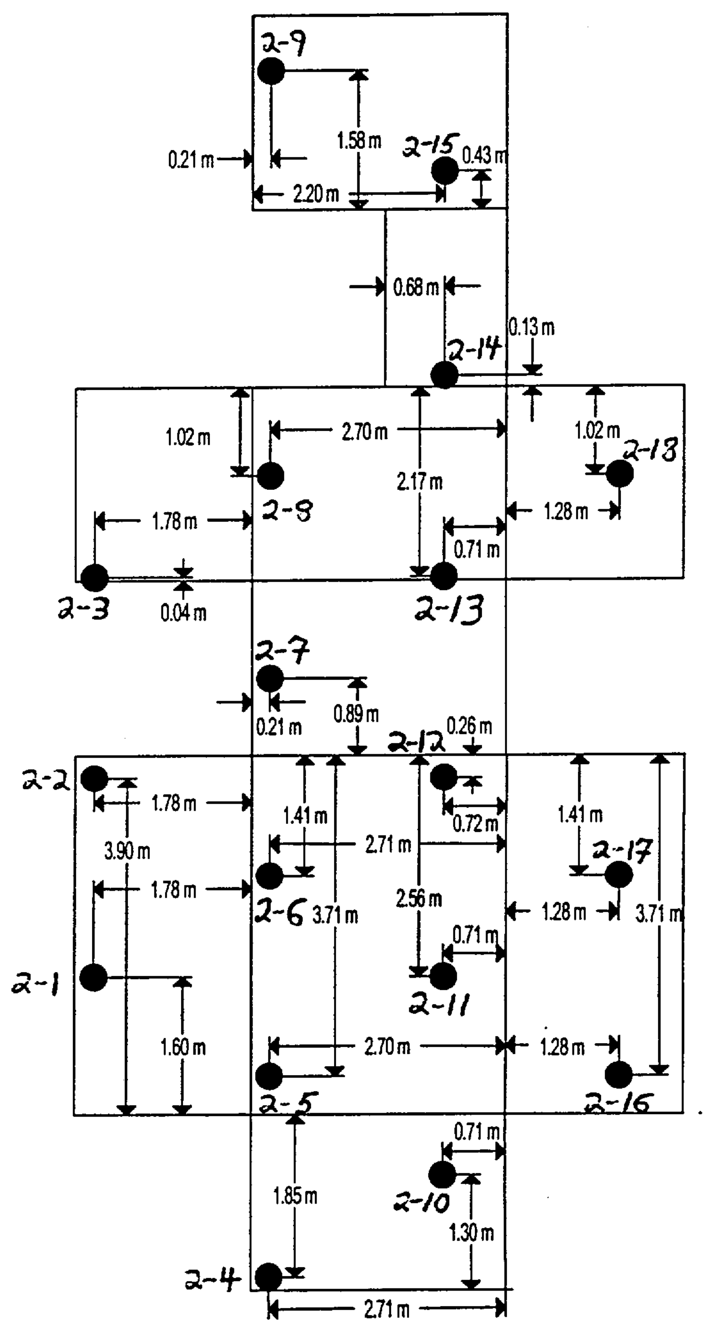
Instrument Used: L2224 serial # 162420 / 43-89 scintillation probe # PR-171381
Instrument Efficiency: 0.2275

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

FIGURE 6-7 EJECTOR PIT ROOM

Survey Unit 2



LOCATION DESIGNATION	DESCRIPTION OF LOCATION
4-1	Southwest corner of west wall 0.94 meters above floor
4-2	Middle of west wall 0.94 meters above floor
4-3	Northwest corner of west wall 0.94 meters above floor
4-4	Floor south side near entrance
4-5	Floor north side
4-6	Northwest corner of north wall 0.41 meters above floor
4-7	Southeast corner on east wall of entrance 0.34 meters above floor
4-8	Northeast corner on east wall of entrance 0.34 meters above floor
4-9	Floor near north wall
4-10	North wall 1.26 meters above floor
4-11	South wall next to former stall area 1.04 meters above floor
4-12	East wall of entrance 1.81 meters above floor
4-13	East wall of former stall area 0.15 meters above floor
4-14	East wall of former stall area 1.62 meters above floor
4-15	Ceiling ventilation grate west side
4-16	Ceiling ventilation grate east side

ST. ALBANS FINAL STATUS SURVEY REPLICATE SUMMARY SHEET							
SURVEY UNIT 4 (Men's Toilet)							
		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	Surface	Ambient Background[1]	Count	DPM/100cm^2	Background (cpm)	Sample Count (2 min)	DPM/100cm^2
4-4XD	West Floor	197	258	268	82.65	153	0
4-6XD	North Wall	199	271	316	82.65	151	0
4-14XD	East Wall	216	401	813	82.65	168	3

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

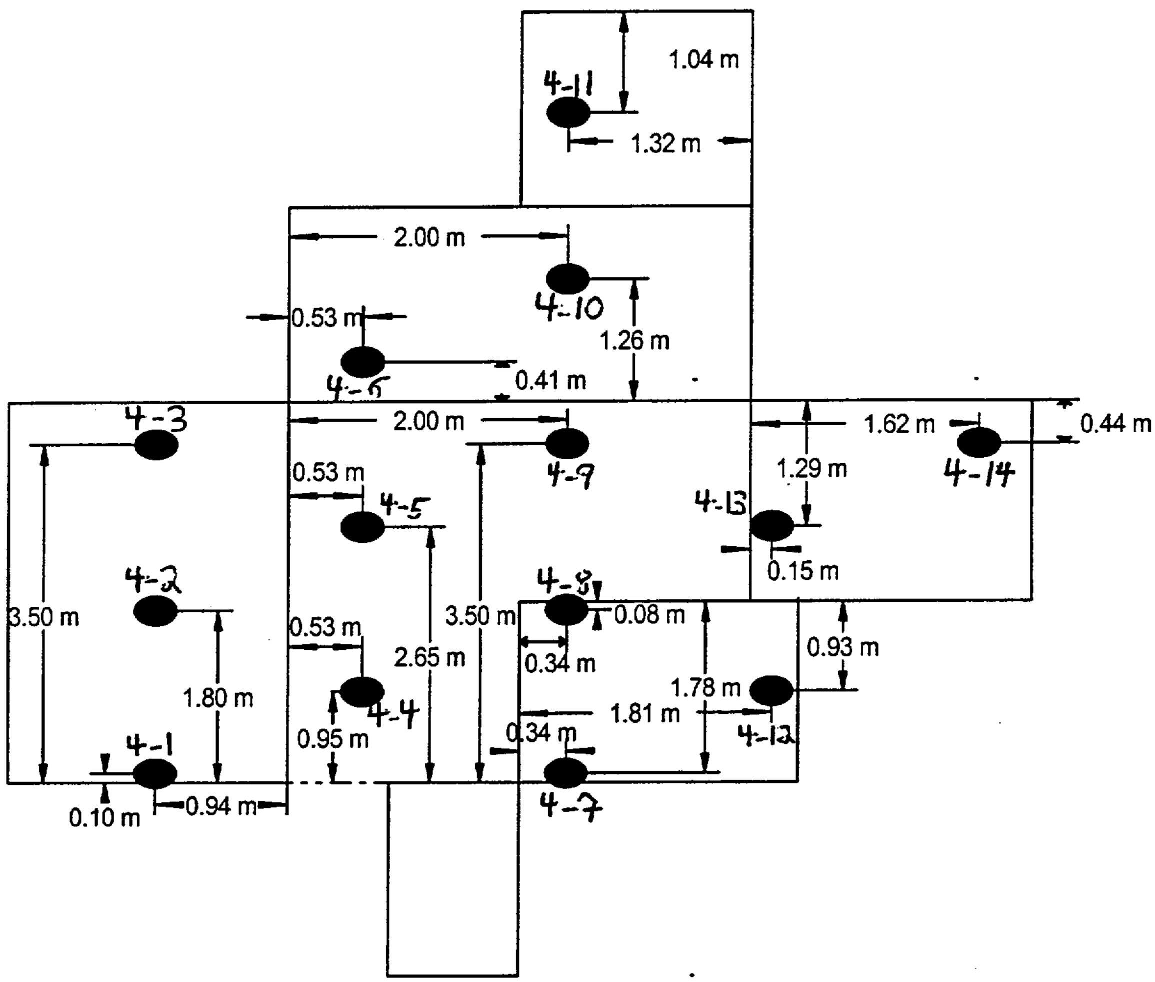
Date: 01/16/01
Surveyor: Edmond Young

Direct Scan:
Instrument Used: L2224 serial # 162420 / 43-89 scintillation probe # PR-171381
Instrument Efficiency: 0.2275

Removable Contamination:
Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

MEN'S TOILET

Survey Unit 4



LOCATION DESIGNATION	DESCRIPTION OF LOCATION
5-1	Corridor South Wall opposite entrance to lab
5-2	Not accessible - use door to lab entrance 0.59 meters above right hand lower corner of door
5-3	Corridor 45 floor
5-4	Corridor South Wall next to ejector pit entrance
5-5	Corridor North Wall opposite ejector pit entrance
5-6	Corridor 45 floor
5-7	Foyer floor next to shield wall outside entrance to x-ray treatment room
5-8	X-ray treatment room west wall 0.81 meters above floor
5-9	X-ray treatment room south wall 1.5 meters above southwest corner of floor
5-10	X-ray control room north wall 0.15 meters above floor
5-11	X-ray control room floor
5-12	X-ray treatment room floor
5-13	X-ray treatment room north wall 0.5 meters above floor
5-14	X-ray control room south wall 1.85 meters above southeast corner of floor
5-15	X-ray control room floor
5-16	X-ray treatment room floor
5-17	X-ray treatment room south wall 1.5 meters above southeast corner of floor

ST. ALBANS FINAL STATUS SURVEY REPLICATE SUMMARY SHEET

SURVEY UNIT 5 (Corridor 45, Treatment Unit & Associated Equipment Room, and Foyer at Foot of Stairs)

		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	Surface	Ambient Background[(1)]	Count	DPM/100cm^2	Background (cpm)	Sample Count (2 min)	DPM/100cm^2
5-3XD	Floor	196	220	105	82.65	147	0
5-6XD	Floor	170	209	171	82.65	173	8
5-8XD	Wall	271	550	1226	82.65	147	0
Date:	01/16/01						
Surveyor:	Edmond Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan: Instrument Used: L2224 serial # 162420 / 43-89 scintillation probe # PR-171381
Instrument Efficiency: 0.2275

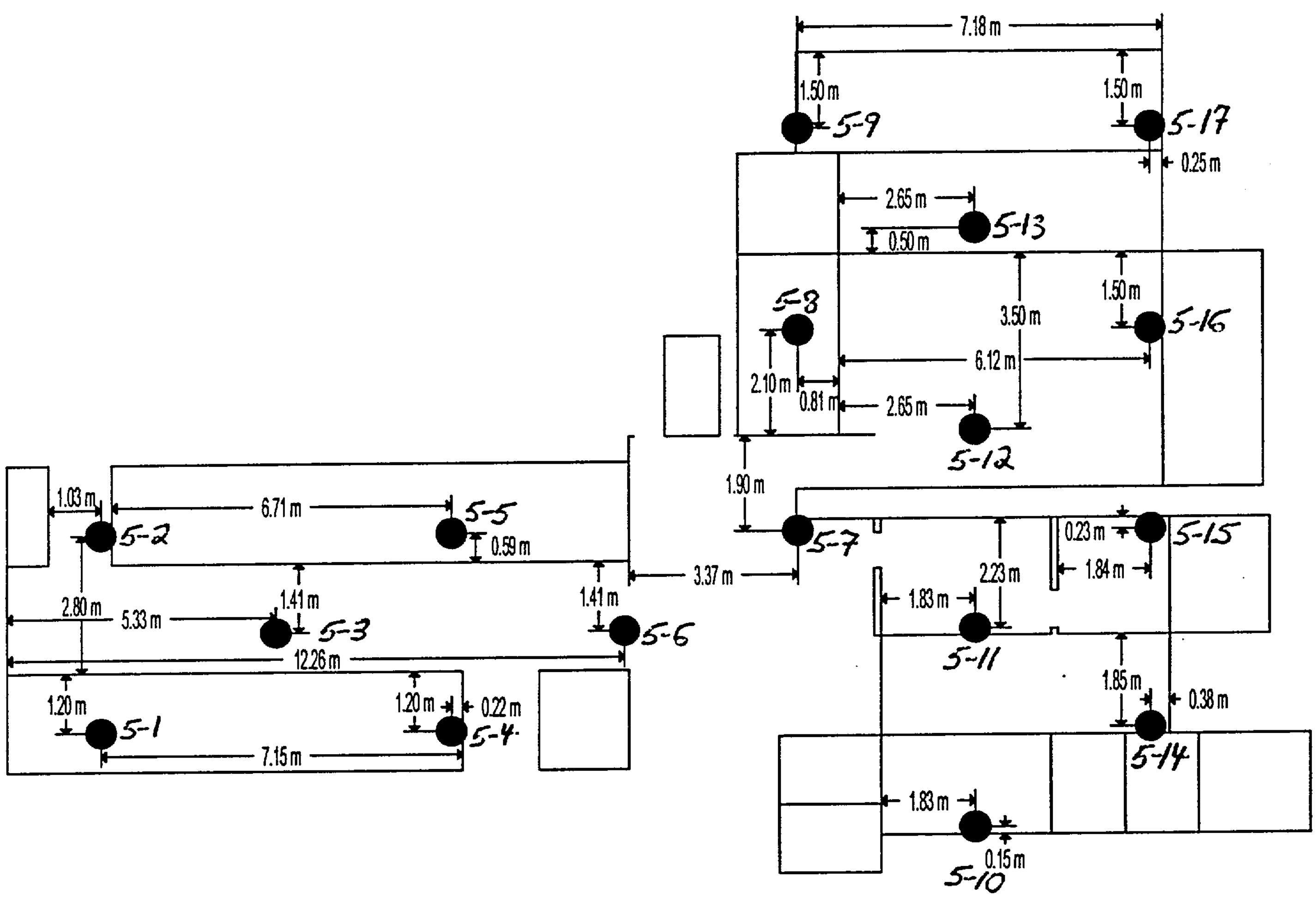
Removable Contamination: Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

SURVEY UNIT 5 (Corridor 45, Treatment Unit and Associated Equipment Room, and Foyer at Foot of Stairs)		
Map Locator	**SOIL SAMPLE DESIGNATION**	**COLLECTION LOCATION DESCRIPTION**
T	SA5SS301XX	Stainless steel/cast iron common trench crossing corridor 45 north side
U	SA5SS302XX	Stainless steel/cast iron common trench crossing corridor 45 center
V	SA5SS303XX	Stainless steel/cast iron common trench crossing corridor 45 south side
W	SA5SS302XD	Stainless steel/cast iron common trench crossing corridor 45 center - Duplicate Sample

SURVEY UNIT 5 (Corridor 45, Treatment Unit and Associated Equipment Room, and Foyer at Foot of Stairs)				
SOIL SAMPLE DESIGNATION	COLLECTION LOCATION DESCRIPTION	Sr-90 ACTIVITY CONCENTRATION (pCi/g)	TOTAL UNCERTAINTY +/- 2 σ (pCi/g)	MDC (pCi/g)
SA5SS301XX	Stainless steel/cast iron common trench crossing corridor 45 north side	-0.02	0.35	0.62
SA5SS302XX	Stainless steel/cast iron common trench crossing corridor 45 center	0.04	0.42	0.72
SA5SS303XX	Stainless steel/cast iron common trench crossing corridor 45 south side	0.47	0.40	0.65
SA5SS302XD	Stainless steel/cast iron common trench crossing corridor 45 center - Duplicate Sample	-0.07	0.31	0.54

FIGURE 6-4 CORRIDOR 45, TREATMENT UNIT AND ASSOCIATED EQUIPMENT ROOM, AND FOYER AT FOOT OF STAIRS

Survey Unit 5



LOCATION DESIGNATION	DESCRIPTION OF LOCATION
8A-1	X-ray shield wall outside surface
8A-2	X-ray shield wall outside surface
8A-3	X-ray shield wall outside surface
8A-4	North wall 0.9 meters above floor in northeast corner
8A-5	East floor next to X-ray shield wall
8A-6	Southeast corner on floor near wall
8A-7	South wall 1.73 meters above floor
8A-8	North portion of floor 1.0 meter from wall
8A-9	Center of room on floor
8A-10	South portion of floor near wall
8A-11	Wall on south side of room behind stairs to lower level 0.9 meter above floor
8A-12	Wall on east side stairs to lower level, north corner 0.33 meter above floor
8A-13	Wall on east side stairs to lower level, south corner 0.33 meter above floor
8A-14	South wall 0.26 meters above floor
8A-15	Wall in southwest corner of room 1.15 meters above floor

ST. ALBANS FINAL STATUS SURVEY SUMMARY SHEET							
SURVEY UNIT 8A (Drum Storage Above Machine Room)							
		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	**Surface**	**Ambient Background[1]**	**Count**	**DPM/100cm^2**	**Background (cpm)**	**Sample Count (2 min)**	**DPM/100cm^2**
8A-9XD	Floor	124	188	281	79.55	160	1
8A-10XD	Floor	161	205	193	79.55	165	6
8A-13XD	Wall	150	190	176	79.55	172	13
Date:	01/26/2001						
Surveyor:	Edmund Young						

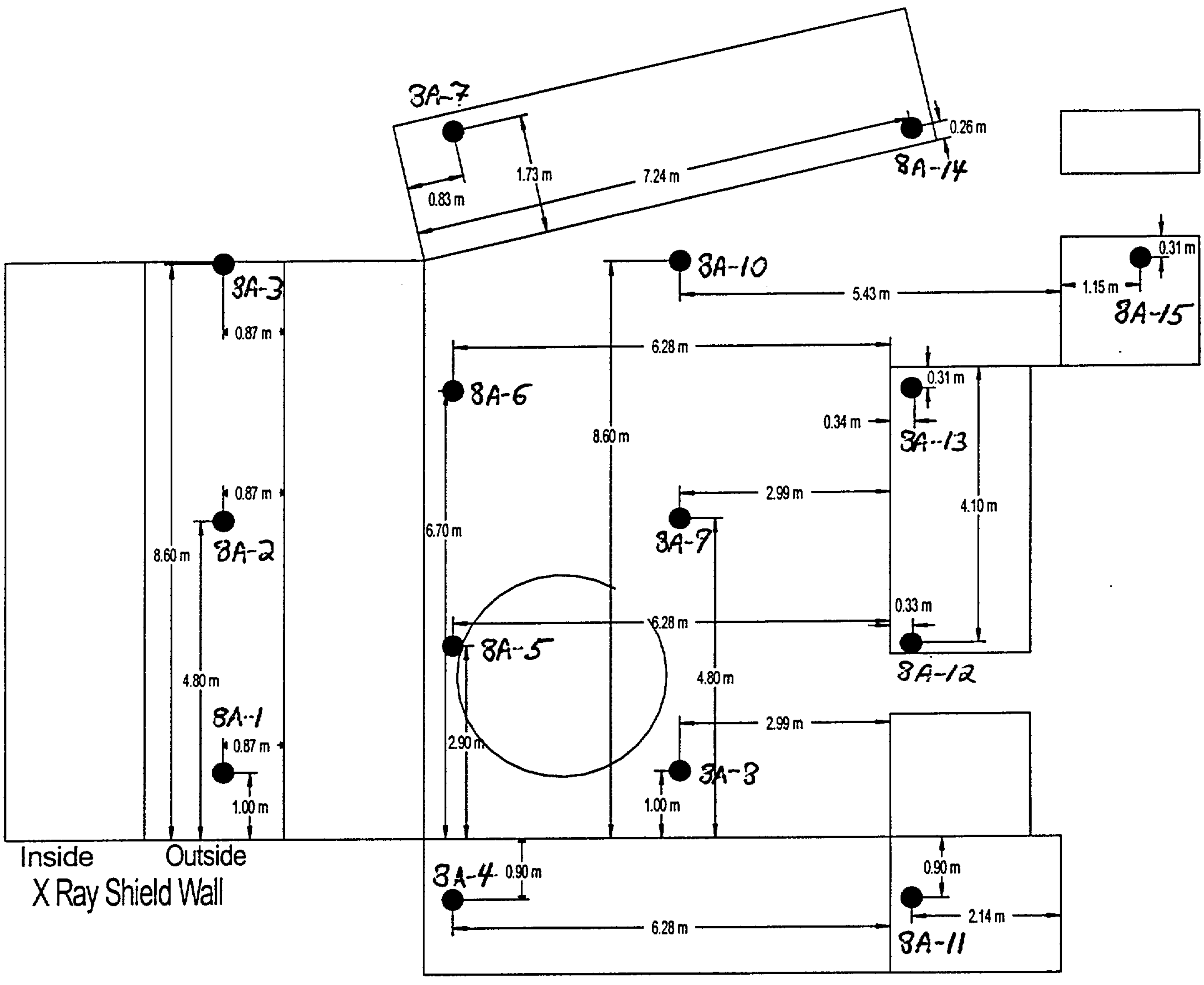
[1] Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan: Instrument Used: L2224 serial # 162420 / 43-89 scintillation probe # 171381
Instrument Efficiency: 0.2275

Removable Contamination: Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

SECONDARY RADMATERIAL STORAGE AREA
ABOVE X-RAY MACHINE

Survey Unit 8A



LOCATION DESIGNATION	DESCRIPTION OF LOCATION
8B-1	North wall 1.65 meters above floor in northeast corner
8B-2	Northeast side of floor near doorway
8B-3	East side of floor next to wall
8B-4	Southeast side of floor near doorway
8B-5	On south wall 1.86 meters above the floor
8B-6	North portion of floor next to wall
8B-7	North middle section of floor
8B-8	South middle section of floor
8B-9	South portion of floor near wall
8B-10	North wall 1.66 meters above floor in northwest corner
8B-11	Northwest side of floor near wall
8B-12	West side of floor near wall
8B-13	Southwest side of floor near wall
8B-14	On south wall 1.84 meters above the floor

ST. ALBANS FINAL STATUS SURVEY REPLICATE SUMMARY SHEET							
SURVEY UNIT 8B (RadMaterial Storage Area)							
		1 MINUTE DIRECT MEASUREMENT RESULT, COUNTS		DIRECT MEASUREMENT TOTAL SR-90 SURFACE ACTIVITY	SR-90 BETA SMEAR RESULTS, COUNTS		TRANSFERABLE SR-90 SURFACE ACTIVITY
Location Designation	**Surface**	**Ambient Background[1]**	**Count**	**DPM/100cm^2**	**Background (cpm)**	**Sample Count (2 min)**	**DPM/100cm^2**
8B-1XD	Wall	182	203	92	79.55	167	8
8B-3XD	Floor	167	196	127	79.55	141	0
8B-8XD	Floor	172	210	167	79.55	156	0
Date:	01/26/2001						
Surveyor:	Edmund Young						

(1) Background measurement performed using a wooden shield (i.e., result represents only gamma component)

Direct Scan:

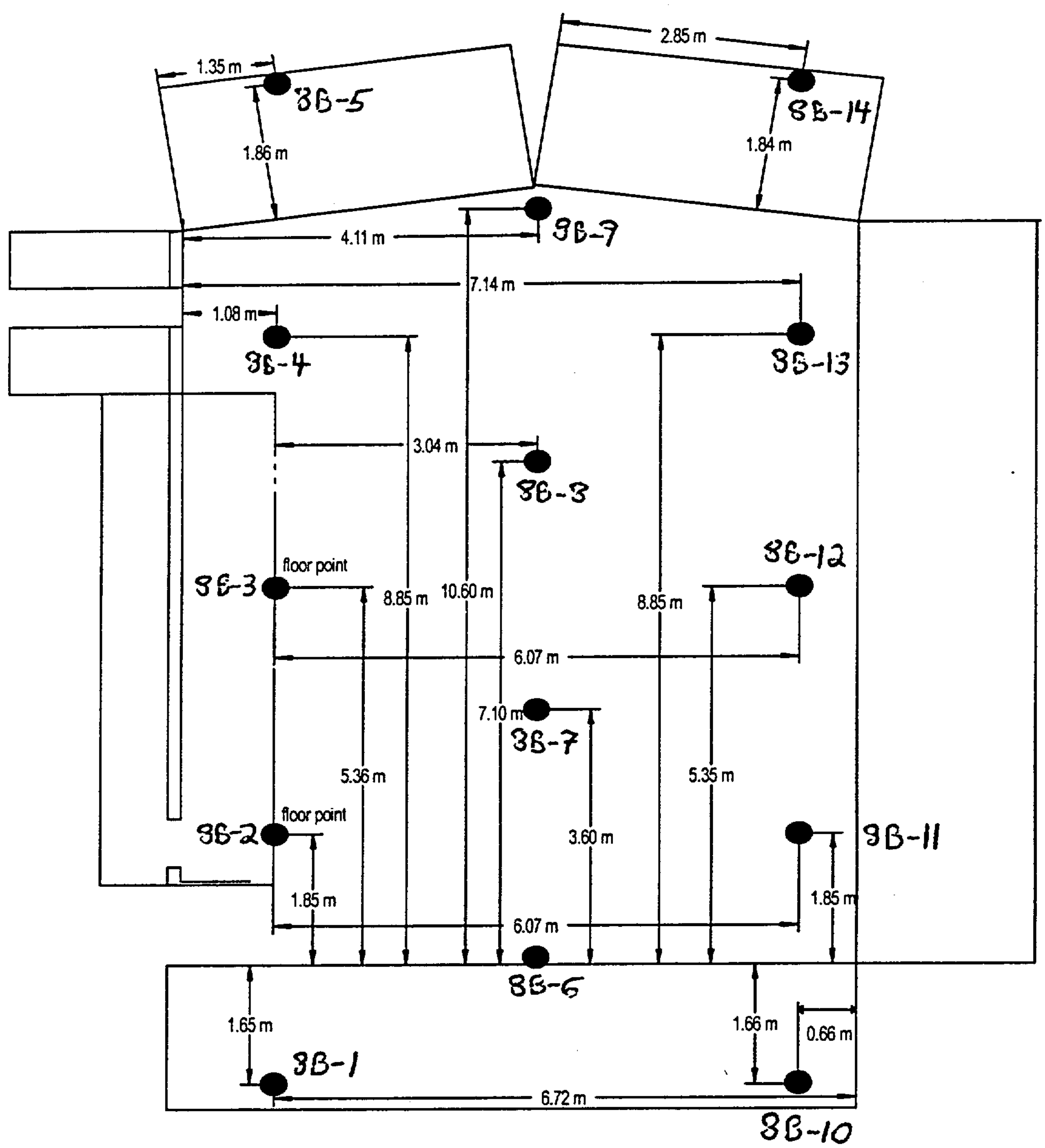
Instrument Used: L2224 serial # 162420 / 43-89 scintillation probe # PR-171381
Instrument Efficiency: 0.2275

Removable Contamination:

Instrument Used: L2929 serial # 163827 / 43-10-1 alpha beta sample counter # 171322
Instrument Efficiency: 0.486

RADMATERIAL STORAGE AREA

Survey Unit 8B



Appendix C:

Scan MDC Calculations

1.0 INTRODUCTION

Cabrera Services, Inc. (CABRERA) will perform a Final Status Survey (FSS) of select buildings on the St. Albans Veterans Administration Extended Care Center Facility (VAECC) property located in Queens, New York. The FSS is designed in accordance with guidance from the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). The number of samples required per survey unit depends upon the scan sensitivity or scan minimum detectable concentration of the instrumentation used and is a critical factor in developing FSS design. The scan MDC can be estimated by using the methodology in MARSSIM Section 6.7.2.1. This document provides the technical basis for estimating the scan MDC for beta radiation using a Ludlum Model 43-89 detector or equivalent coupled to a ratemeter. The type of ratemeter used has no bearing on calculating scan MDC.

1.1 Objective

The specific objective of this technical memorandum is to estimate the scan MDC of a plastic scintillator to measure beta emitters on selected structural materials in the buildings on the VAECC property during remedial and FSS activities. This is accomplished utilizing the methodology and approach documented in MARSSIM (Section 6.7.2.1) for scanning of beta emitters. It is important to note that this document is solely to be used to estimate scan MDC prior to conducting surveys on the VAECC property.

2.0 ESTIMATION OF MINIMUM DETECTABLE COUNT RATE (MDCR)

The MDCR is dependent upon several factors including surveyor performance, instrument sensitivity, distribution of contamination, etc.

2.1 Determination of Number of Source Counts

The MDCR is calculated by obtaining the minimum detectable number of source counts (S_i) in a given time interval, *i*. S_i is calculated by using equation 6-8 in MARSSIM as:

$$S_i = d' \sqrt{b_i}$$

where, d' = is the detectability value associated with the desired performance selected from Table 6-5 in MARSSIM

b_i = background counts

The number of background counts will fluctuate with the type of structural material due to the varying concentration of naturally occurring radioactive material present. A government subcontractor performed a radiation survey of buildings in Maywood, New Jersey in March of 1998 (USACE 1998). During that effort, a local fire station and Building #52 were used to obtain expected background responses from concrete, concrete block, and brick. The average and maximum count rates for each of these materials, as determined during the 1998 survey, are listed in Table 1. The listed values are assumed to be representative of background count rates that will be observed during the FSS of the VAECC building. Based upon manufacture specifications for both of these instrument types, it is also assumed that the response of the Ludlum Model 43-89 will be comparable to that of the Eberline AB-100 used during the 1998 survey.

Table 1. Average and Maximum Background Count Rates for Select Material from 1998 Survey.

	Material			
	Brick	**Concrete Block**	**Concrete Floor**	**Concrete Wall**
Average Count Rate (cpm)	606	387	341	365
Maximum Count Rate (cpm)	822	514	549	537

Since the average and the maximum count rates for each of the concrete materials are similar in value, it is assumed that any concrete material will exhibit approximately the same background count rate. Therefore, an MDCR is calculated for brick and concrete only and the MDCR for concrete will be applied to concrete floors, concrete walls, concrete block, etc. To be conservative, the maximum background count rate for the two materials is chosen as the expected background count rate (822 cpm for brick and 549 cpm for concrete). This is considered conservative because it will result in a higher scan MDC.

It is assumed that during a typical scanning survey an elevated source of radioactivity will remain under the probe for one second. The width of the detector is 10 cm. This corresponds to a scan speed of 10 cm per second. Therefore, the number of background counts in the observation interval of one second when scanning concrete material is calculated as:

$$b_i = (549\,\text{cpm})\left(\frac{1\,\text{sec.}}{60\,\frac{\text{sec.}}{\text{min}}}\right) = 9.15\ \text{counts}$$

The value of d' is selected from Table 6.5 in MARSSIM and is based upon the acceptable true and corresponding false positive proportions or rates during scanning. For example, if a 95% confidence level is placed on the ability to correctly detect the presence of radioactivity above background, then there is only a 5% chance that radioactivity above background will be missed. Further, if a 25% confidence level is placed on falsely identifying areas as containing radioactivity above background, then 75% of the time areas not containing radioactivity above background will be correctly determined as background. For the purposes of the FSS work plan, a 95% confidence level will be used for correctly detecting the presence of radioactivity, with an allowance for 25% false positive detection. The value for d' in Table 6-5 of

MARSSIM for these confidence levels is 2.32. Therefore, the minimum number of source counts, when scanning concrete material, is calculated as:

$$S_i = 2.32\sqrt{9.15} = 7.02 \text{ counts}$$

2.2 Calculation of MDCR

The MDCR is calculated by using equation 6-9 in MARSSIM.

$$MDCR = S_i \frac{60}{i}$$

When a scanning survey is performed, the surveyor will investigate potential locations that exhibit elevated count rates to determine if the location contains radioactivity above background. It is assumed that a surveyor typically stops the probe over a suspect location for four seconds before making a decision as to whether or not radioactivity above background is present. Therefore, when scanning concrete material, the MDCR is calculated as:

$$MDCR = (7.02 \text{ cpm})\left(\frac{60 \text{ sec.}}{4 \text{ sec.}}\right) = 105.3 \text{ cpm}$$

3.0 ESTIMATION OF SCAN MDC

The scan MDC is determined from the Minimum Detectable Count Rate (MDCR), by applying necessary conversion factors that account for surveyor performance, detector efficiency, probe area, etc. The scan MDC is calculated by using equation 6-10 in MARSSIM as:

$$\text{Scan MDC} = \frac{MDCR}{\sqrt{p}\, \epsilon_i \epsilon_s \frac{\text{probe area}}{100 \text{ cm}^2}}$$

where, MDCR = minimum detectable count rate

ε_i = instrument efficiency

ε_s = surface efficiency

p = surveyor efficiency,

The Nuclear Regulatory Commission publication NUREG-1507 recommends surveyor efficiency values between 0.75 and 0.5. To be conservative, 0.5 is chosen. Ludlum Measurements, Incorporated lists the efficiency for the Model 44-116 probe for Tc-99 as 15%, which is the value used in the following calculation. The listed efficiency for the Model 43-89 for Sr-90 is 16%, which would cause a slightly conservative result. This efficiency is assumed as the combined surface and instrument efficiency listed above. The probe area of the Model 43-89 is 126 square centimeters. The Scan MDC for concrete material is thus calculated as:

$$\text{Scan MDC} = \frac{105.3\ \text{cpm}}{\sqrt{0.5}\left(0.15\frac{c}{d}\right)\left(\frac{126\ \text{cm}^2}{100\ \text{cm}^2}\right)} = 788\ \text{dpm}$$

Having a percentage of false positives does not require sampling, but rather further investigation by either slowing the scan speed in the location of interest or performing an integrated count. A higher false positive value is actually conservative because background locations are investigated as though they contained residual radioactivity. The ramification of increasing the false positive proportion is that survey scanning time is slightly increased.

The above calculation was repeated for calculation of the scan MDC for brick material. However, due to the greater background count rate exhibited from brick, a false positive proportion of 35% must be used to achieve the DCGL of 855 dpm and 60% in order to achieve the DCGL of 590 dpm when surveying brick material.

4.0 SUMMARY

Using MARSSIM methodology, the calculated scan MDCs for a 43-89 scintillation detector employed for this radiological survey is:

- For concrete material, the scan MDC is 788 dpm/100cm^2 when using a 25% false positive and a 95% correct detection. When the false positive is adjusted to 50%, a scan MDC of 557 dpm/100cm^2 is achieved.
- For Brick material, the scan MDC is 839 dpm/100cm^2 when using a 35% false positive and a 95 % correct detection. When the false positive is adjusted to 60%, a scan MDC of 573 dpm/100cm^2 is achieved.

Appendix D:

Static Measurement MDC Calculations

1.0 INTRODUCTION

The St. Albans Veterans Administration Extended Care Center (VAECC) housed a nuclear medicine operation at the facility. This facility had laboratory research performed under an NRC "Possession Only" byproduct materials license during the 1960s. Several areas of the facility have elevated levels of Sr-90 surface contamination and volumetric material concentrations. The facility will be decommissioned which will entail the use of field health physics instruments.

1.1 OBJECTIVE

The objective of this technical memorandum is to calculate the minimum detectable concentration (MDC) for the health physics field instrument(s) used during cleanup. The contaminant of concern (COC), Sr-90, is used for the MDC calculations.

2.0 MINIMUM DETECTABLE CONCENTRATION

The detection limits for field survey instruments are an important criterion to assure that proper instrumentation is chosen for the field measurements to be taken. The MDC is the minimum activity concentration, at a given confidence level, that the instrument is able to detect. It is dependent upon the instrument efficiency, the background, and count time of the sample and background.

There are numerous MDC expressions (NRC 1997a) and (NRC 1997b) that may be utilized. This technical memorandum utilizes the more recent expressions presented in Table 3.1 of (NRC 1997a) and Equation 6-7 of (NRC 1997b). The MDC formulas listed from Brodsky & Gallaghar and by Strom & Stansbury in (NRC 1997a) are equivalent and simplify to the former expression when the background count time and the sample count time are equal to 1 minute. Equation 6-7 of (NRC 1997b) has a separate term, C, showing more clearly the detector efficiency variable and other factors used to convert MDC counts to concentration. This expression, with a 1 minute field background and sample count time is used as the basis for all calculations in this memorandum.

3.0 MINIMUM DETECTABLE CONCENTRATION CALCULATION

3.1 Minimum Detectable Concentration Expression

The MDC expression from (NRC 1997b) based on 95 % confidence, and 1minute count and background time is:

$$MDC = C \times \left(3 + 4.65\sqrt{B}\right)$$

Where,

C = Detector Efficiency, dpm/count

B = Background Count - 1 Minute, counts

3.2 Detection Equipment

A gas proportional counter such as the Eberline 43-68 or equivalent provides a highly sensitive detector for detecting beta emissions. The manufacturer provides a beta efficiency of 0.30 counts per disintegration for Sr-90/Y-90. This is similar to the gas proportional detector efficiency for Sr-90/Y-90 listed in (NRC 1997a) of 0.34 counts per disintegration.

Background is a variable in the MDC expression. Manufacturer data indicates a "typical" background for a gas proportional detector of 350 counts per minute when detecting beta. Data from (NRC 1997a) shows a similar background of 354 counts per minute for the gas proportional detector when detecting beta. This background is based upon an ambient gamma background of approximately 10 μR/hr.

A gas proportional detector will normally provide a greater efficiency for detection of beta radiation and therefore a lower MDA than other field instruments. However, these instruments will also have a higher background due to ambient gamma background. Additionally, these detectors are required to have a counting gas (P-10) that requires supply lines from the gas supply to the detector. This may become unwieldy in the field.

An alternative is to utilize a scintillation detector that requires no special counting gas and provides field flexibility with lower background contribution. Manufacturer data indicates a "typical" background for a beta scintillation detector of 300 -350 counts per minute. The efficiency for such detectors is 0.20 counts per disintegration for Sr-90/Y-90.

Since the surface being measured is concrete in a below grade level basement facility, the detector background will depend significantly on the beta and gamma background at the site. Constituents in the concrete such as aggregate may change the background substantially. Data is presented in an MDC table to illustrate the variability of MDC with background.

3.3 Results

3.1.1 Surface MDC

Table 1 lists the MDC values for a gas proportional detector in terms of disintegrations per 100 cm^2 and pCi per 100 cm^2 based on background rates varying from 350 to 1000 counts per minute. Table 2 lists the corresponding MDC values for a PhoSwich scintillation detector.

3.1.2 Estimated Volumetric MDC

Assume the surface is contaminated to a depth in excess of the maximum range of a Y-90 beta particle in concrete (0.468 cm max range; RAD 1970) having a density of 2.35 g/cm^3. It is further assumed that 100% of the beta particles originating from a depth of less than 0.0468 cm (one-tenth of the maximum range of the Y-90 beta) below the concrete surface and that are emitted in the direction of the detector are detected. None of the beta particles emanating from a location deeper than 0.0468 cm from the surface of the concrete reach the detector. Assuming uniform distribution of any contamination in this thin slab of "near surface" concrete and adjusting for the density of concrete (2.35 g/cm^3) results in a total mass of contaminated concrete of:

$$100 \text{ cm}^2 \times 0.047 \text{ cm} \times 2.35 \text{ g/cm}^3 = 11 \text{ g}$$

A simplified estimate of the volumetric concentration activity MDA may be made by dividing the areal concentration MDA by this thin section of concrete representing one tenth of the maximum range of Y-90 beta particles in the concrete. Table 3 lists this estimate of volumetric concentration activity as a function of background and detector.

4.0 CONCLUSION

A gas proportional detector is expected to have a field MDC of 300 dpm/100 cm^2 at typical background levels as provided by the equipment manufacturer.

A beta scintillation detector is expected to have a field MDC of 418 dpm/100cm^2 at typical background levels as provided by the equipment manufacturer.

Field MDCs for Sr-90/Y-90 are expected to range from 300 to 750 dpm/100cm^2 depending upon the detector and background rates experienced in the field. The corresponding estimated field volumetric MDCs are expected to range from 11 to 31 pCi/g.

TABLE 1

MDC VERSUS BACKGROUND FOR GAS PROPORTIONAL DETECTOR

Efficiency Factor, C (DPM/Count)	Background, B (Counts)	MDC Result (DPM/100 cm^2)	MDC Result (pCi/100 cm^2)
3.33	350	300	135
3.33	400	320	144
3.33	500	356	160
3.33	600	389	175
3.33	700	420	189
3.33	800	448	202
3.33	900	475	214
3.33	1000	500	225

TABLE 2

MDC VERSUS BACKGROUND FOR BETA SCINTILLATION DETECTOR

Efficiency Factor, C (DPM/Count)	Background, B (Counts)	MDC Result (DPM/100 cm^2)	MDC Result (pCi/100 cm^2)
5	300	418	188
5	400	480	216
5	500	535	241
5	600	585	263
5	700	630	284
5	800	673	303
5	900	713	321
5	1000	750	338

TABLE 3

ESTIMATED VOLUMETRIC MDC VERSUS BACKGROUND FOR GAS PROPORTIONAL AND BETA SCINTILLATION DETECTORS

Background, B (Counts)	~Volumetric MDC Gas Proportional, pCi/g	~Volumetric MDC Beta Scintillation, pCi/g
300	11	17
350	12	18
400	13	20
500	15	22
600	16	24
700	17	26
800	18	28
900	19	29
1000	20	31

REFERENCES

NRC 1997a NUREG-1507 "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions", December 1997

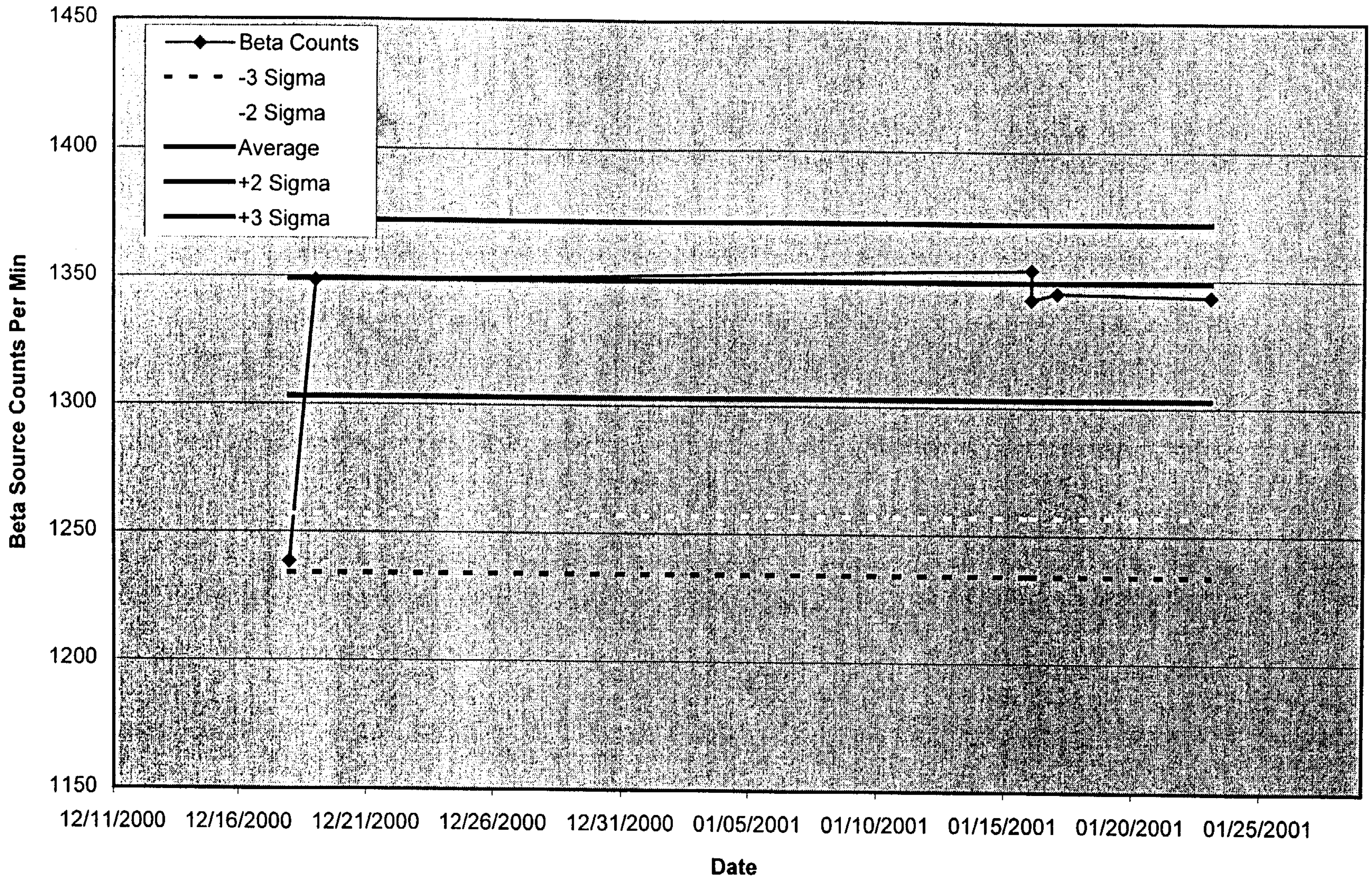
NRC 1997b NUREG-1575 "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)", December 1997

RAD 1970 Radiological Health Handbook, Revised Edition, January 1970

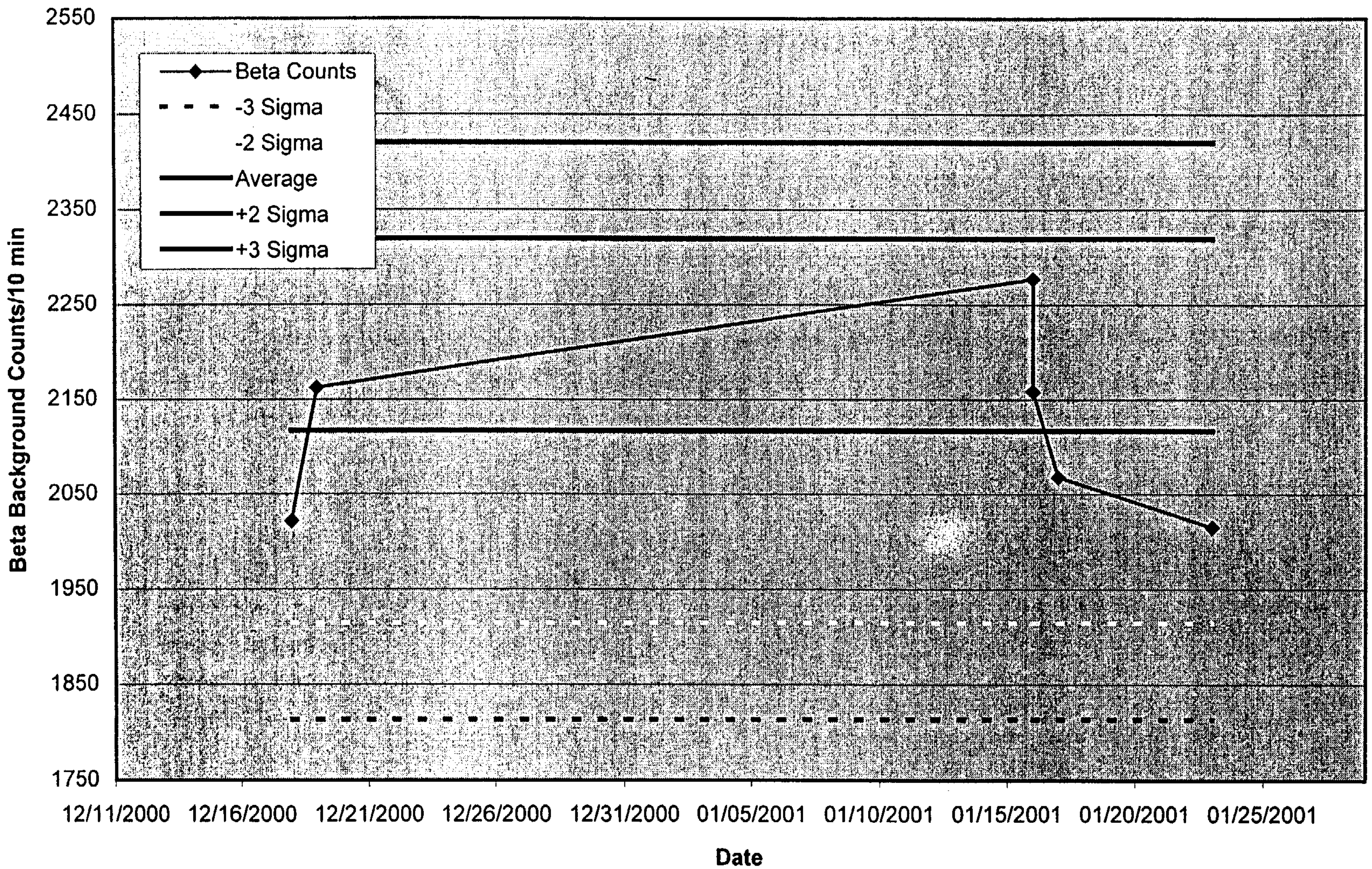
Appendix E:

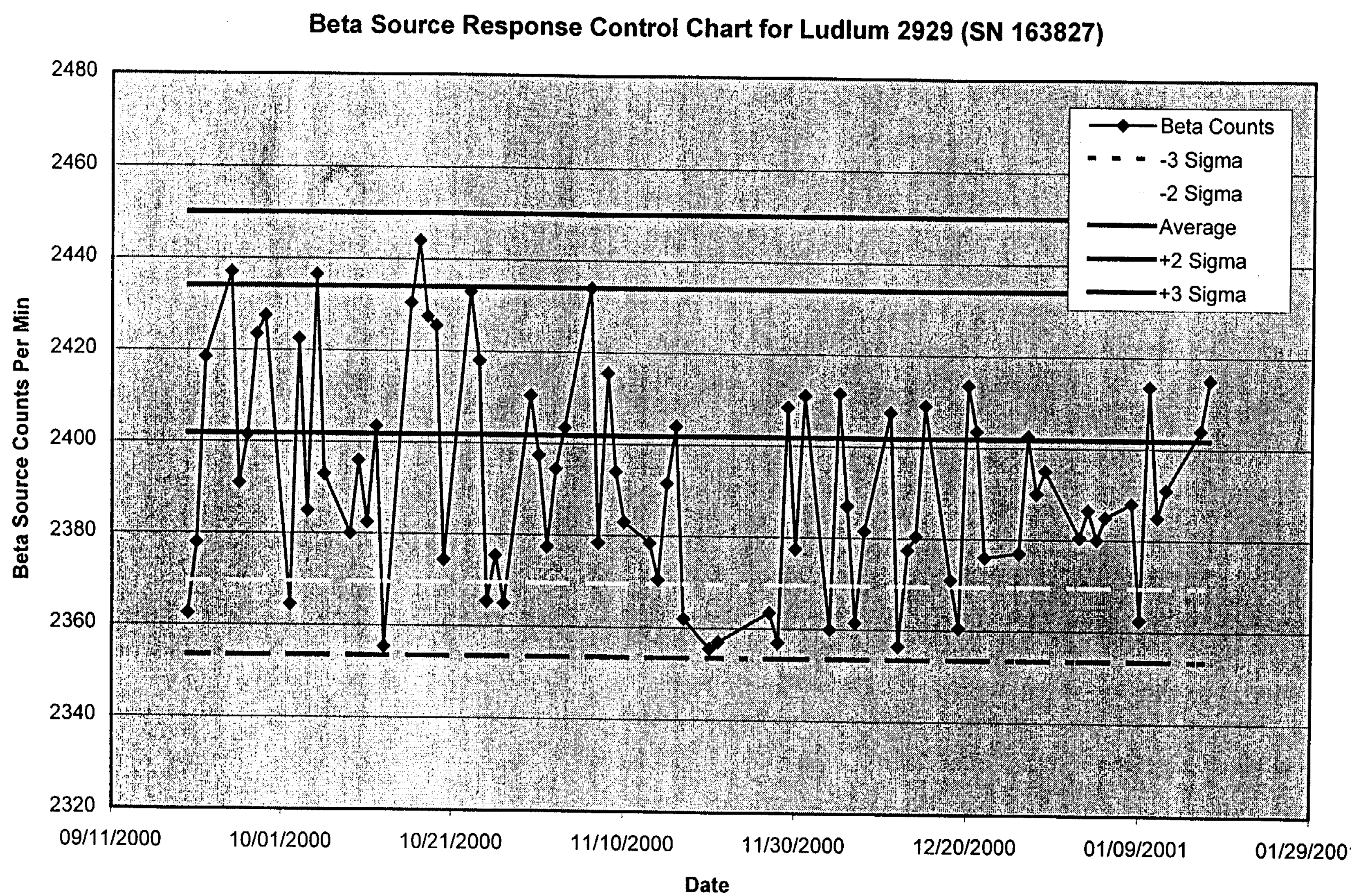
Instrumentation Quality Control Charts

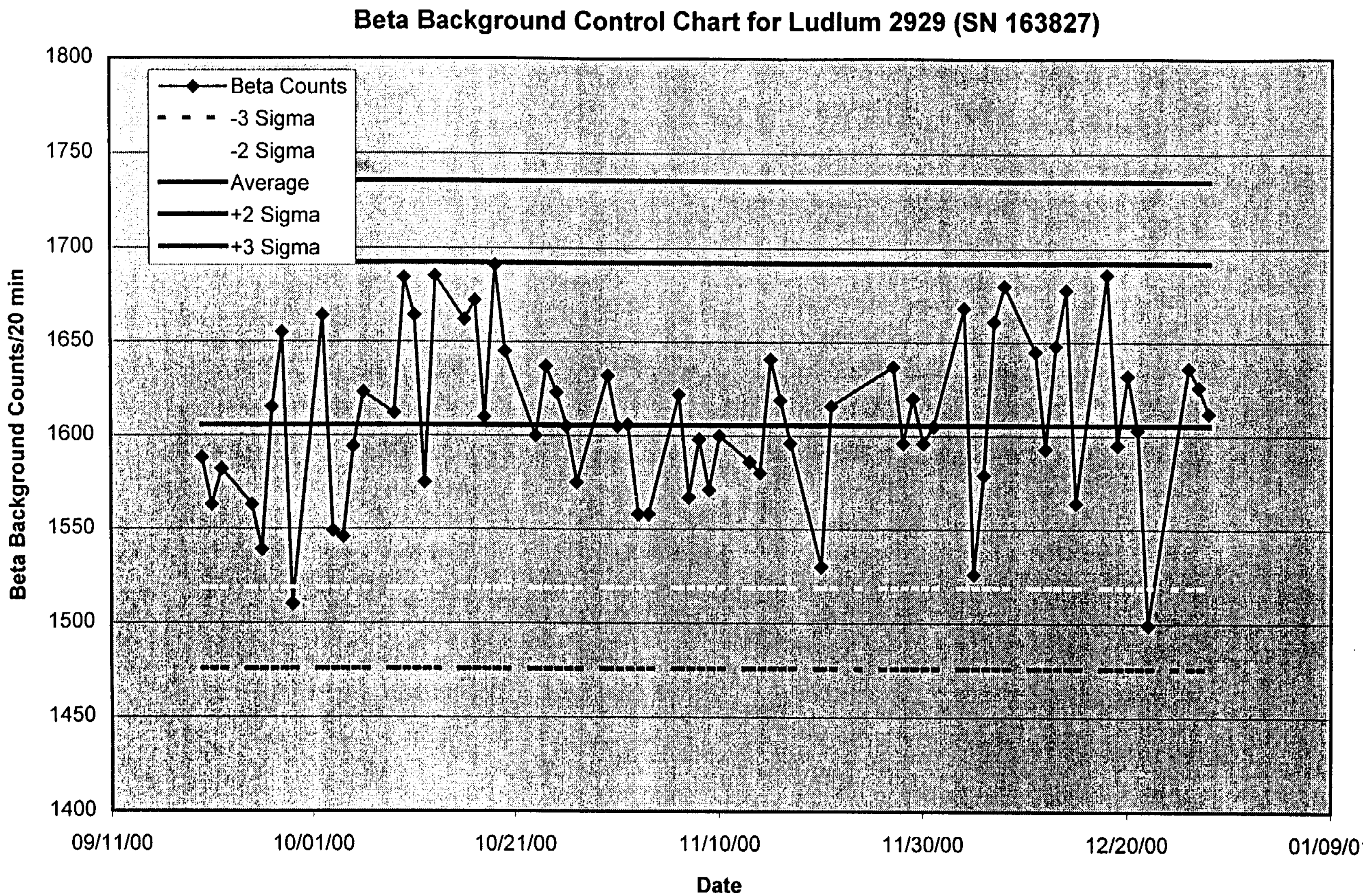
Beta Source Response Control Chart for Ludlum 2224 (SN162420)



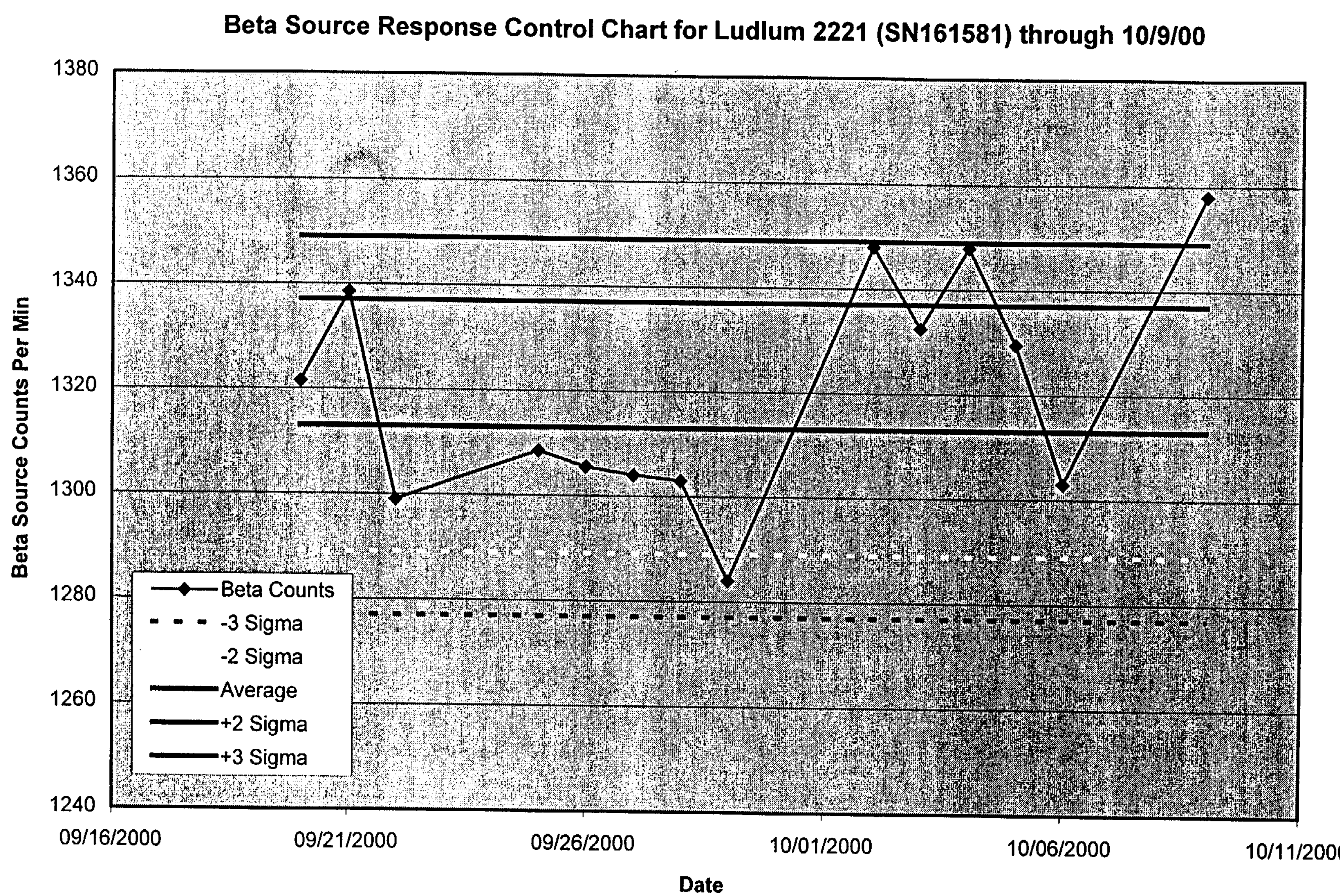
Beta Background Control Chart for Ludlum 2224 (SN162420)



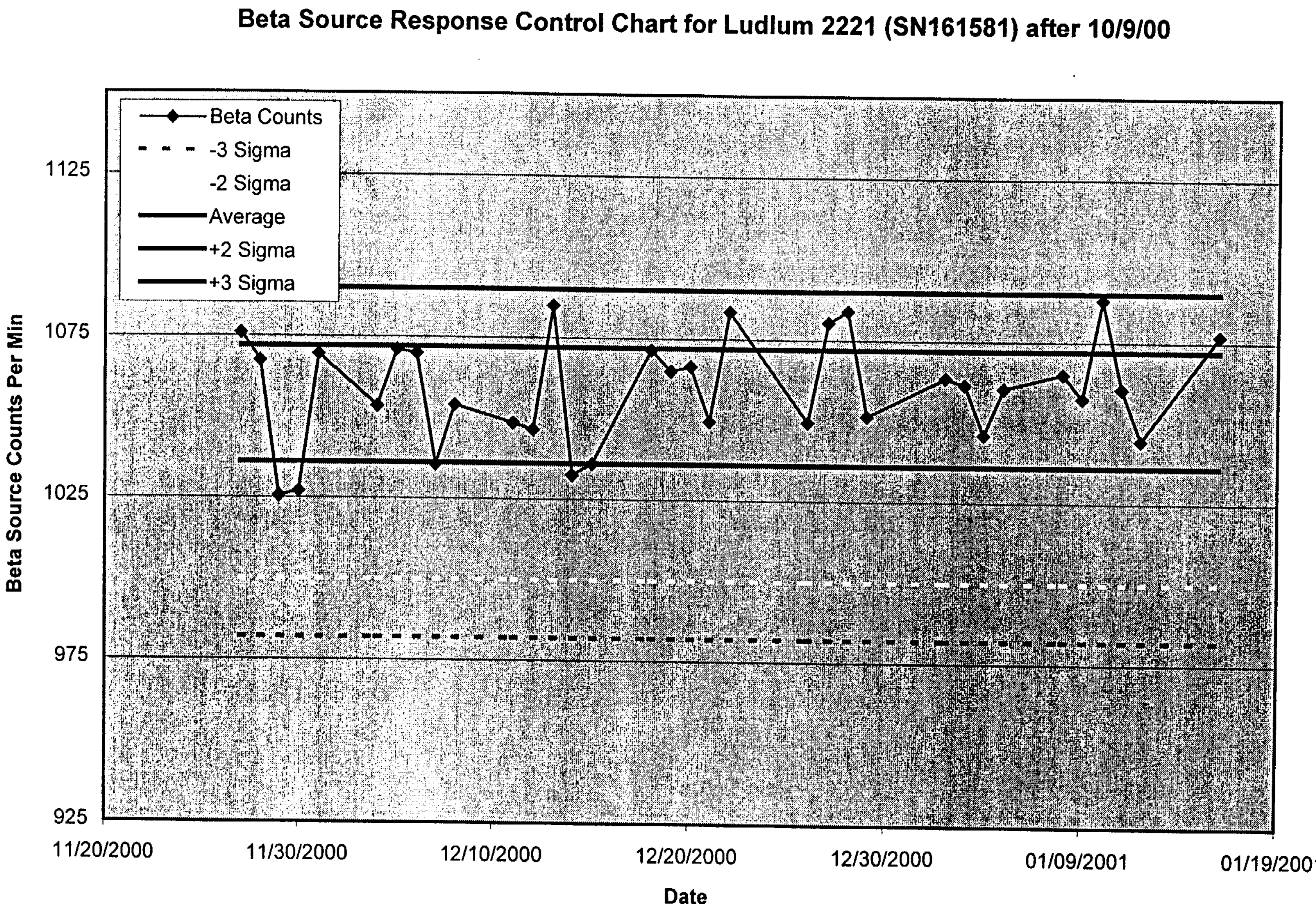

Beta Source Response Control Chart for Ludlum 2929 (SN 163827)
Beta Counts
-3 Sigma
-2 Sigma
Average
+2 Sigma
+3 Sigma
Beta Source Counts Per Min
2480
2460
2440
2420
2400
2380
2360
2340
2320
09/11/2000
10/01/2000
10/21/2000
11/10/2000
11/30/2000
12/20/2000
01/09/2001
01/29/2001
Date



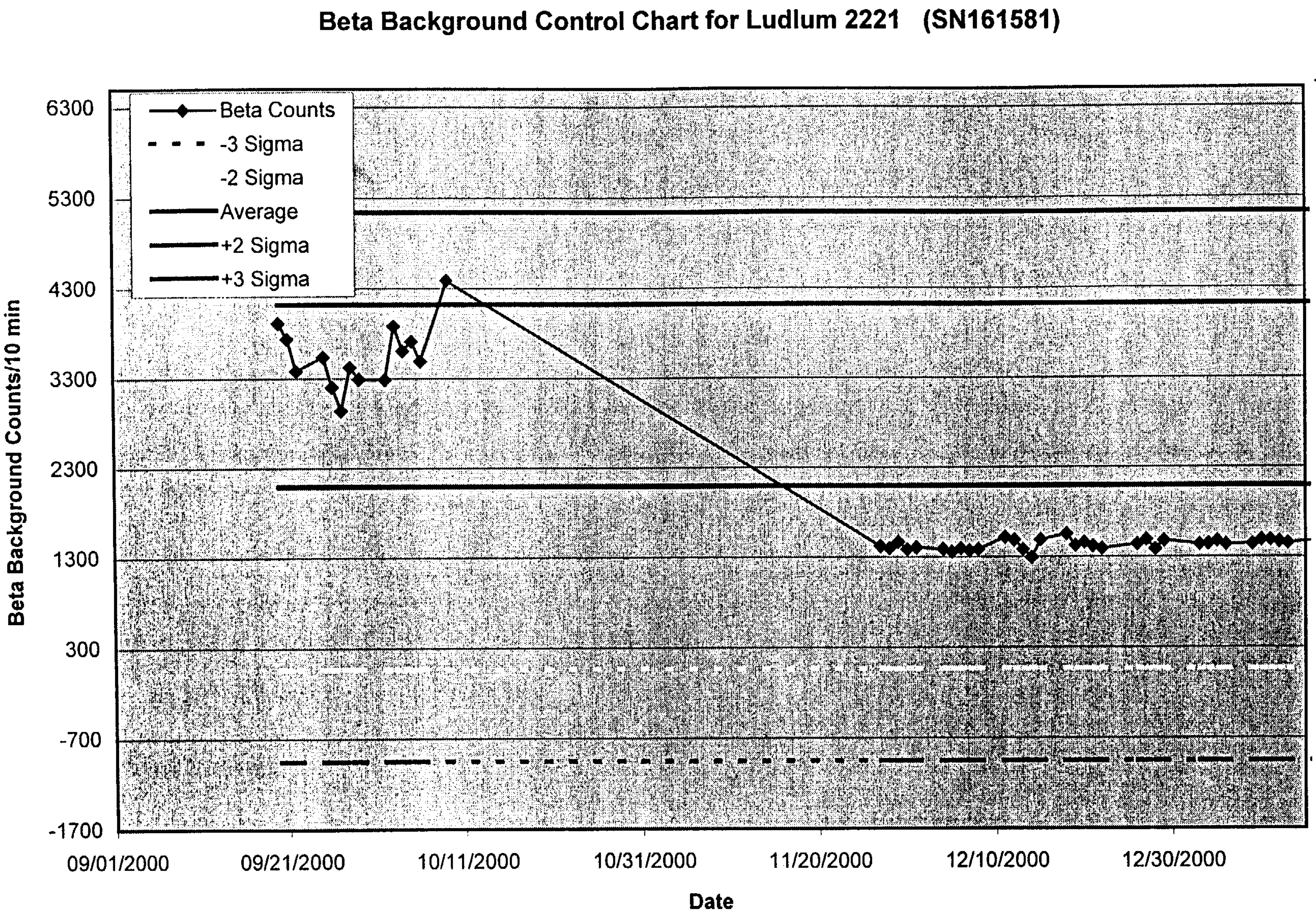
Beta Background Control Chart for Ludlum 2929 (SN 163827)
Beta Counts
-3 Sigma
-2 Sigma
Average
+2 Sigma
+3 Sigma
Beta Background Counts/20 min
1800
1750
1700
1650
1600
1550
1500
1450
1400
09/11/00
10/01/00
10/21/00
11/10/00
11/30/00
12/20/00
01/09/01
Date

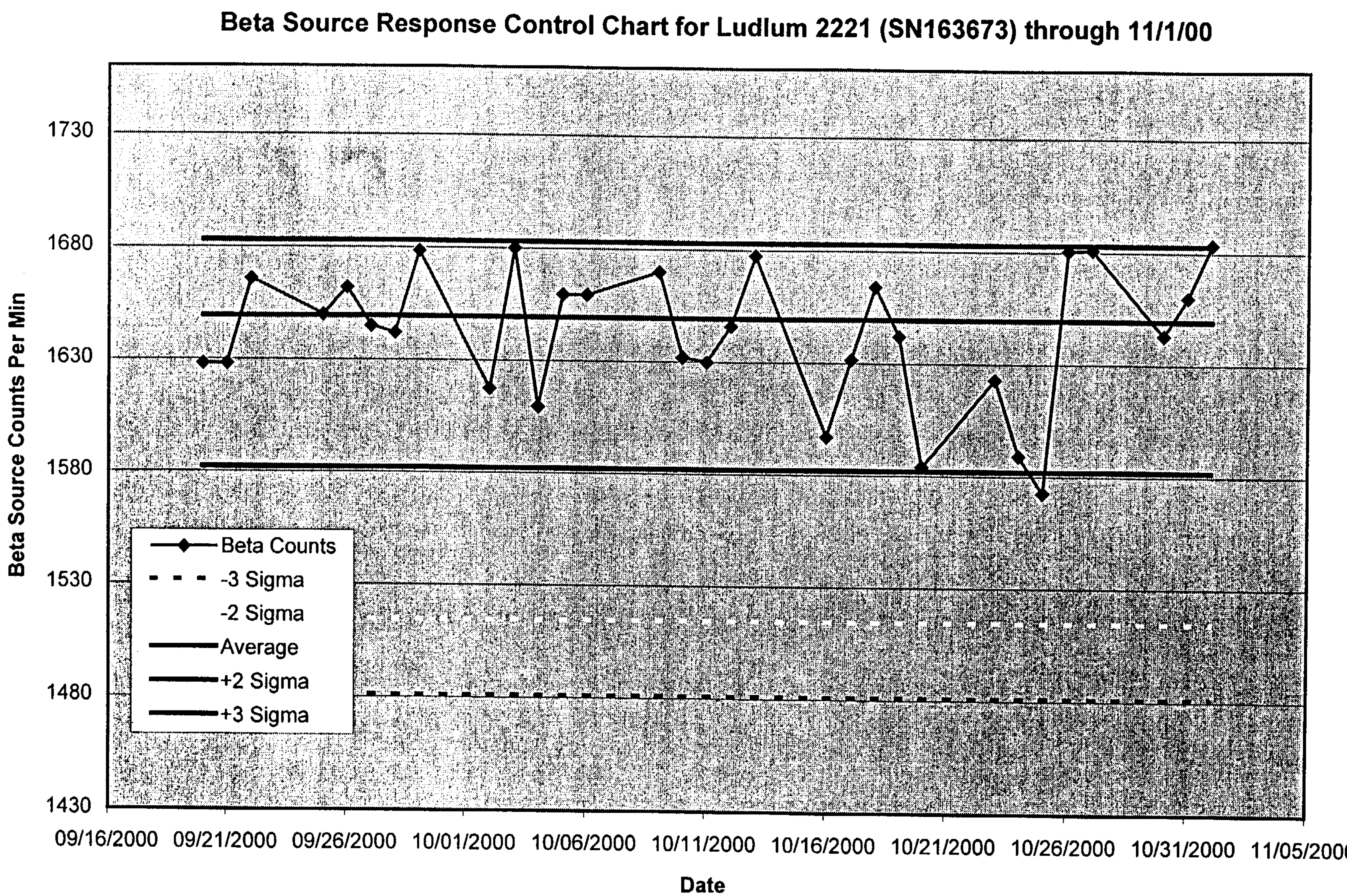


Beta Source Response Control Chart for Ludlum 2221 (SN161581) through 10/9/00
1380
1360
1340
1320
1300
1280
1260
1240
Beta Source Counts Per Min
Beta Counts
-3 Sigma
-2 Sigma
Average
+2 Sigma
+3 Sigma
09/16/2000
09/21/2000
09/26/2000
10/01/2000
10/06/2000
10/11/2000
Date



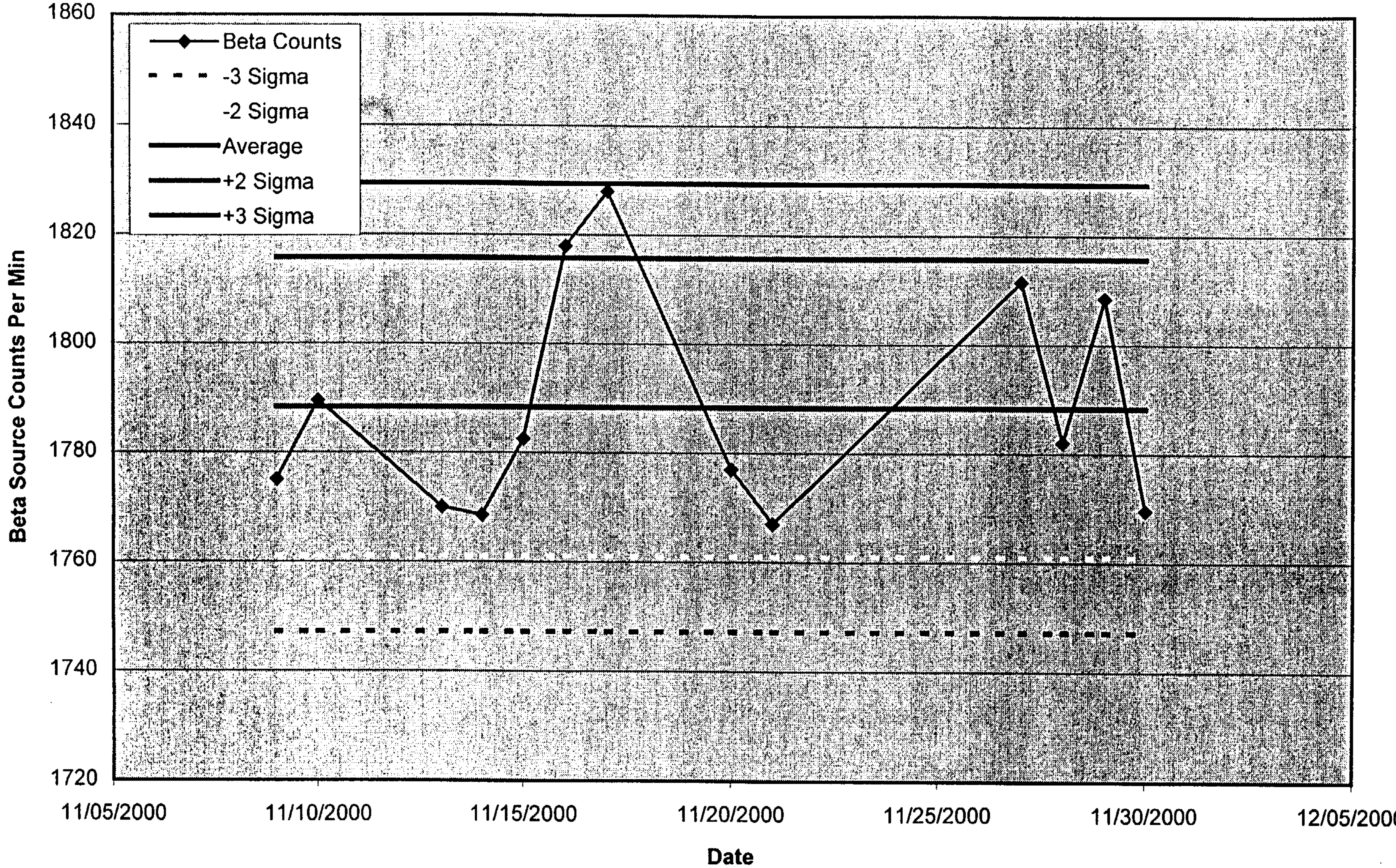
Beta Source Response Control Chart for Ludlum 2221 (SN161581) after 10/9/00
Beta Counts
-3 Sigma
-2 Sigma
Average
+2 Sigma
+3 Sigma
1125
1075
1025
975
925
Beta Source Counts Per Min
11/20/2000
11/30/2000
12/10/2000
12/20/2000
12/30/2000
01/09/2001
01/19/2001
Date


Beta Background Control Chart for Ludlum 2221 (SN161581)
Beta Counts
-3 Sigma
-2 Sigma
Average
+2 Sigma
+3 Sigma
Beta Background Counts/10 min
6300
5300
4300
3300
2300
1300
300
-700
-1700
09/01/2000
09/21/2000
10/11/2000
10/31/2000
11/20/2000
12/10/2000
12/30/2000
Date

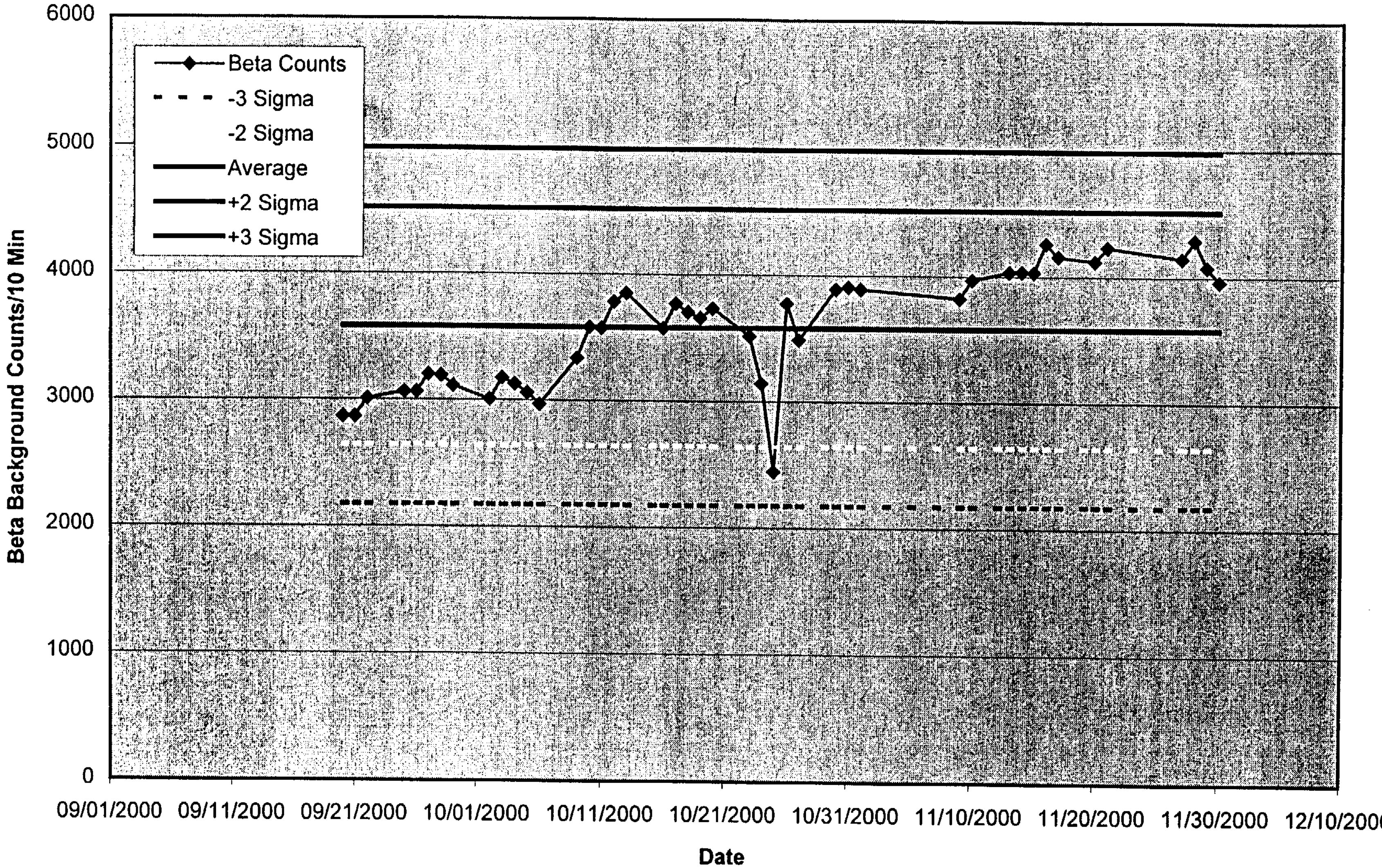


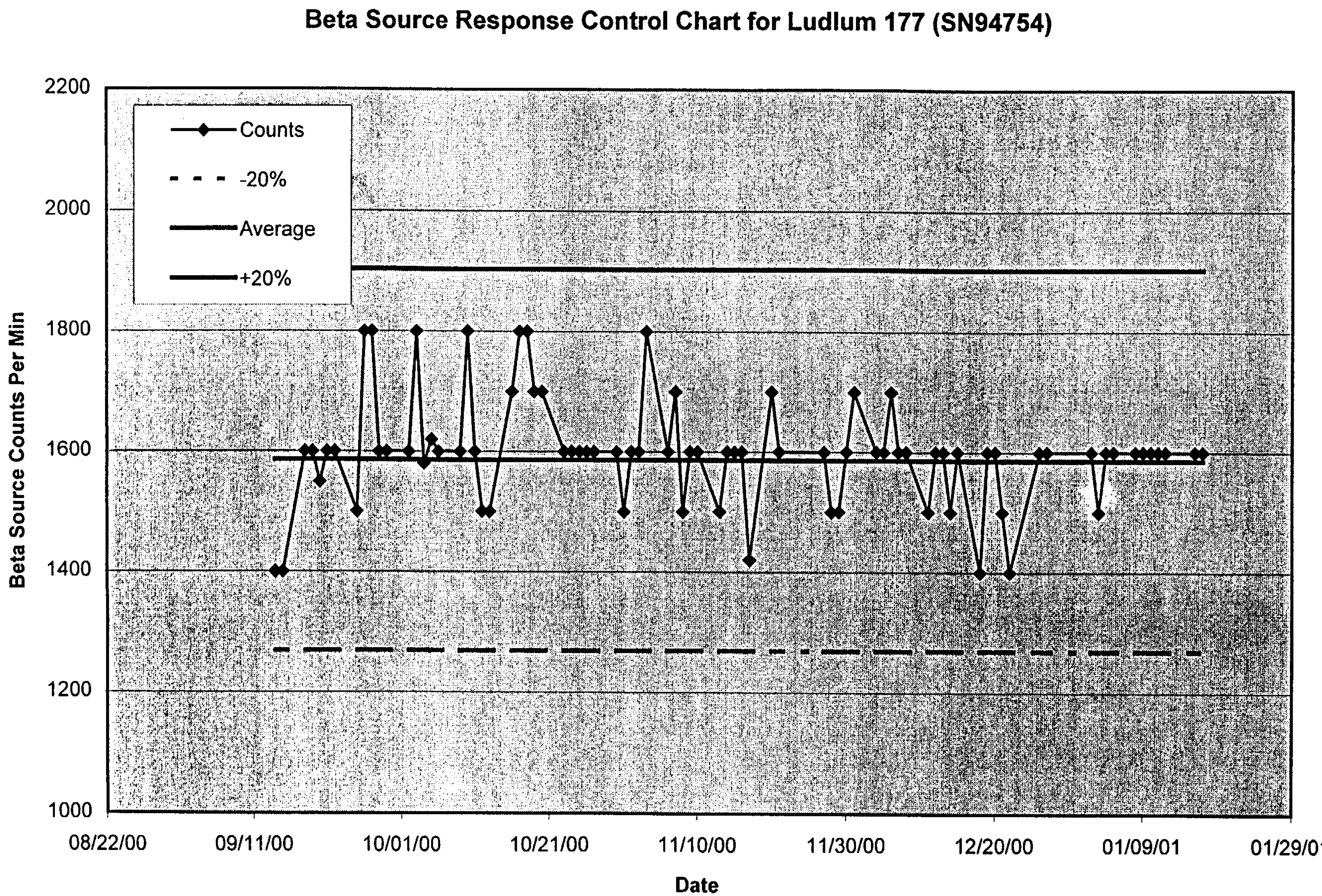
Beta Source Response Control Chart for Ludlum 2221 (SN163673) through 11/1/00
1730
1680
1630
1580
1530
1480
1430
Beta Source Counts Per Min
Beta Counts
-3 Sigma
-2 Sigma
Average
+2 Sigma
+3 Sigma
09/16/2000
09/21/2000
09/26/2000
10/01/2000
10/06/2000
10/11/2000
10/16/2000
10/21/2000
10/26/2000
10/31/2000
11/05/2000
Date

Beta Source Response Control Chart for Ludlum 2221 (SN163673) after 11/1/00

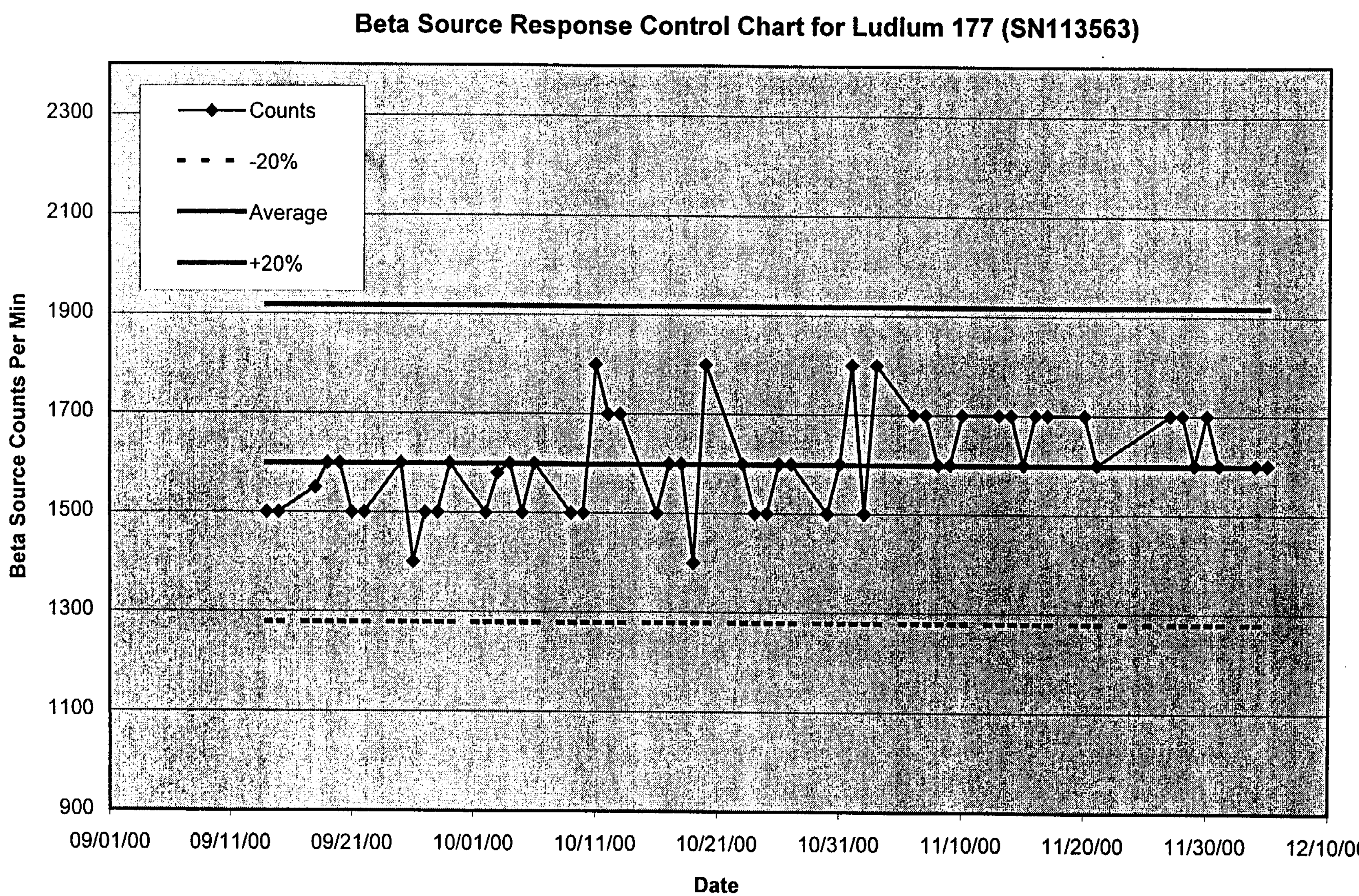


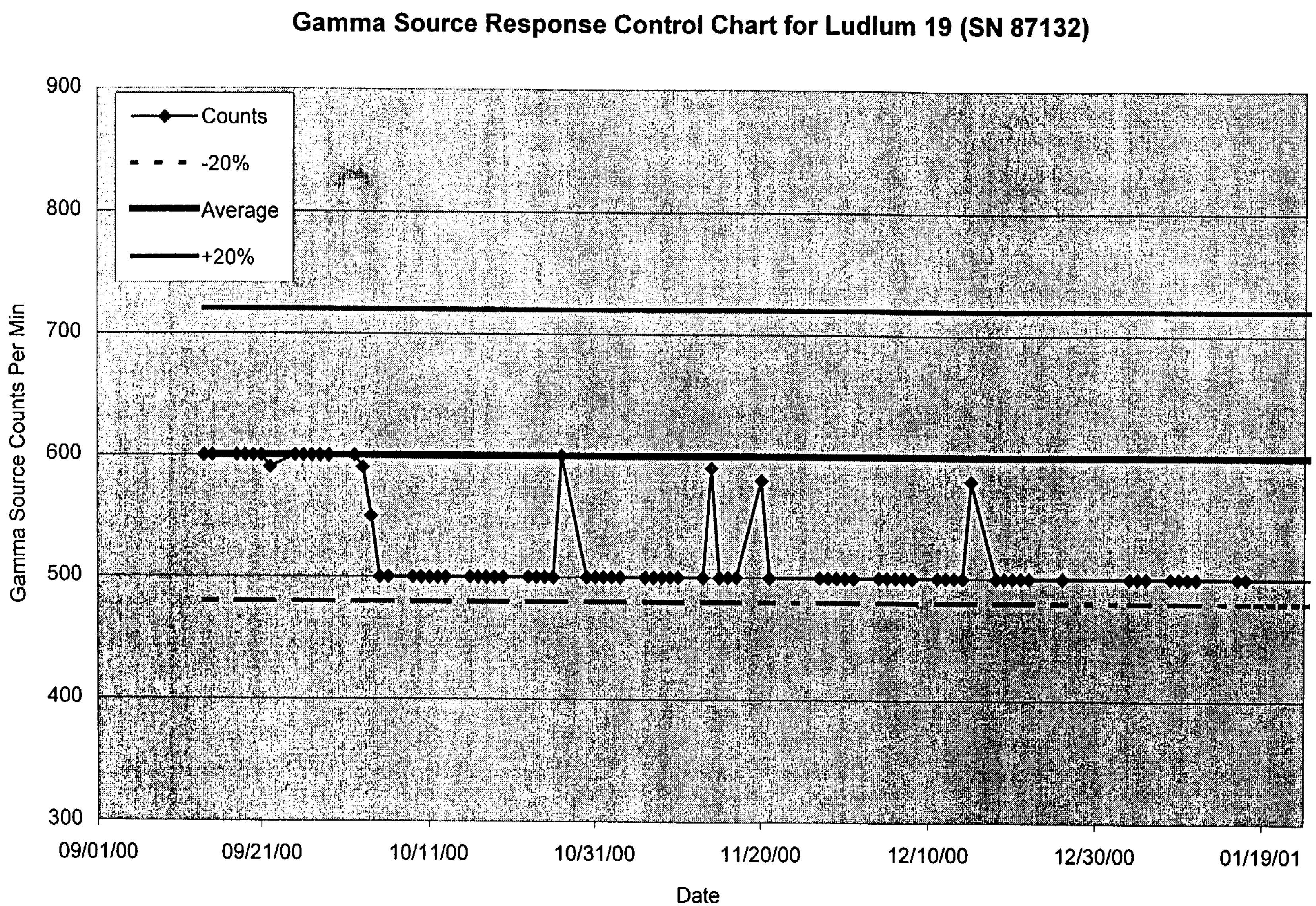
Beta Background Control Chart for Ludlum 2221 (SN163673)




Beta Source Response Control Chart for Ludlum 177 (SN94754)
Counts
-20%
Average
+20%
Beta Source Counts Per Min
2200
2000
1800
1600
1400
1200
1000
08/22/00
09/11/00
10/01/00
10/21/00
11/10/00
11/30/00
12/20/00
01/09/01
01/29/01
Date

Beta Source Response Contr(Chart for Ludlum 177 (SN113563)





Gamma Source Response Control Chart for Ludlum 19 (SN 87132)
Counts
-20%
Average
+20%
Gamma Source Counts Per Min
900
800
700
600
500
400
300
09/01/00
09/21/00
10/11/00
10/31/00
11/20/00
12/10/00
12/30/00
01/19/01
Date

Appendix F:

Operating Procedures

1.0 PURPOSE

This procedure provides the methods Cabrera Services, Inc. (CABRERA) uses in operation of air samplers and calculation of radioactive particulate activity in air sample. This procedure describes the methods used to calculate Derived Air Concentration (DAC) DAC-hour exposures to workers. Adherence to this procedure will provide reasonable assurance that the surveys performed have accurate and reproducible results.

2.0 APPLICABILITY

This procedure will be used by CABRERA personnel to operate air samplers during surveys and work activities at the St. Albans VAECC facilities, calculate, and record DAC-Hour exposures to workers. Air samples are performed when the average beta contamination on facility surfaces, equipment and waste packages exceed the contamination limits specified in Table 1 of the Radiation Protection Program (RPP) and included as Appendix A of the HASP. Air monitoring shall be performed in areas where there exists potential to exceed 10 percent of any DAC.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

Not Applicable

3.2 Limitations

Not Applicable

3.3 Requirements

3.3.1 Air samplers should only be operated in temperatures between -4^0 F to 122^0 F.

3.3.2 Air sampler inspections shall be performed by qualified Health Physics personnel.

4.0 REFERENCES

- HASP — Safety and Health Program (Radiation Safety Program)
- OP-001 — Radiological Surveys
- OP-021 — Alpha-Beta Sample Counting Instrumentation
- Reg Guide 8.25 — Air sampling in the Workplace
- NUREG-1556 — Consolidated Guidance About Material Licenses (Vol.11)

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Restricted Area – An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

5.2 Smear Sample Survey – A survey technique using filter paper smears to determine quantities of alpha and beta emitting radioactive material which can be removed from facility surfaces and waste packages.

5.3 Air Sample Survey – A survey technique which collects particulates from a known volume of air and determines the concentrations of radioactive materials associated with the airborne particulates.

5.4 Annual Limit on Intake (ALI) – The annual limit on intake (ALI) of radioactive materials is the smaller amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year (40 hours per week for 50 weeks) that would result in a committed effective dose equivalent (CEDE) of 5 rem or a committed dose equivalent (CDE) of 50 rems to any individual organ or tissue.

5.5 Derived Air Concentration (DAC) – Derived air concentration is the concentration of a given radionuclide in air which, if breathed by "reference man" for a working year (40 hours per week for 50 weeks) under the conditions of light work (inhalation rate of 1.2 cubic meters of air per hour), results in an air intake of one ALI.

5.6 DAC-Hour – The product of the concentration of radioactive material in air (expressed as a multiple of the derived air concentration for each nuclide) and the time of exposure to that nuclide, in hours, 2000 DAC-Hours represents one ALI.

5.7 Airborne Radioactivity Area – A room, enclosure or area in which the radioactive material is dispersed in the form of dusts, fumes, mists, particulates, vapors and the concentration of the dispersed radioactive materials in excess of:

5.7.1 The derived air concentrations (DAC's) specified in Table 1, column 3 of Appendix B, Title 10 Part 20 of the Code of Federal Regulations, or

5.7.2 Concentrations such that an individual present in the area without respiratory protective equipment could exceed, during the hours the individual is present in a week, an intake of 0.6 percent on the annual limit on intake (ALI) or 12 DAC-hrs.

5.8 Effluent Monitoring – A process, by which discharge of effluents to the environment of isotopes listed in, CFR Title 10 Part 20 Appendix B Table 2 column 1, is measured.

5.8.1 The limit for Sr-90 is 6E-12 uCi/cc

5.8.2 Monitoring of effluent discharge must be continuous during operation of the system

6.0 EQUIPMENT

6.1 Air sampling equipment will be selected for the type of analysis specified in the HASP. All samplers will be properly calibrated and the calibrations current.

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – the PM is responsible for ensuring that personnel assigned the task of air sampling and air sampling analysis are familiar with this procedure, adequately trained with the specific instrument being used to perform surveys.

7.2 Radiation Safety Officer (RSO) – The RSO is responsible for monitoring compliance with this procedure and training personnel in the use of the air sampling and air sampling analysis. The RSO can also assist in the interpretation of the results obtained during surveys.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT performing air sampling and air sampling analysis are responsible for knowing and complying with this procedure.

8.0 INSTRUCTIONS

8.1 Initial Preparation

8.1.1 Select the air sampler to be used for the type of sample to be used and verify that the instrument has a currently valid calibration. If the work area contains radioiodine or tritium, contact the radiation safety officer for special sampling procedures before proceeding.

8.1.1.1 Area air samples are normally collected with a low volume air sampler having normal airflow of 1 CFM to 5 CFM.

8.1.1.2 Breathing zone air samples are normally collected using lapel air samplers, which have a normal airflow of 1 to 5 liters per minute.

8.1.1.3 Effluent samples are normally collected using in-line isokinetic sampling systems that match duct airflow speed with sample line speed.

8.1.1.4 All air sampling devices shall be calibrated to ensure accurate sample volumes are collected. The frequency of calibration shall not exceed one (1) year.

8.1.2 Attach the air sampling head to the intake of the low volume sample pump, to the tygon tubing of the Lapel sampler, or to the sampling system of the effluent discharge system.

8.1.3 Obtain the filter paper to be used in the sample and mark the backside of the filter with a unique number, which will represent the sample. During the collection and handling of air sample filter papers, caution must be used to prevent the samples from being contaminated by other radioactive materials.

8.1.4 Place the filter paper in the holder and position the sampler as indicated below.

8.1.4.1 Area air samples are collected by placing the sample head at a distance of 3 to 6 feet above the floor and as close to the work area as practical. If there is airflow in the work area, the sampler should be placed "down wind" of the area where workers will be resuspending radioactive particulates into the workers atmosphere.

8.1.4.2 Lapel air samples are collected from workers breathing zone. The sample head is attached to the shoulder of the worker with the sample head facing forward. The tygon tubing connecting the sample head to the pump is run down the back of the worker with the sample pump attached to the workers belt.

8.1.4.3 Inline air samples are collected from exhaust system/vent systems. The sample head is placed between the sample probe and the sample pump in a smooth path without obstruction. Airflow should be matched to the flow in the system being sampled.

8.2 Collecting the sample

8.2.1 When the sample head is in position, start the sample pump and adjust the flow rate to the highest flow rate, which can be maintained without flow rate fluctuations or, in the case of effluent sampling, adjust to that specified by special instructions.

8.2.2 Record the time the sample was started and the initial flow rate of the sample pump on Form OP-002-01, Air Sample Data Sheet. Record the following effluent sampling data: System description, Flow rate in LPM, Time and date start on Form OP-002-04

8.2.3 If possible, identify the radionuclides, which will be encountered in the work area and record the radionuclides along with the DAC for each radionuclide in the space provided on the Air Sample Data sheet. If a mixture of radionuclides is present, the DAC used in the calculations of DAC-Hours will be the most restrictive concentration.

8.2.4 Collect the sample for the maximum time possible, which represents the exposure encountered by the worker.

8.2.5 At the end of the collection period, note the flow rate of the sample pump and record this flow rate and the time, which the sampling stopped on the Air Sample Data sheet.

8.2.6 Effluent sampling must be in progress any time the system is operating. Any time a sampler is found to be non-operational during system operation contact the RSO or duly authorized representative. Record the time the sample system was stopped and calculate the total volume of air sampled on the Air Sample Data Sheet.

CAUTION: Be sure not to remove activity from the sample surface. Handle the filter with care.

8.2.7 Remove the sample filter and place the filter in an individual envelope or poly bag to ensure no possibility of contamination by other sources of radioactivity.

8.2.8 Record the names of workers who were in the area and the time spent in the work area on the Air Sample Data sheet.

8.2.9 Determine the average sample flow rate by adding the initial sample flow rate and the final sample flow rate and dividing by 2. Record the average flow sample flow rate in the space provided on the Air Sample Data sheet.

8.2.10 Calculate the total air volume sampled by multiplying the average flow rate in cubic centimeters per minute by the total minutes the sampler operated using the indicated spaces on the Air Sample Data sheet.

8.3 Determining minimum detectable activity (MDA) – During calculations or air concentrations in the following sections, the MDA for each analysis is calculated to determine the statistical significance of the calculated air concentrations.

8.3.1 For each air concentration calculation (alpha and beta) in the following sections, calculate the MDA using the following formula:

$$MDA\ in\ \mu Ci/cm^3 = \frac{\frac{k_\alpha^2}{T_{s+b}} + 2\left[k_\alpha\right]\sqrt{\frac{R_b}{T_b} + \frac{R_b}{T_{s+b}}}}{(2.22\times 10^6)(E)(V)}$$

Where:

E = Counter efficiency in CPM/DPM

R_b = Background Count Rate in CPM

T_b = Background Counting Time in Minutes

T_{s+b} = Sample Counting Time in Minutes

V = Sample Volume in cm^3

$2.22X10^6$ = Disintergrations per minute per microCurie (DPM/uCi)

k_α = 1.645 for a confidence level of 95% and 1.96 for a confidence level of 99%

8.3.2 If the MDA is larger than 10% of the Derived Air Concentration, recount the background for a longer time and/or increase the sample count time to lower the MDA. (The maximum count time should not exceed 1 hour for background and 30 minutes for the sample). Enter the MDA for each air concentration calculated in the space provided on the Air Sample Data sheet.

8.3.3 When calculating MDA for Effluent air analyses use a minimum of four (4) hours. MDA must be less than the limit listed in 10 CFR 20 Appendix B Table 2 Column 1 (insoluble). If this value (6E-12 for Sr-

90) is exceeded contact the RSO or duly appointed representative.

8.4 Initial Air Sample Analysis – The initial analysis of air sample provides the air concentrations for short-lived radionuclides and a first estimate of the long-lived air concentrations. In situations where there is a potential for worker intakes to exceed 40 DAC-Hours in a week or if the radionuclides of interest are short-lived, air samples should be available before work resumes the following day.

8.4.1 Air particulate samples are to be analyzed as a minimum for gross alpha and gross beta activity using a Ludlum Model 2929 Dual Channel Scaler or equivalent.

8.4.2 Place the air sample collection media in the sample counter with the upstream collection side toward the detector. Count the air sample and calculate the sample activity and record results on appropriate form(s).

8.4.3 Record the alpha and beta sample DPM results in the Air Sample Data sheet.

8.4.4 Calculate the alpha and beta air concentrations using the following formula. Adjustment due to alpha self absorption are made as appropriate.

$$\text{Air Concentration } (\mu Ci / cc) = \frac{\alpha \; or \; \beta \; DPM}{(2.22 \times 10^{6} \; DPM / \mu Ci)(Sample Volume(cm^{3}))}$$

8.4.5 Enter the alpha and beta air concentrations on the Air Sample Data sheet in the space provided for the initial air concentrations.

NOTE: If the air sample concentration is greater than 10% of the DAC value, notify the RSO or duly authorized representative for further instructions.

8.4.6 If the air concentration is less than 10 percent of the most restrictive DAC, no further analysis of the air sample is required. If the air concentration exceeds 10% of the DAC concentration, proceed with the analysis in section 8.5.

8.5 Air sample analysis for long-lived radionuclides – This analysis allows for decay of naturally occurring radionuclides and provides for correcting air concentrations for naturally occurring radionuclides.

8.5.1 Air particulate samples are analyzed following 12 hour decay, and again at 72 hours if necessary to allow for decay of radon, for gross alpha and gross beta using a Ludlum Model 2929 Dual Channel Scaler or equivalent.

8.5.2 Place the air sample in the sample counter with the collection side toward the detector. Count the air sample and calculate the sample activity and record results on appropriate form(s).

8.5.3 Record the alpha and beta sample DPM results in the Air Sample Data sheet.

8.5.4 Calculate the alpha and beta air concentrations using the following formula. Adjustments due to self absorption are made as appropriate.

$$\text{Air Concentration } (\mu Ci/cc) = \frac{\alpha \text{ or } \beta\ DPM}{(2.22\times10^{6}\ DPM/\mu Ci)(Sample\,Volume(cm^{3}))}$$

8.5.5 Enter the alpha and beta air concentrations on the Air Sample Data sheet in the space provided for the 12-hour decay concentrations. If the 12-hour decay air concentrations is below 10% of the DAC no further analysis is required.

8.5.6 If the 12-hour air concentration is above 10% percent of the DAC value, recount the air sample following 72 hours of decay from the time the sample was stopped. Calculate the air concentration using the formula in step 8.5.4 and record the air concentrations in the space provided for the 72-hour decay air concentration on the Air Sample Data sheet. If the 72-hour air concentration is below 10% of the DAC value, no further analysis is required.

8.5.7 If the air concentrations exceed 10% of the DAC values, notify the RSO or duly authorized representative for further instructions. Save the air sample for possible further analysis. For air samples, which exceed 10% of the DAC values, an exposure is assigned to the workers residing in the area where the sample was taken.

8.6 Assignment of DAC-Hour exposures to workers

8.6.1 For air samples which exceed 10% of the DAC values, calculate the workers DAC-Hour exposure using the following formula:

$$\text{Exposure in DAC-Hours} = \frac{A \times B}{C}$$

Where:

A = Area or Lapel air sample concentration in uCi/cm^3

B = Hours worker was in the calculated air concentration

C = DAC air concentration in uCi/cm^3 from regulatory reference.

8.6.2 Enter the DAC-Hour exposure on the column provided on the Air Sample Data sheet. If respiratory protection was used during the exposure period, contact the RSO or duly authorized representative for the protection factor used to adjust DAC-Hour exposure.

8.7 Effluent Air Discharge Calculation

8.7.1 Calculate the discharge concentration using the following formula:

$$\text{Air Concentraion}(\mu Ci/cc) = \frac{DPM}{(2.22 \times 10^6\ DPM/\mu Ci)(Sample\ Volme(cm^3))}$$

Record the value on the Data sheet and inform the RSO or his duly authorized representative if the value exceeds, either the value listed in 10 CFR 20 Appendix B Table 2 Column 1. (This value is 6E-12 for Sr-90), Or greater than the MDA for the measurement.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 The alpha and beta counter used to count air samples will be calibrated daily when in with a known radioactive source with activity traceable to the National Institute of Standards and Technology (NIST).

9.2 Records

9.2.1 Documented information shall be legibly written in ink.

9.2.2 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.3 The health physics technician performing air sampling and analysis shall ensure that this procedure is the most current and approved revision.

9.2.4 The health physics technician performing air sampling and analysis shall review all applicable forms for accuracy and completeness.

9.2.5 Entries on and any other pertinent forms must be dated and initialed by the health physics technician performing the air sampling and analysis to be valid.

9.2.6 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

OP-002-01	Air Sample Data Sheet
OP-002-02	Daily Air Sample Record
OP-002-03	Contamination Limits
OP-002-04	Effluent Air Sample Data Sheet

OP-002-01
Air Sample Data Sheet

Sample # ____________________ Date ____________________

Description: ____

Radionuclides: ____________________ DAC value: ________________________

____________________ DAC value: ________________________

____________________ DAC value: ________________________

Initial sample flow rate: ____________ Time sampler on: ____________________

Final sample flow rate: ____________ Time sampler off: ____________________

Average sample flow rate: __________ Total sample time:________________ hours

Total sample volume: ______________ cm^3

Initial Air Concentration:

Alpha = ____________ $\mu Ci\ \alpha/cm^3$ Beta = ___________ $\mu Ci\ \beta/cm^3$

MDA = ____________ $\mu Ci\ \alpha/cm^3$ MDA = ___________ $\mu Ci\ \beta/cm^3$

12 Hour Decay Air Concentration:

Alpha = ____________ $\mu Ci\ \alpha/cm^3$ Beta = ___________ $\mu Ci\ \beta/cm^3$

MDA = ____________ $\mu Ci\ \alpha/cm^3$ MDA = ___________ $\mu Ci\ \beta/cm^3$

72 Hour Decay Concentration:

Alpha = ____________ $\mu Ci\ \alpha/cm^3$ Beta = ___________ $\mu Ci\ \beta/cm^3$

MDA = ____________ $\mu Ci\ \alpha/cm^3$ MDA = ___________ $\mu Ci\ \beta/cm^3$

Performed By: ____________________________ Date: __________________________

OP-002-02
Daily Air Sample Record

Worker Name	Sample Date	Final Count Date	Time In	Time out	Total time (Hrs.)	Concentration (uCi/cm^3)	DAC-Hour Exposure

OP-002-03

Contamination Limits from Table 1 of RPM

RADIONUCLIDE	ALLOWABLE SURFACE CONTAMINATION (DPM/100 CM^2)	
	REMOVABLE	FIXED + REMOVABLE
Transuranics, Ra-226, Ra-228, Th-230, Pa-231, Ac-227, I-125, I-129	20	100
Th-Natural, Th-232, Sr-90, Ra-223 Ra-224, U-232, I-126, I-131, I-133	200	1000
U-Natural, U-235, U-238, and associated Decay products	1000	5000
Beta-Gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	1000	5000

OP-002-04

Effluent Air Sample Data Sheet

Sample # ____________________ Date ____________________

Description: ____

Radionuclides: ____________________ Effluent Air Limit: ____________________

Radionuclides: ____________________ Effluent Air Limit: ____________________

Sample flow rate: ____________ Time sampler on: ____________________

Sample flow rate: ____________ Time sampler off: ____________________

Total sample time: ______________ hours

Sample Flow Rate in Liters/min X time in minutes = Total sample volume: ____________ Liters X 1000 = ________ cm^3

Air Concentration:

$$\text{Air Concentraion}(\mu Ci/cc) = \frac{DPM}{(2.22\times10^{6}\ DPM/\mu Ci)(Sample\,Volme(cm^{3}))}$$

Activity = ____________ $\mu Ci\ \beta/cm^3$

MDA = ____________ $\mu Ci\ \beta/cm^3$

1.0 PURPOSE

This procedure describes the circumstances when a Radiation Work Permit (RWP) is required on Cabrera Services Inc. (CABRERA) Projects and addresses the requirements for planning, developing, issuing, using, modifying and terminating RWP's. The RWP provides a complete document addressing existing radiological conditions, work scope, radiological limitations, specific protective requirements, ALARA considerations and instructions to radiation workers. Adherence to this procedure will provide reasonable assurance that personnel exposures will be below specified limits, personnel will remain free of contamination and radioactive material contamination will not be spread beyond the designated contamination area location.

2.0 APPLICABILITY

This procedure will be used at the discretion of the Health Physics Technician or Project Manager to initiate an RWP prior to jobs where CABRERA personnel enter areas where; contamination is present above the limits specified in the Radiation Safety Program (RSP), when radiation exposure rates classify the work area as a radiation area, when air concentrations could exceed 10% of the Derived Air Concentration (DAC). This procedure describes the radiological surveys required to generate an RWP and provides guidelines to specific protective measures required based upon the radiological conditions in the work area.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

3.1.1 No work shall be performed involving radioactive material without initiation of an RWP unless otherwise directed by the RSO or duly authorized representative.

3.2 Limitations

Not Applicable

3.3 Requirements

3.3.1 All work activities performed under this procedure shall be in accordance with Specific Project Health and Safety Plan (HASP) and its RSP.

3.3.2 The RWP requirements may be upgraded by the RSO or duly authorized representative. RWP requirements may not be downgraded except as described in paragraph 8.3.

3.3.3 Whenever practical, airborne radioactivity shall be controlled by the use of engineering controls. Engineering controls include, but are not limited to, decontamination, HEPA vacuums, ventilation, and containment.

3.3.4 A control point shall be set up at the discretion of the RSO or duly authorized representative at the location of entrance/exit to a contaminated area. At this control point, anyone exiting the contaminated area shall frisk all materials, including hands and feet, and notify the HPT if activities are above the levels presented in Table I of the Radiation Safety Program.

4.0 REFERENCES

- HASP Safety and Health Program (Radiation Safety Program)
- OP-001 Radiological Surveys
- OP-002 Air Sampling and Analysis
- OP-019 Radiological Posting
- OP-020 Operation of Contamination Survey Meters
- OP-021 Alpha-Beta Counting Instrumentation
- OP-022 Operation of Ionization Chambers
- OP-023 Operation of Micro-R Meters

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Airborne Radioactivity Area – A room, enclosure or area in which radioactive material is dispersed in the air in the form of dusts, fumes, particulates, mists, vapors, or gases and the concentration of the dispersed radioactive material is in excess of:

5.1.1 The derived air concentrations (DAC's) specified in Table 1, column 3 of Appendix B, Title 10 Part 20 of the Code of Federal Regulations.

5.1.2 Concentrations such that an individual present in the area without respiratory protective equipment could exceed, during the hours the individual is present in a week, an intake of 0.6% of the annual limit on intake (ALI) or 12 DAC-hours.

5.2 Contaminated Area –A restricted area that has radioactive materials above the limits specified in the Final Decommissioning Plan in the form of dusts, particulates, and sorbed contaminants that could adhere to personnel clothing and skin while working in the area.

5.3 Radiation Area – Any area accessible to personnel in which there exists ionizing radiation at dose rates such that an individual could receive a deep dose equivalent in excess of 5 millirems in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

5.4 Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.

5.5 Personnel Survey – A survey with radiation detection instrumentation that measures the amount of radioactive materials on personnel clothing or skin surfaces.

5.6 Lens Dose Equivalent (LDE) – Exposure to the lens of the eye taken as the dose equivalent at a tissue depth of 0.3 centimeters.

5.7 Shallow Dose Equivalent (SDE) – External exposure of the skin or extremity taken at a tissue depth of 0.007 cm and averaged over an area of 1 cm^2.

5.8 Total Effective Dose Equivalent (TEDE) – TEDE is the sum of the deep dose equivalent (external dose) and the committed effective dose equivalent (internal dose).

5.9 Total Organ Dose Equivalent (TODE) – TODE is the sum of the external component (deep dose equivalent) and the internal component (committed dose equivalent to an organ or tissue).

6.0 EQUIPMENT

None Required

7.0 RESPONSIBILITES

7.1 Project Manager (PM) - The PM is responsible for ensuring that all necessary personnel are familiar with this procedure, adequately trained in the used of the procedure, and have access to a copy of this procedure.

7.2 Radiation Safety Officer (RSO) - The RSO is responsible for monitoring compliance with this procedure and training of personnel working with this procedure. The RSO ensures the HPT are qualified by training and experience to perform the requirements of this procedure. The RSO is responsible for issue, control, and termination of RWP's.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT are responsible for performing the necessary surveys in support of RWP's, and job coverage of RWP's. The HPT has the responsibility to stop work if any unsafe condition exists in the work area, non-compliance with procedural requirements occurs, or significant changes in radiological conditions occur.

7.5 Radiation Workers – Radiation Workers are responsible to read, understand, sign, and comply with the provisions of the RWP.

8.0 INSTRUCTIONS

8.1 Conditions Requiring an RWP

8.1.1 Work involving radioactive material shall require a RWP unless otherwise directed by the RSO or duly authorized representative.

8.1.2 Listed below are examples of jobs that require a RWP. If there is any question whether a job requires a RWP, the final determination will be made by the RSO or duly authorized representative.

8.1.2.1 Work on or with material having total fixed activity in excess of 1000 dpm/100 cm^2 β, γ and/or 100 dpm/100 cm^2 α.

8.1.2.2 Work on or with material having loose surface activity in excess of 20 dpm/100 cm^2 α and/or 200 dpm/100 cm^2 β, γ to 1000 dpm/100cm^2 β, γ depending on the nuclide(s) present.

8.1.2.3 Filter changeouts of contaminated or potentially contaminated systems (i.e., Pre-filter, HEPA filters).

8.1.2.4 Work on any contaminated or potentially contaminated ventilation system where the integrity of the system may be breached or the interior accessed.

8.1.2.5 When air operated tools are to be used in a manner that is likely to generate airborne contamination.

8.1.2.6 Any job requiring welding, grinding or burning on contaminated material or equipment.

8.1.2.7 Work in a posted Airborne Radioactivity Area.

8.1.2.8 Work in a posted Radiation Area.

8.1.2.9 Work in a posted Contaminated Area.

8.1.3 Direct surveillance by qualified RSO or duly authorized representative may be used in lieu of a RWP in an emergency situation. The RSO or duly authorized representative have the authority to direct all matters associated with radiation protection and shall specify the radiological requirements to control personnel exposure to radiation.

8.2 RWP Initiation

8.2.1 RWPs are initiated by the cognizant individual responsible for the task. The initiator shall complete the location of work, detailed description of work, and job supervisor on Attachment 1. A RWP addition sheet (AP-012-02) shall be used as needed and attached to the RWP.

8.2.2 Work to be performed shall be clearly described.

8.2.3 The RSO or duly authorized representative shall approve the RWP. The RWP will not be approved unless the detailed description of work can be clearly understood.

8.2.4 The RSO or duly authorized representative may request that a detailed procedure be prepared if, in his/her opinion, the description of the work to be performed is unclear or the safety risks are considered to be high.

8.2.5 RWP numbers consist of the project name and a year prefix followed by the next available sequential number. Record the RWP number in the RWP Log sheet (AP- 012- 03) with a brief description of the description of work and on AP-012- 01 in the RWP "No." box.

8.2.6 The RSO or duly authorized representative shall complete the summary of radiological conditions and required radiological control sections of AP-012-01. Historical and/or pre-job surveys should be used for the radiological condition section.

8.2.7 The RSO or duly authorized representative shall review and approve the RWP prior to implementation.

8.2.8 An RWP may remain in effect for the duration of the job. However, RWPs authorizing work for periods anticipated to be greater than one month should be reviewed and re-authorized on a monthly basis.

8.3 RWP Implementation

8.3.1 Individuals authorized to work on the RWP shall print and sign their name on the original copy of the RWP, indicating that they have read and understand the RWP requirements. The RSO or duly authorized representative is responsible for ensuring the proper implementation of the RWP.

8.3.2 A copy of the RWP should be kept at the job site.

8.3.3 Individuals may be added to a non-terminated RWP by the HPT and are required to sign both the original and working copy.

8.3.4 Changes made to a non-terminated RWP shall be authorized by the by the RSO or duly authorized representative. The changes shall be made to both the original and the job site copy.

8.3.4.1 Initial and date any changes made.

8.3.5 If the scope of worker conditions (scope of work or radiological conditions) are significantly different than those expected when the RWP was generated, the RWP shall be terminated and a new one issued.

8.4 RWP Termination

8.4.1 A RWP may be terminated by the RSO or duly authorized representative for any of the following reasons:

8.4.1.1 Work is complete

8.4.1.2 Work scope or radiological conditions significantly different from the RWP.

8.4.1.3 At the discretion of the RSO or duly authorized representative.

8.4.2 The terminated RWP package shall consist of the following:

- Pre-job survey(s) and/or historical information
- Post-job survey (if applicable)
- All copies of the RWP
- Copies of air sample results from individuals working under the RWP (if applicable).

8.4.3 The RWP package shall be reviewed and terminated by the RSO or duly authorized representative.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 Individual(s) working under a RWP shall be trained in the requirements of this procedure.

9.1.2 Individual(s) working under a RWP shall ensure that this procedure and associated attachments are the most current revision.

9.1.3 Information documented on any of the attachments shall be legibly written in ink. Drawing a line through the error and initialing the change shall make any corrections.

9.1.4 The terminated RWP package shall be kept by the RSO or duly authorized representative for future review.

9.2 Records

9.2.1 Records of work performed under a RWP and records directly related to the RWP shall be kept by the RSO or duly authorized representative.

9.2.2 The original copy of the RWP shall be kept by the RSO or duly authorized representative.

10.0 ATTACHMENTS

- AP-012-01 Radiation Work Permit
- AP-012-02 Additional RWP Sign-In Sheet
- AP-012-03 Radiation Work Permit Log

AP-012-01
ST. ALBANS PROJECT RADIATION WORK PERMIT

Job Supervisor	Date	No.

Location of Work :

Description of Work :

SUMMARY OF RADIOLOGICAL CONDITIONS

Location	Contamination Levels	Radiation Levels	Airborne Concentrations

REQUIRED RADIOLOGICAL CONTROLS

Coveralls	Glove Liners	Lapel Air Sampler
Hood	Plastic Shoe Covers	Lab Coat
Surgeons Cap	Rubber Shoe Covers	Pre-Job Meeting
Surgeons Gloves	Tape Gloves to Sleeves	Continuous HP Coverage
Rubber Gloves	Plastic Suit	TLD
Trained Radiation Worker(s)		

SPECIAL INSTRUCTIONS :

SIGNATURE INDICATES THAT YOU HAVE READ AND UNDERSTAND THE RADIOLOGICAL CONDITIONS AND CONTROLS

Name	Signature	Name	Signature

APPROVED BY:____________________ DATE:__________

REAPPROVED BY:____________________ DATE:__________

RWP TERMINATED BY:____________________ DATE:__________

AP-012-02 ST. ALBANS PROJECT RADIATION WORK PERMIT ADDITION SHEET - RWP #			
NAME	SIGNATURE	NAME	SIGNATURE

Reviewed By: ______________________ Date: __________

AP-012-03
RADIATION WORK PERMIT LOG SHEET

RWP #	General Description	Date Issued	Date Terminated

Reviewed by: ______________________________ Date: ____________

1.0 PURPOSE

This procedure provides instructions for monitoring personnel for exposure to radiation in the workplace. Adherence to this procedure will provide reasonable assurance that exposures to radiation will be properly monitored enabling exposure to be controlled to As Low As Reasonably Achievable (ALARA).

2.0 APPLICABILITY

External radiation monitoring shall be conducted when it is likely that an adult will exceed 10% of the annual limits listed in 10 CFR 1201(a) or at a more conservative limit chosen by the RSO or duly authorized representative.

This procedure will be used for monitoring of all personnel for exposure to radiation. Monitoring will be provided as described in the site specific work plan for the job to be accomplished.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

Not Applicable

3.2 Limitations

Not Applicable

3.3 Requirements

3.3.1 Site Registration Form

3.3.1.1 All new personnel and visitors required to enter a RCA must complete a Site Registration Form (AP-008-01) prior to starting work at a facility.

3.3.1.2 Completed Site Registration Form will be retained with the individual personnel exposure file. Site Registration Forms for CABRERA personnel will be updated annually or earlier if existing information is known to be incorrect.

3.3.2 Occupational Radiation Exposure History

3.3.2.1 An NRC Form 4 or equivalent must be completed by each individual and reviewed by the RSO or duly authorized representative prior to the individual being permitted to work in a radiological controlled area (RCA) where a dose of more than 25 mrem could be received.

3.3.3 Dosimetry Assignment

3.3.3.1 The Thermoluminescent Dosimeter (TLD) badge number, name, social security number, whether or not a worker has a completed NRC Form 4 or equivalent, the monitoring period (date from...to) and the individuals date of birth shall be recorded on OP-008-01, for each individual monitored on a project. The original form will be maintained as a permanent record of the project monitoring. A copy will be maintained in the CABRERA, East Hartford office.

3.3.4 Occupational Exposure Limits & Administrative Control Levels.

3.3.4.1 Nuclear Regulatory Commission limits per calendar year:

- Whole Body (TEDE) 5 Rem
- Lens Dose Equivalent (LDE) 15 Rem
- Shallow Dose Equivalent (SDE) (Skin or Extremity) 50 Rem
- Organ Dose (CDE) 50 Rem

3.3.4.2 Administrative Control Levels (per quarter)

- Whole Body (TEDE) 1.25 Rem
- Lens Dose Equivalent (LDE) 3.75 Rem
- Shallow Dose Equivalent (SDE) (Skin or Extremity) 12.5 Rem
- Organ Dose (CDE) 12.5 Rem

3.3.4.3 Only the CABRERA RSO or duly authorized representative shall authorize exposure above the Quarterly Administrative Control Levels.

3.3.5 Radiological Control Areas

3.3.5.1 An RCA is considered to be any portion of a facility, plant, vehicle or project for which restrictions apply for purposes of occupational radiation exposure control. Radiation exposures received within the boundary of a restricted area are occupational exposures. As described in the applicable Project Detail Work Procedure, RCAs will be established to provide the specific radiological controls necessary for the completion of the work scope and the protection of all project personnel. The following guidelines apply:

3.3.5.2 An RCA is always located within a restricted area as defined by 10 CFR 20. Each radiation area, high radiation area, airborne radioactivity area and contaminated area shall be contained within an RCA.

3.3.5.3 Personnel and casual visitors within an RCA will be provided with appropriate dosimetry and monitored for radiation exposure when appropriate.

3.3.6 Radiation Work Permits

3.3.6.1 Personnel working in an RCA must be assigned to a specific RWP applicable to the job being performed.

3.3.6.2 Direct Reading Dosimeters will not be required at the St. Albans VAECC.

3.3.7 Occupational Radiation Exposure History Request

3.3.7.1 An Occupational Radiation Exposure Request, AP-008-05 will be completed for all personnel for whom permanent exposure results have been obtained. Copies of this letter will be sent to the individual, and maintained in the individual's personnel exposure file by the CABRERA Radiation Safety Office, East Hartford.

3.3.7.2 Any time CABRERA is required to report an individual's exposure to the Nuclear Regulatory Commission or other regulatory agency, a copy of the report will be sent to the individual.

3.3.8 Project Records / Documentation

3.3.8.1 Upon completion of the project, it will be the responsibility of the RFS or designee to forward all project records, logs, and communications regarding personnel exposure, exposure records, dosimetry records, and all other pertinent information about personnel dosimetry and individual radiation protection for RSO or duly authorized representative review, and filing in anticipation of NRC review.

4.0 REFERENCES

- HASP Safety and Health Program (Radiation Safety Program)
- AP-012 Radiation Work Permits
- OP-001 Radiation and Contamination Surveys
- AP-009 Training Program

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Monitoring – Measurement of radiation exposure to evaluate potential dose equivalent to the individual.

5.2 Dosimetry – Devices worn on the body (TLD) to measure the radiation dose received by the exposed individual.

5.3 Dose – The deposition of energy in matter. Equivalent to the radiation dose times the quality factor for the type of radiation.

5.4 Quality Factor – The factor, which is radiation dependent and identifies the relative biological effectiveness of a radiation type and energy. The quality factor is multiplied times the Dose to yield the Dose Equivalent.

5.5 TEDE – The Total Effective Dose Equivalent – The sum of the Deep Dose Equivalent (external dose) and the Committed Effective Dose Equivalent (internal dose).

5.6 CDE – Committed Dose Equivalent – The dose equivalent to organs or tissues that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

5.7 CEDE – Committed Effective Dose Equivalent – The sum of the products of all organs or tissues with CDE and their respective weighting factors.

5.8 SDE – Shallow Dose Equivalent – Applies to the skin and to any extremity, it is used for external radiation which cause primary energy deposition in the first 0.007 cm of tissue averaged over one square centimeter.

5.9 LDE- Eye Dose Equivalent – The dose delivered to the lens of the eye at a tissue depth of 0.3 centimeters.

5.10 DDE – Deep Dose Equivalent – The dose equivalent delivered by external radiation to tissue at a depth of 1 centimeter.

5.11 TLD – Thermoluminescent Dosimeter – A device which provides passive measurement of DDE, SDE, and/or LDE.

6.0 EQUIPMENT

None

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – The PM is responsible for ensuring that personnel assigned the tasks using radioactive or hazardous materials are properly trained in their use and the necessity that they be monitored for exposure to radiations and hazardous materials as described in the site specific work plan.

7.2 Radiation Safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in the use of personal monitoring devices for radiation and hazardous materials.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT are responsible for performing the surveys described in the site specific work plan and ensuring the proper use of monitoring devices by workers.

7.5 Workers – All personnel are required to wear their dosimerty as required by the RWP and to maintain their exposure to radiation ALARA.

8.0 INSTRUCTIONS

8.1 Radiation Dosimetry – TLD

8.1.1 At a minimum, TLD's provided by a NVLAP certified vendor for the exposure period, will be used to monitor all personnel who could potentially receive 10% or more of the permissible dose limit for external radiation exposure. Personnel working in RCA's, will wear a TLD. Other appropriate radiation exposure monitors will be assigned accordingly (e.g., extremity dosimetry) at the discretion of the RSO or duly authorized representative.

8.1.2 TLD's are the permanent record of an individual's occupational radiation exposure. Upon receipt of project dosimetry, TLD's and extremity dosimetry shall be stored in a low background area inside the project main office or in other designated storage locations when not in use. A (TLD) control badge shall be kept where the assigned badges are stored when they are not in use. All CABRERA personnel entering a RCA will be issued, at a minimum, a TLD.

8.1.3 The individual's name, social security number, issue date, and date of return will be recorded on form AP-008-03.

8.1.4 The TLD, which monitors DDE, SDE, and/or LDE, shall be worn on the front torso in the region of the torso, expected to receive the highest dose. In cases where other areas of the body may receive a higher dose, the HPT shall evaluate and formally require (by specification on the RWP) that the dosimetry be worn at that body location. Multibadging may be utilized in certain situations as deemed appropriate by the RSO/RFS.

8.1.5 Extremity monitoring shall be provided when necessary as described by the specific site work plan, or at the discretion of the RSO/RFS.

8.2 Visitors/Group Monitoring

8.2.1 A casual visitor is any person touring or visiting the RCA on an infrequent basis, escorted while in the restricted area and not performing or supervising hands on work.

8.2.2 Visitors will be issued a TLD on a case by case basis depending on the type and duration of the job. The RFS or RSO shall determine if a TLD is to be issued to a visitor. TLD's will always be issued to contractors expected to exceed 500 mrem. A visitor expected to receive in excess of 25 mrem shall be trained and provided dosimetry.

8.3 Visitor RCA Conditions

8.3.1 A visitor may be escorted into a RCA provided that:

8.3.1.1 No entries into a high radiation areas, surface contamination areas, or airborne radioactivity areas shall be allowed,

8.3.1.2 External radiation exposure is limited to 50 mrem per year, or 10 mrem per entry.

8.3.1.3 The visitor is furnished with dosimetry, when appropriate.

8.4 Visitor Dosimetry

8.4.1 Visitors within an RCA shall receive, as a minimum, a TLD

8.4.2 Visitor TLD results are recorded on form AP-008-01, which is maintained at the facility. When a visitor is issued a TLD, the individual's, name, social security number, issue date, and date of return will also be recorded on form AP-008-03.

8.5 Lost, Damaged or Questionable Dosimetry

8.5.1 In the event of a Lost, Damaged or Questionable TLD, the RFS or RSO shall be notified immediately. A Lost, Damaged or Questionable Dosimetry Report, (AP-008-02) will be completed and filed in the individual's exposure file. The dose estimated from all exposure received while the individual was in an exposure situation must be determined and recorded in the individual's dose record.

8.5.2 In the event of multiple occurrences, the RSO or duly authorized representative shall be notified immediately.

8.5.3

8.6 Project Dosimetry Issuance/Control

8.6.1 Prior to project commencement, the RFS and/or the RSO will determine the appropriate radiation monitoring dosimetry required based upon the radionuclides and activity present at the work area. The RFS will contact the RSO to provide the following information:

- CABRERA Project Name and Account Number
- Project start date and project duration
- Suggested dosimetry required for project, including radiation type to monitor for
- Quantity of dosimeters requested on a quarterly basis including controls
- Name, address, social security, birth date of project personnel to be monitored.
- Address dosimetry is to be shipped to.

8.6.2 Personnel assigned to projects will wear the appropriate dosimetry for no more than one quarter or the duration of the project, whichever is shortest.

8.6.2.1 It will be the responsibility of the RFS or RSO to return dosimetry to the vendor for processing at the end of each quarterly monitoring period.

8.6.2.2 If the original projected project duration is extended, the RFS or designee shall inform the RSO so that the proper arrangements can be made to supply additional dosimetry from the vendor.

8.6.2.3 The quarterly issue period may be extended at the discretion of the RSO or duly authorized representative. Extensions shall be "with cause" actions and documented by memo, at a minimum.

8.6.2.4 Dosimetry shall be maintained on site in a low dose rate area with control(s), when not being worn by personnel.

8.6.3 Dosimetry Processor (Vendor)

8.6.3.1 The dosimetry vendor must be NVLAP certified in accordance with the project Health and Safety Plan and 10 CFR 20.1501.

8.6.3.2 Upon receiving project dosimetry, the RFS or designee shall verify that the dosimetry received meets the requirements of the project. Any problems should be reported to the CABRERA RSO or duly authorized representative for immediate attention and resolution. All documentation received with dosimetry will be filled out completely. When all required preliminary training documentation has been completed as described in the project Detail Work Procedure, dosimetry will be issued to project personnel.

8.7 It is the responsibility of the RFS or designee to ensure that AP-008-03 is completed at the time of dosimetry issuance and a copy is sent to the CABRERA East Hartford Office location.

9.0 QUALITY ASSURANC/RECORDS

9.1 Records

9.1.1 Documented information shall be legibly written in ink.

9.1.2 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.1.3 The health physics technician using this procedure shall ensure that it is the most current and approved revision.

9.1.4 The health physics technician shall review Forms AP-008-01 through AP-008-04 for accuracy and completeness.

9.1.5 Entries on Forms AP-008-01 through AP-008-04 and any other pertinent forms must be dated and initialed by the health physics technician performing the inventory to be valid.

9.1.6 The RSO or duly authorized representative shall review completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

- AP-008-01 Site Registration Form
- AP-008-02 Lost, Damaged or Questionable Dosimetry Report
- AP-008-03 Radiation Dosimetry Issue Log
- AP-008-04 Radiation Exposure Report
- AP-008-05 Occupational Exposure History Request NRC Form 4

AP- 008-01
Site Registration Form

ADMINISTRATIVE INFORMATION	
Name:	Date:
Social Sec. No.:	Date of Birth:
Permanent Address:	
Employer's Name:	
Employer's Address:	
CABRERA Project Name/No.:	
Project Contact:	
Signature:	**Date:**
DOSIMETRY USE ONLY	
DRD No.:	DRD Reading:_____________mrem
TLD Badge No.:	TLD Badge Results____________mrem
RADIATION SAFETY OFFICER APPROVAL	
This person has met the requirements for radiation work as specified in the CABRERA Radiation Safety Manual:	Yes No
This person meets the requirements for radiation work with consideration of the notes below:	Yes No
Notes:	
CABRERA RSO Signature:	

AP-008-02
Lost, Damaged or Questionable Dosimetry Report

ADMINISTRATIVE
Report Date/Time:
Project Name/No.:
Project Manager/Contact:
Individual's Name/SSN:
Badge No.:
Date/Time of Incident:
Location if known:
Applicable RWP No.:
Date Badge was Issued:
DOSE CALCULATION
1. Dose from dosimeter readings (Total from date issued) thru__________(Date) = _______mrem
2. Current dosimeter reading (If more than one dosimeter, use highest reading) =________mrem
3. If individual was not wearing a dosimeter, or lost the dosimeter, assign highest exposure received by workers in the same area . If none, use dose rate x time in area for the same period. Dose Rate______________(mrem/hour) x Time_____________(hours) = ________mrem
Total estimated exposure to be assigned: =________mrem
THE METHOD USED TO ESTIMATE MY EXPOSURE HAS BEEN EXPLAINED TO ME, AND THE ESTIMATE DOSE ASSIGNED TO MY RECORD IS ACCEPTABLE FOR THIS EVENT. **Individual's Signature:**____________________________ **Date:**_______________
DOSE RECORD AUTHORIZATION
Dose Estimate Calculations By:____________________________ Date:_______________
Dose Estimate Reviewed By:(RSO)___________________________ Date:_______________
Dose Estimate Posted By:_______________________________ Date:_______________

AP-008-03
Radiation Dosimetry Issue Log

Project/Location:______________________ Badge Series No.:__________

TLD#	Name	SSN	Form 4 (Y/N)	Dates (From/To)	DOB

Reviewed by:______________________ **Date:**__________

AP-008-04
Radiation Exposure Record

Name: **SSN:**

Birth Date:

TLD Badge No.:

Quarterly Whole Body Dose: 1st_________ 2nd_________ 3rd_________ 4th_________

Lifetime Whole Body Dose Equivalent:___________(Rem) **Monitoring Year:**________

Monitoring Period	Whole Body (DDE)	Shallow Dose (SDE)	Extremity Dose (SDE)	Lens Dose (LDE)	Organ Dose (CDE)	Internal Effective Dose (CEDE)	Total Effective Dose Equivalent – Rem (DDE+CEDE) TEDE/Cumulative	
January								
February								
March								
April								
May								
June								
July								
August								
September								
October								
November								
December								
Yearly Totals								

Notes:

N/M = Not Monitored

Reviewed:________________________________ **Date:**____________

RSO:____________________________________ **Date:**____________

AP-008-05
OCCUPATIONAL RADIATION EXPOSURE HISTORY

Name:	**SSN:**
Address:	
Date of Birth:	

The above individual was monitored by: TLD: Direct Reading Dosimeter:

This is a: Record: Estimate:

Monitoring Device Number:______________

The monitoring period was: From:______________ To:______________

The Occupational Radiation Exposure was received during:

Assignment for: ____________________ License No.: ____________________

Address: ________________________

City/State/ZIP: ____________________

Telephone: ______________________

RADIATION EXPOSURE RESULTS

Deep Dose Equivalent for the period stated above: ___________Rem (DDE)

Shallow Dose (skin) for the period stated above: ___________Rem (SDE)

Extremity Dose for the period stated above: ___________Rem (SDE)

Eye Dose Equivalent for the period stated above: ___________Rem (LDE)

Committed Effective Dose Equivalent (Internal): ___________Rem (CEDE)

Total Effective Dose Equivalent (DDE + CEDE): ___________Rem (TEDE)

This report is furnished to you under the provisions of Nuclear Regulatory Commission Regulation 10 CFR Part 20 titled "Standards for Protection Against Radiation". You should preserve this report for further reference.

Radiation Safety Officer:_____________________________ Date:________________

1.0 PURPOSE

This procedure provides the methods for operating beta/gamma survey meters when performing contamination surveys. Adherence to this procedure will provide reasonable assurance that the surveys performed have reproducible results.

2.0 APPLICABILTY

This procedure will be used by Cabrera Services, Inc. (CABRERA) personnel to measure fixed and removable beta-gamma emitting contamination on facility surfaces, equipment, waste packages, personnel, personnel protective clothing, etc.

3.0 PRECAUTIONS, LIMITATIONS, AND REQUIREMENTS

3.1 Precautions

3.1.1 Ensure that the thin Mylar or mica window on the probe face is protected from punctures during survey operations.

3.1.2 If any instrument inconsistencies are observed (e.g., unusually high or low background readings, source checks outside the acceptable range, etc.), remove the instrument from use, label it "OUT OF SERVICE" and report the condition to the Radiation Safety Officer (RSO) or duly authorized representative.

3.2 Limitations

Not Applicable

3.3 Requirements

3.3.1 Calibration sources shall be traceable to the National Institutes of Science and Technology (NIST).

3.3.2 A battery check, general observation of instrument condition and source check shall be performed each day before instrument use and daily following work activities as a final verification.

3.3.3 Survey instrument calibrations shall be performed by an NRC or Agreement State licensed calibration facility.

4.0 REFERENCES

- HASP — Safety and Health Program (Radiation Safety Program)
- OP-001 — Radiological Surveys
- OP-009 — Use and Control of Radioactive Check Sources

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.

5.2 Contamination Survey - A survey technique to determine fixed and removable contamination levels.

5.3 Acceptance Range - A range of values that describe an acceptable daily instrument source check result.

6.0 EQUIPMENT

Applicable alpha, beta/gamma survey instrumentation chosen at the discretion of the RSO/RFS or duly authorized designee.

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – the PM is responsible for ensuring that personnel assigned the task of operating contamination survey meters are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in the use of contamination survey meters described in this procedure.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT operating contamination survey meters are responsible for knowing and complying with this procedure.

8.0 OPERATION

8.1 Instrument Inspection

8.1.1 Select the contamination survey meter and probe to be used in the survey.

8.1.2 Before each use, perform the following checks:

8.1.2.1 Verify the instrument has a current calibration label.

8.1.2.2 Visually inspect the instrument for physical damage or defects.

8.1.2.3 Position the meter switch to "BAT". Check to see that the needle falls within the "Bat Test" checkband.

- If the needle falls below the "Bat Test" checkband, install new battery(s).
- If the needle still falls outside the "Bat Test" checkband after the installation of new battery(s), tag the instrument "Out of Service" and notify the RSO or duly authorized representative.

8.1.3 Remove and tag the instrument "Out of Service" if it fails any of the criteria in Step 8.1.2.1 through 8.1.2.3 and notify the RSO or duly authorized representative.

NOTE: Any defects, damages or other physical abnormalities require that the instrument be removed from service and the RSO or duly authorized representative be notified.

8.2 Pre-operation of instrument

8.2.1 Position the meter fast/slow ("F/S") switch to "S".

8.2.2 Position the meter switch to the appropriate range scale.

8.2.3 Obtain an OP-020-01 Form.

8.2.4 If a Quality Control (Q.C.) acceptance range has not already been calculated on the OP-020-01 Form, then follow the instructions below, other wise proceed to step 8.2.6.

8.2.5 Enter the QC check source, probe, and meter numbers on Form OP-020-01.

8.2.5.1 Ensure the source and detector are in a reproducible geometry, which will be used each time this check is performed.

8.2.5.2 Obtain ten separate measurements in a low background area.

8.2.5.3 Calculate the average of the ten measurements by adding the measurements and dividing the sum by ten.

8.2.5.4 Multiply the average measurement value established in 8.2.5.3 by 0.8 and record on Form OP-020-01 as the lower QC acceptance range.

8.2.5.5 Multiply the average measurement value established in 8.2.5.3 by 1.2 and record on Form OP-020-01 as the upper QC acceptance range.

8.2.6 Place the QC check source and detector in the proper geometry established for QC check.

8.2.7 Allow the instrument reading to stabilize (approximately 30 seconds). Compare the reading to the response check criteria on Form OP-020-01. If the response reading falls outside of the acceptance range, note Fail on Form OP-020-01, tag the instrument "Out of Service" and notify the RSO or duly authorized representative. If the reading falls inside the acceptance range, note Pass on Form OP-020-01; the instrument is ready for performing surveys.

8.3 Contamination Survey Techniques

Caution: The window area of beta detector windows is 1.7 mg/cm^2 mica. The window can be easily damaged while surveying areas having protruding fragments. Remove these fragments, if possible, before performing surveys.

Note: To maintain the calibrated detection efficiency, the detector must be held at the appropriate height, determined during calibration, when surveying. For example, if a beta probe's efficiency was calculated at 1/2 inch from the calibration source, the detector must be held at 1/2 inch from the surface being surveyed to maintain calibrated detection efficiency.

Note: Avoid contacting the detector probe to the area being surveyed. This potentially could contaminate the probe.

8.3.1 Verify the instrument selector switch is in the X 0.1 position.

8.3.2 For a stationary reading, place the detector over the area to be measured and allow meter to stabilize. Record the average meter indication in CPM β/PA on applicable forms.

8.3.3 For a scan survey move the detector slowly over the surface (less than one detector width per second). Observe meter indication. If increased readings are observed return to the area and obtain a stationary reading. Record maximum area meter indication in CPM β/PA, on applicable forms.

8.4 Interpretation of Results

The meter reading on the alpha and beta/gamma survey meters must be corrected for detector efficiency and detector surface area before comparing results with the contamination units in Section 3.6 of the Radiation Safety Program. The conversion from CPM α/PA or CPM β/PA to DPM α/100 cm^2 or β/100 cm^2 is performed using the following equation.

$$(\mathrm{DPM}\ /100\,\mathrm{cm}^2) = \frac{(\mathrm{AxB})}{\mathrm{C}}$$

Where:

A = Alpha or Beta/Gamma survey meter indication in net CPM α/PA or β/PA (i.e. Gross Alpha or Beta Survey Counts minus background counts = Net CPM/PA)

B = 100 cm^2 divided by the effective detector surface area in cm^2. With an effective surface area of 50 cm^2 for the Ludlum 43-5 alpha detector, the value of B is approximately 2 or for the 15 cm^2 for the Ludlum 44-9 beta detector, the value of B is approximately 6.7.

C = Detector efficiency (expressed as decimal).

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 The health physics technician performing the survey shall ensure that this procedure is the most current and approved revision.

9.2 Records

9.2.1 Documented information shall be legibly written in ink.

9.2.2 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.3 The HPT performing the survey shall review Form OP-020-01 and any other applicable forms for accuracy and completeness.

9.2.4 Entries on Form OP-020-01 and any other pertinent forms must be dated and initialed by the HPT performing the survey to be valid.

9.2.5 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

OP-020-01 Survey Meter Source Check Form

OP-020-01 - Survey Meter Source Check Form

Probe: ____________________________ Serial No.: ________________

Meter: ____________________________ Serial No.: ________________ Cal. Due __________

Source: __________________ QC Acceptance Range: Lower ________ Upper ____________

Date	Reading	Pass/ Fail	H.P. Technician	H.P. Tech Initials

Reviewed By: ______________________________ Date: ______________

1.0 PURPOSE

This procedure provides instruction on the operation and setup of an alpha/beta sample counter. Adherence to this procedure will provide reasonable assurance that the surveys performed have reproducible results.

2.0 APPLICABILITY

This procedure will be used by Cabrera Services, Inc., (CABRERA) personnel operating an alpha/beta sample counter during surveys. Types of surveys that may use an alpha/beta sample counter are:

- Smear surveys performed to determine the removal of alpha and/or beta contamination on facility surfaces, equipment, waste, and source packages, etc.
- Air sample surveys performed in a workers breathing zone and effluent discharge to determine alpha and/or beta air concentrations.

3.0 PRECAUTIONS, LIMITATIONS, AND REQUIREMENTS

3.1 Precautions

3.1.1 If any instrument inconsistencies are observed (e.g., unusually high or low background counts, source checks outside the tolerance range, etc.), remove the instrument from use and report the condition to the RSO or duly authorized representative.

3.1.2 Individuals performing work with an alpha/beta counter shall be familiar with the requirements set forth in the current and approved version of this procedure.

3.2 Limitations

3.2.1 This instrument should be set up for use in low background area as determined by the RSO or duly authorized representative.

3.3 Requirements

3.3.1 Calibration sources shall be traceable to the National Institutes of Science and Technology (NIST).

3.3.2 Survey instrument calibrations shall be performed by an NRC or Agreement State licensed calibration facility.

3.3.3 A battery check, general observation of instrument condition and source check shall be performed each day before instrument use and daily following work activities as a final verification.

4.0 REFERENCES

• HASP	Safety and Health Program (Radiation Safety Program)
• OP-001	Radiological Surveys
• OP-002	Air Sampling and Analysis
• NUREG-1556	Consolidated Guidance About Material Licenses (Vol.11)

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.

5.2 Smear sample survey – a technique using a two-inch diameter filter papers to determine removable contamination of alpha and/or beta emitting radioactive material.

5.3 Air sample survey – a technique in which particulates are collected from a known volume of air drawn through a filter paper and concentrations of airborne alpha and beta activity associated with the particulates is determined by sample counting.

5.4 Plateau – portion of a voltage curve where changes in operating voltage introduce minimum changes in the counting rate.

5.5 Chi-square test – A statistical test to evaluate the operation of a sample counter by determining how data fit a series of counts to a Poisson distribution.

5.6 Daily calibration – A determination of alpha and beta sample counting efficiency by counting National Institute of Standard Technologies (NIST) radioactive standards.

6.0 EQUIPMENT

Ludlum model 2929 or equivalent

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – the PM is responsible for ensuring that personnel assigned the task of operating alpha/beta sample counters are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation Safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in the use of alpha/beta sample counters described in this procedure.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT using alpha/beta sample counters are responsible for knowing and complying with this procedure.

8.0 OPERATION

8.1 Instrument Inspection

8.1.1 Before each use, perform the following checks:

8.1.1.1 Verify the instrument has a current calibration label.

8.1.1.2 Visually inspect the instrument for physical damage or defects.

8.1.2 Remove and tag the instrument "Out of Service" if it fails any of the criteria in Step 8.1.1.1 through 8.1.1.2 and notify the RSO or his duly authorized representative.

NOTE: Any defects, damages or other physical abnormalities require that the instrument be removed from service and the RSO or his duly authorized representative be notified.

8.2 Initial Startup.

8.2.1 Turn high voltage potentiometer to its lowest position (fully counterclockwise).

8.2.2 Turn instrument on.

8.2.3 The operator can select one of four operational procedures depending on the function to be performed. Before performing any of the following complete steps 8.1.1 to 8.1.2.

a) Plateau Curve – The Plateau Curve is used to find the proper operating voltage of the instrument and will be performed at the discretion of the RSO or duly authorized representative. This test shall be documented on the attached Form OP-021-01 or equivalent.

b) Chi–square Test – The Chi-Square Test will be performed at the discretion of the RSO or duly authorized representative in order to test the operational adequacy of the instrument and will be recorded on Form OP-021-02. This test statistically evaluates the sample counter against a poisson distribution.

c) Daily Calibration Check – This portion of the procedure is performed before samples are counted on any day the instrument is in use.

8.3 Plateau Curve

NOTE: Before beginning, record the previous calibration high voltage values.

8.3.1 Set up the instrument in a low background area.

8.3.2 Rotate the high voltage potentiometer slowly clockwise until the meter indicates proper voltage. This proper voltage is approximately 500 volts.

8.3.3 Set time multiplier switch to "x1."

8.3.4 Set the instrument-preset timer to one (1) minute.

8.3.5 Insert an alpha calibration standard into the center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a one minute count.

8.3.6 Upon completion of the count, record high voltage reading and digital counts appearing in the instrument alpha display in the indicated columns on Form OP-021-01(Plateau Data Sheet)

8.3.7 Continue increasing high voltage by 50-volt increments, as described above, obtaining counts and recording data until the end of the plateau is reached. If rapid increase in count rate is observed, proceed to step 8.3.8. If not, notify the RSO or duly authorized representative.

8.3.8 Remove the alpha source and replace with a beta source.

8.3.9 Reduce high voltage reading to the voltage level chosen during Step 8.3.2 by turning potentiometer counterclockwise.

8.3.10 Perform one-minute counts at 50-volt increments and record the data on Form OP-020-01, until the end of the plateau is reached. If a rapid increase in count rate is observed reduce the high voltage.

8.3.11 Using linear graph paper or equivalent plotting system, plot alpha and beta counts on the "Y" axis and the voltage for the indicated count on the "X" axis.

8.3.12 Select an operating voltage 1/3 the distance beyond the knee of the plateau curve by marking the voltage on the graph and on the plateau data sheet.

8.3.13 Sign and date Form OP-021-01 and forward the results along with any graphs produced to the RSO or duly authorized representative for review.

8.4 Chi-Square Test

8.4.1 Set up the Instrument in a low background area.

8.4.2 Ensure the high voltage potentiometer is positioned according to the posted instrument label. Adjust if necessary.

8.4.3 Set the time multiplier switch to "x1".

8.4.4 Set the instrument-preset timer to one (1) minute.

8.4.5 Insert the alpha calibration standard into center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a one minute count.

8.4.6 Upon completion of the count, record digital counts appearing in the alpha display in the "X_i" column on Form OP-021-02 (Chi -Square Data Sheet).

8.4.7 Repeat counting sequence without changing settings until a total of 20 counts have been taken and recorded in the "X_i" column on Form OP-021-02.

8.4.8 Add the 20 counts recorded in the "X_i" column and record in the "Sum" column. Then divide by 20 to obtain the mean number of counts (X_m) and record on the line "X_m".

8.4.9 Calculate the individual count "X_i" difference from the mean (X_m) value and record in the "(X_i-X_m)" column on Form OP-021-02 for all 20 values.

8.4.10 Calculate $(X_i-X_m)^2$, sum the "$(X_i-X_m)^2$ " column, and record on Form OP-020-02.

8.4.11 Calculate the value of Chi- Square using the following formula.

$$X^2 = \frac{\sum(X_i - X_m)^2}{X_m}$$

8.4.12 The value of Chi-square should be between 8.91 and 32.8 (represents a probability between 0.025 and 0.975). Record this value at "X^2". If the Chi-square value falls outside this range, contact the RSO or duly authorized representative for further instructions.

8.4.13 Sign and date Form OP-021-02 and forward the results to the RSO or duly authorized representative for review.

8.5 Daily Calibration Check

8.5.1 Ensure the high voltage potentiometer is positioned according to the posted instrument label. Adjust, slowly, if necessary.

8.5.2 Set time multiplier switch to "x1".

8.5.3 Set the instrument-preset timer to five (5) minutes.

8.5.4 Record the source type to be used and corresponding serial number on the proper line indicated on Form OP-021-03. Use separate rows of the form for each source efficiency to be calculated.

8.5.5 Insert a blank sample into the center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a five minute background count.

8.5.6 Calculate and record the background total counts and count rate in the columns labeled "Total Counts" and "BKG CPM" respectively, under Background Information on Form OP-021-03. The background count rate in CPM (counts per minute) can be calculated as follows:

$$CPM = \frac{\text{Total Counts}}{\text{Total Time}}$$

8.5.7 Remove the blank sample and insert the alpha or beta calibration standard into the center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a five minute count.

8.5.8 Upon completion of the measurement, calculate and record the total counts and count rate in the columns labeled "Total Counts" and "CPM" respectively, under Source Information on Form OP-021-03. The count rate (CPM) can be calculated as listed in Step 8.5.6.

8.5.9 Calculate Net Source CPM as below and record on Form OP-021-03 under "Net CPM".

$$\text{Net Source CPM} = \text{CPM} - \text{BKG CPM}$$

NOTE: Obtain activity (DPM) value from the source certification paperwork. Decay correct activity, if needed.

8.5.10 Use the source disintegration per minute (DPM) to calculate the efficiency as shown below and record as a decimal on Form OP-021-03.

$$\%\ Efficiency = \frac{Net\ Source\ CPM}{DPM} * 100$$

8.5.11 To calculate the efficiency for the next source, remove the current source standard, insert a new source standard and repeat steps 8.5.1 through 8.5.10, as necessary.

8.5.12 Remove calibration standards and place in source holders.

8.5.13 Generate a control chart tracking the daily efficiencies and notify the RSO or duly authorized representative if any point falls outside of 2σ variance.

NOTE: For the first day on control chart use five data points to begin trend line.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 The alpha/beta sample counter will be checked for proper calibration daily with a NIST traceable source when in use.

9.1.2 Chi-square and plateau tests are verified and noted as currently valid.

9.1.3 The HPT shall ensure that the attachments are of the most current.

9.2 Records

9.2.1 Documented information shall be legible written in ink.

9.2.2 Data shall not be obliterated by erasing or using white-out. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed and dated.

9.2.3 The HPT shall review completed attachment forms for accuracy and completeness.

9.2.4 Entries on forms must be dated and initialed by the HPT to be valid.

9.2.5 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

- OP-021-01 Plateau Data Sheet
- OP-021-02 Chi–Square Data Sheet
- OP-021-03 Daily Calibration Check

OP-021-01

Plateau Data Sheet

Date:________________ Recommended Operating Voltage:__________________

Instrument:____________________________ Serial Number:__________________

Alpha Source Serial No._________________________ Activity (dpm)_________________

Beta Source Serial No.__________________________ Activity (dpm)_________________

Voltage Setting	Alpha Counts	Voltage Setting	Alpha Counts	Voltage Setting	Beta Counts	Voltage Setting	Beta Counts

Prepared By:____ Date:___________
Print/Sign

Reviewed By:____ Date:___________
Print/Sign

OP-021-02

Chi-Square Data Sheet

Date:________Instrument:__________________Serial Number:___________ X^2________

Alpha Source No./Activity:________________Beta Source No./Activity:__________________

Count Number	X_i	(X_i-X_m)	$(X_i-X_m)^2$
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
Sum		\\\	
X_m		\\\	\\\

Prepared By: ____ Date: _______________
Print/Sign

Reviewed By: ____ Date: _______________
Print/Sign

OP-021-03

Daily Calibration Check

Instrument________________________________ Serial No.________________

Alpha Source No./Activity______________ Beta Source No./Activity______________

Background Information				Source Information				
Date/Time	Total Time	Total Counts	BKG CPM	Total Time	Total Counts	CPM	Net CPM	% Eff.

Prepared By: ________________________________ Date: ______________
Print/Sign

Reviewed By: ________________________________ Date: ______________
Print/Sign

1.0 PURPOSE

The purpose of this procedure is to provide instruction for the operation of the micro-R meter for gamma radiation surveys. Adherence to this procedure will provide reasonable assurance that the radiological surveys performed have reproducible results.

2.0 APPLICABILITY

This procedure will be used by Cabrera Services, Inc. (CABRERA) personnel operating the micro-R meter during gamma radiation surveys. The micro-R meter is used to determine gamma radiation levels from St. Albans VAECC facility surfaces, equipment, waste and source packages, etc., containing gamma emitting radioactive materials.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

3.1.1 Individuals performing work with the micro-R meter shall be familiar with the requirements set forth in the current and approved version of this procedure.

3.1.2 If any instrument inconsistencies are observed (e.g., unusually high or low background readings, source checks outside the acceptable range, etc.), remove the instrument from use, label it "OUT OF SERVICE" and report the condition to the Radiation Safety Officer (RSO) or duly authorized representative.

3.2 Limitations

None

3.3 Requirements

3.3.1 Calibration sources shall be traceable to the National Institutes of Science and Technology (NIST).

3.3.2 A battery check, general observation of instrument condition and source check shall be performed each day before instrument use and daily following work activities as a final verification.

3.3.3 Survey instrument calibrations shall be performed by an NRC or Agreement State licensed calibration facility.

4.0 REFERENCES

- HASP Safety and Health Program (Radiation Safety Program)
- OP-001 Radiological Surveys
- OP-009 Use and Control of Radioactive Check Sources
- OP-020 Operation of Contamination Survey Meters
- NUREG-1556 Consolidated Guidance About Material Licenses (Vol.11)

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.

5.2 Gamma Radiation Survey – A survey technique to determine gamma radiation levels from radioactive material(s) in facilities, materials, landmasses, etc.

5.3 Acceptance Range – A range of values that describe an acceptable daily instrument source check result.

6.0 EQUIPMENT

Ludlum Model 19 or equivalent

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – the PM is responsible for ensuring that personnel assigned the task of operating a micro-R meter is familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in the operation of a micro-R meter described in this procedure.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT operating the micro-R meter are responsible for knowing and complying with this procedure.

8.0 OPERATION

8.1 Instrument Inspection

8.1.1 Before each use, perform the following checks:

8.1.1.1 Verify the instrument has a current calibration label.

8.1.1.2 Visually inspect the instrument for physical damage or defects.

8.1.1.3 Position the meter switch to "BAT". Check to see that the needle falls within the "Bat Test" checkband.

- If the needle falls below the "Bat Test" checkband, install new battery(s).
- If the needle still falls outside the "Bat Test" checkband after the installation of new battery(s), tag the instrument "Out of Service" and notify the RSO or duly authorized representative.

8.1.2 Remove and tag the instrument "Out of Service" if it fails any of the criteria in Step 8.1.1.1 through 8.1.1.3 and notify the RSO or duly authorized representative.

NOTE: Any defects, damages or other physical abnormalities require that the instrument be removed from service and the RSO or duly authorized representative be notified.

8.2 Pre-operation of instrument

8.2.1 Position the meter fast/slow ("F/S") switch to "S".

8.2.2 Position the meter switch to the appropriate range scale.

8.2.3 If a Quality Control (Q.C.) acceptance range has not already been calculated, then follow the instructions below, other wise proceed to step 8.2.5.

8.2.3.1 Ensure the source and detector are in documented reproducible positions, which will be used each time this check is performed. Document this position on appropriate form.

8.2.4 Place the QC check source and detector in the documented position on appropriate form.

8.2.5 Allow the instrument reading to stabilize (approximately 30 seconds). Compare the reading to the response check criteria. If the response reading falls outside of the acceptance range, tag the instrument "Out of Service," and notify the RSO or duly authorized representative.

8.3 Operation of the instrument

8.3.1 Grid Surveys

8.3.1.1 Turn the audio switch to the "On" position.

8.3.1.2 Verify the instrument selector switch is on the lowest scale (usually the μR position). Turn the instrument selector switch to the next higher scale only if meter indication is off scale.

8.3.1.3 For a stationary grid reading in a facility or land mass, position the instrument one meter above the surface to be surveyed and allow meter to stabilize. With the instrument toggle switch set in the "SLOW" position, the meter reaches 90% of its final reading in 22 seconds. Record the average meter indication in μR/hr on appropriate form(s).

Note: Two survey methods (step 8.3.1.4 or 8.3.1.5) can be used to obtain contact readings in the survey grids. The survey method used will be specified in the site specific work plan.

8.3.1.4 For a scan survey, make sure the meter response is set to fast and suspend the instrument from a strap which locates the detector at surface or ground level. Move the instrument slowly over the surface while walking in an "S" pattern unless otherwise instructed by the RSO or duly authorized representative. Areas, which could concentrate radioactive materials such as drainage ditches, floor cracks, and wall/floor joints, should be surveyed. Observe meter indication and listen for increases in audible clicks from the speaker. If elevated readings above background are observed, a stationary survey shall be performed (at one-meter height and at the surface) at the point of elevated activity. Record area meter indications above background in μR/hr on appropriate form.

8.3.1.5 As an alternate to the "S" pattern survey used in step 8.3.1.4, the survey grid can be divided into subgrids and readings taken as directed by the site work plan. Elevated measurements should be performed in the same manner as above (i.e., at one meter and at the surface). The readings from each measurement are recorded on appropriate form.

8.3.2 Waste Container Surveys

8.3.2.1 Set the instrument scale to accommodate the highest expected radiation level. If radiation levels may approach 5000 μR/hr (5 mR/hr) obtain an instrument with appropriate range before performing any radiation surveillance.

8.3.2.2 Slowly scan the total surface of the package and record the maximum contact reading obtained on appropriate forms.

8.3.2.3 Obtain instrument readings at one meter from all sides of the package and record the maximum reading obtained on appropriate form.

8.3.3 Final Verification

Upon completion of work activities, repeat steps 8.1.1.1 through 8.2.2 and 8.2.4 through 8.2.5, as a final verification that the instrument is working properly

8.3.4 Additional Information

8.3.4.1 In a uniform background radiation field (without interfering sources of radiation), methods such as selectively shielding the detector, soil sample analysis, etc., can be used to differentiate between extraneous radioactive sources (e.g., skyshine or radioactive waste shipment containers), naturally occurring radioactive material and/or radioactive contamination.

8.3.4.2 Note the location of installed devices, which contain radioactive material and could cause elevated background radiation levels in localized areas.

8.3.4.3 Land mass surveys might contain areas with naturally occurring radioactive materials, which will elevate background radiation levels.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 The health physics technician performing the survey shall ensure that this procedure is current.

9.2 Records

9.2.1 Documented information shall be legibly written in ink.

9.2.2 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.3 The health physics technician performing the survey shall review appropriate forms and any other applicable forms for accuracy and completeness.

9.2.4 Entries must be dated and initialed by the health physics technician performing the survey to be valid.

9.2.5 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

None

1.0 PURPOSE

The purpose of this procedure is to provide instructions for the proper set-up, calibration and data acquisition for the PSR-4 Proportional Probe to be used at the St. Albans Extended Care Facility in the Ejector Pit Room's four-inch diameter underground cast iron pipe.

2.0 APPLICABILITY

This procedure is to be used only in the St. Albans Ejector Pit four-inch diameter underground cast iron pipe. This is because the concept of the probe is to use the eight spring loaded rollers to center the detector within the pipe.

3.0 PRECAUTIONS, LIMITATIONS

3.1 Ensure that safety line is attached to the probe before placing it in the pipe.

3.2 The only radionuclide monitored at St. Albans is Strontium-90 or daughter products of Strontium-90.

3.3 The calibration of this probe will be performed with a Strontium-90 National Institutes of Standards & Technology (NIST) traceable source.

3.4 The P-10 gas cylinder should be properly secured to prevent improper movement.

3.5 Pressure regulator attachment should fit snug to gas cylinder.

3.6 Plastic sheeting should cover cable to prevent contamination.

4.0 REFERENCES

4.1	10 CFR 20	Standards for Protection Against Radiation
4.2	AP-012	Radiation Work Permits
4.3	OP-001	Radiological Surveys
4.4	OP-002	Air Sampling and Analysis
4.5	OP-019	Radiological Posting
4.6	OP-021	Alpha-Beta Counting Instrumentation

5.0 DEFINITIONS

5.1 Activity – The rate of disintegratation or decay of radioactive material. The units of radioactivity for the purposes of this procedure are disintegrations/minute.

5.2 Radiological Controlled Area – A work area whose access is restricted to authorized and trained personnel by the use of a Radiation Work Permit due to one or more of the following conditions: radiation area, high radiation area, contaminated area, highly contaminated area or airborne area.

5.3 Survey – An evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal or presence of radioactive material or other sources of radiation.

6.0 EQUIPMENT

6.1 PSR-4 Probe with Cable.

6.2 P-10 Gas with Pressure/Reducer Regulator.

6.3 Safety Cable.

6.4 Plastic Tubing.

6.5 Ludlum 2221 Scaler Rate Meter.

6.6 NIST traceable SR-90 source.

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) - is responsible for ensuring that personnel assigned the task of surveying materials are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation Safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in the use of contamination survey meters described in this procedure.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT is responsible for performing the surveys performed in this procedure.

8.0 INSTRUCTIONS

8.1 Connect one end of the gas/HV cable to the PSL-4 probe. Connect the other end to the Ludlum 2221 Scaler/Rate meter. Connect the P-10 gas supply as well.

8.2 The calibration of the PSR-4 probe is performed before using it at the St. Albans site. Readings are taken with an Sr-90 NIST traceable 1.25" diameter source. The adjusted net counts are calculated per square centimeter source area and an efficiency (cpm/dpm) is determined.

8.3 Background counts must be subtracted from the gross count readings to determine net counts. Background counts can be significantly higher in the Pit Ejector Room due to the presence of natural radon/thoron from the concrete walls and floors. A concerted effort must be made to reduce the background levels by using forced ventilation.

8.4 Gas purge should be 15-20 minutes at 100 cc/min.

8.5 A safety line should be attached to the probe to pullout should it get stuck. (Note: The P-10 gas/Ludlum 2221 line should not be used as the safety line.)

8.6 Place yellow plastic sleeving (two inches wide) around the probe cable to prevent contamination.

8.7 When moving/guiding probe into pipe, take a one-minute count every four inches.

8.8 Mark gas/HV cable with foot measuring tape to accurately determine depth and positioning in the pipe.

8.9 A number of Quality Assurance counts should be performed at pre-determined locations to determine the reproducibility of the data.

St. Albans Project 00-062

1.0 PURPOSE

The purpose of this procedure is to specify process requirements for evaporating water potentially containing radioactive material spilled in a radiological controlled area by enhanced evaporation methods. This procedure sets forth the specific requirements to assure this process does not release radioactive materials from a radiological controlled area.

2.0 APPLICABILITY

2.1 The procedure will be used to ensure that airborne particulates and effluents released to the environment by this process do not exceed criteria applicable to the license conditions at St. Albans VAECC facility or as specified in regulations or guidance provided by applicable regulatory agencies of the federal or state government.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

3.1.1 Instruments used to perform airborne surveys shall be operated in accordance with the respective operating procedures.

3.1.2 The approved methods for this enhanced evaporation process are heat lamps and/or immersion heaters.

3.1.3 The approved rate of evaporation by these processes shall be to a mild boil or mild simmering level.

3.2 Limitations

3.2.1 All evaporation shall be performed inside the radiological controlled area. Only water may be evaporated.

3.2.2 The evaporation process shall be performed only when Cabrera personnel are physically at the job site.

3.2.3 The only radionuclide monitored at St. Albans is Strontium-90 or daughter products of Strontium-90.

3.2.4 All vapors, fumes or particulates generated by this process shall be capable of being captured and detected by the air monitoring system in place.

3.2.5 This process shall not be used for water containing tritium or volatile radioactive species such as iodine.

3.3 Requirements

None

4.0 REFERENCES

- 10 CFR 20 Standards for Protection Against Radiation
- AP-012 Radiation Work Permits
- OP-001 Radiological Surveys
- OP-002 Air Sampling and Analysis
- OP-019 Radiological Posting
- OP-021 Alpha-Beta Counting Instrumentation
- NUREG-1556 Consolidated Guidance About Material Licenses (Vol.11)
- Reg 1.86 Termination of Operating Licenses for Nuclear Reactors

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Activity – The rate of disintegration (transformation) or decay of radioactive material. The units of activity for the purpose of this procedure are Becquerel (Bq) or micro-Curies (μCi).

5.2 Air Sample Survey – A survey technique which collects particulates from a known volume of air and determines the concentrations of radioactive materials associated with the airborne particulates.

5.3 Radiological Controlled Area – A work area whose access is restricted to authorized and trained personnel by use of a Radiation Work Permit due to one or more of the following conditions: radiation area, high radiation area, contaminated area, highly contaminated area or airborne area.

5.4 Survey – is defined as an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation.

6.0 EQUIPMENT

6.1 Low-Volume air sample pump with particulate filter paper.

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – the PM is responsible for ensuring that personnel assigned the task of surveying materials are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation Safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in the use of contamination survey meters described in this procedure.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT are responsible for performing the surveys described in this procedure.

8.0 INSTRUCTIONS

8.1 Water containing the potentially contaminated radioactive material to be evaporated is to be placed inside a container within the radiological controlled area.

8.2 Follow any specific requirements per the manufacturer regarding the assembly and/or placement of the evaporating enhancement device.

8.3 Place low volume air sampling pump with filter assembly within three feet of the top of the container. Start pump at the beginning of the evaporation process.

8.4 Perform periodic checks of the evaporation process as well as pump operability.

8.5 At the conclusion of the evaporation process for each day, shut off the evaporation device as well as the sample pump.

8.6 Count the filter paper with an alpha/beta proportional counter. If pure gamma emitting isotopes are present, the RSO/RFS should consider other appropriate counting equipment.

8.7 Monitoring of effluents released to the environment by this process will likely have lower concentration limits. Assume sufficient sampling volume is captured for these monitoring points to meet environmental minimum detectable activities.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 Instrumentation used for surveys will be checked with standards each day prior to use and verified to have current valid calibration.

9.1.2 The health physics technician performing the survey shall review Form OP-025-01 for accuracy and completeness.

9.2 Records

9.2.1 Documented information shall be legibly written in ink.

9.2.2 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.3 The health physics technician performing the survey shall ensure that this procedure is the most current and approved revision.

9.2.4 Entries on Form OP-025-01 and any other pertinent forms must be dated and initialed by the health physics technician performing the survey to be valid.

9.2.5 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

1.0 PURPOSE

This procedure provides the methods Cabrera Services, Inc. (CABRERA) use to control recognition of radioactive materials and areas. Adherence to this procedure will provide reasonable assurance that personnel will remain free of contamination, contamination will not spread beyond the designated contamination area, and personnel exposures will be maintained As Low As Reasonably Achievable (ALARA).

2.0 APPLICABILITY

This procedure will be used by CABRERA personnel to control and contain radioactive materials. The following are types of controls methods that will be employed:

- Posting requirements for radioactive materials.
- Establishing and posting radiation areas.
- Establishing and posting contaminated areas.
- Establishing and posting airborne radioactivity areas.

3.0 PRECAUTIONS, LIMITATION, AND REQUIREMENTS

3.1 Precautions

3.1.1 If a HPT is unable to perform this procedure due to errors, extenuating circumstances, or for any reason, the HPT shall immediately stop and notify the RSO.

3.2 Limitation

None

3.3 Requirements

None

4.0 REFERENCES

• 10 CFR 20, Subpart F	Surveys and Monitoring
• 10 CFR 20.2103	Records of Surveys
• HASP	Health and Safety Program
• OP-020	Operation of Contamination Survey Instrument
• OP-021	Alpha-Beta Sample Counting Instrument
• OP-022	Operation of Ionization Chambers

- OP-023 Operation of Micro-R Survey Meters

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Restricted Area – An area to which access is controlled to protect individuals against undo risks from exposure to radiation and radioactive materials.

5.2 Contamination Survey – A survey technique to determine fixed and removable radioactive contamination on components and facilities.

5.3 Radiation Survey – is defined as an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation.

5.4 ALARA – (acronym for "as low as is reasonably achievable") An approach to radiation exposure control to maintain personnel radiation exposures as far below the federal limit as technical, economical and practical considerations permit.

5.5 Radioactive Materials – Materials containing or capable of emitting alpha particles, beta particles, gamma rays, X-rays, neutrons and/or other ionizing radiations.

5.6 Airborne Radioactivity Area – A room, enclosure or area in which radioactive material is dispersed in the form of dusts, fumes, mists, vapors, or gases and the concentration of the of the dispersed radioactive materials in excess of:

5.6.1 The derived air concentrations (DAC's) specified in Table 1, Column 3 of Appendix B, Title 10 Part 20 of the Code of Federal Regulations.

5.6.2 Concentrations such that an individual present in the area without respiratory protective equipment could exceed, during the hours the individual is present in a week an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

6.0 EQUIPMENT

None Required

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – the PM is responsible for ensuring that personnel assigned the task of establishing and posting restricted areas are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation safety Officer (RSO) – The RSO is responsible for monitoring compliance with this procedure and training personnel in establishing and posting restricted areas. The RSO can also assist in the interpretation of the results obtained during surveys.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT establishing and posting restricted areas are responsible for knowing and complying with this procedure.

8.0 INSTRUCTIONS

8.1 Posting Requirements for Radioactive Materials

8.1.1 Any area or room in which there is used or stored an amount of licensed material exceeding 10 times of the quantity of such material specified in Appendix C, Title 10 Part 20 of the Code of Federal Regulations shall be posted with a sign or signs "Caution Radioactive Materials Area" or "Danger, Radioactive Materials".

8.1.2 When posting a room as required in step one, a sign should be placed on each entrance door to the room. If the area to be posted is not a room, the area containing the license material shall be bounded by a yellow and magenta/black rope or ribbon securely fastened to stanchions, posts or other durable devices and signs shall be displayed in all accessible directions.

8.1.3 Any container, which contains licensed material in quantities equal to or greater that the quantities listed in Appendix C, Title 10 Part 20 of the Code of Federal Regulation shall be posted with a sign or label bearing the radiation symbol and the words "CAUTION, RADIOACTIVE MATERIALS" OR "DANGER, RADIOACTIVE MATERIALS".

8.1.4 When posting a container as required by step three, the label should also state the radionuclide present in the container, the activity in the container, the date at which the activity was determined, the radiation levels emanating from the unshielded radioactive source, and the levels from the container holding the radioactive source.

8.1.5 Posting of containers is not required if the containers are in transport and packages and labeled in accordance with the regulations of the Department of Transportation. (Title 49 Parts 172 and 173 of the Code of Federal Regulations). Containers, which are awaiting shipment at a facility, are subject to posting requirements as specified in 8.1.1

8.2 Establishing and Posting Radiation Areas

8.2.1 Any area accessible to personnel in which there exists ionizing radiation at dose rate levels such that an individual could receive a deep dose equivalent in excess of 5 mrem in 1 hour at 30 cm from the source of from any surface that the radiation penetrates shall be identified and posted with a sign "CAUTION RADIATION AREA".

8.2.2 A Micro-R Meter or other calibrated dose rate meter is used to identify the boundary location of the 5 mrem/hr dose rate.

8.2.3 If an entire room or most of the room is at or above the 5 mrem/hr level, a sign should be placed on each entrance door to the room. If the area to be posted is not a room, the area at or above the 5 mrem/hr level shall be bounded by a yellow and magenta/black rope or ribbon securely fastened to stanchions, posts or other durable device and signs shall be displayed in all accessible directions.

8.2.4 An exemption to this posting requirement is allowed in areas or rooms containing radioactive materials for periods less than 8 hours, if each of the conditions is met:

8.2.4.1 The materials are constantly attended to during these periods by an individual who takes the precautions necessary to prevent the exposure to radiation or radioactive materials in excess of the limits specified in the RSP; and

8.2.4.2 The area or room subject to the licensee's control. For example, the area around the truck loading radioactive waste does not require posting if the above conditions are met.

8.2.5 If the dose rates above 100 mrem/hr are encountered, control access to the area and contact the RSO or duly authorized representative for posting instructions.

8.3 Establishing and Posting Contaminated Areas

8.3.1 A restricted area that has fixed and removable radioactive materials in the form of dusts, particulates or sorbed contaminants which are above the limits specified in the RSP shall be identified and posted with a "CONTAMINATED AREA" sign.

8.3.2 Contamination levels are determined using procedure OP-001 (Radiological Surveys) and the results of the survey measurements compared to the contamination limits specified in the RSP.

8.3.3 If an entire room or most of the room is above the contamination criteria, a sign should be placed on the entrance door to the room. If the area to be posted is not a room, the above area contamination criteria shall be bounded by a yellow and magenta/black rope or ribbon securely fastened to stanchions, posts or other durable device and signs displayed in all accessible directions.

8.3.3.1 A single entry point shall be established to access the contaminated area. A step-off pad is placed at the entry point, which provides a defined boundary between contaminated and restricted areas.

8.3.3.2 Receptacles for protective clothing and waste materials shall be placed just inside the entry point to collect protective clothing from personnel exiting the area.

8.3.3.3 If work activities in the work areas are likely to generate significant dusts containing radioactive materials, the area should be enclosed within a containment to prevent the spread of contamination beyond the identified contaminated area.

8.4 Establishing and Posting Airborne Radioactivity Areas

8.4.1 CABRERA's policy is to minimize (and protect, if practical) the amount of radioactive materials taken into a workers body. In order to accomplish this, Airborne Radioactivity Areas are posted at 10% DAC, as specified in Table 1, Column 3 of Appendix B of 10 CFR 20. Maintaining the airborne activity below these limits will eliminate any posting requirements.

8.4.2 To verify that these limits are not exceeded, an air sample is taken during each work activity, which could create an airborne radioactivity hazard. The results of these samples are compared with the above limits to verify the limits are not exceeded. If these limits are exceeded, immediately contact the RSO or duly authorized representative.

8.4.3 A room, enclosure or area shall be posted with a "CAUTION, AIRBORNE RADIOACTIVITY AREA" or "DANGER, AIRBORNE RADIOACTIVITY AREA" if radioactive material is dispersed in the form of fumes, dusts, mists, vapors, or gases and the contamination of the dispersed radioactive materials is in excess of:

8.4.3.1 The derived air concentration (DAC) specified n Table 1, Column 3 of Appendix B, Title 10 Part 20 of the Code of Federal Regulations.

8.4.3.2 Concentration such that an individual present in the area without respiratory protective equipment could exceed, during the hours the individual is present in a week, an intake of 0.6 percent of the annual limit on intake (ALI) or 12 DAC-hours.

8.4.4 If sampling results identify a room, enclosure, or area that requires posting as specified in 8.4.3, immediately stop work activities and contact the RSO or duly authorized representative for instructions.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 Instrumentation used in the surveys will be checked with standards daily and verified to have current valid calibration.

9.2 Records

9.2.1 Record any radioactive materials posting made in the project logbook. Include the date, location, and all information posted.

9.2.2 Record the date and the location of any radiation areas established in the project logbook. Include a sketch of the area and radiation area boundary on survey forms.

9.2.3 Record the date and location of any contaminated areas established in the project logbook. Include a sketch of the area and contaminated area boundary on survey forms.

9.2.4 Record the date and location of any airborne radioactivity areas established in the project logbook. Include a sketch of the area on survey forms. Indicate time and date of any notifications required by this procedure.

9.2.5 Document and record radiological survey records, routine survey schedules, and tracking forms that are generated during the performance of this procedure.

9.2.6 Documented information shall be legibly written in ink.

9.2.7 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.8 The HPT performing the posting shall ensure that this procedure is the most current and approved revision.

9.2.9 The HPT performing the posting shall review Forms and any other applicable forms for accuracy and completeness.

9.2.10 Entries on Forms and any other pertinent forms must be dated and initialed by the HPT performing the posting to be valid.

9.2.11 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

None

1.0 PURPOSE

The purpose of this procedure is to establish the framework and to define the requirements for Cabrera Services, Inc., (CABRERA) personnel performing radiological surveys. Adherence to this procedure will provide reasonable assurance that the radiological surveys performed maintain reproducible results. In addition, adherence to this procedure will provide adequate control of radiation exposures As Low As Reasonably Achievable (ALARA).

2.0 APPLICABILITY

This procedure provides the requirements for identifying, scheduling, and performing routine, clean area, radiation, contamination, and airborne surveys by radiation safety personnel. All remediation and facility areas that are radiologically controlled as well as non-radiologically controlled areas containing fixed contamination and areas adjacent to contaminated areas are within consideration for routine survey performance. This procedure does not include survey requirements for radiation generating devices and survey requirements specified in radiation work permits (RWP's).

This procedure will be used by CABRERA personnel to perform radiation and contamination surveys at St. Albans VAECC facilities. The following types of surveys may be performed using this procedure.

- Surveys performed for shipping radioactive materials.
- Surveys performed to characterize facilities, sites, and items contaminated with radioactive materials.
- Surveys performed to provide radiological support for decontamination and decommissioning facilities and sites.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

3.1.1 Instruments used to perform routine surveys shall be operated in accordance with the respective operating procedure.

3.1.2 Large area smears may be used to augment (but not replace) the 100 cm^2 smear survey. Large area wipes may be counted with the Ludlum Model-3 or equivalent. Large area smears are used to obtain immediate information concerning loose contamination for the purpose of radiological protection and to minimize time spent performing disc smears on an item easily identified as contaminated.

3.1.3 Personnel performing routine surveys shall be logged in on a Radiation Work Permit in accordance with AP-012 (if applicable).

3.1.4 Audible response instruments should be used during direct scan surveys.

3.1.5 The instruments used for routine or special surveys shall be within current calibration and shall have had a performance test check performed daily or before use in accordance with the instrument's operating procedure.

3.2 Limitations

3.2.1 The maximum probe speed during direct scan surveys of surfaces shall be 3 cm/sec.

3.2.2 The probe face shall be held within ¼ inch of the surface being surveyed for alpha radiation, and within ½ inch of the surface being surveyed for beta-gamma radiation.

3.2.3 If an instrument used to perform routine surveys fails any operational check, it shall be removed from service. All data collected during the period of instrument failure must be evaluated by the RSO or duly authorized representative.

3.2.4 Posting of radiological control areas shall be performed in accordance with OP-019.

3.3 Requirements

3.3.1 Obtain and review any previous surveys performed in the area to determine radiation conditions which will be encountered.

3.3.2 Before performing any survey using this procedure, the HPT shall be trained. The training shall allow the HPT to perform surveys independently.

3.3.3 To ensure achieving the required sensitivity of measurements, survey samples will be analyzed in a low-background area.

3.3.4 Dose rate surveys, at a minimum, should be performed in locations where workers are exposed to radiation levels that might result in radiation doses in excess of 10% of the occupational dose limits or where an individual is working in a dose rate area of 2.5 mrem/hr or more.

3.3.5 If contamination is found in unrestricted areas, prevent access to the area and immediately notify the RSO or duly authorized representative.

4.0 REFERENCES

• 10 CFR 20, Subpart F	Surveys and Monitoring
• 10 CFR 20.2103	Records of Surveys
• HASP	Safety and Health Program (RSP)
• AP-012	Radiation Work Permits
• OP-018	Decontamination of Equipment and Tools
• OP-19	Radiological Posting
• OP-020	Operation of Contamination Survey Meters
• OP-021	Alpha-Beta Counting Instrumentation
• OP-022	Operation of Micro-R Meters
• OP-023	Operation of Ionization Chambers
• NUREG-1556	Consolidated Guidance About Material Licenses (Vol.11)

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.

5.2 Contamination Survey – A survey technique to determine fixed and removable radioactive contamination on components and facilities.

5.3 Radiation Survey – is defined as an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation.

5.4 ALARA – (acronym for "as low as is reasonably achievable") An approach to radiation exposure control to maintain personnel exposures as far below the federal limits as technical, economical and practical considerations permit.

6.0 EQUIPMENT

All instruments used to perform routine surveys shall be used in accordance with the applicable CABRERA administrative and operational procedures. Authorized suppliers of properly calibrated and maintained equipment will supply all instruments.

Radiation and Contamination survey meters will be selected based on job specific requirements and will be identified in the Site Specific Work Plan.

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – the PM is responsible for ensuring that personnel assigned the task of performing routine surveys are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation safety Officer (RSO) – The RSO is responsible for monitoring compliance with this procedure and training personnel in performing radiation and contamination surveys. The RSO can also assist in the interpretation of the results obtained during surveys.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT performing radiation and contamination surveys are responsible for knowing and complying with this procedure.

8.0 INSTRUCTIONS

8.1 Safety Considerations

The safety requirements specified in the job specific HASP and Work Plans, along with the Radiation Safety Program, and other safety documentation must be adhered to when performing surveys.

8.2 Initial Preparations

Obtain and review any previous surveys performed in the area to determine radiation conditions, which will be encountered.

8.2.1 Obtain appropriate survey instruments and prepare the instruments for use.

8.2.2 Obtain necessary forms, smears, and protective clothing, which will be used during the survey.

8.2.3 Plan the strategy for performing the survey before entering the area to reduce exposure time within the area.

8.2.4 If smearable contamination is expected to be above allowable limits, set up an anticipate entry into the area which will prevent the spread of contamination in the area.

8.3 Radiation Surveys

8.3.1 If radiation levels are unknown or previous surveys remain in question, first measure general area radiation levels using a Micro-R Meter or equivalent dose rate meter to determine if elevated radiation levels exist in the survey area.

8.3.2 Small Areas/Items/Waste Containers – This survey technique is used to establish exposure rates from small areas, items, or containers, which contain radioactive materials.

8.3.2.1 Scan the entire surface area of the area, item, or container with a Micro-R or equivalent meter and record locations and readings on OP-001-02 or equivalent form.

8.3.2.2 Measure the exposure rate at 30 centimeters from all surfaces or sides of the area, item, or container and record the location and readings on OP-001-02 or equivalent form.

8.3.3 Facility Surveys – This survey technique is used to release facilities (buildings etc.) to "unrestricted" status or determine status of facilities requiring decontamination and decommissioning. Final release of a facility will be established using MARSSIM guidance.

8.3.3.1 Establish a 1 meter by 1 meter grid system of the facility surfaces using a marking system that assigns a unique number/letter system to the center of each grid. Graphically illustrate the location of the grid system on OP-001-02 or equivalent form.

8.3.3.2 Using a Micro-R Meter, obtain radiation levels at 1 meter from the grid center point and at contact with the grid center point. Record reading on OP-001-02 or equivalent Form. If elevated readings are noted, scan the surface of the grid and note location of any elevated readings with a marker and on OP-001-02 or equivalent Form.

8.3.3.3 Obtain 4 Micro-R readings from locations surrounding the facility or within the facility, which do not contain activity. This establishes a background level for comparison to the reading taken in step 8.2.3.2 above.

8.3.4 Area Surveys – This survey technique is used to release land masses to "unrestricted" status or determine status of areas requiring decontamination before release. Final release of a site area will be established using MARSSIM guidance

8.3.4.1 Establish a 10 meter by 10 meter grid system of the area to be surveyed using surveyor stakes or equivalent, which are numbered with a unique number/letter system to identify the center of each grid. List the locations of the "gridded" system on OP-001-02 or equivalent form.

8.3.4.2 Using a Micro-R meter, obtain radiation levels at 1 meter from the grid corner point and at contact with the surface of the ground. Record all readings on OP-001-02 or equivalent Form.

8.3.4.3 Survey the remainder of the grid at the surface using an "S" walking pattern. If elevated readings are noted above or below the grid center point reading, subdivide the grid into 9 subgrids (3 subgrids X 3 subgrids) and obtain readings at 1 meter above the ground surface, and obtain contact readings in the center of the each subgrid. Record all readings on OP-001-02 or equivalent.

8.4 Contamination Surveys

8.4.1 If removable contamination is suspected or previous surveys are in question, first scan likely contaminated area with an α and/or β probe to determine if elevated areas of contamination exists. Obtain smear samples from any elevated areas and count smears in sample counter. If smearable contamination is found, use appropriate protective clothing and entry control techniques to prevent the spread of contamination.

8.4.2 Small Areas/Items/Waste Containers – This survey technique is used to establish contamination levels on small areas, items, or containers, which contain radioactive materials.

8.4.2.1 If the area, item, or waste container contains alpha activity, scan the area with an alpha probe at ¼ inch above the surface. Note readings on OP-001-02 or equivalent Form.

8.4.2.2 If the area, item, or waste container contains beta activity, scan the area with a beta probe at approximately ½ inch above the surface to be surveyed and obtain reading following meter stabilization. Record meter reading on OP-001-02 or equivalent form. The surface of the waste container can be surveyed for beta activity only if the radiation level from the container does not elevate the beta probe background. If the background level is below 200

CPM, scan the surface of the container and note readings on appropriate survey form.

8.4.2.3 To determine the removable surface contamination on area or items, first take a large area smear (LAS) using a paper hand towel or Maslin cloth and count the smear in a low background area using the alpha and beta probes. If no contamination is found on the LAS, take 100 cm^2 smear for every 2 square foot of surface area and count smears for alpha and beta activity. Record results on OP-001-02 or equivalent form.

8.4.2.4 For waste containers, a LAS should be taken from the bottom, top, and sides of the container. If no contamination is found on the LAS, take 300 cm^2 smears for every 2 square foot of surface area and count smears for alpha and beta in a sample counter. Take one smear each from the container sealing area, lid, and container contact points with ground or floor. Record all results of smear activity on OP-001-02 or equivalent Form. If contamination levels are above limits, decontaminate the surface of the container and repeat survey.

8.4.2.5 Facility Surveys – This survey technique is used to aid in the release of facilities (buildings etc.) to "unrestricted" status or determine status of facilities requiring decontamination and decommissioning.

8.4.2.6 The grid system established in section 8.3.3.1 will also be utilized for contamination surveys.

8.4.2.7 Hold the beta probe at approximately ½ inch above the grid center point and obtain reading following meter stabilization. Record the meter reading on OP-001-02 or equivalent form.

8.4.2.8 If the readings are at background levels, randomly scan the remainder of the grid, concentrating on cracks, floor/wall joints, top of horizontal surfaces, ventilation ducts and grills, and other areas that might collect radioactive materials. Mark any locations above the release criteria on OP-001-02 or equivalent form.

8.4.2.9 If readings are at or near the release levels, scan grid surface and identify portion of the grid that is above the release criteria. Note these areas on the survey form and mark the area of the grid with spray marker (or equivalent) on OP-001-02 or equivalent form.

8.4.2.10 Repeat steps 8.4.2.7 through 8.4.2.9 with an alpha probe at ¼ inch above the grid center point. If sufficient documentation of previous history is known about the facility, the alpha survey may not be required if:

- The alpha contamination is known not to be present, or

- The alpha measurements can be randomly taken of every 10th grid.

8.4.2.11 One smear sample from a $100cm^2$ area will be taken in each grid. If the above survey found no elevated readings in the grid, the smear sample will be taken in the center of the grid. If elevated levels readings are identified the smear sample will be taken from the area where the highest reading was obtained.

8.4.2.12 Each smear sample will be labeled with the grid location and counted for alpha and beta activity in the sample counter. The smear sample results will be recorded on OP-001-02 or equivalent Form.

8.4.3 Area Surveys – This survey technique is used to aid release of land masses to "unrestricted" status or determine status of area requiring decontamination before release.

8.4.3.1 The grid system established in section 8.2.4, step 8.2.4.1 will also be utilized for contamination surveys.

8.4.3.2 Hold the beta probe at ½ inch above the grid center point and obtain reading following meter stabilization. Record the meter reading on OP-001-02 or equivalent form.

8.4.3.3 If readings are at background levels, randomly scan the remainder of the grid. Mark any locations above release criteria on OP-001-02 or equivalent form.

8.4.3.4 If readings are at or near the release levels scan the grid surface and identify portion of the grid that is above release criteria. Note these areas on OP-001-02 or equivalent form.

8.4.3.5 Areas contaminated with radioactive materials may require soil sample analysis to determine the activity concentration.

The quantity and location of samples will be determined on a case-by-case basis.

8.5 Frequency and Requirements for Routine Surveys

Appropriate routine radiological surveys shall be performed at the following frequencies as a minimum:

8.5.1 Radiation Surveys

- Upon initial entry after extended periods of closure
- Daily, at contamination control points, where the potential exists for personnel to be exposed to radioactive contamination
- Daily, during continuous operation, and when levels are expected to change in High Radiation Areas
- Weekly, in routinely occupied areas adjacent to radiological control areas
- Weekly for operating HEPA-filtered ventilation units
- Weekly, for any temporary Radiation Area boundaries to ensure that the Radiation Areas do not extend beyond posted boundaries
- Monthly, or upon entry if entries are less than monthly, for Radioactive Material Storage Areas
- Monthly, for potentially contaminated ducts, piping, and hoses in use outside the radiological facilities

8.5.2 Contamination Surveys

- Daily, at contamination control points, personnel protective equipment change out areas, or step-off pads, when in use or once per shift in high use situations
- Daily, in office spaces located in the radiological control areas
- Daily, in lunchrooms or eating areas adjacent to radiological control areas
- Weekly, for all designated lunchrooms supporting the project
- Weekly, in routinely occupied locker rooms or the shower areas

adjacent to radiological control areas

- Weekly, or upon entries, if entries are less frequent, in radiological control areas
- Weekly, or upon entries, if entries are less frequent, in the areas where radioactive materials are handled or stored
- Weekly for all project offices on site
- Monthly, in areas with fixed contamination

8.5.3 Airborne Surveys:

Airborne survey frequency, locations, and methods are determined by the radiation work permits (RWP's) and by the RSO.

8.6 Identifying and Scheduling Routine Radiological Surveys

8.6.1 The RSO or duly authorized representative shall identify and schedule routine surveys as required by the radiological conditions and work activities.

8.6.2 Routine Survey Schedules shall be developed using a standard system for designating surveys as follows:

Frequency of Survey

• Daily	D
• Weekly	W
• Monthly	M
• Quarterly	Q
• Semi-Annually	S
• Annually	A
• Upon Entry	U

Type of Survey

• Radiation	R
• Contamination	C
• Area TLD	T
• Air Sample	A

Example: DRC-1
Where:

D: is the survey frequency (Daily in this example)
R: is the type of survey (Radiation in this example)

C: is a type of survey (Contamination)
1 corresponds to the numerical sequence of the survey

8.6.3 Routine survey schedules shall be submitted to and approved by the RSO or duly authorized representative.

8.6.4 Prepare routine survey tracking forms using the approved routine survey schedules.

8.6.5 Changes to any routine survey schedule shall be submitted to and approved by the RSO or duly authorized representative.

8.6.6 Routine Survey Schedules should be indicated on form OP-001-01or equivalent form. Task Leaders may elect alternate forms of containing, as a minimum, the information included on the OP-001-01 form.

8.7 Using As Low As is Reasonably Achievable (ALARA) Principles for Scheduling and Performing Surveys

8.7.1 Routine surveys should not be performed in High Radiation Areas unless other work necessitates entry. Boundary verification surveys would be appropriate if an entry is not required.

8.7.2 Routine surveys should be performed in conjunction with other work surveys as much as practicable.

8.8 Performance of Routine Surveys

8.8.1 HPT's shall perform routine surveys in accordance with the applicable operational procedure.

8.8.2 Upon completion of a routine survey, the HPT shall initial the appropriate Routine Survey Tracking Form.

8.9 Periodic Evaluation of Routine Surveys

8.9.1 Routine survey schedules shall be reviewed and updated periodically to ensure that all areas within the project boundaries are receiving the appropriate routine survey coverage.

8.9.2 Changes of conditions within the project area will be reported to the RSO or duly authorized representative and may require a modification of the routine radiological survey schedule.

8.10 Management Notification

8.10.1 The RSO shall be notified, in writing by the project manager, of any failure to complete a routine survey as scheduled. The missed survey will be completed within 24 hours of discovering the inconsistency.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 Instruments used to perform routine radiological surveys will be inspected for serviceability each day and checked against check sources to verify they are in proper working condition per the applicable Operational Procedure.

9.1.2 Radiation and Contamination surveys will be reviewed by the RSO or duly authorized representative for accuracy and completeness.

9.2 Records

9.2.1 At a minimum, each survey record should include the following:

- A diagram of the area surveyed, if applicable.
- A list of items and equipment surveyed.
- Specific locations on the survey diagram where wipe test were taken.
- Ambient radiation levels with appropriate units.
- Contamination levels with appropriate units.
- Make and model number of instruments used.
- Background levels, if applicable.
- Name of the person making the evaluation and recording the results and date.

9.2.2 Radiological Survey Records, routine survey schedules, and tracking forms are generated during the performance of this procedure.

9.2.3 Documented information shall be legibly written in ink.

9.2.4 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.5 The health physics technician performing the survey shall ensure that this procedure is the most current and approved revision.

9.2.6 The health physics technician performing the survey shall review Forms and any other applicable forms for accuracy and completeness.

9.2.7 Entries on Forms and any other pertinent forms must be dated and initialed by the health physics technician performing the survey to be valid.

9.2.8 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

- OP-001-01 Routine Survey Schedule
- OP-001-02 Survey Form

OP-001-01
ROUTINE SURVEY SCHEDULE

Survey Designation	Location of Survey

Prepared By: ______________________ Date: __________

Reviewed By: ______________________ Date: __________

OP-001-02 Radiological Survey Sheet

Location:	RWP#	Survey #	Survey Type:	pg. 1 of 1

Smear Results
DPM/100cm^2

No.	α	β	No.	α	β
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

Surveyed By: Date:

Reviewed By: Date:

Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due

Key

○	Smear	"-"	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

1.0 PURPOSE

This procedure describes methods for control of instrument check sources and the methods used to evaluate sources for the potential of leaking radioactive material. These sources are used to ensure proper radiation detection instrument operation. Adherence to this procedure will provide reasonable assurance that personnel exposures will be below specified limits, sources will not be lost or misplaced, personnel will remain free of contamination, and contamination will not be spread beyond any designated contaminated areas. In addition, adherence to this procedure will provide reasonable assurance that leak testing of radioactive sources meet the requirements of 10 CFR 20 and NRC license.

2.0 APPLICABILITY

This procedure will be used by Cabrera Services, Inc. (CABRERA) personnel for use and control of radioactive check sources used for portable radiation detectors. This procedure will also be used for leak testing of radioactive sources and also applies to licensed and exempt sources.

3.0 PRECAUTIONS, LIMITATIONS, AND REQUIREMENTS

3.1 Precautions

3.1.1 When performing a leak test on non-exempt quantity sources, use specific license procedures.

3.1.2 If non-exempt quantity sources are used, the RSO or duly authorized representative will determine any additional precautions (i.e., finger rings, etc.).

3.1.3 If licensed quantity sources are leak tested, the RSO or duly authorized representative will determine any additional precautions (i.e., finger rings, etc.).

3.1.4 The window area of a particle detector is covered with a thin window and may be easily punctured. Avoid surveying areas which have protruding fragments that may puncture the detector face. Remove the protruding fragments, if possible, before surveying. Upon removal of the leak test sample, monitor the sample away from the source. If the sample yields a high-count rate compared to background, assume the source to be leaking and estimate the activity based upon the reading of the portable instrument.

3.2 Limitations

3.2.1 Storage location(s) of instrument check sources will be approved by the RSO or duly authorized representative for protection against loss, leakage, or dispersion by the effect of fire or water.

3.2.2 A Radiation Work Permit must be generated for leak testing of non-exempt sources.

3.3 Requirements

3.3.1 Individual source quantities shall not exceed exempt quantity limits without permission of the RSO or duly authorized representative.

3.3.2 The methods specified in this procedure will be audited annually to ensure compliance with the requirements to control radioactive sources.

3.3.3 The results of leak test samples shall be stated as less than 0.005 microcuries of removable activity if applicable in order to comply with NRC requirements.

3.3.4 Ensure accountability and direct control of the source at all times when it is unlocked. Minimize the number of people in the area of the source during the leak test to reduce exposure and maintain work areas as low as is reasonably achievable (ALARA). If high radiation area controls are necessary, the source must either be locked or guarded.

3.3.5 Only qualified Health Physics personnel may use or have possession of CABRERA radioactive check sources.

4.0 REFERENCES

- OP-001 Radiological Surveys
- OP-020 Operation of Contamination Survey Meters
- OP-021 Alpha-Beta Sample Counting Instrumentation
- OP-022 Operation of Ionization Chambers
- OP-023 Operation of Micro-R Survey Meters
- NUREG-1556 Consolidated Guidance About Material Licenses (Vol.11)

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Restricted Area – An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

5.2 Leak Test – A survey technique used to determine the presence of removable activity from the surface of a sealed source.

6.0 EQUIPMENT

- Ludlum 2929 or equivalent
- Smears
- Portable radiation detection equipment
- Calibration sources

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – The PM is responsible for ensuring that all personnel assigned the tasks of control and leak testing of sealed sources of radioactive material, are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained with radioactive sources as described in this procedure. The RSO ensures the Health Physics Technicians are qualified by training and experience to perform the requirements of this procedure.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT are responsible for control and use of radioactive check sources. The HPT conducting leak tests of sealed sources are responsible to comply with the provisions of this procedure.

8.0 INSTRUCTIONS

8.1 Action Levels

- Inventory

  The RSO or duly authorized representative shall be notified immediately if it has been determined that a source is missing and an immediate search shall be conducted.

- Leakage

If a source is suspected to have lost integrity, the RSO or duly authorized representative shall be notified immediately and a leak test shall be performed.

- Radiation Levels

Radiation levels shall be maintained at less than 2 millirem per hour on any accessible surface where the radioactive check sources are stored. Notify the RSO or duly authorized representative if radiation levels exceed 2 millirem per hour.

8.2 Inventory

A physical inventory of all instrument check sources will be conducted by the RSO or duly authorized representative at least once each quarter and whenever a new check source is received or an old check source is disposed. The results shall be recorded on Form OP-009-01 and shall be retained in the source file for a period of not less than three years.

8.3 Initial Preparations

8.3.1 Select a work area to conduct the leak test that is free of radioactive contamination.

8.3.2 Select instruments that are capable of detecting at least 0.005 microcuries of the radionuclide of concern.

8.3.3 Inform the RSO or duly authorized representative of the source to be leak tested. The RSO or duly authorized representative will evaluate the test and provide precautionary measures to ensure protection of people and equipment in the work area.

8.3.4 Smear the outside surface of the source using cloth or paper. This smear will be the leak test sample that is analyzed for activity associated with a potentially leaking source.

8.3.5 Be cautious when handling leak test samples to prevent the spread of contamination, should the sample have loose radioactivity on it from a leaking source.

8.3.6 If the source emits particle radiation, a very thin window will typically cover the radioactive material. Take special precautions to prevent damage to the window during leak testing.

8.3.7 Be sure to wear rubber or latex gloves when handling the leak test samples or equipment associated with the test.

8.4 Analysis

The leak test sample shall be analyzed by a method, which will ensure detection of at least 0.005 microcuries of the radionuclide of interest. Existing CABRERA procedures shall be used as practical to ensure appropriate analysis and documentation of results.

Note: If the activity estimation determines the leak test sample to be in excess of the leak test limit of 0.005 microcuries, then label the source as unusable to prevent further spread of activity. Conduct a detailed survey of the leak test work area to ensure that activity from the source has not spread beyond the capsule of the source.

8.5 Performing a Leak Test

8.5.1 Although leak tests are not required for exempt quantity sealed sources, in the event a source is suspected of having a loss of encapsulation or other possible leakage, the following procedure shall be followed, under the direction of the RSO or duly authorized representative :

8.5.1.1 A visual inspection of the source shall be made for physical damage. If an area of the source is noticeably damaged, perform the leak test in that area, otherwise proceed to step 8.3.1.2.

8.5.1.2 Determine the extent of source leakage by one of the following methods:

8.5.1.3 Dry Wipe Test - This test will be performed on encapsulated sources or adjacent surfaces of plated or foil sources. The sources shall be wiped with a dry disc smear applying moderate pressure. Removal of any radioactive materials from the source or adjacent surfaces (i.e., source leakage) will be determined by counting the filter paper with appropriate instrumentation.

8.5.1.4 Wet Wipe Test - This test will be performed on encapsulated sources only. The entire surface of the source shall be wiped with a disc smear moistened with water, applying moderate pressure. Removal of any radioactive material from the source will be determined by counting the filter paper with appropriate instrumentation after the filter paper has dried out.

8.5.2 When any contamination or leak test reveals the presence of 0.005 μCi or greater of removable contamination, or activity removed is above the critical level of the detecting instrument, the source shall be retested. The source will be either repaired, if possible, or disposed of as radioactive waste if the second test is unsatisfactory. The results of leak tests for the sources are recorded on Form OP-009-02 and shall be retained for a minimum of three years.

8.6 Survey

The on-contact radiation level exterior to where the sources are stored shall be maintained at less than 2 millirem per hour on any accessible surface. A radiation survey of the storage location shall be performed at least quarterly and after the receipt of any additional check sources.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 The quality of leak test analyses is dependent upon the quality of the wipe, and the quality of analysis. Periodic evaluation of the process and analysis methods shall be conducted to ensure appropriate methods are used and this procedure is followed.

9.2 Records

9.2.1 The RSO or duly authorized representative prepares and maintains a source file which shall, at a minimum, consist of the following:

- Procurement history of each source, including copies of seller certification;
- Status change - damage, sale or transfer, disposal, or recalibration;
- Completed "Sealed Source Inventory and Leak Test" Form ; and,
- Any other correspondence related to the sources.

9.2.2 Documented information shall be legibly written in ink.

9.2.3 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.4 The health physics technician using this procedure shall ensure that it is the most current and approved revision.

9.2.5 The health physics technician performing inventory shall review Forms OP-009-01 and OP-009-02 for accuracy and completeness.

9.2.6 Entries on Forms OP-009-01 and OP-009-02 and any other pertinent forms must be dated and initialed by the health physics technician performing the inventory to be valid.

9.2.7 The RSO or duly authorized representative shall review completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

OP-009-01 Sealed Source Inventory and Leak Test

OP-009-02 Sealed Source Leak Test Data Sheet

OP-009-01
SEALED SOURCE INVENTORY AND LEAK TEST

Inventory Period: First Quarter ☐ Second Quarter ☐ Third Quarter ☐ Fourth Quarter ☐

Isotope	Source (Type/Form)	Serial Number	Location	Initial Activity	Corrected Activity	Leak Test uCi/smear

Comments____

Date Performed:________________ By:____________________
Print/Sign

Reviewed/Approved By:________________________ Date:________
Print/Sign

OP-009-02
Sealed Source Leak Test Data Sheet

Source Information

Source ID Number____________

Source Manufacturer:________________ Date of Assay: _______________

Source Model Number: _______________ Source Serial #_______________

Activity of Source at Assay Date:________Ci Source Today: __________ Ci

Radionuclide name: __________________ Half-life of radionuclide________

Leak Test Sample Information

Location of Leak Test Work Area ____

Describe the method of leak testing:____________________________________

____

Sample Geometry: ___________________ Detector: ______________________

Detection Efficiency:________________c/d Background count time: _______ min.

Background count rate: _____________cpm MDA: _____________ microcuries

Sample net count rate: ______________cpm Sample count time: ________ min.

Leak test sample activity: _______________ microcuries

Leak Test Result – Check all boxes that apply

- ☐ The leak test sample is in excess of the 0.005 microcurie limit
- ☐ The leak test sample is below the 0.005 microcurie limit
- ☐ The source has been controlled to prevent the spread of activity from the shield.

Source Leak Test Performed by:_____________________________ Date: ________

Leak Test Analysis Conducted by: ___________________________ Date: ________

Radiation Safety Officer: __________________________________ Date: ________

1.0 PURPOSE

The purpose of this procedure is to specify requirements for releasing material from controlled areas and to minimize the potential for unintentionally releasing contaminated items to uncontrolled areas in accordance with the provisions stated in Section 4.0, References. This procedure sets forth the specific requirements for release of materials from controlled areas applicable to Cabrera Services, Inc. (CABRERA) field projects.

2.0 APPLICABILITY

2.1 This procedure provides instructions for CABRERA personnel while performing release surveys of items controlled as contaminated or potentially contaminated with radioactive materials.

2.2 The procedure will be used to ensure by survey that materials released from contaminated or potentially contaminated areas will meet the release criteria applicable to the license conditions, St. Albans VAECC facility requirements, or as specified in regulations or guidance provided by applicable regulatory agencies of the federal or state government.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

3.1.1 Instruments used to perform release surveys shall be operated in accordance with the respective operating procedure.

3.1.2 Large area smears may be used to augment (but not replace) the 100 cm^2 smear survey. Large area wipes may be counted with the Ludlum Model-3 or equivalent. Large area smears are used to obtain immediate information concerning loose contamination for the purpose of radiological protection and to minimize time spent performing disc smears on an item easily identified as contaminated.

3.1.3 A release document package, at a minimum, shall include the following forms:

3.1.3.1 The Health Physics daily log.

3.1.3.2 Material Release Log.

3.1.3.3 Radiation and Contamination Survey or an Unconditional Release of Equipment or Items Survey and/or Sample Calculation Worksheet.

3.1.3.4 Daily Instrument Calibration Log.

3.1.4 The release document shall include the following information:

3.1.4.1 The date of the release survey.

3.1.4.2 The number of the release survey.

3.1.4.3 A description or identification of the item.

3.1.4.4 The identity of the Health Physics Technician performing the release survey.

3.1.4.5 The evaluator of the material for release.

3.1.4.6 The release approval of the RSO or duly authorized representative.

3.1.5 Surveys performed for the release of material shall be documented on a Radiation and Contamination Survey and/or on an Unconditional Release of Equipment or Items Survey.

3.1.6 Radiation/contamination surveys shall be performed in accordance with OP-001.

3.1.7 Items identified as radioactive during the release survey shall be controlled in accordance with OP-019.

3.1.8 Personnel performing release surveys shall be logged in on a Radiation Work Permit in accordance with AP-012 (if applicable).

3.1.9 Audible response instruments must be used during direct scan surveys.

3.1.10 The instruments used for release surveys shall be within current calibration and shall have had a response check performed daily or before use in accordance with the instrument's operating procedure.

3.1.11 Items presented for release shall be direct scanned in an area of low background.

3.2 Limitations

3.2.1 The maximum probe speed during direct scan surveys of surfaces shall be 3 cm/sec.

3.2.2 A response check shall be performed at the completion of the workday for instruments used for direct scan surveys in accordance with the instruments operating procedure.

3.2.3 The probe face shall be held within ¼ inch of the surface being surveyed for alpha radiation, and within ½ inch of the surface being surveyed for beta-gamma radiation.

3.2.4 If an instrument used to perform release surveys fails any operational check, it shall be removed from service. All data collected during the period of instrument failure must be evaluated by the RSO or duly authorized representative.

3.2.5 Posting and access control of controlled areas shall be performed in accordance with OP-019.

3.3 Requirements

None

4.0 REFERENCES

- 10 CFR 20 — Standards for Protection Against Radiation
- AP-012 — Radiation Work Permits
- OP-001 — Radiological Surveys
- OP-009 — Use and Control of Radioactive Check Sources
- OP-019 — Radiological Posting
- OP-020 — Operation of Contamination Survey Meters
- OP-021 — Alpha-Beta Counting Instrumentation
- OP-023 — Operation of Micro-R Survey Meters
- NUREG-1556 — Consolidated Guidance About Material Licenses (Vol.11)
- Reg 1.86 — Termination of Operating Licenses for Nuclear Reactors

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Activity – The rate of disintegration (transformation) or decay of radioactive material. The units of activity for the purpose of this procedure are Becquerel (Bq) or micro-Curies (μCi).

5.2 Contamination – Deposition of radioactive material in any place where it is not desired. Contamination may be due to the presence of alpha particle, beta particle or gamma ray emitting radionuclides.

5.3 Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.

5.4 Fixed Contamination – Radioactive contamination that is not readily removed from a surface by applying light to moderate pressure when wiping with a paper or cloth disk smear, or masslinn.

5.5 Minimum Detectable Activity (MDA) – For purposes of this procedure, MDA for removable radioactive contamination is defined as the smallest amount of sample activity that will yield a net count with a 95% confidence level based upon the background count rate of the counting instrument used.

5.6 Release for Unconditional Use – A level of radioactive material below which it is acceptable for use without restrictions. Under normal circumstances, authorized limits for residual radioactive material are set equal to, or below, the values specified in Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors.

5.7 Survey – is defined as an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation.

5.8 Survey Exempt Materials – The contents of sealed containers which remain unopened while in a controlled area are exempt, the outside surfaces are not exempt.

6.0 EQUIPMENT

None

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – the PM is responsible for ensuring that personnel assigned the task of surveying materials are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in the use of contamination survey meters described in this procedure.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT are responsible for performing the surveys described in this procedure.

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8.0 INSTRUCTIONS

8.1 Release Limits for Gross Activity (Unknown Isotopes)

EMISSION	REMOVABLE dpm/100 cm^2	TOTAL (Fixed and Removable dpm/100 cm^2
Beta-Gamma	200	1000

NOTE: If all of the constituents of the contamination are known and documented on the release documents, the release limits of Table 1 of Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors applies.

8.2 Inaccessible Surfaces

8.2.1 Items with inaccessible surfaces should be disassembled as completely as possible to facilitate release surveys. Items with inaccessible surfaces will not be unconditionally released unless evaluated by a designated evaluator who authorizes and documents the release.

8.2.2 The following guidance will be used when performing evaluations:

8.2.2.1 A history of the item should be reviewed.

8.2.2.2 The actual release survey shall be reviewed.

8.2.2.3 Determination of the radiological conditions in the area the item has been used or stored shall be reviewed.

8.3 Materials considered dangerous, fragile, or not readily smearable due to their physical or chemical nature shall not be unconditionally released unless evaluated on a case by case basis for release in a manner consistent with Section 8.2.2. Evaluation for release shall be performed by a designated evaluator only.

8.4 Survey Exempt Materials

8.4.1 Items such as briefcases, pens, papers, personal clothing, etc., are exempt from the Health Physics release survey requirements of this procedure, unless deemed appropriate by the HPT.

8.4.2 Individuals shall survey the exempt items in the same manner as a whole body frisk when leaving a controlled area or have a Health Physics Technician perform the survey.

8.5 Survey Procedure

8.5.1 Upon receipt of an item presented for release, attempt to determine the history:

8.5.1.1 Purpose of item.

8.5.1.2 The current and past use of the item.

8.5.1.3 The location(s) in which the item was used or stored.

8.5.1.4 If the item was ever used for work with radioactive material or used in an area where radioactive material was used or stored.

NOTE: This knowledge of the item history should provide the surveyor with information helpful in performing the release survey.

8.5.2 Using protective clothing such as gloves, perform large area smears of 100% of the accessible surfaces of the item using large area wipes (e.g. masslinn).

8.5.2.1 Determine if transferable (loose) radioactive material is present by measuring the amount of activity on the surface of the cloth.

8.5.2.2 If the presence of radioactive material is indicated by a count rate above background, the item shall be treated as contaminated until the results of the disc smear survey are obtained and determination is made concerning the actual 100 cm^2 loose contamination levels. The material shall be controlled in accordance with OP-019.

8.5.3 Perform a direct scan of 100% of all accessible areas of the item, in accordance with the instrument's operating procedure, and OP-001.

NOTE: Items presented for release shall be direct scanned in an area of low background. Preferably $\leq$ 100 CPM. The Health Physics Technician performing the release survey shall determine if the background is acceptable for direct scan of the item.

8.5.4 If the scan indicates radioactive material on the surface of the item is less than the limits of release for total activity, proceed to 8.5.10.

8.5.5 If the scan indicates radioactive material on the surface is greater than regulatory limits for total activity, the item cannot be released.

8.5.6 During the direct scan of the accessible surfaces of the item, a static measurement shall be taken:

8.5.6.1 If an increase in the audible count rate is detected.

8.5.6.2 After each minute of scanning.

8.5.6.3 When the Health Physics Technician determines that an indication of fixed activity in an area less than ten square centimeters may be present.

8.5.6.4 During the static measurement, the meter probe shall be held at the proper distance from the surface being surveyed for the proper response period to allow the meter reading to stabilize, in accordance with the instrument's operating procedure.

8.5.7 Perform disc smears which are representative of 100% of the effective surface area.

8.5.7.1 100% of the effective accessible surface means performing a 100 cm^2 disc smear on all accessible areas of the item suspected of being contaminated.

8.5.8 Count the smears in accordance with reference OP-001 and/or OP-021 as appropriate.

8.5.8.1 Record smear data on the Radiation and Contamination Survey.

8.5.8.2 If the smear results indicate transferable activity below the release limits, proceed to Step 8.5.10

8.5.8.3 If the smear results indicated transferable activity above the release limits, the item cannot be released

8.5.9 If item has internal or inaccessible surfaces, CABRERA personnel will disassemble the item and repeat Steps 8.5.2 through 8.5.5 or have the item evaluated for release by a designated evaluator.

8.5.10 If the item meets the release limits or is evaluated as meeting the unconditional release criteria complete form OP-004-01. The RSO or duly authorized representative must review the release documents and approve the release before allowing the item to leave the controlled area.

8.5.11 If items are identified as radioactive during the release survey, contact the RSO or duly authorized representative.

8.6 Action level

8.6.1 If direct frisk beta-gamma instrument readings exceed 100 cpm above background (with background less than 200 cpm) those areas shall be surveyed as follows:

8.6.1.1 Perform a smearable contamination survey using 100 cm^2 of affected areas, and count the smears for beta-gamma contamination to determine if contamination is “fixed” or “removable.”

8.6.2 Dose rate surveys, which exceed 0.2 mR/hr, shall be brought to the attention of the RSO or duly authorized representative for release or acceptance approval.

8.7 The results of the survey shall be documented on Radiation and Contamination surveys.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 Instrumentation used for surveys will be checked with standards each day prior to use and verified to have current valid calibration.

9.1.2 When releasing a large volume of materials, a program may be established under the discretion of the RSO or duly authorized representative to ensure by second check that no radioactive material has been released to the public or the environment.

9.1.3 The health physics technician performing the survey shall review Form OP-004-01 and any other applicable forms for accuracy and completeness.

9.2 Records

9.2.1 Documented information shall be legibly written in ink.

9.2.2 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.3 The health physics technician performing the survey shall ensure that this procedure is the most current and approved revision.

9.2.4 Entries on Form OP-004-01 and any other pertinent forms must be dated and initialed by the health physics technician performing the survey to be valid.

9.2.5 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

OP-004-01 Unconditional Release of Equipment or Items Report

OP-004-01
UNCONDITIONAL RELEASE OF EQUIPMENT AND ITEMS LOG

Project Name ______________________________ Project Number ______________

Item/ Equipment Released	Comments	Survey #	Date

Reviewed By: ______________________________ Date: ________

1.0 PURPOSE

This procedure instructs Cabrera Services Inc. (CABRERA) field personnel in the proper use of step-off pads.

This procedure provides the method Cabrera Services, Inc. (Cabrera) uses to ensure step off pads are used in accordance with procedure requirements. Adherence to this procedure will provide reasonable assurance that step-off pads are being used to prevent the spread of contamination. Adherence to this procedure also provides adequate control of contamination levels which meets CABRERA's goal of maintaining radiation exposures As Low As is Reasonably Achievable (ALARA).

2.0 APPLICABILITY

This procedure applies to all CABRERA radiological remediation projects or operations that use step-off pads for radiological contamination control.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

Step-Off pads should always be placed in the Radiological Buffer Area just outside the contamination area as a control to prevent the spread of contamination.

3.2 Limitations and Requirements

Not Applicable

4.0 REFERENCES

- HASP — Health and Safety Plan (Radiation Safety Program)
- OP-001 — Radiological Surveys
- OP-004 — Unconditional Release of Material from Radiological Control Areas

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.

5.2 Contamination Survey – A survey technique to determine fixed and removable radioactive contamination on components and facilities.

5.3 Radiation Survey – is defined as an evaluation of the radiological conditions and potential hazards incident to the production, use, transfer, release, disposal, or presence of radioactive material or other sources of radiation.

5.4 ALARA – (acronym for "as low as is reasonably achievable") An approach to radiation exposure control to maintain personnel radiation exposures as far below the federal limit as technical, economical and practical considerations permit.

6.0 EQUIPMENT

Step-Off Pads

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – The PM is responsible for ensuring that all personnel assigned the task of utilizing step-off pads are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation Safety Officer (RSO) – The Radiation Safety Officer is responsible for monitoring compliance with this procedure and training personnel in the use of step-off pads.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT performing radiological surveys in accordance with this procedure are responsible for knowing and complying with this procedure.

8.0 INSTRUCTION

8.1 Location of Step-Off Pads

8.1.1 Radiation safety personnel will specify the placement of step-off pads based on the requirements listed below:

- A single step-off pad should be installed at exit points from areas where loose surface contamination levels exceed 200 dpm/100 cm^2 for β, γ.
- Two step-off pads, separated by a covered area where possible, should be installed at exit points from areas where contamination

levels exceed one hundred times the limits for a single step-off pad.

8.1.2 Considerations must be given to other radiological conditions and general safety precautions when installing step-off pads:

- Step-off pads should be positioned at personnel control points in such a manner that they do not cause individuals to remain in significant radiation fields while removing protective clothing. In these cases, the step-off pad should be separated from the actual point of exit, by a covered area.

- Step-off pads should be placed in such a manner that they do not constitute a safety hazard. For example, step-off pads should not be placed on steep ground, slippery surfaces, etc.

- Step-off pads should not be placed at Emergency Exits or at an Equipment Exit or Entrance.

8.2 Use of Step-Off Pads

8.2.1 Step off pads shall be considered uncontaminated surfaces in the case of a single step-off pad; or as surfaces of lower contamination than the contaminated area, in the case of first two step-off pads (when exiting the posted area). The step-off pad needs to be surveyed periodically in accordance OP-001.

8.2.2 Before stepping out of the Contaminated Area or Airborne Radioactivity Area to the step-off pad, the worker should:

- Remove exposed tape.
- Remove rubber overshoes.
- Remove outer pair of gloves.
- Remove hood from the rear.
- Remove respiratory protection as applicable.
- Remove coveralls, inside out, touching the insides only.
- Take down barrier closure, as applicable.
- Remove tape or fastener from inner shoe cover.
- Remove each shoe cover, place the shoe cover into the

container for contaminated shoes, and step onto clean step-off pad.

- Remove cloth glove liners.
- Replace barrier closure, as applicable.
- Commence whole body frisking.
- Frisk badge and dosimeter.

8.2.3 The sequence for the removal of primary and supplemental dosimetry is dependent upon where the dosimetry was worn and the potential for contamination.

8.2.4 Use of Multiple Step-Off Pads

- Multiple step-off pads should be used to control exit from high surface contamination areas. These pads define interim control measures within the posted area to limit the spread of contamination. The following controls apply:
- The inner step-off should be located immediately outside of the highly contaminated work area, but still within the posted area.
- The worker should remove highly contaminated outer clothing prior to stepping on the inner step-off pad.
- Additional secondary step-off pads, still within the posted area, may be used as necessary to restrict the spread of contamination out of the immediate area.
- The final or outer step-off pad should be located immediately outside the contamination area.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

None

9.2 Records

9.2.1 All records generated by this procedure are used in the Radiation Protection Program to document contamination levels of work areas and materials onsite.

9.2.2 Radiological survey records, routine survey schedules, and tracking forms are generated during the performance of this procedure.

9.2.3 Documented information shall be legibly written in ink.

9.2.4 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.5 The health physics technician performing the survey shall ensure that this procedure is the most current and approved revision.

9.2.6 The health physics technician performing the survey shall review any applicable forms for accuracy and completeness.

9.2.7 Entries on forms and any other pertinent documents must be dated and initialed by the health physics technician performing the survey to be valid.

9.2.8 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

None

1.0 PURPOSE

1.1 This procedure establishes the Cabrera Services Inc., (CABRERA) Training Program that, upon satisfactory completion, will allow individuals to enter and perform work with US NRC licensed radioactive material.

1.2 Adherence to this procedure along with site specific guidance will provide reasonable assurance that personnel will be aware of their surroundings, the hazards associated with the type of material in the work area, and the type of work conducted.

2.0 APPLICABILITY

2.1 This procedure will be used for all CABRERA project work involving licensed radioactive materials.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

3.1.1 No individual shall be allowed to work with licensed radioactive materials without training qualification and documentation under this program.

3.2 Limitations

3.2.1 Any person successfully completing this program shall be qualified for a period of one year. Annual refresher training is required to maintain training qualifications.

3.3 Requirements

3.3.1 Records of training shall be maintained. Documentation of previous training for which credit is being given shall include: individual's name, date of training, topics covered, and name of the certifying individual.

3.3.2 The training program for employees and contractors, requiring access to licensed radioactive material shall ensure, at a minimum, that the following regulatory requirements are met:

3.3.2.1 10 CFR Part 19.12 - States the training requirements for workers who in the course of employment are likely to receive in a year an occupational dose in excess of 100 mrem (1 mSv):

At a minimum, 4 hours of Radiation Safety Training will be required for subcontracted personnel and any worker meeting the condition stated in CFR 19.12(a). This 4 hour training shall cover the topics required in CFR 19.12 (a)(1) through (a)(6), as well as any pertinent information in 10 CFR parts 19 and 20 and the Site's NRC license and standard operating procedures. It is mandatory that any females participating in this program receive specific training on prenatal radiation exposure (Reference 4.). An annual refresher course in Radiation Safety will also be required, and as be such provided and documented.

3.3.2.2 29 CFR 1910.120 - Contains the minimum training requirements for hazardous waste operations and emergency response personnel, supervisors, and management:

All workers shall be required to possess, and provide documentation of, a current 40-hour EPA Hazardous Waste Operations and Emergency Response (HAZWOPER) Training Certificate. In addition, site specific HAZWOPER training shall be performed to complete the requirements of 29 CFR 1910.120. The site specific HAZWOPER training shall also cover the content of the Emergency Plan, and provide detailed instruction on response to site emergency events.

3.3.3 Individuals performing a specific limited task, or requiring access for observation or similar purposes, shall be exempt from the requirements in Section 3.3.2, and may be allowed on-site if the following requirements are met:

3.3.3.1 Prior to entry, the individual shall have, or be given, the appropriate radiation, hazardous operations, right to know, and other site specific information necessary for the radiological and other hazardous conditions expected to be encountered.

3.3.3.2 The individual shall have approval of the RSO or duly authorized representative to enter the site. The RSO or duly authorized representative shall document this approval by co-signing the individuals entry in the site access log.

3.3.3.3 Such persons shall also have a continuous escort by, or be within continuous view of, a fully trained site representative (e.g. RSO, RFS, HPT).

4.0 REFERENCES

• NRC Regulatory Guide 8.29	"Instruction Concerning Risks From Occupational Radiation Exposure"
• Draft Regulatory Guide DG-8012	"Instruction Concerning Risks From Occupational Radiation Exposure" 12/94
• NRC Regulatory Guide 8.13	"Instruction Concerning Prenatal Radiation Exposure"
• INPO 93-009	Guidelines for General Employee Training
• RSP	Radiation Safety Program
• RSTM	Radiation Safety Training Manual
• 10 CFR Part 19	Code of Federal Regulations
• 10 CFR Part 20	Code of Federal Regulations

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Procedure – A logical, concise document describing the general requirements and methods to be used regarding a specific topic.

5.2 Training – The transfer of information by instruction to ensure knowledgeable personnel.

6.0 EQUIPMENT

None Required

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – The PM is responsible for ensuring that personnel assigned the task of training are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in implementing actions described in this procedure.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. The RFS is responsible for identifying training needs. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – Health Physics Technicians are responsible for radiation and general safety protection and counseling workers in the proper way to protect themselves. The HPT performing requirements of this procedure is responsible for knowing and complying with this procedure.

7.5 All Other Personnel – All CABRERA personnel are responsible to ensure their training needs are met to ensure safe and efficient completion of projects.

8.0 INSTRUCTIONS

8.1 This program is designed to include approximately 4 hours of classroom instruction, practical training as necessary, and three hours to complete a 50 question multiple choice exam (see Attachment B). Each individual will be required to achieve, at a minimum, a passing score of 80%. Any individual that scores below 80% but greater than 65% will be allowed to take the test over after completing the 4 hour course. Additional site-specific HAZWOPER training will also be required as necessary. The course instructor should use training aids, which include, but not be limited to slides, handouts, instruments, etc. to increase trainee understanding of the material being presented.

Note: It is mandatory that any females that are participating in this program and/or allowed access to a licensed site receive specific training on prenatal radiation exposure (see Section 4.0).

8.2 Four Hour Radiation Worker Training

8.2.1 Attachment 1 is an outline of topics to be covered in the 4 hour radiation worker training. This outline shall serve as a general curriculum for instructors.

8.3 HAZWOPER Site Specific Training

8.3.1 The required 40 hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training shall be supplemented with any site specific information which is required by 29 CFR 1910.120, and is pertinent to worker safety at the licensed site. At a minimum, the following information shall be covered:

- Names of personnel and alternates responsible for site safety and health;
- Safety, health and other hazards present on site;
- Site Emergency Response Plan;
- Use of site-specific personal protective equipment;
- Work practices by which the employee can minimize risks from hazards;
- Safe use of engineering controls and equipment on-site

- Medical surveillance requirements, including recognition of symptoms and signs which might indicate overexposure to hazards;
- Site decontamination procedures; and
- Confined space entry procedures.

8.4 Procedures for operation of instruments, methods of job completion, information important to emergency response, and methods of personnel protection will be discussed with all personnel prior to their job assignments which involve these activities.

8.5 An individual training record shall be maintained for each individual assigned to work at CABRERA work sites.

8.6 A course attendance record shall be prepared by the instructor for each class given.

8.7 A review of personnel qualifications shall be completed by the individual and reviewed by the project manager for each individual hired to perform a specific job function at the project site.

8.8 On-The-Job training is as important as other types of training and should be documented when it occurs. An instructor shall validate on-the-job training as it occurs. The project manager may provide this validation in the absence of an instructor.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 Each individual will be required to achieve at a minimum a passing score of 80%. Any individual that scores below 80% but greater than 65% will be allowed to take the test over after completing the 4 hour course. Additional site-specific HAZWOPER training will also be required as necessary. The course instructor should use training aids, which include, but not be limited to slides, handouts, instruments, etc. to increase trainee understanding of the material being presented.

9.2 Records

9.2.1 Documented information shall be legibly written in ink.

9.2.2 Data shall not be obliterated by erasing or using white-out. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.3 The RSO or duly authorized representative shall ensure that the Training procedure is the most current revision number.

9.2.4 The RSO or duly authorized representative shall review the Training examination for accuracy and completeness.

9.2.5 Student taking the exam must date and sign the exam for it to be valid.

9.2.6 The exam shall be kept in the students file folder by the RSO at the site office. The RSO's file cabinet shall be kept locked when unattended.

10.0 ATTACHMENTS

Attachment 1	Radiation Worker Training Instructor Outline
Attachment 2	Guideline for Examination

Attachment 1

Radiation Worker
Training Instructor Outline

INSTRUCTORS OUTLINE

A. INTRODUCTION

1. Goal

Upon successful completion of this program, the individual shall have sufficient understanding of licensed Site procedures and basic principles of radiation protection.

2. Health Physics

   a. State the purpose of Health Physics "To protect people and their environment from the harmful effects of ionizing radiation"

   b. Present a description of the Health Physics Department including the basic responsibilities of:

      i. Radiation Safety Officer (RSO)

      ii. Radiological Field Supervisor (RFS)

      iii. Health Physics Technicians

3. Site history

   a. Give a brief description of the history of the Site including:

      i. chronological history

      ii known hazardous materials

      iii. locations of buried materials

4. Scope of current activities and licensed operations

   a. Give a brief presentation of current activities and licensed activities involving radioactive material on the site. Present general information on the current status of accessible (above ground if any) site contamination. Describe any other hazards that workers may encounter during present and upcoming activities.

B. RADIATION PROTECTION

1. Atomic Structure

a. Atom; Describe the basic structure of the atom

i. Proton - Relative size 1 AMU Positive (+) electrical charge # of protons determines element

ii. Neutron - Relative size 1 AMU, No electrical charge Protons & Neutrons reside in the Nucleus

iii. Electron - Relative size 1/2000 AMU Negative (-) electrical charge Orbits Nucleus

b. A standard atom has equal number of protons and electrons for neutral electrical charge

c. Proton to Neutron ratio equal to 1 in lighter atoms. As atoms get heavier additional neutrons > 1/1 ratio are required for the nucleus to maintain internal balance (stable).

Example:

Hydrogen	1 Proton	0 Neutrons
Oxygen	8 Protons	8 Neutrons
Potassium	19 Protons	20 Neutrons
Iron	26 Protons	30 Neutrons
Lead	82 Protons	126 Neutrons
Thorium	90 Protons	142 Neutrons

d. Isotope; Family of atoms within an element where the nuclei have the same number of protons but differing number of neutrons.

Example:

Element: Thorium, Isotopes: Th-230, Th-232

Th-230: 90 Protons 140 Neutrons

Th-232: 90 Protons 142 Neutrons

e. Imbalance in neutron / proton ratio causes atom to be unstable i.e. RADIOACTIVE.

f. Nature strives to be in balance, to stabilize an unbalanced atom emits radiation.

2. Radioactive Material

An unstable atom or group of atoms who in an effort to become stable emit ionizing radiation.

a. Radioactive Contamination:

i. Radioactive atoms on the surface of non-radioactive material (loose or fixed)

ii. Radioactive material where we don't want it.

b Nuclear Activation:

i. Material not originally radioactive, but activated by exposure to a Nuclear Reactor Core, neutron source, etc.

Example:

Co^{60}

c. Naturally occurring:

i. Radioactive atoms occurring in nature.

3. Radiation

In an effort to balance N/P ratio radioactive isotopes emit ionizing radiation.

Ionization - The removal of an orbiting electron from its parent atom.

There are 4 types of ionizing radiation emitted from unstable atoms. This lecture will deal only with only the 3 natural types of ionizing radiation.

a. Alpha Particles

i. 2 protons (++) 2 neutrons, no electrons (Helium nucleus).

ii. Emitted from nucleus of heavy isotopes.

iii Ionizes by electrical attraction of electrons (-) by protons (++) in the Alpha particle.

iv. Moves at 1/20 the speed of light (slow by nuclear standards).

v. Ionizes very readily due to slow speed and high electrical (++) charge stopped by sheet of paper.

vi. Hazard to body only if taken internally. Dead layer of skin protects from external sources.

vii. Alpha radiation is greatest internal hazard of the radiation's emitted by isotopes of thorium.

b. Beta Particle

i. Particle emitted from the nucleus of unstable isotope.

ii Generally (-) electrical charge.

iii Generated in the nucleus by transformation of a neutron into (+) proton and (-) Beta.

iv. Ionizes by electrical repulsion (-) beta repels electrons.

v. Moves 1/10 the speed of light.

vi. Due to the smaller electrical charge than Alpha, Beta penetrates deeper into materials.

vii. Shielded by 1/4 to 1/2 inch of most solid materials.

viii. External hazard to skin and eyes.

ix. Internal hazard

c. Gamma Ray

i. Packet of energy, no mass (other examples light, radiant heat, radio).

ii. No electrical charge, moves at the speed of light.

iii Emitted in conjunction with beta radiation's.

iv. Ionizes by other indirect methods based on energy (offer to discuss after class).

v. Very high penetrating power due to no electrical interaction.

vi. Major external radiation hazard with some internal hazard also.

Note: Ensure students understand difference between radiation and radioactive material.

4. Units

a. rem - The unit of measurement for reporting biological damage to humans from radiation energy absorbed in human tissue.

i. Generally reported in fractions of a rem or millirem.

1000 millirem = 1 rem.

ii. Used to report total dose

iii. Used to report dose rate (2 rem/hour = 2000 mrem/hr)

Note: Ensure students have firm understanding of dose and dose rate concepts.

b. DPM - Disintegration Per Minute (Unit of activity)

i. A disintegration is the spontaneous emission of particles (and associated gamma rays) from an unstable nuclei.

ii. DPM - Disintegration Per Minute

5. Measurement

a. TLD

i. Used to measure total external dose (Deep, Skin, Eye)

ii. Demonstrate how worn (Whole Body, Wrist, Finger Rings)

iii. What to do when lost or damaged.

iv. What to do when not in use (storage).

v. Used to determine legal external dose

vi Used to comply with 10 CFR 19 and 20

b. Personnel Friskers

i. Used to measure contamination.

ii. Demonstrate instrument and show proper frisking techniques.

iii. Show how to determine background and readings greater than background

c. Radiation Survey Meter

i. Demonstrate general use of dose rate survey meter.

ii. Compare dose rate reading with total dose reading from TLD.

d. Breathing Zone Air Sampler

i. Demonstrate proper use of BZ.

ii. Discuss basic principles of airborne monitoring (DAC) hours.

e. Whole Body Counter / Bioassay

i. Explain basic principles of whole body counting (Analysis of gamma rays emitted by RAM in the body).

ii. Discuss Allowable Limit of Intake (ALI-maximum allowable amount of RAM taken inside the body in one year).

iii. Mention other types of BIOASSAY (urine, fecal analysis).

f. Smear Survey

i. Used for determining levels of loose surface contamination.

ii. Explain units DPM/100 cm^2.

iii. Demonstrate smear technique.

iv. Loose surface contamination limits (clean):

$\leq$20 DPM/100 cm^2 Alpha

$\leq$1000 DPM/100 cm^2 Beta/Gamma

g. Fixed Contamination Survey

i. Demonstrate fixed contamination survey.

ii. Limit for fixed surface:

100 DPM/100 cm^2 Alpha

5000 DPM/100 cm^2 Beta/Gamma

Note: Ensure that all students know that only radiation protection staff may perform radiation and contamination surveys (only exception personnel frisking of body and clothes).

6. Background Radiation

a. Natural sources

i. Radon approximately 200 mrem/year (Rn^{220} from Th^{232}, Rn^{222} from U^{238}). Top 12" in 1 $mile^2$ average in USA 2000 lbs U, 6000 lbs Th

ii. Other than Radon approximately 100 mrem/year

(Cosmic, K^{40})

b. Man made

i. Medical, approximately 53 mrem/yr (39mrem diagnostic x-rays, 14mrem nuclear medicine)

ii. Fallout < 4.0 mrem/yr (historical bomb testing)

iii. Nuclear fuel cycle <0.1 mrem/yr (U mining, transportation, Nuc. plants, waste disposal).

Note: Maximum allowable public exposure from licensed operations is 100 mrem/yr.

iv. Consumer Products <10.0 mrem/yr (tobacco products, building materials, smoke detectors, drinking water, natural gas)

The average person by age 50 will have a total dose of 18 rem (18000 mrem) from all sources

The total average dose for all people is 360 mrem/year. This total is based on the total exposure for all Americans divided by population. An individuals dose is dependent on factors such as geographic location and medical history.

7. Occupational Dose

1992: 250,000 Individuals monitored for occupational exposure

125,000 no measurable exposure

125,000 average exposure of 300 mrem

8. Biological Effects

a. Radiation effects on cells of the body.

i. Cell will die.

ii. Cell will repair it self.

iii. No damage.

iv. Cell is damaged, survives, cannot reproduce.

v. Cell genetic material is damaged, damage is passed on to next generation (mutation).

b. Acute vs Chronic Exposure

i Acute Exposure - High dose in short period.

ii Acute effects

<25 rem no readily detectable effects

>25 rem exposure slight changes in blood (MD)

>100 rem vomiting, diarrhea, loss of hair

450 rem LD-50 with no medical intervention

600 rem LD-100 with no medical intervention

c. Chronic exposure - Low dose over long period of time.

Chronic exposure is the basis for our Radiation Program.

d. Stochastic Damage (Cancer)

i. A particular cells level of cancer risk is dependent on how fast the cells reproduce themselves. "Radiosensitivity"

ii. Cancer Statistics, 20% of all adults will develop a fatal cancer from all possible causes.

In a group of 10,000 workers, 2000 will die from cancer. Expose this same group to 1 rem of ionizing radiation (DDE) statistically 4 additional cancers will result (2000 - 2004). For 100 rem 400 additional cancers.

iii. Relative Risk Table:

Hazard	Est. of days lost
Pack of Cigarettes/day	2370 days
20% overweight	985 days
Home accidents	95 days
1 rem lifetime exposure	1 day

Note: Other statistics are available in reg guide 8.29

iv. Somatic Effects - Effects that appear in the exposed individual

v. Genetic Effects - Effects that appear in the exposed individuals offspring

Note: There is no statistical evidence of genetic effects appearing in humans. Genetic effects have been observed in laboratory animals at very high doses.

9. Exposure Limits

a. External Dose Limits

i. Skin SDE 50 rem/Yr.

ii Max. Extremity 50 rem/Yr.

iii. Eyes LDE 15 rem/Yr (Cataracts).

b. Total Effective Dose Equivalent TEDE

Limit based on total dose to the body from external sources (Deep Dose [gamma] Equivalent) and doses to the body from internal sources.

TEDE = DDE + CEDE

CEDE = %ALI, 1 ALI = 5 rem CEDE

2000 DAC hours = 1 ALI

TEDE Limit - 5 rem/Yr. NRC

c. Declared Pregnant Woman (Dose to Embryo/Fetus)

500 mrem TEDE for duration of pregnancy.

Low limit due to high radiosensitivity of all developing cells.

10 Exposure Control

a. Basic concepts for reducing exposure.

i. Time

ii. Distance

iii Shielding

iv. Source Reduction

b. Radiation Work Permit (RWP)

i. Required for all work with RAM.

ii Must be modified if work scope changes.

iii Must be authorized to work under RWP, authorized personnel must be trained.

iv. Contact Radiation Protection to initiate or to add names to an existing RWP.

c. ALARA As Low As is Reasonably Achievable

i. Discuss concept of ALARA principle.

ii. Management's responsibility to provide adequate work facilities and provide training.

iii. Health Physics responsibilities:

- Awareness of jobs in progress

- Perform proper surveys

- Surveillance of work areas

iv. Workers responsibilities:

- Proper knowledge of job requirements

- Inform HP of work scope and changes

- Follow all rules & procedures

Note: Important to stress to all radiation workers that nobody has better control over your actions than yourself. every rad worker has final responsibility for ensuring a safe working environment.

11. Posting

Discuss standard posting procedures, include Tri-foil symbol, standard yellow & magenta colors, Rad rope and step off pads.

a. Radioactive Material

i. RAM posting indicates the presence of Radioactive Material within the posted area.

b. Radiation Area

i. Indicates that within the posted area radiation dose rates are greater than or equal to 5.0 mrem/hr at 30 centimeters from the radiation source or any surface that the radiation penetrates.

c. Contaminated Area.

i. Indicates that within the posted area loose surface contamination may exist with levels in excess of 20 DPM/100 cm^2 α or 200 DPM/100 cm^2 β, γ.

ii. Requirements for entry into a contaminated area are:

1) Protective Clothing

2) RWP [or HP permission].

12. MISC. Practical Information

a. RAD Waste.

The cost of waste storage for potential disposal is very high

every effort shall be made to limit the generation waste.

b. Airborne Contamination.

i. One potential for unnecessary radiation exposure working at a radiologically contaminated site comes from breathing contaminated air.

ii. Sources of airborne contamination:

- Equipment dissemble & repair

- Decontamination operations

- Filing & Grinding

- Mechanical Shock

- Routine equipment operations

iii. It is very important that HP be notified anytime unplanned operations are taking place that could create an airborne situation.

c. Pathways for internal contamination

i. Inhalation

ii. Oral ingestion

iii. Cuts or other skin openings

d. Protective Clothing

i. Display and discuss standard protective clothing, to include:

- Coveralls

- Lab Coat

- Hood

- Shoe Covers

- Gloves (plastic, latex, cloth)

- Safety Glasses

ii. Using a working copy of an RWP select one student to demonstrate proper dressing.

iii. Review other types of protective clothing such as plastic (tyvek) suites, and face shield.

e. Emergencies

i. For medical emergencies:

- For minor illness leave the area & report to the HSA.

- If minor cuts occur, contact HP prior to reporting to medical.

Note: All cuts, scratches, or other skin openings must be checked by HP prior to entry into any contaminated area, or working with radioactive materials.

Note: If major illness or injury occurs DO NOT remove the individual, if qualified perform first aid, if not get help.

The time utilized in removing an individual from a radiological control area during a medical emergency will have a much greater effect on that persons health than any negative effects of treating the individual within the radiological controlled area.

13. Workers Rights & Responsibilities

a. NRC Form 3

i. Show copy of Form 3, discuss. Give the locations found.

How to report potential violations to the NRC. Rights to obtaining exposure history. Protection from discrimination.

b. Workers responsibilities

i. Stress to all students that they have the greatest responsibility in ensuring a safe working environment.

ii. All persons working with RAM have a legal responsibility to comply with all RWPs, procedures, license requirements and NRC regulations.

Note: Individuals willfully violating safety requirements can be held criminally liable.

c. House Keeping

i. All persons working inside any HP restricted area is responsible for general cleanliness in addition to radiological responsibilities.

14. Facilities Tour & Practical Training

a. All persons unfamiliar with the Site shall have a tour of the work areas and a review of the following.

i. Entry and exit requirements including Personnel frisking.

ii Discussion of contaminated areas including:

Step Off Pads - Posting - Waste Containers

iii. Protective Clothing & Dress out area

iv. Health Physics Office

v. Right to Know Information Center

ATTACHMENT 2
EXAMINATION

RADIATION WORKER

QUALIFICATION EXAM

NAME ____________________ SS# ___-___-___

GRADE: ____________________ GRADED BY ____________________ RETRAIN DATE

I HAVE REVIEWED THIS EXAM AND ALL QUESTIONS ANSWERED INCORRECTLY HAVE BEEN REVIEWED BY THE INSTRUCTOR. I HAVE BEEN GIVEN THE OPPORTUNITY TO ASK QUESTIONS REGARDING THIS EXAM OR OTHER MATERIAL PRESENTED IN THIS COURSE.

SIGNATURE____________________ DATE ____________

This exam contains 50 multiple choice questions, there is only one correct answer for each question. Circle the answer you think is correct. If you decide to change an answer put a line through and initial the answer you are changing and circle your new choice. There is a three hour time limit for this exam. GOOD LUCK

1. A radiation worker who has satisfactorily completed this course in radiation protection will be able to__________.

a. Approve Radiation Work Permits

b. Protect themselves from Radiation hazards they may encounter

c. Enter all posted areas without HP approval

d. All of the above

2. You have the primary responsibility for radiation protection.

a. All the time

b. Only when HP is not in the work area

c. When your supervisor puts you in charge

d. Never (Management responsibility)

3. What three primary components make up an atom ?

a. Alpha, Beta & Gamma

b. Electron, Neutron & Proton

c. Radiation, Contamination & Ionization

d. Nucleus, X-Ray & Cosmic

4. An example of Radioactive Material is__________.

a. A wrench with fixed contamination

b. A frisker check source

c. A smear reading 20,000 DPM/100 cm^2

d. All of the above

5. An example of a type of radiation is _____________.

a. Gamma ray

b. Isotope Thorium-232

c. Nucleus

d. A wrench with fixed contamination

6. Safety Glasses protect your eyes from ___________.

a. Gamma radiation

b. Radioactive Waste

c. Beta Radiation

d. Radon Gas

7. rem is the unit used to measure ________________.

   a. Loose surface contamination

   b. Radiation dose to human tissue

   c. The number of unstable atoms in one gram of soil

   d. Levels of airborne contamination

8. How many millirem (mrem) equals one rem ?

   a. 10

   b. 100

   c. 1000

   d. 100,000

9. Your <u>legal</u> whole body dose (TEDE) is measured by ___________.

   a. TLDs, Bioassay, & B-Z Air Sampler

   b. Frisking

   c. Health Physics survey

   d. RWP

10. The two types of Radiation of primary concern emitted by thorium isotopes are:

a. Alpha & Beta

b. Beta & Gamma

c. Alpha & Gamma

d. Alpha & X-Rays

11. The type of Radiation that will not penetrate a persons dead layer of skin is?

a. Alpha

b. Beta

c. Gamma

d. X-ray

12. A Breathing Zone air sampler (BZ) is used to measure_________

a. Gamma radiation dose to the whole body

b. Surface contamination in work areas

c. Airborne contamination in work area

d. All of the above

13. What instrument is used to measure radioactive material inside the body ?

   a. Hand held frisker

   b. TLD

   c. Whole body counter

   d. Pocket dosimeter

14. A Smear survey is used to determine ___________

   a. Fixed surface contamination

   b. Loose surface contamination

   c. General area dose rates

   d. Skin contamination on personnel

15. Who is allowed to perform smear surveys ?

   a. Only trained radiation workers

   b. Outage services personnel

   c. Health Physics staff

   d. Only personnel listed on the NRC license

16. The average dose received by people in the United States from natural and man-made sources is

a. 1-5 mr/year

b. 10-50 mr/year

c. 100-500 mr/year

d. 1000-5000 mr/year

17. The highest dose from man-made sources to the general public comes from

a. Medical industry

b. Nuclear Power

c. Television Sets

d. Microwave ovens

18. Will human body cells repair themselves after radiation exposure typically received by radiation workers ?

a. Never

b. Usually

c. Always

d. Unknown

19. The major concern for individuals receiving occupation radiation exposure is ____________.

a. Hair loss & Sterility

b. Increased possibility of developing cancer

c. Reduced resistance to colds & viruses

d. No concerns for exposures below NRC limits

20. Women require special training in radiation protection because ________________.

a. Women are more susceptible to radiation damage

b. A developing fetus is more susceptible to radiation damage

c. Women will require more time in restricted areas to perform their work

d. All of the above

21. The least risk to your health is ______________.

a. An exposure to 1 rem of whole body radiation

b. Home accidents

c. Overweight by 20%

d. Smoking 1 pack of cigarettes a day

22. Which of the following exposures has the greatest potential to effect your health ?

a. 10 rem exposure to the whole body

b. 10 rem exposure to the skin of the body

c. 10 rem exposure to your hands & forearms

d. All of the above are equal risk

23. The NRC occupational limit for TEDE (Total Effective Dose Equivalent)?

a. 1.0 rem / Year

b. 2.5 rem / Quarter

c. 5.0 rem / Year

d. 50 rem / Year

24. The NRC Whole Body dose limit (TEDE) for declared pregnant females is?

a. 4.5 rem / Quarter

b. 2.5 rem during pregnancy

c. 500 mrem during pregnancy

d. Not allowed to receive exposure

25. The concept of ALARA is to ____________

a. Keep accurate records on personnel exposure

b. Spread exposure among all radiation workers

c. Develop methods to reduce overall exposure

d. Limit work with Radioactive Material to 40 hrs/week

26. Who has the greatest responsibility for maintaining a successful ALARA program ?

a. Health Physics

b. Management

c. Radiation Workers

d. All of the above

27. What are the standard radiation warning colors ?

a. Yellow & Magenta

b. Black & White

c. Red & White

d. Black & Magenta

28. Body Cells that reproduce the most rapidly tend to be...

a. The least sensitive to Radiation.

b. The most sensitive to Radiation.

c. Sensitivity is unrelated to reproduction rate.

d. None of the above.

29. Before entering an area posted "CONTAMINATED AREA" you must:

a. Obtain an RWP

b. Put on Lab Coat & Gloves

c. Notify your supervisor

d. No requirements for contaminated areas

30. On a radiologically contaminated site, a significant potential for radiation exposure comes from?

a. Breathing Radioactive Material

b. Wearing contaminated protective clothing

c. Instrument check sources

d. TV monitors

31. A standard method of reducing your potential exposure to radiation is?

a. Covering the site with plastic sheeting
b. Using protective clothing for all jobs
c. Building shielding around all sources
d. Time, distance, and shielding

32. Step off pads are considered to be ...

a. Activated
b. Clean
c. Contaminated
d. Useless

33. The TEDE (Total Effective Dose Equivalent) is the sum of.

a. Deep Dose + Skin Dose
b. Deep Dose + Internal Dose
c. Deep Dose + Eye Dose
d. Skin Dose + Internal Dose

34. The <u>unit</u> that applies to surface contamination is..

a. rem

b. mR/hr

c. DPM/100 cm^2

d. DAC hour

35. The <u>unit</u> that applies to airborne exposure is..

a. rem

b. mR/hr

c. DPM/100 cm^2

d. DAC hour

36. If your supervisor tells you to add your name to an RWP and help complete a job for a co-worker, you should ___________.

a. Add your name and follow all instructions on the RWP

b. Sign into the work area using your co-workers name

c. Tell your supervisor he must add your name to the RWP

d. Contact Health Physics to add your name

37. While working inside a contaminated area you get a small tear in the sleeve of your coveralls you should ________________.

a. Put tape over the tear and continue working

b. Leave the area and perform a whole body frisk

c. Continue working and frisk when job is completed

d. Leave the area and notify Health Physics

38. While working inside a controlled area you puncture your glove and receive a small cut on your hand you should ____________.

a. Replace the glove and continue working

b. Leave the area and frisk your hand, if clean return to work

c. Leave the area and contact Health Physics

d. Leave the area, frisk and report to the RFS.

39. While performing a whole body frisk, when should you notify Health Physics of possible contamination ?

a. Any sustained frisker reading above background

b. Any sustained reading of 100 cpm above background

c. When the frisker alarm sounds

d. If the contamination cannot be easily removed

40. The legal requirements for radiation protection are established by _______________.

a. Nuclear Regulatory Commission (NRC)

b. International Atomic Energy Agency (IAEA)

c. Environmental Protection Agency (EPA)

d. Occupational Safety & Health Agency (OSHA)

41. Ensuring that workers receive adequate training in radiation protection is the responsibility of _______________.

a. Each worker

b. The license holder

c. Department supervisors

d. OSHA

42. Where is the NRC Notice to employees (NRC form-3) listing your rights as radiation workers available ?

a. Nailed to a tree on the south end of the site

b. Posted inside each Contaminated Area

c. In the Emergency Operations Program

d. Clearly posted in all buildings on site

43. While working in a highly contaminated area your co-worker receives a severe cut on the arm. what should you do first ?

a. Move the individual to a non-contaminated area.

b. Call for help and try to stop the bleeding (If qualified)

c. Help him walk to the first aid station.

d. Contact Health Physics

44. At your supervisors direction you dump a drum of potentially contaminated trash into the dumpster. The result of this action can be ____________________.

a. The company is fined by the NRC

b. You can be fired

c. You can be held criminally liable

d. All of the above

45. After completing a job inside a contaminated area you need to bring your tools outside the contaminated area, you should __________________.

a. Wipe down the tools and contact Health Physics

b. Wipe down the tools and frisk them when you leave

c. Leave the tools in the area and obtain a new set

d. Smear the tools and check the smear with a frisker

46. You find a container marked Radioactive Material inside the office spaces you should.

a. Move the container into a Contaminated Area

b. Quickly move the container outside

c. Warn people in the area and contact the NRC

d. Warn people in the area and contact Health Physics

47. When can you enter a contaminated area without personal protective equipment?

a. When a health physics representative approves

b. When told to by your supervisor

c. Never

d. When no one is looking

48. Why should liquids never be put into a Rad Waste bag?

a. Liquids add excessive weight to the waste container

b. Liquids can leak out and spread contamination

c. Liquids can cause the waste to rot

d. Liquids can evaporate and cause airborne contamination

49. Which of the following would be an effective way to reduce radioactive waste ?

a. Do not take packing material into a contaminated area

b. Plan jobs to prevent unnecessary trips into the area

c. Whenever possible use tools and equipment already in the area

d. All of the above

50. When may a worker with a cut, scratch, or sore be allowed to enter a Health Physics Contaminated area ?

a. After a proper bandage is applied

b. Only with site medical approval

c. No cuts scratches or sores allowed in restricted areas

d. After Health Physics has checked the injury and given specific approval.

1.0 PURPOSE

This procedure provides instructions for monitoring personnel for exposure to radiation in the workplace. Adherence to this procedure will provide reasonable assurance that exposures to radiation will be properly monitored enabling exposure to be controlled to As Low As Reasonably Achievable (ALARA).

2.0 APPLICABILITY

External radiation monitoring shall be conducted when it is likely that an adult will exceed 10% of the annual limits listed in 10 CFR 1201(a) or at a more conservative limit chosen by the RSO or duly authorized representative.

This procedure will be used for monitoring of all personnel for exposure to radiation. Monitoring will be provided as described in the site specific work plan for the job to be accomplished.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

Not Applicable

3.2 Limitations

Not Applicable

3.3 Requirements

3.3.1 Site Registration Form

3.3.1.1 All new personnel and visitors required to enter a RCA must complete a Site Registration Form (AP-008-01) prior to starting work at a facility.

3.3.1.2 Complete Site Registration Form will be retained with the individual personnel exposure file. Site Registration Forms for CABRERA personnel will be updated annually or earlier if existing information is known to be incorrect.

3.3.2 Occupational Radiation Exposure History

3.3.2.1 An NRC Form 4 or equivalent must be completed by each individual and reviewed by the RSO or duly authorized representative prior to the individual being permitted to work in a radiological controlled area (RCA) where a dose of more than 25 mrem could be received.

3.3.3 Dosimetry Assignment

3.3.3.1 The Thermoluminescent Dosimeter (TLD) badge number, name, social security number, whether or not a worker has a completed NRC Form 4 or equivalent, the monitoring period (date from...to) and the individuals date of birth shall be recorded on OP-008-01, for each individual monitored on a project. The original form will be maintained as a permanent record of the project monitoring. A copy will be maintained in the CABRERA, East Hartford office.

3.3.4 Occupational Exposure Limits & Administrative Control Levels.

3.3.4.1 Nuclear Regulatory Commission limits per calendar year:

- Whole Body (TEDE) 5 Rem
- Lens Dose Equivalent (LDE) 15 Rem
- Shallow Dose Equivalent (SDE) (Skin or Extremity) 50 Rem
- Organ Dose (CDE) 50 Rem

3.3.4.2 Administrative Control Levels (per quarter)

- Whole Body (TEDE) 1.25 Rem
- Lens Dose Equivalent (LDE) 3.75 Rem
- Shallow Dose Equivalent (SDE) (Skin or Extremity) 12.5 Rem
- Organ Dose (CDE) 12.5 Rem

3.3.4.3 The CABRERA RSO or duly authorized representative shall authorize exposure above the Quarterly Administrative Control Levels.

3.3.5 Radiological Control Areas

3.3.5.1 An RCA is considered to be any portion of a facility, plant, vehicle or project for which restrictions apply for purposes of occupational radiation exposure control. Radiation exposures received within the boundary of a restricted area are occupational exposures. As described in the applicable Project Detail Work Procedure, RCAs will be established to provide the specific radiological controls necessary for the completion of the work scope and the protection of all project personnel. The following guidelines apply:

3.3.5.2 An RCA is always located within a restricted area as defined by 10 CFR 20. Each radiation area, high radiation area, airborne radioactivity area and contaminated area shall be contained within an RCA.

3.3.5.3 Personnel and casual visitors within an RCA will be provided with appropriate dosimetry and monitored for radiation exposure when appropriate.

3.3.6 Radiation Work Permits

3.3.6.1 Personnel working in an RCA must be assigned to a specific RWP applicable to the job being performed.

3.3.6.2 Personnel performing work requiring a DRD shall sign in on Form AP-008-06, DRD Dose Tracking Log, prior to the start of work indicating the time of entry, starting DRD dose, and DRD serial number. Upon completion of the work or at the end of shift, personnel shall sign out on the DRD Dose Tracking Log, indicating the time out and the current DRD dose.

3.3.6.3 A weekly accumulated estimated exposure report, based upon Direct Reading Dosimeter (DRD) results, will be maintained and posted for employee review at the start of each workweek. This report will reflect a running total of exposure available for the current calendar quarter. The beginning quarterly available exposure will be 1250 mrem for the individuals with a completed and signed Occupational Exposure History Form.

3.3.7 Occupational Radiation Exposure History Request

3.3.7.1 An Occupational Radiation Exposure Request, AP-008-05 will be completed for all personnel for whom permanent exposure results have been obtained. Copies of this letter will be sent to the individual, and maintained in the individual's personnel exposure file by the CABRERA Radiation Safety Office, East Hartford.

3.3.7.2 Any time CABRERA is required to report an individual's exposure to the Nuclear Regulatory Commission or other regulatory agency, a copy of the report will be sent to the individual.

3.3.8 Project Records / Documentation

3.3.8.1 Upon completion of the project, it will be the responsibility of the RFS or designee to forward all project records, logs, and communications regarding personnel exposure, exposure records, dosimetry records, and all other pertinent information about personnel dosimetry and individual radiation protection for RSO or duly authorized representative review, and filing in anticipation of NRC review.

4.0 REFERENCES

- RSP Radiation Safety Program
- AP-001 Record Retention
- AP-012 Radiation Work Permits
- OP-001 Radiation and Contamination Surveys
- AP-009 Training Program

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Monitoring – Measurement of radiation exposure to evaluate potential dose equivalent to the individual.

5.2 Dosimetry – Devices worn on the body (TLD or DRD) to measure the radiation dose received by the exposed individual.

5.3 Dose – The deposition of energy in matter. Equivalent to the radiation dose times the quality factor for the type of radiation.

5.4 Quality Factor – The factor, which is radiation dependent and identifies the relative biological effectiveness of a radiation type and energy. The quality factor is multiplied times the Dose to yield the Dose Equivalent.

5.5 TEDE – The Total Effective Dose Equivalent – The sum of the Deep Dose Equivalent (external dose) and the Committed Effective Dose Equivalent (internal dose).

5.6 CDE – Committed Dose Equivalent – The dose equivalent to organs or tissues that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

5.7 CEDE – Committed Effective Dose Equivalent – The sum of the products of all organs or tissues with CDE and their respective weighting factors.

5.8 SDE – Shallow Dose Equivalent – Applies to the skin and to any extremity, it is used for external radiation which cause primary energy deposition in the first 0.007 cm of tissue averaged over one square centimeter.

5.9 LDE- Eye Dose Equivalent – The dose delivered to the lens of the eye at a tissue depth of 0.3 centimeters.

5.10 DDE – Deep Dose Equivalent – The dose equivalent delivered by external radiation to tissue at a depth of 1 centimeter.

5.11 TLD – Thermoluminescent Dosimeter – A device which provides passive measurement of DDE, SDE, and/or LDE.

5.12 DRD – Direct Reading Dosimeter – A self indicating, integrating radiation exposure measuring device, (e.g. pocket ion chamber).

6.0 EQUIPMENT

None

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – The PM is responsible for ensuring that personnel assigned the tasks using radioactive or hazardous materials are properly trained in their use and the necessity that they be monitored for exposure to radiations and hazardous materials as described in the site specific work plan.

7.2 Radiation Safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in the use of personal monitoring devices for radiation and hazardous materials.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT are responsible for performing the surveys described in the site specific work plan and ensuring the proper use of monitoring devices by workers.

7.5 Workers – All personnel are required to wear their dosimerty as required by the RWP and to maintain their exposure to radiation ALARA.

8.0 INSTRUCTIONS

8.1 Radiation Dosimetry – TLD

8.1.1 At a minimum, TLD's provided by a NVLAP certified vendor for the exposure period, will be used to monitor all personnel who could potentially receive 10% or more of the permissible dose limit for external radiation exposure. Personnel working in areas with dose rates above 5 mrem/hour, will wear a TLD and a low range Direct Reading Dosimetry (DRD). Other appropriate radiation exposure monitors will be assigned accordingly (e.g., extremity dosimetry) at the discretion of the RSO or duly authorized representative.

8.1.2 TLD's are the permanent record of an individual's occupational radiation exposure. Upon receipt of project dosimetry, TLD's and extremity dosimetry shall be stored in a low background area inside the project main office or in other designated storage locations when not in use. A (TLD) control badge shall be kept where the assigned badges are stored when they are not in use. All CABRERA personnel entering a RCA where 25 mrem could be received will be issued, at a minimum, a TLD.

8.1.3 The individual's name, social security number, issue date, and date of return will be recorded on form AP-008-03.

8.1.4 The TLD, which monitors DDE, SDE, and/or LDE, shall be worn on the front torso in the region of the torso, expected to receive the highest dose. In cases where other areas of the body may receive a higher dose, the HPT shall evaluate and formally require (by specification on the RWP) that the dosimetry be worn at that body location. Multibadging may be utilized in certain situations as deemed appropriate by the RSO/RFS.

8.1.5 Extremity monitoring shall be provided when necessary as described by the specific site work plan, or at the discretion of the RSO/RFS.

8.2 Direct Reading Dosimeters

8.2.1 Personnel working in a RCA may be issued/monitored by a DRD. DRD's may either be issued for an individual or group depending on the type and duration of work to be performed. The RFS or RSO will determine if it will be necessary to issue individual or group DRD's. The DRD's used for general radiation work will have a range of 0 to 200 millirem. DRD's will be reset to zero (0) at the start of each work shift.

8.3 Visitors/Group Monitoring

8.3.1 A casual visitor is any person touring or visiting the RCA on an infrequent basis, escorted while in the restricted area and not performing or supervising hands on work.

8.3.2 Visitors will be issued a TLD on a case by case basis depending on the type and duration of the job. The RFS or RSO shall determine if a TLD is to be issued to a visitor. TLD's will always be issued to contractors expected to exceed 500 mrem. A visitor expected to receive in excess of 25 mrem shall be trained and provided dosimetry.

8.4 Visitor RCA Conditions

8.4.1 A visitor may be escorted into a RCA provided that:

8.4.1.1 No entries into a high radiation areas, surface contamination areas, or airborne radioactivity areas shall be allowed,

8.4.1.2 External radiation exposure is limited to 50 mrem per year, or 10 mrem per entry.

8.4.1.3 The visitor is furnished with dosimetry, when appropriate.

8.5 Visitor Dosimetry

8.5.1 Visitors within an RCA shall receive, as a minimum, a low range 0-200 mR Direct Reading Dosimeter (DRD)

8.5.2 Visitor TLD results are recorded on form AP-008-01, which is maintained at the facility. When a visitor is issued a TLD, the individual's, name, social security number, issue date, and date of return will also be recorded on form AP-008-03.

8.6 Lost, Damaged or Questionable Dosimetry

8.6.1 In the event of a Lost, Damaged or Questionable TLD or DRD, the RFS or RSO shall be notified immediately. A Lost, Damaged or

Questionable Dosimetry Report, (AP-008-02) will be completed and filed in the individual's exposure file. The dose estimated from all exposure received while the individual was in an exposure situation must be determined and recorded in the individual's dose record.

8.6.2 In the event of multiple occurrences, the RSO or duly authorized representative shall be notified immediately.

8.7 Dropped or Off-Scale Personal Ion Chambers

8.7.1 If a DRD is dropped or if it's hairline is no longer visible (off-scale), the response of this device may no longer be valid and an estimate of the dose received by an individual must be made based on; dose rates and time in the work area, typical dose received on that type of job, or the dose received by another person doing the same type of work in the same area. Form AP-008-02 shall be used to document this type of situation. The dose determined shall be added to the dose record at the discretion of the RSO. The RSO or duly authorized representative shall review, approve, and maintain all completed dose estimates.

8.8 Project Dosimetry Issuance/Control

8.8.1 Prior to project commencement, the RFS and/or the RSO will determine the appropriate radiation monitoring dosimetry required based upon the radionuclides and activity present at the work area. The RFS will contact the RSO to provide the following information:

- CABRERA Project Name and Account Number
- Project start date and project duration
- Suggested dosimetry required for project, including radiation type to monitor for
- Quantity of dosimeters requested on a quarterly basis including controls
- Name, address, social security, birth date of project personnel to be monitored.
- Address dosimetry is to be shipped to.

8.8.2 Personnel assigned to projects will wear the appropriate dosimetry for no more than one quarter or the duration of the project, whichever is shortest.

8.8.2.1 It will be the responsibility of the RFS or RSO to return dosimetry to the vendor for processing at the end of each quarterly monitoring period.

8.8.2.2 If the original projected project duration is extended, the RFS or designee shall inform the RSO so that the proper arrangements can be made to supply additional dosimetry from the vendor.

8.8.2.3 The quarterly issue period may be extended at the discretion of the RSO or duly authorized representative. Extensions shall be "with cause" actions and documented by memo, at a minimum.

8.8.2.4 Dosimetry shall be maintained on site in a low dose rate area with control(s), when not being worn by personnel.

8.8.3 Dosimetry Processor (Vendor)

8.8.3.1 The dosimetry vendor must be NVLAP certified in accordance with the project Health and Safety Plan and 10 CFR 20.1501.

8.8.3.2 Upon receiving project dosimetry, the RFS or designee shall verify that the dosimetry received meets the requirements of the project. Any problems should be reported to the CABRERA RSO or duly authorized representative for immediate attention and resolution. All documentation received with dosimetry will be filled out completely. When all required preliminary training documentation has been completed as described in the project Detail Work Procedure, dosimetry will be issued to project personnel.

8.9 It is the responsibility of the RFS or designee to ensure that AP-008-03 is completed at the time of dosimetry issuance and a copy is sent to the CABRERA East Hartford Office location.

9.0 QUALITY ASSURANC/RECORDS

9.1 Quality Assurance

9.1.1 DRD's shall be calibrated by a certified laboratory or validated procedure every six months when in use.

9.2 Records

9.2.1 Documented information shall be legibly written in ink.

9.2.2 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.3 The health physics technician using this procedure shall ensure that it is the most current and approved revision.

9.2.4 The health physics technician shall review Forms AP-008-01 through AP-008-04 for accuracy and completeness.

9.2.5 Entries on Forms AP-008-01 through AP-008-04 and any other pertinent forms must be dated and initialed by the health physics technician performing the inventory to be valid.

9.2.6 The RSO or duly authorized representative shall review completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

- AP-008-01 Site Registration Form
- AP-008-02 Lost, Damaged or Questionable Dosimetry Report
- AP-008-03 Radiation Dosimetry Issue Log
- AP-008-04 Radiation Exposure Report
- AP-008-05 Occupational Exposure History Request NRC Form 4
- AP-008-06 DRD Dose Tracking Log

AP- 008-01
Site Registration Form

ADMINISTRATIVE INFORMATION	
Name:	Date:
Social Sec. No.:	Date of Birth:
Permanent Address:	
Employer's Name:	
Employer's Address:	
CABRERA Project Name/No.:	
Project Contact:	
Signature:	**Date:**
DOSIMETRY USE ONLY	
DRD No.:	DRD Reading:______________mrem
TLD Badge No.:	TLD Badge Results____________mrem
RADIATION SAFETY OFFICER APPROVAL	
This person has met the requirements for radiation work as specified in the CABRERA Radiation Safety Manual:	Yes No
This person meets the requirements for radiation work with consideration of the notes below:	Yes No
Notes:	
CABRERA RSO Signature:	

AP-008-02
Lost, Damaged or Questionable Dosimetry Report

ADMINISTRATIVE
Report Date/Time:
Project Name/No.:
Project Manager/Contact:
Individual's Name/SSN:
Badge No.:
Date/Time of Incident:
Location if known:
Applicable RWP No.:
Date Badge was Issued:
DOSE CALCULATION
1. Dose from dosimeter readings (Total from date issued) thru__________(Date) = ________mrem
2. Current dosimeter reading (If more than one dosimeter, use highest reading) =________mrem
3. If individual was not wearing a dosimeter, or lost the dosimeter, assign highest exposure received by workers in the same area . If none, use dose rate x time in area for the same period. Dose Rate______________(mrem/hour) x Time____________(hours) = ________mrem
Total estimated exposure to be assigned: =________mrem
THE METHOD USED TO ESTIMATE MY EXPOSURE HAS BEEN EXPLAINED TO ME, AND THE ESTIMATE DOSE ASSIGNED TO MY RECORD IS ACCEPTABLE FOR THIS EVENT. **Individual's Signature:**______________________________ **Date:**_______________
DOSE RECORD AUTHORIZATION
Dose Estimate Calculations By:______________________________ Date:_______________
Dose Estimate Reviewed By:(RSO)___________________________ Date:_______________
Dose Estimate Posted By:__________________________________ Date:_______________

AP-008-03
Radiation Dosimetry Issue Log

Project/Location:______________________________ Badge Series No.:__________

TLD#	Name	SSN	Form 4 (Y/N)	Dates (From/To)	DOB

Reviewed by:______________________________ **Date:**______________

AP-008-04
Radiation Exposure Record

Name: **SSN:**

Birth Date:

TLD Badge No.:

Quarterly Whole Body Dose: 1st_________ 2nd_________ 3rd_________ 4th_________

Lifetime Whole Body Dose Equivalent:__________**(Rem)** **Monitoring Year:**________

Monitoring Period	Whole Body (DDE)	Shallow Dose (SDE)	Extremity Dose (SDE)	Lens Dose (LDE)	Organ Dose (CDE)	Internal Effective Dose (CEDE)	Total Effective Dose Equivalent – Rem (DDE+CEDE) TEDE/Cumulative	
January								
February								
March								
April								
May								
June								
July								
August								
September								
October								
November								
December								
Yearly Totals								

Notes:

N/M = Not Monitored

Reviewed:____________________________ **Date:**____________

RSO:____________________________ **Date:**____________

AP-008-05
OCCUPATIONAL RADIATION EXPOSURE HISTORY

Name:	**SSN:**
Address:	
Date of Birth:	

The above individual was monitored by: TLD: Direct Reading Dosimeter:

This is a: Record: Estimate:

Monitoring Device Number:_______________

The monitoring period was: From:_______________ To:_______________

The Occupational Radiation Exposure was received during:

Assignment for: _____________________ License No.: _____________________

Address: ___________________________

City/State/ZIP: _____________________

Telephone: _________________________

RADIATION EXPOSURE RESULTS

Deep Dose Equivalent for the period stated above:	___________Rem (DDE)
Shallow Dose (skin) for the period stated above:	___________Rem (SDE)
Extremity Dose for the period stated above:	___________Rem (SDE)
Eye Dose Equivalent for the period stated above:	___________Rem (LDE)
Committed Effective Dose Equivalent (Internal):	___________Rem (CEDE)
Total Effective Dose Equivalent (DDE + CEDE):	___________Rem (TEDE)

This report is furnished to you under the provisions of Nuclear Regulatory Commission Regulation 10 CFR Part 20 titled "Standards for Protection Against Radiation". You should preserve this report for further reference.

Radiation Safety Officer:_______________________________ Date:_______________

AP-008-06

DRD Dose Tracking Log

Name	Date	DRD Serial No.	Time In	Dose In	Time Out	Dose Out	Net Dose

Reviewed:______________________ **Date:**__________

RSO:______________________ **Date:**__________

1.0 PURPOSE

This procedure provides the methods for operating alpha/beta survey meters when performing contamination surveys. Adherence to this procedure will provide reasonable assurance that the surveys performed have reproducible results.

2.0 APPLICABILTY

This procedure will be used by Cabrera Services, Inc. (CABRERA) personnel to measure fixed and removable alpha and/or beta emitting radioactive material on facility surfaces, equipment, waste packages, personnel, personnel protective clothing, etc.

3.0 PRECAUTIONS, LIMITATIONS, AND REQUIREMENTS

3.1 Precautions

3.1.1 Ensure that the thin Mylar or mica window on the probe face is protected from punctures during survey operations.

3.1.2 If any instrument inconsistencies are observed (e.g., unusually high or low background readings, source checks outside the acceptable range, etc.), remove the instrument from use, label it "OUT OF SERVICE" and report the condition to the Radiation Safety Officer (RSO) or duly authorized representative.

3.2 Limitations

None

3.3 Requirements

3.3.1 Calibration sources shall be traceable to the National Institutes of Science and Technology (NIST).

3.3.2 A battery check, general observation of instrument condition and source check shall be performed each day before instrument use and daily following work activities as a final verification.

3.3.3 Survey instrument calibrations shall be performed by an NRC or Agreement State licensed calibration facility.

4.0 REFERENCES

- RSP Radiation Safety Program
- AP-001 Record Retention
- OP-001 Radiological Surveys
- OP-009 Use and Control of Radioactive Check Sources

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Restricted Area - An area containing radioactive material(s) to which access is controlled to protect individuals from exposure to ionizing radiation.

5.2 Alpha/Beta Contamination Survey - A survey technique to determine fixed and removable alpha/beta contamination.

5.3 Acceptance Range - A range of values that describe an acceptable daily instrument source check result.

6.0 EQUIPMENT

6.1 For Alpha Surveys Ludlum Model 43-5 probe and Ludlum Model 3 survey meter or equivalent meter/probe combination.

6.2 For Beta Surveys Ludlum Model 44-9 probe and Ludlum Model 3 survey meter or equivalent meter/probe combination.

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – the PM is responsible for ensuring that personnel assigned the task of operating contamination survey meters are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in the use of contamination survey meters described in this procedure.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT operating contamination survey meters are responsible for knowing and complying with this procedure.

8.0 OPERATION

8.1 Instrument Inspection

8.1.1 Select the contamination survey meter and probe to be used in the survey.

8.1.2 Before each use, perform the following checks:

8.1.2.1 Verify the instrument has a current calibration label.

8.1.2.2 Visually inspect the instrument for physical damage or defects.

8.1.2.3 Position the meter switch to "BAT". Check to see that the needle falls within the "Bat Test" checkband.

- If the needle falls below the "Bat Test" checkband, install new battery(s).
- If the needle still falls outside the "Bat Test" checkband after the installation of new battery(s), tag the instrument "Out of Service" and notify the RSO or duly authorized representative.

8.1.2.4 Check alpha detectors for light leaks by pointing the mylar window of the detector toward a light source and observing no change in the meter indication.

8.1.3 Remove and tag the instrument "Out of Service" if it fails any of the criteria in Step 8.1.2.1 through 8.1.2.44 and notify the RSO or duly authorized representative.

NOTE: Any defects, damages or other physical abnormalities require that the instrument be removed from service and the RSO or duly authorized representative be notified.

8.2 Pre-operation of instrument

8.2.1 Position the meter fast/slow ("F/S") switch to "S".

8.2.2 Position the meter switch to the appropriate range scale.

8.2.3 Obtain an OP-020-01 Form.

8.2.4 If a Quality Control (Q.C.) acceptance range has not already been calculated on the OP-020-01 Form, then follow the instructions below, other wise proceed to step 8.2.5.

8.2.4.1 Ensure the source and detector are in documented reproducible positions, which will be used each time this check is performed. Document this position on Form OP-020-01.

8.2.5 Place the QC check source and detector in the documented position on Form OP-020-01.

8.2.6 Allow the instrument reading to stabilize (approximately 30 seconds). Compare the reading to the response check criteria on Form OP-020-01. If the response reading falls outside of the acceptance range, tag the instrument "Out of Service" and notify the RSO or duly authorized representative.

8.3 Contamination Survey Techniques

Caution: The window area of alpha detectors are covered with a very thin (1 mg/cm^2) aluminized Mylar window and beta detector windows are 1.7 mg/cm^2 mica. Either window can be easily when surveying areas, which have protruding fragments that might puncture the detector face. Remove these fragments before performing surveys.

Note: To maintain the calibrated detection efficiency, the detector must be held at the appropriate height, determined during calibration, when surveying. For example, if a beta probe's efficiency was calculated at 1/2 inch from the calibration source, the detector must be held at 1/2 inch from the surface being surveyed to maintain calibrated detection efficiency.

Note: Avoid contacting the detector probe to the area being surveyed. This potentially could contaminate the probe.

8.3.1 Verify the instrument selector switch is in the X 0.1 position.

8.3.2 For a stationary reading, place the detector over the area to be measured and allow meter to stabilize. Record the average meter indication in either CPM α/PA (probe area) or CPM β/PA on applicable forms.

8.3.3 For a scan survey move the detector slowly over the surface (less than one detector width per second). Observe meter indication. If increased readings are observed return to the area and obtain a stationary reading. Record maximum area meter indication in either CPM α/PA or CPM β/PA, on applicable forms.

8.4 Final Verification

Upon completion of work activities, repeat steps 8.1.2.1 through 8.2.2.4 and

8.2.5 through 8.2.6, as a final verification that the instrument is working properly

8.5 Interpretation of Results

The meter reading on the alpha and beta survey meters must be corrected for detector efficiency and detector surface area before comparing results with the contamination units in Section 3.6 of the Radiation Safety Program. The conversion from CPM α/PA or CPM β/PA to DPM α/100 cm^2 or β/100 cm^2 is performed using the following equation.

$$(DPM\ /100\,cm^2) = \frac{(AxB)}{C}$$

Where:

A = Alpha or Beta survey meter indication in net CPM α/PA or β/PA (i.e. Gross Alpha or Beta Survey Counts minus background counts = Net CPM/PA)

B = 100 cm^2 divided by the effective detector surface area in cm^2. With an effective surface area of 50 cm^2 for the Ludlum 43-5 alpha detector, the value of B is approximately 2 or for the 15 cm^2 for the Ludlum 44-9 beta detector, the value of B is approximately 6.7.

C = Detector efficiency (expressed as decimal).

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 The health physics technician performing the survey shall ensure that this procedure is the most current and approved revision.

9.2 Records

9.2.1 Documented information shall be legibly written in ink.

9.2.2 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.3 The HPT performing the survey shall review Form OP-020-01 and any other applicable forms for accuracy and completeness.

9.2.4 Entries on Form OP-020-01 and any other pertinent forms must be dated and initialed by the HPT performing the survey to be valid.

9.2.5 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

OP-020-01 Survey Meter Source Check

Survey Meter Source Check Form

Instrument: ______________________ Serial No.: ________

Source: ______________ Acceptable Range: ________ to ________

Date	Cal Due	Reading	H.P. Technician	H.P. Technician Initial

Review By: ______________________ Date: ____________

1.0 PURPOSE

This procedure provides instruction on the operation and setup of an alpha/beta sample counter. Adherence to this procedure will provide reasonable assurance that the surveys performed have reproducible results.

2.0 APPLICABILITY

This procedure will be used by Cabrera Services, Inc., (CABRERA) personnel operating an alpha/beta sample counter during surveys. Types of surveys that may use an alpha/beta sample counter are:

- Smear surveys performed to determine the removal of alpha and beta contamination on facility surfaces, equipment, waste, and source packages, etc.
- Air sample surveys performed in a workers breathing zone to determine alpha and beta air concentrations.

3.0 PRECAUTIONS, LIMITATIONS, AND REQUIREMENTS

3.1 Precautions

3.1.1 If any instrument inconsistencies are observed (e.g., unusually high or low background counts, source checks outside the tolerance range, etc.), remove the instrument from use and report the condition to the RSO or duly authorized representative.

3.1.2 Individuals performing work with an alpha/beta counter shall be familiar with the requirements set forth in the current and approved version of this procedure.

3.2 Limitations

3.2.1 This instrument should be set up for use in low background area as determined by the RSO or duly authorized representative.

3.3 Requirements

3.3.1 Calibration sources shall be traceable to the National Institutes of Science and Technology (NIST).

3.3.2 Survey instrument calibrations shall be performed by an NRC or Agreement State licensed calibration facility.

3.3.3 A battery check, general observation of instrument condition and source check shall be performed each day before instrument use and daily following work activities as a final verification.

4.0 REFERENCES

• RSP	Radiation Safety Program
• AP-005	ALARA Program
• AP-001	Record Retention
• AP-013	Packaging Radioactive Material
• OP-001	Radiological Surveys
• NUREG-1556	Consolidated Guidance About Material Licenses (Vol.11)

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.

5.2 Smear sample survey – a technique using a two-inch diameter filter papers to determine removable contamination of alpha and/or beta emitting radioactive material.

5.3 Air sample survey – a technique in which particulates are collected from a known volume of air drawn through a filter paper and concentrations of airborne alpha and beta activity associated with the particulates is determined by sample counting.

5.4 Plateau – portion of a voltage curve where changes in operating voltage introduce minimum changes in the counting rate.

5.5 Chi-square test – A statistical test to evaluate the operation of a sample counter by determining how data fit a series of counts to a Poisson distribution.

5.6 Daily calibration – A determination of alpha and beta sample counting efficiency by counting National Institute of Standard Technologies (NIST) radioactive standards.

6.0 EQUIPMENT

Ludlum model 2929 or equivalent

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – the PM is responsible for ensuring that personnel assigned the task of operating alpha/beta sample counters are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation Safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in the use of alpha/beta sample counters described in this procedure.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT using alpha/beta sample counters are responsible for knowing and complying with this procedure.

8.0 OPERATION

8.1 Instrument Inspection

8.1.1 Before each use, perform the following checks:

8.1.1.1 Verify the instrument has a current calibration label.

8.1.1.2 Visually inspect the instrument for physical damage or defects.

8.1.2 Remove and tag the instrument "Out of Service" if it fails any of the criteria in Step 8.1.1.1 through 8.1.1.2 and notify the RSO or his duly authorized representative.

NOTE: Any defects, damages or other physical abnormalities require that the instrument be removed from service and the RSO or his duly authorized representative be notified.

8.2 Initial Startup.

8.2.1 Turn high voltage potentiometer to its lowest position (fully counterclockwise).

8.2.2 Turn instrument on.

8.2.3 The operator can select one of four operational procedures depending on the function to be performed. Before performing any of the following complete steps 8.1.1 to 8.1.2.

a) Plateau Curve – The Plateau Curve is used to find the proper operating voltage of the instrument and will be performed at the discretion of the RSO or duly authorized representative. This test shall be documented on the attached Form OP-021-01 or equivalent.

b) Chi–square Test – The Chi-Square Test will be performed at the discretion of the RSO or duly authorized representative in order to test the operational adequacy of the instrument and will be recorded on Form OP-021-02. This test statistically evaluates the sample counter against a poisson distribution.

c) Daily Calibration Check – This portion of the procedure is performed before samples are counted on any day the instrument is in use.

8.3 Plateau Curve

NOTE: Before beginning, record the previous calibration high voltage values.

8.3.1 Set up the instrument in a low background area.

8.3.2 Rotate the high voltage potentiometer slowly clockwise until the meter indicates proper voltage. This proper voltage is approximately 500 volts.

8.3.3 Set time multiplier switch to "x1."

8.3.4 Set the instrument-preset timer to one (1) minute.

8.3.5 Insert an alpha calibration standard into the center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a one minute count.

8.3.6 Upon completion of the count, record high voltage reading and digital counts appearing in the instrument alpha display in the indicated columns on Form OP-021-01(Plateau Data Sheet)

8.3.7 Continue increasing high voltage by 50-volt increments, as described above, obtaining counts and recording data until the end of the plateau is reached. If rapid increase in count rate is observed, proceed to step 8.3.8. If not, notify the RSO or duly authorized representative.

8.3.8 Remove the alpha source and replace with a beta source.

8.3.9 Reduce high voltage reading to the voltage level chosen during Step 8.3.2 by turning potentiometer counterclockwise.

8.3.10 Perform one-minute counts at 50-volt increments and record the data on Form OP-020-01, until the end of the plateau is reached. If a rapid increase in count rate is observed reduce the high voltage.

8.3.11 Using linear graph paper or equivalent plotting system, plot alpha and beta counts on the "Y" axis and the voltage for the indicated count on the "X" axis.

8.3.12 Select an operating voltage 1/3 the distance beyond the knee of the plateau curve by marking the voltage on the graph and on the plateau data sheet.

8.3.13 Sign and date Form OP-021-01 and forward the results along with any graphs produced to the RSO or duly authorized representative for review.

8.4 Chi-Square Test

8.4.1 Set up the Instrument in a low background area.

8.4.2 Ensure the high voltage potentiometer is positioned according to the posted instrument label. Adjust if necessary.

8.4.3 Set the time multiplier switch to "x1".

8.4.4 Set the instrument-preset timer to one (1) minute.

8.4.5 Insert the alpha calibration standard into center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a one minute count.

8.4.6 Upon completion of the count, record digital counts appearing in the alpha display in the "X_i" column on Form OP-021-02 (Chi -Square Data Sheet).

8.4.7 Repeat counting sequence without changing settings until a total of 20 counts have been taken and recorded in the "X_i" column on Form OP-021-02.

8.4.8 Add the 20 counts recorded in the "X_i" column and record in the "Sum" column. Then divide by 20 to obtain the mean number of counts (X_m) and record on the line "X_m".

8.4.9 Calculate the individual count "X_i" difference from the mean (X_m) value and record in the "(X_i-X_m)" column on Form OP-021-02 for all 20 values.

8.4.10 Calculate $(X_i-X_m)^2$, sum the "$(X_i-X_m)^2$ " column, and record on Form OP-020-02.

8.4.11 Calculate the value of Chi- Square using the following formula.

$$X^2 = \frac{\sum (X_i - X_m)^2}{X_m}$$

8.4.12 The value of Chi-square should be between 8.91 and 32.8 (represents a probability between 0.025 and 0.975). Record this value at "X^2". If the Chi-square value falls outside this range, contact the RSO or duly authorized representative for further instructions.

8.4.13 Sign and date Form OP-021-02 and forward the results to the RSO or duly authorized representative for review.

8.5 Daily Calibration Check

8.5.1 Ensure the high voltage potentiometer is positioned according to the posted instrument label. Adjust, slowly, if necessary.

8.5.2 Set time multiplier switch to "x1".

8.5.3 Set the instrument-preset timer to five (5) minutes.

8.5.4 Record the source type to be used and corresponding serial number on the proper line indicated on Form OP-021-03. Use separate rows of the form for each source efficiency to be calculated.

8.5.5 Insert a blank sample into the center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a five minute background count.

8.5.6 Calculate and record the background total counts and count rate in the columns labeled "Total Counts" and "BKG CPM" respectively, under Background Information on Form OP-021-03. The background count rate in CPM (counts per minute) can be calculated as follows:

$$CPM = \frac{\text{Total Counts}}{\text{Total Time}}$$

8.5.7 Remove the blank sample and insert the alpha or beta calibration standard into the center of the sample tray, slide the sample tray under the detector and depress the "COUNT" button to obtain a five minute count.

8.5.8 Upon completion of the measurement, calculate and record the total counts and count rate in the columns labeled "Total Counts" and "CPM" respectively, under Source Information on Form OP-021-03. The count rate (CPM) can be calculated as listed in Step 8.5.6.

8.5.9 Calculate Net Source CPM as below and record on Form OP-021-03 under "Net CPM".

$$\text{Net Source CPM} = \text{CPM} - \text{BKG CPM}$$

NOTE: Obtain activity (DPM) value from the source certification paperwork. Decay correct activity, if needed.

8.5.10 Use the source disintegration per minute (DPM) to calculate the efficiency as shown below and record as a decimal on Form OP-021-03.

$$\%\ Efficiency = \frac{Net\ Source\ CPM}{DPM} * 100$$

8.5.11 To calculate the efficiency for the next source, remove the current source standard, insert a new source standard and repeat steps 8.5.1 through 8.5.10, as necessary.

8.5.12 Remove calibration standards and place in source holders.

8.5.13 Generate a control chart tracking the daily efficiencies and notify the RSO or duly authorized representative if any point falls outside of 2σ variance.

NOTE: For the first day on control chart use five data points to begin trend line.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 The alpha/beta sample counter will be checked for proper calibration daily with a NIST traceable source when in use.

9.1.2 Chi-square and plateau tests are verified and noted as currently valid.

9.1.3 The HPT shall ensure that the attachments are of the most current.

9.2 Records

9.2.1 Documented information shall be legible written in ink.

9.2.2 Data shall not be obliterated by erasing or using white-out. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed and dated.

9.2.3 The HPT shall review completed attachment forms for accuracy and completeness.

9.2.4 Entries on forms must be dated and initialed by the HPT to be valid.

9.2.5 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

- OP-021-01 Plateau Data Sheet
- OP-021-02 Chi–Square Data Sheet
- OP-021-03 Daily Calibration Check

OP-021-01

Plateau Data Sheet

Date:________________ Recommended Operating Voltage:____________________

Instrument:____________________________ Serial Number:__________________

Alpha Source Serial No.________________________ Activity (dpm)________________

Beta Source Serial No.________________________ Activity (dpm)________________

Voltage Setting	Alpha Counts	Voltage Setting	Alpha Counts	Voltage Setting	Beta Counts	Voltage Setting	Beta Counts

Prepared By:____ Date:____________
Print/Sign

Reviewed By:____ Date:____________
Print/Sign

OP-021-02

Chi-Square Data Sheet

Date:________ Instrument:__________________ Serial Number:___________ X^2________

Alpha Source No./Activity:_______________ Beta Source No./Activity:__________________

Count Number	X_i	(X_i-X_m)	$(X_i-X_m)^2$
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
Sum		\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	
X_m		\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\

Prepared By: ____ Date: ______________
Print/Sign

Reviewed By: ____ Date: ______________
Print/Sign

OP-021-03

Daily Calibration Check

Instrument_______________________ Serial No.______________

Alpha Source No./Activity______________ Beta Source No./Activity______________

Background Information				Source Information				
Date/Time	Total Time	Total Counts	BKG CPM	Total Time	Total Counts	**CPM**	**Net CPM**	**% Eff.**

Prepared By: ______________________________ Date: ______________
Print/Sign

Reviewed By: ______________________________ Date: ______________
Print/Sign

1.0 PURPOSE

This procedure provides the methods for operating ion chamber instruments for dose rate surveys. Adherence to this procedure will provide reasonable assurance that the radiological surveys performed have reproducible results.

2.0 APPLICABILITY

This procedure will be used by Cabrera Services, Inc. (CABRERA) CABRERA personnel to operate Ionization chambers during dose rate surveys.

3.0 PRECAUTIONS, LIMITATIONS, AND REQUIREMENTS

3.1 Precautions

3.1.1 During surveys, exercise care not to puncture the thin Mylar window.

3.1.2 If any instrument inconsistencies are observed (e.g., unusually high or low background readings, source checks outside the acceptable range, etc.), remove the instrument from use, label it "OUT OF SERVICE" and report the condition to the RSO.

3.2 Limitations

Not Applicable

3.3 Requirements

3.3.1 Calibration sources shall be traceable to the National Institutes of Science and Technology (NIST).

3.3.2 Survey instrument calibrations shall be performed by a NRC or Agreement State recognized and licensed calibration facility.

3.3.3 A battery check, general observation of instrument condition and source check shall be performed each day before instrument use and daily following work activities as a final verification.

4.0 REFERENCES

- RSP — Radiation Safety Program
- ALARA — ALARA Program
- AP-001 — Record Retention
- OP-001 — Radiological Surveys
- OP-009 — Use and Control of Radioactive Check Sources
- NUREG-1556 — Consolidated Guidance About Material Licenses (Vol.11)

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.

5.2 Radiation Area - Any area accessible to personnel where dose rate levels from ionizing radiation are such that an individual could receive a deep dose equivalent in excess of 5 mrem in one hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

5.3 Dose – The deposition of energy in matter. Equivalent to the radiation dose times the quality factor for the type of radiation.

5.4 Quality Factor – The factor, which is radiation dependent and identifies the relative biological effectiveness of a radiation type and energy. The quality factor is multiplied times the Dose to yield the Dose Equivalent.

5.5 TEDE – The Total Effective Dose Equivalent – The sum of the Deep Dose Equivalent (external dose) and the Committed Effective Dose Equivalent (internal dose).

5.6 CDE – Committed Dose Equivalent – The dose equivalent to organs or tissues that will be received from an intake of radioactive material by an individual during the 50-year period following the intake.

5.7 CEDE – Committed Effective Dose Equivalent – The sum of the products of all organs or tissues with CDE and their respective weighting factors.

5.8 SDE – Shallow Dose Equivalent – Applies to the skin and to any extremity, it is used for external radiation which cause primary energy deposition in the first 0.007 cm of tissue averaged over one square centimeter.

5.9 EDE- Eye Dose Equivalent – The dose delivered to a thickness of tissue 300 mg/cm^2 by external radiation.

5.10 DDE – Deep Dose Equivalent – The dose equivalent delivered by external radiation to tissues deeper than 1 centimeter.

5.11 Daily calibration – A determination of alpha and beta sample counting efficiency by counting National Institute of Standard Technologies (NIST) radioactive standards.

6.0 EQUIPMENT

Ludlum model 9 Ionization Chamber or equivalent

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – the PM is responsible for ensuring that personnel assigned the task of operating ionization chambers are familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation Safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in the use of ionization chambers described in this procedure.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT using ionization chamber survey meters are responsible for knowing and complying with this procedure.

8.0 OPERATION

8.1 Instrument Inspection

8.1.1 Select the ion chamber to be used in the survey.

8.1.2 Before each use, perform the following checks:

8.1.2.1 Verify the instrument has a current calibration label.

8.1.2.2 Visually inspect the instrument for physical damage or defects.

8.1.2.3 Position the meter switch to "BAT". Check to see that the needle falls within the "Bat Test" check-band.

- If the needle falls below the "Bat Test" check-band, install new battery(s).
- If the needle still falls outside the "Bat Test" check-band after the installation of new battery(s), tag the instrument "Out of Service" and notify the RSO or duly authorized representative.

8.1.3 Remove and tag the instrument "Out of Service" if it fails any of the criteria in Step 8.1.2.1 through 8.1.2.3 and notify the RSO or duly authorized representative.

NOTE: Any defects, damages or other physical abnormalities require that the instrument be removed from service and the RSO or duly authorized representative be notified.

8.2 Pre-operation of instrument

8.2.1 Position the meter fast/slow ("F/S") switch to "S".

8.2.2 Position the meter switch to the appropriate range scale.

8.2.3 Obtain an OP-020-01 Form.

8.2.4 If a Quality Control (Q.C.) acceptance range has not already been calculated on the OP-020-01 Form, then follow the instructions below, other wise proceed to step 8.2.6.

8.2.5 Enter the QC check source, probe, and meter numbers on Form OP-020-01.

8.2.5.1 Ensure the source and detector are in a reproducible geometry, which will be used each time this check is performed.

8.2.5.2 Obtain ten separate measurements in a low background area.

8.2.5.3 Calculate the average of the ten measurements by adding the measurements and dividing the sum by ten.

8.2.5.4 Multiply the average measurement value established in 8.2.5.3 by 0.8 and record on Form OP-020-01 as the lower QC acceptance range.

8.2.5.5 Multiply the average measurement value established in 8.2.5.3 by 1.2 and record on Form OP-020-01 as the upper QC acceptance range.

8.2.6 Place the QC check source and detector in the proper geometry established for QC check.

8.2.7 Allow the instrument reading to stabilize (approximately 30 seconds). Compare the reading to the response check criteria on Form OP-020-01. If the response reading falls outside of the acceptance range, note Fail on Form OP-020-01, tag the instrument "Out of Service" and notify the RSO or duly authorized representative. If the reading falls inside the acceptance range, note Pass on Form OP-020-01; the instrument is ready for performing surveys.

8.3 Operation of Instrument

8.3.1 Gamma Survey Techniques

8.3.1.1 Switch the audio toggle switch to the "ON" position.

8.3.1.2 Ensure the beta shield is covering the Mylar window.

8.3.1.3 When entering a radiation area of unknown radiation levels turn the range selector switch to the highest scale or the highest scale for the dose rate expected. Rotate the range selector switch downscale until an upscale meter needle deflection is observed.

8.3.1.4 When obtaining a gamma exposure rate place the entire detector volume in and perpendicular to the radiation field.

8.3.1.5 Gamma exposure rates are obtained in the area where a worker will be located during work activities. If only a position of the workers body will be exposed to the field, the highest exposure rate will be used to determine working time.

8.3.1.6 Gamma exposure rates on waste packages are obtained by placing the centerline of the detector at the indicated distance from the package and perpendicular to the radiation field.

8.3.1.7 Record the highest meter indication in mR/hr and its location on the forms provided in procedure OP-001.

8.3.2 Survey techniques for Lens of Eye Dose

For lens of eye equivalent doses, record the dose for the beta shield in the closed configuration if the shield is 300 mg/cm^2 thick or less. If the beta shield is greater than 300 mg/cm^2, then conservatively use the beta shield in the open configuration to record equivalent dose for the lens of the eye.

8.3.3 Beta Survey Technique

Caution: The window area of the detector is covered with a 7 mg/cm^2 aluminized Mylar covering and can be easily punctured. Avoid protruding fragments that might puncture the detector face.

8.3.3.1 When a higher reading is obtained with the beta shield open compared with the beta shield closed, this indicates the presence of beta radiation.

8.3.3.2 To obtain the beta dose first obtain a reading with the beta shield closed (CW) as described in Section 8.3.1. Next, obtain a reading with the beta shield open (OW) at the same location holding the meter in the same configuration.

8.3.3.3 Determine the beta dose using the following formula:

$$\text{True } \beta \text{ Dose} = (OW - CW) \times BCF$$

Where: OW = Open Window reading (beta shield open)

CW = Closed Window reading (beta shield closed)

BCF = Beta Correction Factor (5 for reading taken at 4 centimeters - use with caution this is isotope dependent)

8.3.3.4 Beta dose rates to the skin or lens of the eye are obtained in the area where workers will be located during work activities. If only a portion of the workers body will be exposed to the field, the highest exposure rate will be used to determine working time.

8.3.3.5 Beta dose rates to the skin are obtained by obtaining measurement at 4 centimeters from the surface contacted by the worker.

8.3.3.6 Record the beta dose rates in mrad/hr (β) and location on the forms provided in procedure OP-001.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 The health physics technician performing the survey shall ensure that this procedure is current.

9.2 Records

9.2.1 Documented information shall be legibly written in ink.

9.2.2 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.3 The HPT shall ensure that the attachments are of the most current.

9.2.4 The HPT shall review completed attachment forms for accuracy and completeness.

9.2.5 Entries on forms must be dated and initialed by the HPT to be valid.

9.2.6 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

None

1.0 PURPOSE

The purpose of this procedure is to provide instruction for the operation of the micro-R meter for gamma radiation surveys. Adherence to this procedure will provide reasonable assurance that the radiological surveys performed have reproducible results.

2.0 APPLICABILITY

This procedure will be used by Cabrera Services, Inc. (CABRERA) personnel operating the micro-R meter during gamma radiation surveys. The micro-R meter is used to determine gamma radiation levels from facility surfaces, equipment, waste and source packages, etc., containing gamma emitting radioactive materials.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

3.1.1 Individuals performing work with the micro-R meter shall be familiar with the requirements set forth in the current and approved version of this procedure.

3.1.2 If any instrument inconsistencies are observed (e.g., unusually high or low background readings, source checks outside the acceptable range, etc.), remove the instrument from use, label it "OUT OF SERVICE" and report the condition to the Radiation Safety Officer (RSO) or duly authorized representative.

3.2 Limitations

None

3.3 Requirements

3.3.1 Calibration sources shall be traceable to the National Institutes of Science and Technology (NIST).

3.3.2 A battery check, general observation of instrument condition and source check shall be performed each day before instrument use and daily following work activities as a final verification.

3.3.3 Survey instrument calibrations shall be performed by an NRC or Agreement State licensed calibration facility.

4.0 REFERENCES

- RSP — Radiation Safety Program
- ALARA — ALARA Program
- AP-001 — Record Retention
- OP-001 — Radiological Surveys
- OP-009 — Use and Control of Radioactive Check Sources
- OP-020 — Operation of Contamination Survey Meters
- NUREG-1556 — Consolidated Guidance About Material Licenses (Vol.11)

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Restricted Area – An area to which access is controlled to protect individuals against undue risks from exposure to radiation and radioactive materials.

5.2 Gamma Radiation Survey – A survey technique to determine gamma radiation levels from radioactive material(s) in facilities, materials, landmasses, etc.

5.3 Acceptance Range – A range of values that describe an acceptable daily instrument source check result.

6.0 EQUIPMENT

Ludlum Model 19 or equivalent

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – the PM is responsible for ensuring that personnel assigned the task of operating a micro-R meter is familiar with this procedure, adequately trained in the use of this procedure, and have access to a copy of this procedure.

7.2 Radiation safety Officer (RSO) – The RSO is responsible for verifying that personnel comply with this procedure and are trained in the operation of a micro-R meter described in this procedure.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT operating the micro-R meter are responsible for knowing and complying with this procedure.

8.0 OPERATION

8.1 Instrument Inspection

8.1.1 Before each use, perform the following checks:

8.1.1.1 Verify the instrument has a current calibration label.

8.1.1.2 Visually inspect the instrument for physical damage or defects.

8.1.1.3 Position the meter switch to "BAT". Check to see that the needle falls within the "Bat Test" checkband.

- If the needle falls below the "Bat Test" checkband, install new battery(s).
- If the needle still falls outside the "Bat Test" checkband after the installation of new battery(s), tag the instrument "Out of Service" and notify the RSO or duly authorized representative.

8.1.2 Remove and tag the instrument "Out of Service" if it fails any of the criteria in Step 8.1.1.1 through 8.1.1.3 and notify the RSO or duly authorized representative.

NOTE: Any defects, damages or other physical abnormalities require that the instrument be removed from service and the RSO or duly authorized representative be notified.

8.2 Pre-operation of instrument

8.2.1 Position the meter fast/slow ("F/S") switch to "S".

8.2.2 Position the meter switch to the appropriate range scale.

8.2.3 If a Quality Control (Q.C.) acceptance range has not already been calculated, then follow the instructions below, other wise proceed to step 8.2.5.

8.2.3.1 Ensure the source and detector are in documented reproducible positions, which will be used each time this check is performed. Document this position on appropriate form.

8.2.4 Place the QC check source and detector in the documented position on appropriate form.

8.2.5 Allow the instrument reading to stabilize (approximately 30 seconds). Compare the reading to the response check criteria. If the response reading falls outside of the acceptance range, tag the instrument "Out of Service," and notify the RSO or duly authorized representative.

8.3 Operation of the instrument

8.3.1 Grid Surveys

8.3.1.1 Turn the audio switch to the "On" position.

8.3.1.2 Verify the instrument selector switch is on the lowest scale (usually the μR position). Turn the instrument selector switch to the next higher scale only if meter indication is off scale.

8.3.1.3 For a stationary grid reading in a facility or land mass, position the instrument one meter above the surface to be surveyed and allow meter to stabilize. With the instrument toggle switch set in the "SLOW" position, the meter reaches 90% of its final reading in 22 seconds. Record the average meter indication in μR/hr on appropriate form(s).

Note: Two survey methods (step 8.3.1.4 or 8.3.1.5) can be used to obtain contact readings in the survey grids. The survey method used will be specified in the site specific work plan.

8.3.1.4 For a scan survey, make sure the meter response is set to fast and suspend the instrument from a strap which locates the detector at surface or ground level. Move the instrument slowly over the surface while walking in an "S" pattern unless otherwise instructed by the RSO or duly authorized representative. Areas, which could concentrate radioactive materials such as drainage ditches, floor cracks, and wall/floor joints, should be surveyed. Observe meter indication and listen for increases in audible clicks from the speaker. If elevated readings above background are observed, a stationary survey shall be performed (at one-meter height and at the surface) at the point of elevated activity. Record area meter indications above background in μR/hr on appropriate form.

8.3.1.5 As an alternate to the "S" pattern survey used in step 8.3.1.4, the survey grid can be divided into subgrids and readings taken as directed by the site work plan. Elevated measurements should be performed in the same manner as above (i.e., at one meter and at the surface). The readings from each measurement are recorded on appropriate form.

8.3.2 Waste Container Surveys

8.3.2.1 Set the instrument scale to accommodate the highest expected radiation level. If radiation levels may approach 5000 μR/hr (5 mR/hr) obtain an instrument with appropriate range before performing any radiation surveillance.

8.3.2.2 Slowly scan the total surface of the package and record the maximum contact reading obtained on appropriate forms.

8.3.2.3 Obtain instrument readings at one meter from all sides of the package and record the maximum reading obtained on appropriate form.

8.3.3 Final Verification

Upon completion of work activities, repeat steps 8.1.1.1 through 8.2.2 and 8.2.4 through 8.2.5, as a final verification that the instrument is working properly

8.3.4 Additional Information

8.3.4.1 In a uniform background radiation field (without interfering sources of radiation), methods such as selectively shielding the detector, soil sample analysis, etc., can be used to differentiate between extraneous radioactive sources (e.g., skyshine or radioactive waste shipment containers), naturally occurring radioactive material and/or radioactive contamination.

8.3.4.2 Note the location of installed devices, which contain radioactive material and could cause elevated background radiation levels in localized areas.

8.3.4.3 Land mass surveys might contain areas with naturally occurring radioactive materials, which will elevate background radiation levels.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 The health physics technician performing the survey shall ensure that this procedure is current.

9.2 Records

9.2.1 Documented information shall be legibly written in ink.

9.2.2 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.3 The health physics technician performing the survey shall review appropriate forms and any other applicable forms for accuracy and completeness.

9.2.4 Entries must be dated and initialed by the health physics technician performing the survey to be valid.

9.2.5 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

None

1.0 PURPOSE

This procedure provides the methods Cabrera Services, Inc. (CABRERA) uses in operation of air samplers and calculation of radioactive particulate activity in air sample. This procedure describes the methods used to calculate Derived Air Concentration (DAC) DAC-hour exposures to workers. Adherence to this procedure will provide reasonable assurance that the surveys performed have accurate and reproducible results.

2.0 APPLICABILITY

This procedure will be used by CABRERA personnel to operate air samplers during surveys and work activities at customer facilities, calculate, and record DAC-Hour exposures to workers. Air samples are performed when the average alpha and beta contamination on facility surfaces, equipment and waste packages exceed the contamination limits specified in Table 1 of the Radiation Protection Manual (RPM) and included as Attachment OP-002-03 of this procedure. Air monitoring shall be performed in areas where there exists potential to exceed 10 percent of any DAC.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

Not Applicable

3.2 Limitations

Not Applicable

3.3 Requirements

3.3.1 Air samplers should only be operated in temperatures between -4^0 F to 122^0 F.

3.3.2 Air sampler inspections shall be performed by qualified Health Physics personnel.

4.0 REFERENCES

- RSP — Radiation Safety Program
- AP-001 — Record Retention
- OP-021 — Alpha-Beta Sample Counting Instrumentation
- Reg Guide 8.25 — Air sampling in the Workplace
- NUREG-1556 — Consolidated Guidance About Material Licenses (Vol.11)

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Restricted Area – An area, access to which is limited by the licensee for the purpose of protecting individuals against undue risks from exposure to radiation and radioactive materials. Restricted area does not include areas used as residential quarters, but separate rooms in a residential building may be set apart as a restricted area.

5.2 Smear Sample Survey – A survey technique using filter paper smears to determine quantities of alpha and beta emitting radioactive material which can be removed from facility surfaces and waste packages.

5.3 Air Sample Survey – A survey technique which collects particulates from a known volume of air and determines the concentrations of radioactive materials associated with the airborne particulates.

5.4 Annual Limit on Intake (ALI) – The annual limit on intake (ALI) of radioactive materials is the smaller amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year (40 hours per week for 50 weeks) that would result in a committed effective dose equivalent (CEDE) of 5 rem or a committed dose equivalent (CDE) of 50 rems to any individual organ or tissue.

5.5 Derived Air Concentration (DAC) – Derived air concentration is the concentration of a given radionuclide in air which, if breathed by "reference man" for a working year (40 hours per week for 50 weeks) under the conditions of light work (inhalation rate of 1.2 cubic meters of air per hour), results in an air intake of one ALI.

5.6 DAC-Hour – The product of the concentration of radioactive material in air (expressed as a multiple of the derived air concentration for each nuclide) and the time of exposure to that nuclide, in hours, 2000 DAC-Hours represents one ALI.

5.7 Airborne Radioactivity Area – A room, enclosure or area in which the radioactive material is dispersed in the form of dusts, fumes, mists, particulates, vapors and the concentration of the dispersed radioactive materials in excess of:

5.7.1 The derived air concentrations (DAC's) specified in Table 1, column 3 of Appendix B, Title 10 Part 20 of the Code of Federal Regulations, or

5.7.2 Concentrations such that an individual present in the area without respiratory protective equipment could exceed, during the hours the individual is present in a week, an intake of 0.6 percent on the annual limit on intake (ALI) or 12 DAC-hrs.

6.0 EQUIPMENT

6.1 None

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – the PM is responsible for ensuring that personnel assigned the task of air sampling and air sampling analysis are familiar with this procedure, adequately trained with the specific instrument being used to perform surveys.

7.2 Radiation Safety Officer (RSO) – The RSO is responsible for monitoring compliance with this procedure and training personnel in the use of the air sampling and air sampling analysis. The RSO can also assist in the interpretation of the results obtained during surveys.

7.3 Radiological Field Supervisor (RFS) – During field assignments, the RFS is responsible for ensuring that this procedure is implemented. When the RSO is not on site, the RFS will act as the RSO's duly authorized representative for radiological issues.

7.4 Health Physics Technicians (HPT) – The HPT performing air sampling and air sampling analysis are responsible for knowing and complying with this procedure.

8.0 INSTRUCTIONS

8.1 Initial Preparation

8.1.1 Select the air sampler to be used for the type of sample to be used and verify that the instrument has a currently valid calibration. If the work area contains radioiodine or tritium, contact the radiation safety officer for special sampling procedures before proceeding.

8.1.1.1 Area air samples are normally collected with a low volume air sampler having normal airflow of 1 CFM to 5 CFM.

8.1.1.2 Breathing zone air samples are normally collected using lapel air samplers, which have a normal airflow of 1 to 5 liters per minute.

8.1.1.3 All air sampling devices shall be calibrated to ensure accurate sample volumes are collected. The frequency of calibration shall not exceed one (1) year.

8.1.2 Attach the air sampling head to the intake of the low volume sample pump or to the tygon tubing of the Lapel sampler.

8.1.3 Obtain the filter paper to be used in the sample and mark the backside of the filter with a unique number, which will represent the sample. During the collection and handling of air sample filter papers, caution must be used to prevent the samples from being contaminated by other radioactive materials.

8.1.4 Place the filter paper in the holder and position the sampler as indicated below.

8.1.4.1 Area air samples are collected by placing the sample head at a distance of 3 to 6 feet above the floor and as close to the work area as practical. If there is airflow in the work area, the sampler should be placed “down wind” of the area where workers will be resuspending radioactive particulates into the workers atmosphere.

8.1.4.2 Lapel air samples are collected from workers breathing zone. The sample head is attached to the shoulder of the worker with the sample head facing forward. The tygon tubing connecting the sample head to the pump is run down the back of the worker with the sample pump attached to the workers belt.

8.2 Collecting the sample

8.2.1 When the sample head is in position, start the sample pump and adjust the flow rate to the highest flow rate, which can be maintained without flow rate fluctuations.

8.2.2 Record the time the sample was started and the initial flow rate of the sample pump on Form OP-002-01, Air Sample Data Sheet.

8.2.3 If possible, identify the radionuclides, which will be encountered in the work area and record the radionuclides along with the DAC for each radionuclide in the space provided on the Air Sample Data sheet. If a mixture of radionuclides is present, the DAC used in the calculations of DAC-Hours will be the most restrictive concentration.

8.2.4 Collect the sample for the maximum time possible, which represents the exposure encountered by the worker.

8.2.5 At the end of the collection period, note the flow rate of the sample pump and record this flow rate and the time, which the sampling stopped on the Air Sample Data sheet.

CAUTION: Be sure not to remove activity from the sample surface. Handle the filter with care.

8.2.6 Remove the sample filter and place the filter in an individual envelope or poly bag to ensure no possibility of contamination by other sources of radioactivity.

8.2.7 Record the names of workers who were in the area and the time spent in the work area on the Air Sample Data sheet.

8.2.8 Determine the average sample flow rate by adding the initial sample flow rate and the final sample flow rate and dividing by 2. Record the average flow sample flow rate in the space provided on the Air Sample Data sheet.

8.2.9 Calculate the total air volume sampled by multiplying the average flow rate in cubic centimeters per minute by the total minutes the sampler operated using the indicated spaces on the Air Sample Data sheet.

8.3 Determining minimum detectable activity (MDA) – During calculations or air concentrations in the following sections, the MDA for each analysis is calculated to determine the statistical significance of the calculated air concentrations.

8.3.1 For each air concentration calculation (alpha and beta) in the following sections, calculate the MDA using the following formula:

$$MDA\ in\ \mu Ci/cm^3 = \frac{\frac{k_\alpha^2}{T_{s+b}} + 2\left[k_\alpha\right]\sqrt{\frac{R_b}{T_b} + \frac{R_b}{T_{s+b}}}}{(2.22\times 10^6)(E)(V)}$$

Where:

E = Counter efficiency in CPM/DPM

R_b = Background Count Rate in CPM

T_b = Background Counting Time in Minutes

T_{s+b} = Sample Counting Time in Minutes

V = Sample Volume in cm^3

$2.22X10^6$ = Disintergrations per minute per microCurie (DPM/uCi)

k_α = 1.645 for a confidence level of 95% and 1.96 for a confidence level of 99%

8.3.2 If the MDA is larger than 10% of the Derived Air Concentration, recount the background for a longer time and/or increase the sample count time to lower the MDA. (The maximum count time should not exceed 1 hour for background and 30 minutes for the sample). Enter the MDA for each air concentration calculated in the space provided on the Air Sample Data sheet.

8.4 Initial Air Sample Analysis – The initial analysis of air sample provides the air concentrations for short-lived radionuclides and a first estimate of the long-lived air concentrations. In situations where there is a potential for worker intakes to exceed 40 DAC-Hours in a week or if the radionuclides of interest are short-lived, air samples should be available before work resumes the following day.

8.4.1 Air particulate samples are to be analyzed as a minimum for gross alpha and gross beta activity using a Ludlum Model 2929 Dual Channel Scaler or equivalent.

8.4.2 Place the air sample collection media in the sample counter with the upstream collection side toward the detector. Count the air sample and calculate the sample activity and record results on appropriate form(s).

8.4.3 Record the Alpha and Beta sample DPM results in the Air Sample Data sheet.

8.4.4 Calculate the alpha and beta air concentrations using the following formula. Adjustment due to alpha self absorption are made as appropriate.

$$\text{Air Concentration } (\mu Ci/cc) = \frac{\alpha \text{ or } \beta \text{ } DPM}{(2.22 \times 10^6 \text{ } DPM/\mu Ci)(Sample Volume(cm^3))}$$

8.4.5 Enter the alpha and beta air concentrations on the Air Sample Data sheet in the space provided for the initial air concentrations.

NOTE: If the air sample concentration is greater than 10% of the DAC value, notify the RSO or duly authorized representative for further instructions.

8.4.6 If the air concentration is less than 10 percent of the most restrictive DAC, no further analysis of the air sample is required. If the air concentration exceeds 10% of the DAC concentration, proceed with the analysis in section 8.5.

8.5 Air sample analysis for long-lived radionuclides – This analysis allows for decay of naturally occurring radionuclides and provides for correcting air concentrations for naturally occurring radionuclides.

8.5.1 Air particulate samples are analyzed following 12 hour decay, and again at 72 hours if necessary to allow for decay of radon, for gross alpha and gross beta using a Ludlum Model 2929 Dual Channel Scaler or equivalent.

8.5.2 Place the air sample in the sample counter with the collection side toward the detector. Count the air sample and calculate the sample activity and record results on appropriate form(s).

8.5.3 Record the Alpha and Beta sample DPM results in the Air Sample Data sheet.

8.5.4 Calculate the alpha and beta air concentrations using the following formula. Adjustments due to self absorption are made as appropriate.

$$\text{Air Concentration } (\mu Ci/cc) = \frac{\alpha \text{ or } \beta \; DPM}{(2.22 \times 10^{6} \; DPM/\mu Ci)(Sample Volume(cm^{3}))}$$

8.5.5 Enter the alpha and beta air concentrations on the Air Sample Data sheet in the space provided for the 12-hour decay concentrations. If the 12-hour decay air concentrations is below 10% of the DAC no further analysis is required.

8.5.6 If the 12-hour air concentration is above 10% percent of the DAC value, recount the air sample following 72 hours of decay from the time the sample was stopped. Calculate the air concentration using the formula in step 8.5.4 and record the air concentrations in the space provided for the 72-hour decay air concentration on the Air Sample Data sheet. If the 72-hour air concentration is below 10% of the DAC value, no further analysis is required.

8.5.7 If the air concentrations exceed 10% of the DAC values, notify the RSO or duly authorized representative for further instructions. Save the air sample for possible further analysis. For air samples, which exceed 10% of the DAC values, an exposure is assigned to the workers residing in the area where the sample was taken.

8.6 Assignment of DAC-Hour exposures to workers

8.6.1 For air samples which exceed 10% of the DAC values, calculate the workers DAC-Hour exposure using the following formula:

$$\text{Exposure in DAC-Hours} = \frac{A \times B}{C}$$

Where:

A = Area or Lapel air sample concentration in uCi/cm^3

B = Hours worker was in the calculated air concentration

C = DAC air concentration in uCi/cm^3 from regulatory reference.

8.6.2 Enter the DAC-Hour exposure on the column provided on the Air Sample Data sheet. If respiratory protection was used during the exposure period, contact the RSO or duly authorized representative for the protection factor used to adjust DAC-Hour exposure.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 The alpha and beta counter used to count air samples will be calibrated daily when in with a known radioactive source with activity traceable to the National Institute of Standards and Technology (NIST).

9.2 Records

9.2.1 Documented information shall be legibly written in ink.

9.2.2 Data shall not be obliterated by erasing, using white-out, or by any other means. Incorrect entries shall be corrected by striking a single line across the entry. The correction shall be entered, initialed, and dated.

9.2.3 The health physics technician performing air sampling and analysis shall ensure that this procedure is the most current and approved revision.

9.2.4 The health physics technician performing air sampling and analysis shall review all applicable forms for accuracy and completeness.

9.2.5 Entries on and any other pertinent forms must be dated and initialed by the health physics technician performing the air sampling and analysis to be valid.

9.2.6 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

OP-002-01	Air Sample Data Sheet
OP-002-02	Daily Air Sample Record
OP-002-03	Contamination Limits

OP-002-01

Air Sample Data Sheet

Sample # ________________ Date ________________

Description: ____

Radionuclides: ________________ DAC value: ________________

________________ DAC value: ________________

________________ DAC value: ________________

Initial sample flow rate: __________ Time sampler on: ________________

Final sample flow rate: __________ Time sampler off: ________________

Average sample flow rate: ________ Total sample time:____________ hours

Total sample volume: ___________ cm^3

Initial Air Concentration:

Alpha = __________ $\mu Ci\ \alpha/cm^3$ Beta = _________ $\mu Ci\ \beta/cm^3$

MDA = __________ $\mu Ci\ \alpha/cm^3$ MDA = _________ $\mu Ci\ \beta/cm^3$

12 Hour Decay Air Concentration:

Alpha = __________ $\mu Ci\ \alpha/cm^3$ Beta = _________ $\mu Ci\ \beta/cm^3$

MDA = __________ $\mu Ci\ \alpha/cm^3$ MDA = _________ $\mu Ci\ \beta/cm^3$

72 Hour Decay Concentration:

Alpha = __________ $\mu Ci\ \alpha/cm^3$ Beta = _________ $\mu Ci\ \beta/cm^3$

MDA = __________ $\mu Ci\ \alpha/cm^3$ MDA = _________ $\mu Ci\ \beta/cm^3$

Performed By: ______________________ Date: ____________________

OP-002-02

Daily Air Sample Record

Worker Name	Sample Date	Final Count Date	Time In	Time out	Total time (Hrs.)	Concentration (uCi/cm^3)	DAC-Hour Exposure

Appendix G:

Instrumentation Calibration Certificates

GTS Instrument Services
2045 Route 286
Pittsburgh, PA 15239-2839
724/733-1900 Fax: 724/327-8189

CALIBRATION CERTIFICATE

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION

Customer Name: GTS INSTRUMENT SERVICES
Customer Address: 2045 Rt. 286
Pittsburgh, PA 15239

Customer P.O.#
Work Order #

INSTRUMENT INFORMATION

Instrument Manufacturer: Ludlum
Model: 19 Serial Number: 87132 (441)
External Probe(s) ______ Serial # ______

Calibration Method: ~~137~~ Pulser s/n 101500
Cs s/n 10263 200mCi

INSTRUMENT CALIBRATION INFORMATION

	Instrument Range	Calibration Standard Value	Instrument Response: Before Calib.	Instrument Response: After Calib.	Comment
1	25	2.25K CPM		10 uR/hr	All Calibrations Btn. + & - 10%
2		4.5K		20	
3					Battery: OK
4	50	2.25K		10	
		9K		40	Mechanical Zero: OK
6	250	0.05 mR/hr		52	
7		0.1		100	Response: OK
8		0.2		190	
9					Reset: OK
10	500	0.1		100	
11		0.2		200	Audio: OK
12		0.4		380	
13					Light: OK
14	5000	1		1,000	
15		2		2,000	High Voltage = 718 Volts
16		4		3,950	1000 uR/hr = 225K CPM
17					
18					
19					
20					
21					
22					
23					

STATEMENT OF CERTIFICATION

We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all of the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology (We are not responsible for damage incurred during shipment or use of this instrument).

Instrument Calibrated by: [signature] (Signed)
Calibration Date: 09-07-00
Next Calibration Due: 09-07-01

I certify that the above information is correct:
[signature]
Administrative Coordinator

Date: 09-07-00

GTS Instrument Services
2045 Route 286
Pittsburgh, PA 15239-2839
724/733-1900 Fax: 724/327-8189

CALIBRATION CERTIFICATE

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION

Customer Name: GTS INSTRUMENT SERVICES
Customer Address: 2045 Rt. 286
Pittsburgh, PA 15239

Customer P.O.#
Work Order #

INSTRUMENT INFORMATION

Instrument Manufacturer Ludlum
Model 177 Serial Number 94754 (312)
External Probe(s) 44-9 Serial # 150382 (456)

Calibration Method ^{99}Pulser s/n 101500
^{99}Tc s/n S1256
^{137}Cs s/n 10263 200mCi

INSTRUMENT CALIBRATION INFORMATION

	Instrument Range	Calibration Standard Value	Instrument Response: Before Calib.	Instrument Response: After Calib.	Comment
1	X1	100 CPM		100 CPM	All Calibrations Btn. + & - 10%
2		200		200	
3		400		400	Battery: OK
	X10	1K		1K	Mechanical Zero: OK
6		2K		2K	
7		4K		4K	Response: OK
8					
9	X100	10K		10K	Reset: OK
10		20K		20K	
11		40K		40K	Speaker: OK
12					
13	X1K	100K		100K	Alarm: OK
14		200K		200K	
15		400K		400K	High Voltage = 900 Volts
16					
17					1 mR/hr = 3K CPM in ^{137}Cs field
18					
19					^{99}Tc Efficiency = 10.4%
20					
21					
22					
23					

STATEMENT OF CERTIFICATION

We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all of the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology (We are not responsible for damage incurred during shipment or use of this instrument).

Instrument Calibrated by: (Signed)
Calibration Date: 09-07-00
Next Calibration Due: 09-07-01

I certify that the above information is correct:
Administrative Coordinator
Date 09-07-00

CALIBRATION CERTIFICATE

GTS Instrument Services
2045 Route 286
Pittsburgh, PA 15239-2839
724/733-1900 Fax: 724/327-8189

This Certificate will be accompanied by Calibration Charts or Readings where applicable

CUSTOMER INFORMATION

Customer Name: GTS INSTRUMENT SERVICES
Customer Address: 2045 Rt. 286
Pittsburgh, PA 15239

Customer P.O.#
Work Order #

INSTRUMENT INFORMATION

Instrument Manufacturer: Ludlum
Model: 177 Serial Number: 113563 (259)
External Probe(s): 44-9 Serial #: 150396 (451)

Calibration Method:
Pulser s/n 101500
^{137}Cs s/n 10263 200mCi
^{99}Tc s/n S1256

INSTRUMENT CALIBRATION INFORMATION

	Instrument Range	Calibration Standard Value	Instrument Response: Before Calib.	Instrument Response: After Calib.	Comment
1	X1	100 CPM		100 CPM	All Calibrations Btn. + & - 10%
2		200		200	
3		400		400	Battery: OK
4					
	X10	1K		1K	Mechanical Zero: OK
6		2K		2K	
7		4K		4K	Response: OK
8					
9	X100	10K		10K	Reset: OK
10		20K		20K	
11		40K		40K	Speaker: OK
12					
13	X1K	100K		100K	Alarm: OK
14		200K		200K	
15		400K		400K	High Voltage = 900 Volts
16					1 mR/hr = 3.2K CPM in ^{137}Cs field
17					
18					^{99}Tc Efficiency = 10.4%
19					
20					
21					
22					
23					

STATEMENT OF CERTIFICATION

We Certify that the instrument listed above was calibrated and inspected prior to shipment and that it met all of the Manufacturers published operating specifications. We further certify that our Calibration Measurements are traceable to the National Institute of Standards and Technology (We are not responsible for damage incurred during shipment or use of this instrument).

Instrument Calibrated by: (Signed)
Calibration Date: 09-07-00
Next Calibration Due: 09-07-01

I certify that the above information is correct:
Administrative Coordinator
Date: 09-07-00

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-467
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER CABRERA SERVICES ORDER NO. 252317

Mfg. Ludlum Measurements, Inc. Model 2929 Serial No. 163827

Mfg. Ludlum Measurements, Inc. Model 43-10-1 Serial No. PR171322

Cal. Date 30-Aug-00 Cal Due Date 30-Aug-01 Cal. Interval 1 Year Meterface 202-014

Check mark ✓ applies to applicable instr. and/or detector IAW mfg. spec. T. 76 °F RH 33 % Alt 702.8 mm H

✓ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See commen

✓ Mechanical ck. ✓ Window Operation

✓ Audio ck.

✓ Meter Zeroed Alpha Sensitivity 175 mV Beta Sensitivity 4 mV Beta Window 50 mV

✓ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 12/19/89.

Instrument Volt Set 875 V = 3.47 on High Voltage dial. High Voltage set with detector connected.

✓ HV Readout (2 points) Ref./Inst. 487 / 500 V Ref./Inst. 2019 / 2000 V

COMMENTS:

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

Alpha Channel Digital Readout	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
	400K cpm		400958
	40K cpm		~~40010~~ 40102 CT
	4K cpm		4008
	400 cpm		401
	40 cpm		40

Beta/Gamma Channel Digital Readout	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
	400K cpm		400996
	40K cpm		40087
	4K cpm		4005
	400 cpm		401
	40 cpm		40

*Uncertainty within ± 10% C.F. within ± 20%

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniqu The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978. State of Texas Calibration License No. LO-1

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ Neutron Am-241 Be S/N T

✓ Alpha S/N Pu239 s/n4337 ✓ Beta S/N C14 s/n1659 ✓ Other Tc-99 s/n635/83

✓ m 500 S/N 121036 ☐ Oscilloscope S/N ✓ Multimeter S/N 61341135

Calibrated By: Connie Tomlinson Date 30 Aug 00

Reviewed By: [signature] Date 30-Aug-00

FORM C22 12/29/1999

☐ Passed Dielectric (Hi-Pot) and Continuity Test

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Designer and Manufacturer of Scientific and Industrial Instruments

Bench Test Data For Detector

Detector 43-10-1 Serial No. PR171322

Customer CABRERA SERVICES

Counter 2929 Serial No. 163827

Count Time 1Minute

Other

Order #. 252317

Alpha Input Sensitivity 175 mV

Beta Input Sensitivity 4 mV

Beta Window 50 mV

Distance Source to Detector tray

High Voltage	Background		Isotope C14 Size 155,824cpm		Isotope Pu239 Size 15,700cpm		Isotope TC-99 Size 14,300cpm	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
850	0	53	0	21072	12259	482	6	8079
→ 875	0	62	0	25306	12491	387	15	8741
900	0	71	0	28765	12232	429	17	9164
925	0	95	1	32127	12289	554	10	9315

_ Gas Proportional detector count rate decreased ≤ 10% after 15 hour static test using 39" cable.

_ Gas proportional detector count rate decreased ≤ 10% after 5 hour static test using 39" cable and alpha/beta counter.

Signature Connie Tomlinson

Date 30 Aug 00

CALIBRATION CERTIFICATE

CTI

Calibration Technology

A Division of RSCS, Inc.

CUSTOMER NAME: Cabrera Services, Inc.
809 Main Street
East Hartford, CT 06108

COMPANY CONTACT: Jason Marsden PHONE: 860-289-1885

INSTRUMENT MAKE: LUDLUM Model: 2221 Serial Number: 161581

PRECISION CHECK				
TEST 1	TEST 2	TEST 3	MEAN	SAT/UNSAT
99.0	100.0	100.0	99.7	SAT

ACCURACY CHECK			
SCALE	EXPOSURE RATE	AS FOUND	AS LEFT
X1000	400.00 Kcpm	400.23 Kcpm	400.23 Kcpm
	100.00 Kcpm	99.89 Kcpm	99.89 Kcpm
X100	40.00 Kcpm	39.99 Kcpm	39.99 Kcpm
	10.00 Kcpm	9.97 Kcpm	9.97 Kcpm
X10	4.00 Kcpm	3.99 Kcpm	3.99 Kcpm
	1.00 Kcpm	1.00 Kcpm	1.00 Kcpm
X1	400.00 cpm	399.00 cpm	399.00 cpm
	100.00 cpm	99.00 cpm	99.00 cpm

All readings are within +/- 10% unless otherwise noted
All scale(s) were calibrated using a pulser
Calibrated with 43-89 (010955)
Efficiency with spacers for Sr/Y-90 = 0.1546 C/D
(high voltage set at 820 Volts)

CALIBRATED BY: ON: 09/14/00 EXPIRES ON: 03/14/01

This calibration was performed using a NIST Traceable radiation source, in conformance to MIL-STD 45662. RSCS New Hampshire Radioactive Material License Number: 381R, Cesium Calibration Source: Tech Ops Mod 773. Serial Number 58, Activity 112 millicuries on 9/9/92.
RSCS recommends that their customers remit a check source with their meters for calibration. If supplied, the check source will be characterized at the time of calibration.

Radiation Safety & Control Services, Inc.
91 Portsmouth Avenue • Stratham, NH 03885-2468
1-800-525-8339 • (603) 778-2871 • Fax (603) 778-6879 • www.radsafety.com

Calibration Technology

A Division of RSCS, Inc.

Calibration Certificate

Customer Name: Cabrera Services, Inc.
809 Main Street
East Hartford, CT 06108

Company Contact: Curtis Hales — Phone: 718-298-8613

Instrument Make: Ludlum — Model:2221 — Serial Number: 161581

Precision Check				
Test 1	Test 2	Test 3	Mean	Sat/Unsat
100	100	100	100	Sat

Accuracy Check			
Scale	Exposure Rate	As Found	As Left
X1000	400.00 Kcpm	400.05 Kcpm	400.05 Kcpm
	100.00 Kcpm	99.93 Kcpm	99.93 Kcpm
X100	40.00 Kcpm	39.89 Kcpm	39.89 Kcpm
	10.00 Kcpm	9.96 Kcpm	9.96 Kcpm
X10	4.00 Kcpm	4.01 Kcpm	4.01 Kcpm
	1.00 Kcpm	1.00 Kcpm	1.00 Kcpm
X1	400.00 cpm	399.30 cpm	399.30 cpm
	100.00 cpm	99.7 cpm	99.7 cpm

All readings within +/- 10% unless otherwise noted. All Scales were calibrated using a pulser.
Calibrated with a 43-89 probe (S/N 118277)
See attached sheets for Efficiency Plateaus. All efficiencies performed at 1cm.
Window Off, HV = 925 selected
Efficiencies: Sr/Y-90 = 0.1252 Counts/Decay
Pu-239 = 0.1604 Counts/Decay

Calibrated By: [signature] Date: 11/17/00 Expires On: 5/17/2001

This calibration was performed using a NIST Traceable radiation source, in conformance to MIL-STD 45662. RSCS New Hampshire Radioactive Material License Number: 381R; Cesium 137 Calibration Source: Tech Ops Model 773, Serial Number 58, Activity 112 millicuries on 09-09-92. RSCS calibration services are performed in accordance with the RSCS Radiation Protection Program Manual and all applicable sections of 10 CFR 21.The Services provided on Cabrera Services (RMA # 2000-023) were provided in compliance with RSCS, Inc. Quality program: Radiation Protection Program, Rev 3 Dated 1/1/96 .

CALIBRATION CERTIFICATE

CTI

Calibration Technology

A Division of RSCS, Inc.

CUSTOMER NAME: Cabrera Services, Inc.
809 Main Street
East Hartford, CT 06108

COMPANY CONTACT: Jason Marsden PHONE: 860-289-1885

INSTRUMENT MAKE: LUDLUM Model: 2221 Serial Number: 163673

PRECISION CHECK				
TEST 1	TEST 2	TEST 3	MEAN	SAT/UNSAT
100.0	100.0	99.0	99.7	SAT

ACCURACY CHECK			
SCALE	EXPOSURE RATE	AS FOUND	AS LEFT
X1000	400.00 Kcpm	398.72 Kcpm	398.72 Kcpm
	100.00 Kcpm	99.73 Kcpm	99.73 Kcpm
X100	40.00 Kcpm	39.88 Kcpm	39.88 Kcpm
	10.00 Kcpm	9.98 Kcpm	9.98 Kcpm
X10	4.00 Kcpm	3.99 Kcpm	3.99 Kcpm
	1.00 Kcpm	0.99 Kcpm	0.99 Kcpm
X1	400.00 cpm	399.00 cpm	399.00 cpm
	100.00 cpm	100.00 cpm	100.00 cpm

All readings are within +/- 10% unless otherwise noted
All scale(s) were calibrated using a pulser
Calibrated with 43-89 (S/N 171386)
Efficiency with spacers for Sr/Y-90 = 0.2234 C/D
(high voltage set to 800 Volts)

CALIBRATED BY: [signature] ON: 09/14/00 EXPIRES ON: 03/14/01

This calibration was performed using a NIST Traceable radiation source, in conformance to MIL-STD 45662. RSCS New Hampshire Radioactive Material License Number: 381R, Cesium Calibration Source: Tech Ops Mod 773. Serial Number 58, Activity 112 millicuries on 9/9/92. RSCS recommends that their customers remit a check source with their meters for calibration. If supplied, the check source will be characterized at the time of calibration.

Radiation Safety & Control Services, Inc.
91 Portsmouth Avenue • Stratham, NH 03885-2468
1-800-525-8339 • (603) 778-2871 • Fax (603) 778-6879 • www.radsafety.com

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER CABRERA SERVICES ORDER NO. 257129/252367

Mfg. Ludlum Measurements, Inc. Model 2221 Serial No. 163673

Mfg. Ludlum Measurements, Inc. Model 43-89 Serial No. PK171386

Cal. Date 21-Dec-00 Cal Due Date 21-Dec-01 Cal. Interval 1 Year Meterface 202-159

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 20 % Alt 711.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☑ Input Sens. Linearity
☑ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 4.4 VDC

☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 12/19/89.

Instrument Volt Set 700 V Input Sens. 4 mV Det. Oper. 700 V at 4 mV Threshold Dial Ratio 100 = 4 mV

☑ HV Readout (2 points) Ref./Inst. 498 / 500 V Ref./Inst. 2009 / 2000 V

COMMENTS:
Instrument calibrated with a 5'cable.
High voltage set with detector connected.
Overload checked but not set.
Firmware version 261072

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
X 1000	400 K cpm	400	400
X 1000	100 K cpm	100	100
X 100	40 K cpm	400	400
X 100	10 K cpm	100	100
X 10	4 K cpm	400	400
X 10	1 K cpm	100	100
X 1	400 cpm	400	400
X 1	100 cpm	100	100

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

Digital Readout REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	Log Scale REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
400 K cpm	40046 (0)	40046 (0)	500 K cpm	500K	500K
40 K cpm	4005	4005	50 K cpm	50K	50K
4 K cpm	400	400	5 K cpm	5K	5K
400 cpm	40	40	500 cpm	500	500
40 cpm	4	4			

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978 State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ Neutron Am-241 Be S/N T-30

☐ Alpha S/N ☑ Beta S/N Tc99#Ni-EV,Sr90/Y90#4016 ☐ Other

☑ m 500 S/N 70648 ☐ Oscilloscope S/N ☑ Multimeter S/N 61730074

Calibrated By: [signature] Date 21-Dec-00

Reviewed By: [signature] Date 27 Dec 00

☐ Passed Dielectric (Hi-Pot) and Continuity Test

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER CABRERA SERVICES ORDER NO. 251142

Mfg. Ludlum Measurements, Inc. Model 2224-1 Serial No. 162420

Mfg. Ludlum Measurements, Inc. Model 43-89 Serial No. PR121381

Cal. Date 11-Aug-00 Cal Due Date 11-Aug-01 Cal. Interval 1 Year Meterface 202-848

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 39 % Alt 702.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical ck. ☑ Meter Zeroed ☐ Background Subtract ☐ Input Sens. Linearity
☐ F/S Resp. ck ☑ Reset ck. ☑ Window Operation ☑ Geotropism
☑ Audio ck. ☐ Alarm Setting ck. ☑ Batt. ck. (Min. Volt) 2.2 VDC

☐ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 12/19/89.

Instrument Volt Set 675 V Input Sens. Comment mV Det. Oper. 675 V at Comment mV Threshold Dial Ratio ____ = ____ m

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 1000 / 1000 V

COMMENTS:

Firmware version: 390096
Alpha Threshold: 120mv.
Beta Threshold: 3.5mv
Beta Window: 30mv.
Overload checked but not set.
High Voltage set with the detector disconnected.

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

RANGE/MULTIPLIER	REFERENCE CAL. POINT	INSTRUMENT REC'D "AS FOUND READING"	INSTRUMENT METER READING*
x1000	800kcpm		800
x1000	200kcpm		200
x100	80kcpm		800
x100	20kcpm		200
x10	8kcpm		800
x10	2kcpm		200
x1	800cpm		800
x1	200cpm		200

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

Digital Readout: REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	Log Scale: REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
800kcpm		801104			
80kcpm		8011			
8kcpm		8012			
800cpm		800			
80cpm		80			

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978

State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources:

Cs-137 Gamma S/N ☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☐ T879 ☐ E552 ☐ E551 ☐ Neutron Am-241 Be S/N T-30

☑ Alpha S/N 4337 Pu239 ☑ Beta S/N 635/83 Tc99, 8050 Sr90Y90 ☐ Other

☑ m 500 S/N 94940 ☐ Oscilloscope S/N ☑ Multimeter S/N 68160950

Calibrated By: [signature] Date 11 Aug 00

Reviewed By: [signature] Date 14 Aug 00

FORM C22A 10/20/1988

Passed Dielectric (Hi-Pot) and Continuity Test

Certificate

Automated Engineering & Electronic Services

165 Deer Run Ridge RD. Kingston Tennessee 37763 1-423-376-0229 Fax 1-423-376-0229 www.radprobe-aees.com

Certificate of Calibration

For

Ratemeter/Scalar **Type**

Model Number: 2221 Serial Number: 97841 Client : Cabrera

Probe No.: PSL-4 Serial Number: NA PO #: 01-218/01-209

The subject instrument was calibrated to the indicated specifications using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constraints. This document certifies that the instrument met the following specifications upon its return to the submitter. Upon receipt the instrument was found: **Within Specs.** **As Found**

AEES Inc. calibrations control system complies to the guides lines of ANSI N323-1997, ANSI/NCSL Z540-1-1994 and Mil Std 45662A

Electronic files are identified by MDL_SN_DATE_PROBE MDL_PROBE SN

Analog Cal Data

Scale / Range	Test Value	As Found Value	Varianc 0.1 Max	As Left Value	Variance 0.1 Max.	Calib. Tol.
1	100	100	0.00	100	0.00	0.1
1	400	400	0.00	400	0.00	0.1
10	100	1000	0.00	1000	0.00	0.1
10	400	4000	0.00	4000	0.00	0.1
100	100	10000	0.00	10000	0.00	0.1
100	400	40000	0.00	40000	0.00	0 1
1000	100	100000	0.00	100000	0.00	0 1
1000	400	400000	0.00	400000	0.00	0 1

HV Value	BKGD CPM	Gross Cnts	Net Cnts
1700	3	118	115
1725	12	178	166
1750	8	425	417
1775	18	682	664
1800	25	978	953
1825	49	1339	1290
1850	87	1632	1545
1875	139	1965	1826
1900	205	2262	2057
1925			
1950			
1975			
2000			
2025			
2050			

Voltage Increment 25 Volts **Simple Plateau** **Dual Plateau**

Efficiency

Recommended HV @ 1800 volts

NA ERR

NA ERR

NA ERR

Digital Cal

Time	Test Val	As Found	Variance	As Left	Variance
0 1	1000	100	0.00	100	0.00
1	1000	1000	0.00	1000	0.00
5	1000	5000	0.00	5000	0.00
10	1000	NA	-1.00	NA	-1.00

HV	As Found	As Left
500	502	502
1000	1005	1005
1500	1505	1505
2000	2015	2015
2500	NA	NA

Procedures

- PROS-100 Amplifier Calibrations
- PROS-200 Counters Calibrations
- PROS-300 Support Circuits Tests
- PROS-400 — Not Required
- PROS-500 Geotropic Tests
- PROS-600 Probe Calibrations
- PROS-800 — Not Required

Test

Com Port tested:	No	Geotropic Tested.	Yes
Repairs performed	No	Thermo Tested:	No
Response Tests:	Yes	Functional Tests:	Yes
Speaker Testsed	Yes	Timer Tested:	Yes
Battery Level:	5.2	Alpha threshold	NA
Flow Rate [cc/min]	100+	Beta threshold	50

M&TE	SN.	Due Date
MP-1	132	6-20-2001
ESV	17231	2-07-2002
Scope	2850	6-26-2001

M&TE	SN	Due Date
Temperature in Deg F		78
Pressure in mm/hg		745
Relative Humidity		57

Sources

Source	SN.	DPM	Cal Due Date
TC-99	129682	5632	6-1-94

Flexible source provided by GTS Duratek

Remarks: Source Geometry during plateaus was 0.5 inches from mylar surface. Flow rate set at 100 cc/min...

Allow 30 minutes purge time at 100+ cc/min to assure sufficient purge, then operate flow at 100 cc/min.

Not Used/No/NA = Not Req. or needed

Performed By: [signature] Date: 3-16-2001

Reviewed By: [signature] Date: 3-16-01

File Name format: model_sn_date_(probe model_probe sn)