APPENDICES

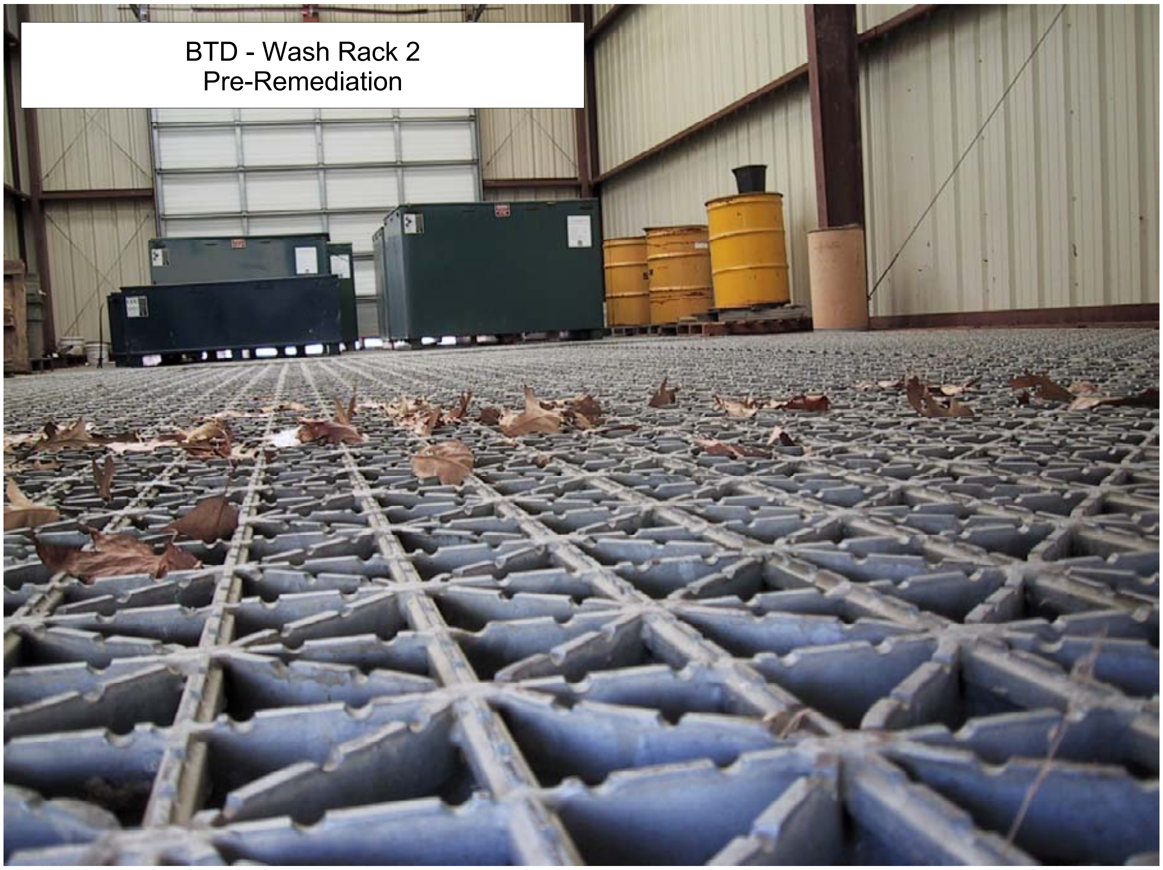
Appendix A: Building Photographs

BTD - BARF Building
Pre-Remediation

BTD - BARF Building
Post-Remediation

BTD - BARF Building
Exterior

BTD - Wash Rack 3
Interior


BTD - Wash Rack 2
Pre-Remediation


BTD - Wash Rack 2
Post-Remediation

BTD - Concrete Pad #2
(Behind Building 701)

BTD - Concrete Pad #1
(Behind DU Test Enclosure Building)

Appendix B: Final Status Survey Plan for BTD Armor Reclamation Facility, Aberdeen Proving Ground, Aberdeen, MD

Final Status Survey Plan
For Bomb Throwing Device Armor Reclamation Facility
Aberdeen Proving Ground, Aberdeen, MD

Contract Number
DAAA09-00G-0002/0039

Prepared for:

U.S. Army Joint Munitions Command
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ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
APG	Aberdeen Proving Ground
ATC	Army Test Center
BARF	BTD Armor Reclamation Facility
BTD	Bomb Throwing Device
CABRERA	Cabrera Services, Inc.
cpm	Counts Per Minute
DCGL or DCGLw	Derived Concentration Guideline Level
dpm	Disintegrations Per Minute
DU	Depleted Uranium
FSS	Final Status Survey
HSA	Historical Site Assessment
JMC	Joint Munitions Command
LBGR	Lower Bound of the Grey Region
LAB	Liquid Abrasive Blaster
MARSSIM	Multi-Agency Radiation Survey And Site Investigation Manual
MDC	Minimum Detectable Concentration
μR	Microroentgen
mrem	Millirem
NAD	Normalized Absolute Difference
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
QA	Quality Assurance
QC	Quality Control
ROC	Radionuclides of Concern
SU	Survey Unit

1.0 INTRODUCTION

Cabrera Services, Inc. (CABRERA) is under contract to the United States Army Joint Munitions Command (JMC) to provide support to the Army Test Center (ATC) at the Aberdeen Proving Ground (APG) in Aberdeen, MD. The ATC intends to remove equipment used in the decontamination of steel plates within the BTD Armor Reclamation Facility (BARF). The decontamination equipment and ancillary support systems to be removed are part of a Liquid Abrasive Blaster (LAB). This document presents the plans for BARF Final Status Survey (FSS) activities, which are designed in accordance with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC, 2000) guidance. The FSS is a survey of the interior of the BARF. Areas outside the BARF interior walls, floor and ceiling and land areas surrounding the BARF will be addressed under a separate effort.

1.1 General History

APG is a Government-owned and operated testing facility in Aberdeen, MD. The ATC is a tenant activity located at APG. The ATC possesses a Nuclear Regulatory Commission (NRC) license (SUB 834) for the use of depleted uranium (DU) at APG. The ATC utilized the BARF to house the LAB. The LAB was an enclosed system used to decontaminate pieces of steel plate and other small objects with water jets and abrasive. A ventilation system with a pre-filter demister and a HEPA filter removed airborne particulates prior to ventilation release to the environment. A hopper attached to the LAB retained spent abrasive and removed contamination.

Steel plates slated for decontamination were brought to the LAB by fork lift and loaded in the LAB for decontamination. Since the LAB was operated as a closed system with HEPA ventilation the potential for spread of contamination was small. Routine radiation contamination surveys were performed in accordance with license requirements.

In addition, several small boxes of slightly contaminated trash were stored in the southern portion of the building. Several boxes of clean unused HEPA filters were also stored in this area. Routine surveys were performed on all boxes and containers stored in the area.

1.2 General Approach to Building Investigation

The site radiological investigations are designed using the approach outlined in MARSSIM (NRC, 2000).

- Assemble sufficient data to classify areas by contamination potential
- Estimate number of measurement locations
- Identify survey units
- Implement FSS

2.0 SITE ASSESSEMENT

2.1 General Areas for Investigation

The BARF is a steel beam sheet metal constructed building with insulated walls and roof covered with a flexible protective plastic cover. The floor is a concrete pad. The interior of the BARF is approximately 12 meters long by 14.8 meters wide with a ceiling height of 6 meters. The building is bisected by a sheetrock wall with doors leading from one side to the other. There are no drains, sumps, or ventilation system penetrations other than the LAB HEPA ventilation system. A small heating system with insulated ductwork, rollup doors for equipment entry, smaller doorways for personnel entry, and electrical circuit boxes are other general features found in the building.

The northern portion of the BARF contained the LAB decontamination equipment and a small capacity crane used to help lift and load steel plates into the LAB. The southern part of the building was used to store clean unused HEPA filters and small amounts of containerized contaminated trash. Routine radiation contamination surveys were provided on all floor areas within the BARF, on stored boxes and containers, and occasionally on wall surfaces.

No contamination was found on the LAB HEPA filter and areas downstream in the ventilation system ducts during removal of the LAB. Minor contamination was found within the LAB enclosure, the hopper which contained water and abrasive, the HEPA pre-filter, and small areas on the outside of the LAB enclosure near loading points. The lack of activity downstream of the HEPA filter indicates a well-designed system that did not release airborne radioactivity to the environs. Other general surveys do not show contamination on the walls of the BARF. Routine surveys showed only occasional activity on the floor areas surrounding the LAB. Surveys of selected areas in the overhead and on the crane are also negative with respect to contamination.

2.2 Radionuclides of Concern

Site Radionuclides of Concern (ROC) are limited to depleted uranium (DU) and short-lived uranium progeny (Appendix A). The uranium ratios are based on isotopic uranium weight ratios used for shipments of routine DU waste from APG (BARG, 1995). The activity fractions are calculated from the isotopic weight ratios and the specific activity of each uranium isotope. The result is a Uranium-234 (^{234}U):Uranium-235 (^{235}U):Uranium-238 (^{238}U) ratio of 0.084:0.012:0.904. This composition is similar to the 0.190:0.021:0.790 average ratio from three DU soil samples described in the APG report (ANL 1999) entitled "Derived Uranium Guideline for the Depleted Uranium Study Area of the Transonic Range, Aberdeen Proving Ground, Maryland", Argonne National Laboratory Environmental Assessment Department, April 1999.

The calculated $DCGL_w$ for the ROC is 100 dpm of total uranium per 100 cm^2 that is calculated using the MARSSIM technique described in section 4.1.

3.0 SURVEY INSTRUMENTATION AND TECHNIQUES

The purpose of this section is to describe radiological survey instruments and techniques to be used for surveys that will be implemented during site radiological investigations. Specific measurement/sampling frequencies and approaches for FSSs are discussed in later sections.

3.1 Surface Alpha Radioactivity Scan Surveys

3.1.1 Eberline FCM4M and Ludlum Model 43-37

Surface scanning for alpha radioactivity will be performed to identify locations, if any, where contaminant concentrations exceed the criterion for unrestricted release. Alpha scanning will be performed on floor surfaces and lower walls using an Eberline FCM4M (active area of 728 cm^2) gas proportional floor monitor, Ludlum Model 43-37 handheld (active area of 582 cm^2) gas proportional detector, or equivalent. Using MARSSIM equation J-7 and the assumptions listed in Table 3.1-1 (scan speeds, background, efficiency, dwell times, etc), the probabilities of two or more counts occurring during the survey of a contaminated area equal to the derived concentration guideline ($DCGL_W$) may be computed from:

$$P(n \geq 2) = 1 - P(n = 0) - P(n = 1) \qquad \text{(MARSSIM Equation J-7)}$$

$$= 1 - \left(e^{-A}\right) \times \left(1 + A\right)$$

$$\text{for } A = \frac{(GE + B)t}{60}$$

where

$P(n \geq 2)$	=	probability of getting 2 or more counts during the time interval t
$P(n = 0)$	=	probability of not getting any counts during the time interval t
$P(n = 1)$	=	probability of getting 1 count during the time interval t
G	=	source activity (dpm)
E	=	detector efficiency (4π)
B	=	background count rate (cpm)
t	=	dwell time over source (seconds)

Alpha scanning will be performed with these instruments by moving the active area of the detector over the surface of interest at or below the given scan speed (Table 3.1-1). If two or more counts occur over the observation interval (Table 3.1-1), a one-minute integrated measurement will be performed at that location prior to scanning being resumed. If the result of the integrated measurement is in excess of the release criteria action level (Section 4.2), the area will be marked for biased measurements and investigated by the Field Supervisor.

3.1.2 Ludlum Model 43-89

Upper wall and ceiling surfaces may not be readily scanned using a Ludlum 43-37 handheld gas proportional counter due to potential long gas delivery tubing lines. These areas are class 3 areas having 10 percent of their areas scanned and may alternatively be scanned with a Ludlum Model 43-89 hand held (active area 126 cm^2) alpha scintillation detector, or equivalent. If the Ludlum Model 43-89 alpha scintillation detector is used, then MARSSIM equation J-5 and the assumptions listed in Table 3.1-1, with a probability of at least one count occurring while surveying an area of contamination equal to the $DCGL_W$ $P(n \geq 1)$, will be implemented instead of MARSSIM equation J-7. Using MARSSIM equation J-5 and the assumptions listed in Table 3.1-1 (scan speeds, background, efficiency, dwell times, etc), the probability that a single count is sufficient to cause a surveyor to stop and investigate further is:

$$P(n \geq 1) = 1 - P(n = 0) = 1 - e^{-A} \qquad \text{(MARSSIM J-5)}$$

$$\text{for } A = \frac{GEd}{60v}$$

where,

$P(n \geq 1)$ = probability of getting 1 or more counts during the time interval t
$P(n = 0)$ = probability of not getting any counts during the time interval t
G = source activity (dpm)
E = detector efficiency (4π)
d = width of the detector in the direction of scan (cm)
v = scan speed (cm/s)

Alpha scanning will be performed using the Ludlum Model 43-89 detector by moving the active area of the detector over the surface of interest at the given scan speed and assumptions shown in Table 3.1-1. Whenever a count is detected during the scan, the detector will be held in place over the location where the count was detected for approximately for the duration of the pause time (approximately 7-8 seconds). If a second count is detected over this location during the pause time, a two minute integrated count will be performed. If the result of the integrated measurement is in excess of the release criteria (Section 4.1), the area will be marked for biased measurements and investigated by the Field Supervisor. For all instruments, scanning will be performed with the active area of the detector at a height of 0.5 cm above the surface of interest.

To assist in scanning, grids will be marked on surfaces requiring a surface scan. Grids on the floor and lower walls will be one square meter in area. Areas of elevated radioactivity identified during scanning will be physically marked and biased integrated measurements will be performed to quantify surface alpha activity concentrations.

Table 3.1-1: Alpha Scan Assumptions

Model #	Probe Area (cm^2)	Probe Width (cm)	α Efficiency (cpm /dpm)	α Bkgrd (cpm)	Scan Speed (cm/sec)	Pause Time (sec)	P(n>=1)	Dwell Time (sec)	P(n>=2)
FCM4M	728	15	0.15	10	7.5	NA	NA	2.0	0.91
43-37	582	15	0.15	10	6	NA	NA	2.5	0.91
43-89	126	9	0.15	3	1	7.3	0.90	NA	NA

3.2 Integrated Direct Surface Alpha Radioactivity Measurements

Integrated direct measurements (i.e., static measurements) of surface alpha radioactivity will be performed during FSSs to compare contaminant concentrations at discrete sampling locations to the release criterion and facilitate statistical testing. Interior surfaces will be cleaned prior to surveying to remove dirt and grime that could shield alpha emissions from surfaces of interest. The cleaning implements used and the wastes generated during cleaning will be collected and stored on site and disposed in accordance with the contaminants found. Integrated measurements of floors and walls will be performed using a Ludlum Model 43-37 handheld (active area of 582 cm^2) gas proportional detector, Eberline FCM4M (detector surface area of 728 cm^2) gas proportional floor monitor, Ludlum Model 43-89 hand held (active area 126 cm^2) alpha scintillation detector, or equivalent. The estimated detector sensitivities and assumptions used for each of the detectors are presented in Table 3.2-1.

Static measurements will be performed in accordance with CABRERA procedures OP-020 "*Operation of Contamination Survey Meters," Rev 0,* and *OP-021 "Alpha-Beta Counting Instrumentation," Rev 0, and* CABRERA standard radiation instrumentation templates *"Alpha Beta Counting and Smear Worksheet", Rev 1.* Prior to use, FSS instrumentation will be checked for expected response using a Chi-Square distribution utilizing the CABRERA template *"Chi-Square Worksheet", Rev 0.*

The net count rate using the referenced templates will be determined as the difference between the measurement countrate and the daily background countrate measured prior to use.

Table 3.2-1: Detector Sensitivities and Assumptions

Model #	Count Time (min)	Probe Area (cm^2)	α Efficiency (cpm /dpm)	α Background (cpm)	α Static MDC (dpm / 100 cm^2)
FCM4M	1	728	0.15	10	16
43-37	1	582	0.15	10	20
43-89	2	126	0.15	3	30
2929	4	swipe	0.30	0.5	5

3.3 Smear Sample Collection and Analysis

Smear samples for gross transferable alpha contamination will be collected and analyzed to determine if transferable activity is less then 10% of total activity as assumed in the release criterion and to ensure compliance with the equipment release criterion of Army Regulation (AR) 11-9 presented in Appendix B.

Smear samples will be collected over approximately 100 cm^2 areas at biased locations identified during scanning activities, and at other biased locations such as overhead ductwork. Smear samples will be analyzed for alpha radioactivity using a Ludlum 2929 alpha/beta scintillation counter or equivalent in accordance with CABRERA procedure *Alpha Beta Counting Instrumentation, Rev 0*. Based on the assumptions listed in Table 3.2-1, an alpha MDC of 5 dpm/100cm2 will be achieved.

3.4 Gamma Dose Rate Measurements

Gamma dose rate measurements may be qualitatively performed during the FSSs to ensure worker health and safety and to identify unusual dose rate conditions. Measurements will be performed using a Bicron® MicroRem tissue-equivalent scintillation detector, or equivalent, and will be performed in accordance with CABRERA Procedure OP-023, *Operation of micro-R Meters, Rev 0*. Measurements will be performed using the "slow" response time constant setting. The detector will be positioned over the area of interest and allowed to stabilize prior to recording the measurement. The technician will use their judgment to determine when the instrument has stabilized, it is estimated that this will take at least 15 seconds. Such measurements will typically be performed at 1 meter from and/or on contact with the surface being evaluated.

3.5 Volumetric Samples and Analysis

Volumetric samples may be collected from areas of interest (e.g., ventilation) for analysis by alpha spectroscopy for isotopic uranium. If samples are collected to quantify surface activity concentrations, the area over which the sample is collected will be noted so laboratory results can be converted into units of dpm/100cm^2. Volumetric samples will be collected in accordance with CABRERA procedure *OP-005 Volumetric and Material Sampling, rev 0*. Samples will be sent to Paragon Analytics, Inc. for analysis and analyzed in accordance with Paragon's standard operating procedure.

4.0 FINAL STATUS SURVEY DESIGN

The FSS to be performed at the BARF is designed in accordance with Final Status Survey guidance from MARSSIM (NRC, 2000). FSS activities will consist of gross alpha scan surveys and integrated measurements on interior surfaces at frequencies based on MARSSIM guidance. The FSS is designed conservatively in that the radiological background present in survey materials (i.e., concrete floor) will be neglected and the measure of total activity will be used for statistical comparisons to release criteria. Survey activities will also include biased smear sample collection and the performance of gamma dose rate measurements. Biased survey measurements may be performed on building systems (e.g., ventilation) and additional analysis of samples by alpha spectroscopy may be performed. MARSSIM area classifications will be reviewed and possibly revised based on the results of these surveys.

4.1 Residual Radioactivity Limit (DCGL)

As described by MARSSIM, a DCGL is a derived radionuclide activity concentration within a survey unit that corresponds to a release criterion. Per the license requirement of 10CFR20 Subpart E, a release criterion of 25 mrem/yr per year will be used for the BARF. Doses from residual radioactivity will be kept as low as reasonably achievable (ALARA) whenever possible. Using MARSSIM Section 4.3.4, the equation below, and knowing that there is one alpha decay per decay of each uranium isotope, a single total uranium $DCGL_W$ of 100 dpm alpha/100cm^2 was derived for DU. This $DCGL_W$ was calculated using the values provided by the NRC screening guidelines of 90.6 dpm/100cm^2, 97.6 dpm/100cm^2, 101 dpm/100cm^2 and for U^{234}, U^{235}, and U^{238}, respectively, as presented in Table 5.19 of NUREG/CR-5512, volume 3, October 1999 and the DU activity fractions as presented in Section 2.2 of this FSS.

$$DCGL_W = \frac{1}{\left(\frac{f_1}{DCGL_1}\right) + \left(\frac{f_2}{DCGL_2}\right) + \left(\frac{f_3}{DCGL_3}\right)}$$

Where: $DCGL_w$= Combined gross activity DCGL (i.e., release limit).

f = Activity fraction of radionuclide

DCGL = DCGL of radionuclide

4.2 Action Levels

The total uranium $DCGL_W$ of 100 dpm alpha/100cm^2 will be used conservatively as the action level for both static and scanning measurements. If any survey measurement results in readings above the $DCGL_W$, the Field Supervisor shall be notified and the detector and survey location shall be evaluated. Following evaluation, a follow-up measurement shall be performed at the measurement location to verify the initial result.

4.3 General Area Classification based on contamination potential

Using MARSSIM Section 5.3 as guidance, the BARF will initially be subdivided into four Class 1 Survey Units (SUs) and one Class 3 SU as listed in Table 4.3-1. The initial classifications are

based on contamination potential and area size. MARSSIM recommends that interior Class 1 SUs be less than 100 square meters in size and each of the four Class 1 SU range from 77.6 m^2 to 88.8 m^2. The floor and lower walls of the northern room of the BARF share similar contamination potential because this area housed the LAB decontamination equipment and was where the decontamination process was performed. Although the lab system was self-contained and surveys did not routinely identify transferable contamination on the floor or walls, contaminated materials were moved through this room via the south rollup door to be loaded in and out of the LAB system. In accordance with MARSSIM guidance, the south room floor and lower walls will initially be considered Class 1 SUs as well because this area was once used to store containerized contaminated trash.

MARSSIM does not specify area limits on Class 3 SUs. Since the upper wall and ceiling surfaces of the north and south rooms share similar potential for contamination, these areas were combined into one Class 3 SU. The potential for contamination on the upper walls and ceiling surface in the north room is small because no contamination was identified on the LAB HEPA filter or at downstream areas in the ventilation system. The lack of activity downstream of the HEPA filter indicates a well-designed system that did not release airborne radioactivity to the environs. In addition, transferable contamination was not identified during routine surveys in the BARF and the primary mechanism for transport (i.e., ventilation system) was not contaminated.

Maps presenting the BARF SU delineations and the reference coordinate system are presented in Appendix C.

Table 4.3-1: Survey Units

SU #	Description	Area (m^2)	Material	Class
SU 1	North Room Floor	88.8	Concrete	1
SU 2	South Room Floor	88.8	Concrete	1
SU 3	North Room Lower Wall	76.6	Foam / Sheet Metal	1
SU 4	South Room Lower Wall	76.6	Foam / Sheet Metal	1
SU 5	Ceilings and Upper Walls	488	Foam / Sheet Metal	3

4.4 Number of Static Measurements

MARSSIM discusses a method to determine the number of measurement locations required in a given survey unit. A minimum number of measurement locations are required in each survey unit to obtain sufficient statistical confidence that the conclusions drawn from the measurements are correct. The following subsections describe the bases for and derivation of the minimum required measurement locations per survey unit.

4.4.1 Estimation of Relative Shift

The minimum number of measurement locations required is dependent on the distribution of site residual radionuclide concentrations relative to the $DCGL_w$ and acceptable decision error limits (α and β).

The relative shift describes the relationship of site residual radionuclide concentrations to the $DCGL_w$ and is calculated using the following equation, found in Section 5.5.2.3 of MARSSIM. The relative shift is calculated as follows:

$$\Delta/\sigma = \frac{DCGL_w - LBGR}{\sigma}$$

Where: $DCGL_w$= the DCGL (i.e., release limit).

LBGR = concentration at the lower bound of the gray region. The Lower Bound of the Grey Region (LBGR) is the concentration to which the survey unit must be cleaned in order to have an acceptable probability of passing the statistical tests.

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).

As previously stated, the $DCGL_w$ for surface alpha radioactivity is 100 dpm/100cm^2. The LBGR was conservatively estimated at 70 dpm alpha/100 cm^2 based on previous studies with similar instruments on concrete. Without prior survey, it is reasonable to assume a coefficient of variation on the order of 30 percent (MARSSIM Section 5.5.2.2). Using a coefficient of variation of 30 percent and the LBGR as an estimate of the sample mean, a sigma value of 21 dpm/100cm^2 is obtained. Using the parameters discussed above, the relative shift is calculated as 1.4.

4.4.2 Determination of N (Number of Required Measurement Locations)

The final number of required measurement locations per survey unit is 20 as per MARSSIM (Table 5.5) given a relative shift of 1.4 and an error rate for both Type I and Type II errors of five percent (i.e., $\alpha = \beta = 0.05$). The actual number of measurements to be performed in each survey unit ranges from 20 to 24 samples based on the size of the survey area (Section 4.6).

4.5 Elevated Measurement Criterion ($DCGL_{EMC}$)

MARSSIM states that, for Class 1 survey units, a dose area factor should 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. For the purpose of ALARA, the $DCGL_W$ will be used as the $DCGL_{EMC}$ which corresponds to an area factor of one. Since the scan MDC of the instrumentation is sensitive enough to identify the $DCGL_W$ at least ninety percent of the time, it is unlikely that small areas of elevated activity exceeding the release criterion would be missed during scanning.

4.6 Static Measurement Locations

Measurement locations in Class 1 survey units have been established using a random start point in a systematic rectangular grid. The grid spacing for Class 1 survey units will be determined, based on the measured area of the survey unit, using the following equation (Equation 5-7 from MARSSIM).

$$L = \sqrt{\frac{A}{N}}$$

Where: L = rectangular grid spacing for survey unit
A = area of survey unit
N = number measurement locations

Measurement spacing results (L) using the equation above, 20 systematic static measurement locations, and the area of the Class 1 survey units presented in Section 4.3 ($77.6m^2$ and $88.8m^2$) results in a measurement spacing of approximately 2m. Maps presenting the BARF SU delineations and the reference coordinate system are presented in Appendix C.

In accordance with MARSSIM, static measurement spacing for the Class 3 SU will be performed at random locations. Maps presenting the BARF SU delineations and the reference coordinate system are presented in Appendix C.

4.7 Surface Alpha Radioactivity Scan Surveys

Class 1 SU scan surveys will be performed as described in Section 4.1 and will cover 100% of reasonably accessible surfaces. Areas of elevated radioactivity identified during scanning will be physically marked and biased integrated measurements will be performed to quantify surface alpha activity concentrations for direct comparison to the $DCGL_W$. Survey areas in excess of the $DCGL_W$ will be investigated by the Field Supervisor and flagged for additional biased sampling (e.g. smear sampling, alpha spectroscopy).

Scan surveys in Class 3 SUs will cover at least 10% of surface areas and, when possible, will be biased toward areas with high potential for the presence of contamination. Examples of areas with potentially higher concentrations of contamination include ventilation intake and exhaust ports and areas where DU contamination may have settled from the air, such as ceiling trusses and joints. Areas of elevated radioactivity identified during scanning will be physically marked and biased integrated measurements will be performed to quantify surface alpha activity concentrations for direct comparison to the $DCGL_W$. Since contamination is not expected in Class 3 areas, any biased measurements confirmed to be in excess of the $DCGL_W$ will trigger investigation by the Field Supervisor and a re-evaluation of the area classification.

4.8 Integrated Direct Surface Alpha Radioactivity Measurements

Measurements of surface alpha radioactivity will be performed in SUs at locations selected for MARSSIM statistical testing and at biased locations identified prior to and during scanning activities. Such measurements will be performed as described in Section 3.2.

4.9 Smear Sample Collection and Analysis

Smear samples will be collected at biased survey locations and at least 10% of systematic survey locations. Smear samples will be collected as described in Section 3.3.

4.10 Gamma Exposure Rate Measurements

Gamma exposure rate measurements may be performed to ensure worker safety and to identify unusual exposure rate conditions. Gamma exposure rate measurements will be performed as described in Section 3.4.

5.0 EQUIPMENT RELEASE

5.1 Survey of Equipment for Release without Restriction

Certain equipment present inside the BARF may need to be surveyed for consideration of release without restriction. If necessary, CABRERA will follow the surface release limits of 1,000 dpm/100 cm^2 of DU alpha activity per Army Regulation 11-9 *The Army Radiation Safety Program*. It is expected that all final release surveys of equipment will be performed by the licensee and these surveys will follow APG procedures. If CABRERA performs these release surveys for APG, then CABRERA will follow the APG procedures.

6.0 DATA PROCESSING

For this FFS, it is essential that all significant events be documented and retained for future reference. While many types of project events have specific forms on which they are documented, many events occur on a routine basis during survey field activities that must be documented as they occur. Additionally, project data transactions must also be recorded as they occur. To provide a practical means of capturing this information, a project logbook will be initiated upon project commencement.

Significant project events, including data transactions involving project electronic data, shall be recorded in the Project Logbook. Data transactions are defined as any transfer, download, export, copy, differential correction, sort, or other manipulation performed on project electronic data. Project Logbook records shall be sufficient to allow data transactions to be reconstructed after the project is completed. The Field Supervisor shall be responsible for maintaining the Project Data Logbook and will review the Project Data Logbook at least daily to report significant issues.

The Project Logbook is considered a legal record and will be permanently bound and the pages will be pre-numbered. Pages may not be removed from the logbook under any circumstances. Entries shall be legible, factual, detailed, and complete and shall be signed and dated by the individual(s) making the entries. If a mistake is made, the individual making the entry shall place a single line through the erroneous entry and shall initial and date the deletion. Under no circumstances shall any previously entered information be completely obliterated. Use of whiteout in the Project Logbook is not permitted for any reason. Only one Project Logbook will be maintained. If a Project Logbook is completely filled, another volume shall be initiated. In this case, each volume shall be sequentially numbered.

6.1 Project Electronic Data

Much of this FSS will rely on data collected and stored electronically. Electronic data is subject to damage and/or loss if not properly protected. As such, all project electronic data shall be downloaded from its collection device (e.g., laptop computers, data loggers, etc.) on at least a daily basis. At the conclusion of each day's survey activities, the Field Supervisor shall back up all electronic data collected that day to appropriate removable media (e.g., CD, zip disk, or equivalent) and shall ensure the backup is removed from site. Under no circumstances shall the backup be stored in the same building in which the original project electronic data is stored.

Data files shall be named according to a naming protocol designated by the field supervisor. No variations from this protocol shall occur without the prior concurrence of the field supervisor. During data download and transfer transactions, the applicable data file name(s) shall be included in project data logbook entries.

7.0 SURVEY QUALITY ASSURANCE/QUALITY CONTROL

Activities associated with this work plan shall be performed in accordance with written procedures and/or protocols in order to ensure consistent, repeatable results. Topics covered in project procedures and protocols may include proper use of instrumentation, Quality Control (QC) requirements, equipment limitation, etc. Quality Assurance (QA) measures for this FSS are described herein.

7.1 Instrumentation Requirements

The Field Supervisor is responsible for determining the instrumentation required to complete the requirements of this work plan. Only instrumentation approved by the Field Supervisor will be used to collect radiological data. The Field Supervisor is responsible for ensuring individuals are appropriately trained to use project instrumentation and other equipment, and that instrumentation meets the required detection sensitivities. Instrumentation shall be operated in accordance with either a written procedure or manufacturers' manual, as determined by the Field Supervisor. The procedure and/or manual will provide guidance to field personnel on the proper use and limitations of the instrument.

7.1.1 Calibration Requirements

Instruments used during the FSS shall have current calibration/maintenance records kept on site for review and inspection. The records will include, at a minimum, the following:

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

Instrumentation shall be maintained and calibrated to manufacturers' specifications to ensure that required traceability, sensitivity, accuracy and precision of the equipment/instruments are maintained. Instruments will be calibrated at a facility possessing appropriate NRC and/or Agreement State licenses for performing calibrations using National Institute of Standards and Technology (NIST) traceable sources.

7.1.2 Instrument QC Source and Background Checks

Prior to and after daily use, alpha and gamma measuring instruments will be QC checked by comparing the instruments' response to a designated alpha or gamma radiation source and to ambient background. QC source checks will be performed with the designated source positioned in a reproducible geometry. Background checks will be performed in an identical fashion with the source removed. During QC checks, instruments will be inspected for physical damage, current calibration and erroneous responses. The individual performing these tasks shall document the results in accordance with the associated instrument procedure and/or protocols. Instrumentation that does not meet the specified requirements of calibration, inspection, or response check will be removed from service. If an instrument is removed from service, any data obtained after the last successful QC check will be considered suspect due to faulty instrumentation.

Quality control source checks for the Eberline FCM4M, Ludlum 43-37, Ludlum 43-89 will consist of a one-minute integrated count with the designated Thorium–230 (^{230}Th) and Technetium-99 (^{99}Tc) sources. QC source checks for the Bicron® MicroRem meter will consist of observing needle deflection and estimating an average dose rate once the instrument readings have stabilized (approximately 22 seconds) using a ^{137}Cs source. The acceptance criterion for these instrument response checks is within +/- 20% of the average response generated using ten initial source checks and ten measurements of ambient background performed at the beginning of the project. A response check outside these criteria will be cause for evaluation of conditions (e.g., instrument operation, source/detector geometry). The response check will be repeated once prior to field use of that instrument. Instruments that fail the second successive response check will be removed from service. Only Field Supervisors can return a failed instrument back to service after proper corrective actions are taken.

Quality control source response checks for the Ludlum 2929 will be checked daily by evaluating response to designated ^{230}Th (Alpha) and ^{99}Tc (Beta) sources and ambient background. Response checks will consist of one-minute counts of a ^{230}Th, ^{99}Tc source, and a 20 minute count of ambient background. The acceptance criteria for instrument response will be set to two and three-sigma of the average response generated using ten initial source checks and ten measurements of ambient background. A daily response check outside the two-sigma, but within the three-sigma criteria will be cause for a recount prior to use. A response check outside two sigma on the second count will be cause for further evaluation and or re-performance of QC control values prior to continued use. Response checks falling outside acceptance criteria will be cause for notification of the Field Supervisor and evaluation of conditions (e.g., instrument operation, source/detector geometry) prior to further counts and/or removal of the instrument from service. Instruments must pass a response check prior to field use. Only Field Supervisors can return a failed instrument back to service after proper corrective actions are taken.

Quality control for volumetric sample analysis will be performed in accordance with applicable Paragon standard operating procedures.

7.2 Direct Alpha, Smear, and Exposure Rate Measurements

Instrumentation will be operated in accordance with standard operating procedures and/or protocols.

7.2.1 Duplicate Measurements

Duplicate measurements will be required for 10% of the static measurement locations for each survey unit. Duplicate measurements will be compared to the initial analytical results by determining a Normalized Absolute Difference (NAD) value and comparing it against the performance criteria specified as follows:

Analyses of field and laboratory duplicates will be compared to the initial analytical results by determining a NAD value for each data set by the following equation (PROB, 1993):

$$\text{NAD} = \frac{|\text{Sample - Duplicate}|}{\sqrt{\sigma^2_{\text{Sample}} + \sigma^2_{\text{Duplicate}}}}$$

Where: Sample = first sample value (original),
Duplicate = second sample value (duplicate),
σ_{Sample} = 2σ counting uncertainty of the sample, and,
$\sigma_{\text{Duplicate}}$ = 2σ counting uncertainty of the duplicate

The calculated NAD results will be compared to a performance criteria of less than or equal to 1.96. Calculated NAD values less than 1.96 will be considered acceptable and values greater than 1.96 will be investigated for possible discrepancies in analytical precision, or for sources of disagreement with the following assumptions of the test:

- the sample measurement and duplicate or replicate measurement are of the same normally distributed population
- the standard deviations, σ_{Sample} and $\sigma_{\text{Duplicate}}$, represent the true standard deviation of the measured population

8.0 REFERENCES

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(BARG, 1995) Specific Manufacturing Capability Program*, Depleted Uranium Constituents and Decay Heating*, Lockheed, Idaho presentation, dated October 3, 1995.

(CABRERA, 2000a) CABRERA OP-020, "*Operation of Contamination Survey Meters", Rev 0*

(CABRERA, 2000b) CABRERA OP-021, "*Alpha-Beta Counting Instrumentation", Rev 0*

(CABRERA, 2000c) Cabrera OP-023, "*Operation of micro-R Meters", Rev 0*

(NRC, 1999) NUREG/CR-5512, Volume 3 *Residual Radioactive Contamination from Decommissioning*, *Parameter Analysis*, Draft Report for Comment, U.S. Nuclear Regulatory Commission, dated October, 1999.

(NRC, 2000) NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM), U.S. Nuclear Regulatory Commission, dated August, 2000.

Appendix A: Uranium 238 Decay Series

Uranium 238 Decay Series

(Excerpted from Radioactive Decay Data Tables, David Kocher, 1981)

Radionuclide	Half-Life	Emissions	Energy (MeV)	Percent Yield
U-238	4.5 x 109 y	α	4.2	75
		α	4.15	25
Th-234	24.1 d	β	0.193	79
		β	0.1	21
		γ	0.093	4
		γ	0.063	3.5
Pa-234m	1.17 min	β	2.29	98
Pa-234	6.75 h	β	0.53	<1
		β	1.13	<1
U-234	2.47 x105 y	α	4.72	28
		α	4.77	72
Th-230	8.0 x 104 y	α	4.62	24
		α	4.68	76
Ra-226	1602 y	α	4.60	6
		α	4.78	95
		γ	0.186	4
Rn-222	3.82 d	α	5.49	100
Po-218	3.05 min	α	6.0	100
Pb-214	26.8 min	β	0.65	50
		β	0.71	40
		γ	0.3	19
		γ	0.35	36
Bi-214	19.7 min	β	1.0	23
		β	1.51	40
		β	3.26	19
		γ	0.609	47

Appendix B:
Army Regulation 11-9
Army Radiation Safety Program

Appendix C:
Survey Unit Maps and Sample Locations

Appendix C: Final Status Survey Plan For Wash Rack Facilities #2 and #3, Aberdeen Proving Ground, Aberdeen, MD

Final Status Survey Plan
For Wash Rack Facilities #2 and #3
Aberdeen Proving Ground, Aberdeen, MD

Contract Number
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Prepared for:

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LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
APG	Aberdeen Proving Ground
ATC	Army Test Center
CABRERA	Cabrera Services, Inc.
cpm	Counts Per Minute
DCGL or DCGLw	Derived Concentration Guideline Level
dpm	Disintegrations Per Minute
DU	Depleted Uranium
FSS	Final Status Survey
HSA	Historical Site Assessment
JMC	Joint Munitions Command
LBGR	Lower Bound of the Grey Region
MARSSIM	Multi-Agency Radiation Survey And Site Investigation Manual
MDC	Minimum Detectable Concentration
μR	Microroentgen
mrem	Millirem
NAD	Normalized Absolute Difference
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
QA	Quality Assurance
QC	Quality Control
ROC	Radionuclides of Concern
SU	Survey Unit

1.0 INTRODUCTION

Cabrera Services, Inc. (CABRERA) is under contract to the United States Army Joint Munitions Command (JMC) to provide support to the Army Test Center (ATC) at the Aberdeen Proving Ground (APG) in Aberdeen, MD. The ATC intends to survey two Wash Rack Facilities (WRFs) for unrestricted release. This document presents the plans for WRF #2 and WRF #3 Final Status Survey (FSS) activities, which are designed in accordance with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC, 2000) guidance. The FSS is a survey of the interior of both WRFs. Areas outside the WRFs interior walls, floors and ceilings as well as the surrounding land areas will be addressed under a separate effort.

1.1 General History

APG is a Government-owned and operated testing facility in Aberdeen, MD. The ATC is a tenant activity located at APG. The ATC possesses a Nuclear Regulatory Commission (NRC) license (SUB 834) for the use of depleted uranium (DU) at APG. Since the construction of WRF #2 and WRF #3 in 1992, the ATC has utilized these facilities as warehouses. The WRFs have never been used as wash racks. The WRFs were used to store items and equipment, some of which were contaminated with DU. WRF #2 housed DU in the form of penetrators, floor sweepings, liquid abrasive residue from previous decontamination activities, and range debris (e.g., paper, plastic, wood). WRF #3 was used for the storage of uncontaminated Navy accelerator parts and the temporary housing of a cutting table contaminated with DU.

1.2 General Approach to Building Investigation

The site radiological investigations are designed using the approach outlined in MARSSIM (NRC, 2000).

- Select instrumentation and measurement techniques (Section 3.0)
- Develop a Derived Concentrations Guideline Level (Section 2.2 and Section 4.1)
- Classify areas by contamination potential (Section 4.3)
- Estimate number of measurement locations (Section 4.4)
- Identify survey units (Table 4.3-1)
- Collect Data (Sections 4.7, 4.8, 4.9, 4.10)
- Evaluate Data (Section 7.1)

2.0 SITE ASSESSEMENT

2.1 General Areas for Investigation

The WRFs are similar in construction and consist of steel beam frame and sheet metal walls with no interior insulation or wallboard. The interior of the WRFs are approximately 56' long by 26' wide with a ceiling height of 20'. The floors consist of steel plate with a recessed trough running the length of the facilities. The trough area is approximately 20' wide by 4" deep. The trough area contains multiple raised (~3") steel beams which were used to support steel floor grating. The grating, which was removed prior to this FFS, was flush with the surrounding floor plate. There are no drains, sumps, heating, cooling, or ventilation systems in these facilities. Steel rollup doors for equipment entry are located at both ends of these facilities.

Since the WRFs were used as storage facilities for contaminated materials, the primary area of investigation is the floor, trough area, and lower wall surfaces (6' and below). WRF #2 housed DU in the form of penetrators, floor sweepings, liquid abrasive residue from previous decontamination activities, and range debris (e.g., paper, plastic, wood). Some of these contaminated materials may have been spilled prior to packaging and loose contamination could be transferred to the facility. WRF #3 was used for the storage of uncontaminated Navy accelerator parts and the temporary housing of a cutting table contaminated DU. Contamination left by the cutting table was identified in the southwest corner of the facility. This contamination was removed though decontamination activities prior to the initiation of the FSS. Past routine surveys of the WRFs have identified minor levels of DU contamination on the floor areas of these facilities.

2.2 Radionuclides of Concern

Site Radionuclides of Concern (ROC) are limited to depleted uranium (DU) and short-lived uranium progeny (Appendix A). The uranium ratios are based on isotopic uranium weight ratios used for shipments of routine DU waste from APG (BARG, 1995). The activity fractions are calculated from the isotopic weight ratios and the specific activity of each uranium isotope. The result is a Uranium-234 (^{234}U):Uranium-235 (^{235}U):Uranium-238 (^{238}U) ratio of 0.084:0.012:0.904. This composition is similar to the 0.190:0.021:0.790 average ratio from three DU soil samples described in the APG report (ANL 1999) entitled "Derived Uranium Guideline for the Depleted Uranium Study Area of the Transonic Range, Aberdeen Proving Ground, Maryland".

3.0 SURVEY INSTRUMENTATION AND TECHNIQUES

The purpose of this section is to describe radiological survey instruments and techniques to be used for surveys that will be implemented during site radiological investigations. For this FSS, scanning and integrated direct measurements performed to measure surface radioactivity concentrations will be based solely on alpha emissions. Beta measurements will be collected in tandem with alpha measurements and presented for qualitative review in an appendix of the FSS report. Specific measurement/sampling frequencies and approaches for the FSS are discussed in later sections.

Prior to the initiation of survey activities, interior surfaces will be cleaned to remove dirt and grime that could shield alpha emissions from detection. The cleaning implements used and the wastes generated during cleaning will be collected and stored on site and disposed in accordance with the contaminants found.

3.1 Surface Alpha Radioactivity Scan Surveys

Surface scanning will be performed to identify locations, if any, where contaminant concentrations exceed the criterion for unrestricted release. Scanning will be performed with the active area of the detector at a height of 0.5 cm above the surface of interest using the detector specific assumptions listed in Table 3.1-1. Scanning measurements will be performed in accordance with CABRERA procedures OP-020 "*Operation of Contamination Survey Meters," Rev 0*.

3.1.1 Ludlum Model 43-37 and Eberline FCM4M

Scanning will be performed on floor surfaces and lower walls using an Eberline FCM4M (active area of 728 cm^2) gas proportional floor monitor, Ludlum Model 43-37 handheld (active area of 582 cm^2) gas proportional detector, or equivalent. Using MARSSIM equation J-7 and the instrument specific assumptions listed in Table 3.1-1, the Scan MDC is determined to be equal to $DCGL_W$. Using the detector specific assumptions presented in Table 3.1-1, the chance of detecting a concentration equal to the $DCGL_W$ would be 91% and signified by the incidence of two alpha counts occurring within the dwell time of that instrument.

$$P(n \geq 2) = 1 - P(n = 0) - P(n = 1) \qquad \text{(MARSSIM Equation J-7)}$$

$$= 1 - \left(e^{-A}\right) \times \left(1 + A\right)$$

$$A = \frac{(GE + B)t}{60}$$

where

$P(n \geq 2)$ = probability of getting 2 or more counts during the time interval t
$P(n = 0)$ = probability of not getting any counts during the time interval t
$P(n = 1)$ = probability of getting 1 count during the time interval t
G = source activity (dpm)
E = detector efficiency (4π)
B = background count rate (cpm)
t = dwell time over source (seconds)
A = detector area (cm^2)

If two or more alpha counts occur during the dwell time, a one-minute integrated measurement will be performed at that location. If the result of the integrated alpha measurement is in excess of the release criteria action level (Section 4.2), the area will be marked for biased measurements and investigated by the Field Supervisor.

3.1.2 Ludlum Model 43-89 and Ludlum Model 43-93

Upper wall and ceiling surfaces may not be readily scanned using a Ludlum 43-37 handheld gas proportional counter due to potential long gas delivery tubing lines. These areas may alternatively be scanned with a Ludlum Model 43-89 (active area 126 cm^2) or Ludlum Model 43-93 (100 cm^2) active area scintillation detectors, or equivalent.

Using MARSSIM equation J-5 and the instrument specific assumptions listed in Table 3.1-1, the Scan MDC is determined to be equal to derived concentration guideline ($DCGL_W$). The chance of detecting a concentration equal to the $DCGL_W$ would be 90% and signified by the incidence of one alpha count occurring within the pause time of that stationary instrument.

$$P(n \geq 1) = 1 - P(n = 0) = 1 - e^{-A} \qquad \text{(MARSSIM J-5)}$$

$$\text{for } A = \frac{GEd}{60v}$$

where,

$P(n \geq 1)$ = probability of getting 1 or more counts during the time interval t
$P(n = 0)$ = probability of not getting any counts during the time interval t
G = source activity (dpm)
E = detector efficiency (4π)
d = width of the detector in the direction of scan (cm)
v = scan speed (cm/s)
A = detector area (cm^2)

Whenever an alpha count is detected during the scan, the detector will be held in place over the location where the count was detected for approximately for the duration of the pause time (approximately 7-8 seconds). If a second alpha count is detected over this location during the

pause time, a two minute integrated count will be performed. If the result of the integrated measurement is in excess of the release criteria (Section 4.1), the area will be marked for biased measurements and investigated by the Field Supervisor.

Table 3.1-1: Alpha Scan Assumptions

Model #	Probe Area (cm^2)	Probe Width (cm)	α Efficiency (cpm /dpm)	α Bkgd (cpm)	Scan Speed (cm/sec)	Pause Time (sec)	P(n>=1)	Dwell Time (sec)	P(n>=2)
FCM4M	728	15	0.15	10	7.5	NA	NA	2.0	0.91
43-37	582	15	0.15	10	6	NA	NA	2.5	0.91
43-89	125	9	0.15	3	1	7.3	0.90	NA	NA
43-93	100	9	0.15	3	1	7.3	0.90	NA	NA

3.2 Integrated Direct Surface Alpha Radioactivity Measurements

Integrated direct measurements (i.e., static measurements) of surface alpha radioactivity will be performed during FSSs to compare contaminant concentrations at discrete sampling locations to the release criterion and facilitate statistical testing. Integrated measurements of floors and walls will be performed using a Ludlum Model 43-37 handheld (active area of 582 cm^2) gas proportional detector, Eberline FCM4M (detector surface area of 728 cm^2) gas proportional floor monitor, Ludlum Model 43-89 hand held (active area 126 cm^2) alpha scintillation detector, Ludlum Model 43-93 hand held (active area 100 cm^2) alpha scintillation detector or equivalent. The estimated detector sensitivities and assumptions used for each of the detectors are presented in Table 3.2-1.

Static measurements will be performed in accordance with CABRERA procedures OP-020 "*Operation of Contamination Survey Meters," Rev 0,* and OP-021 *"Alpha-Beta Counting Instrumentation," Rev 0, and* CABRERA standard radiation instrumentation templates *"Alpha Beta Counting and Smear Worksheet", Rev 1.* Prior to use, FSS instrumentation will be checked for expected response using a Chi-Square distribution utilizing the CABRERA template *"Chi-Square Worksheet", Rev 0.*

The net count rate using the referenced templates will be determined as the difference between the measurement count rate and the daily background count rate measured prior to use.

Table 3.2-1: Detector Sensitivities and Assumptions

Model #	Count Time (min)	Probe Area (cm^2)	α Efficiency (cpm /dpm)	α Background (cpm)	α Static MDC (dpm / 100 cm^2)
FCM4M	1	728	0.15	10	16
43-37	1	582	0.15	10	20
43-89	2	126	0.15	3	38
43-93	2	126	0.15	3	48
2929	4	swipe	0.30	0.5	5

3.3 Smear Sample Collection and Analysis

Smear samples for gross transferable alpha contamination will be collected and analyzed to determine if transferable activity is less than or equal to 10% of total activity as assumed in the $DCGL_W$ (Section 4.1) and to ensure compliance with the equipment release criterion of Army Regulation (AR) 11-9 presented in Appendix B. Smear results for beta activity will be collected in tandem with alpha activity measurements and recorded for qualitative assessment.

Smear samples will be collected over approximately 100 cm^2 areas at biased locations identified during scanning activities. Smear samples will be analyzed for alpha and beta radioactivity using a Ludlum 2929 alpha/beta scintillation counter or equivalent in accordance with CABRERA procedure OP-021 *"Alpha-Beta Counting Instrumentation," Rev 0*. Based on the assumptions listed in Table 3.1-1, an alpha MDC of 5 dpm/100cm^2 will be achieved.

3.4 Gamma Dose Rate Measurements

Gamma dose rate measurements may be qualitatively performed during the FSSs to ensure worker health and safety and to identify unusual dose rate conditions. Measurements will be performed using a Bicron® MicroRem tissue-equivalent scintillation detector, or equivalent, and will be performed in accordance with CABRERA Procedure OP-023, *Operation of micro-R Meters, Rev 0*. Measurements will be performed using the "slow" response time constant setting. The detector will be positioned over the area of interest and allowed to stabilize prior to recording the measurement. The technician will use their judgment to determine when the instrument has stabilized, it is estimated that this will take at least 15 seconds. Such measurements will typically be performed at 3' from and/or on contact with the surface being evaluated.

4.0 FINAL STATUS SURVEY DESIGN

The FSS to be performed at the WRFs are designed in accordance with Final Status Survey guidance from MARSSIM (NRC, 2000). FSS activities will consist of gross alpha and beta scan surveys and integrated measurements on interior surfaces at frequencies based on MARSSIM guidance. The FSS is designed conservatively in that the radiological background present in survey materials (i.e., floor and walls) will be neglected and the measure of total activity will be used for statistical comparisons to release criteria. Survey activities will also include biased smear sample collection and the performance of gamma dose rate measurements. MARSSIM area classifications will be reviewed and possibly revised based on the results of these surveys.

4.1 Residual Radioactivity Limit (DCGL)

As described by MARSSIM, a DCGL is a derived radionuclide activity concentration within a survey unit that corresponds to a release criterion. Per the license requirement of 10CFR20 Subpart E, a release criterion of 25 mrem/yr per year will be used for the WRF. Doses from residual radioactivity will be kept as low as reasonably achievable (ALARA) whenever possible. Using MARSSIM Section 4.3.4, the equation below, and knowing that there is one alpha decay per decay of each uranium isotope, a single total uranium $DCGL_W$ of 100 dpm alpha/100cm^2 was derived for DU. This $DCGL_W$ was calculated using the values provided by the NRC screening guidelines of 90.6 dpm/100cm^2, 97.6 dpm/100cm^2, 101 dpm/100cm^2 and for U^{234}, U^{235}, and U^{238}, respectively, as presented in Table 5.19 of NUREG/CR-5512, volume 3, October 1999 and the DU activity fractions as presented in Section 2.2 of this FSS. As noted in the NUREG/CR-5512 document, screening level guidelines are based on the assumption that the fraction of removable surface contamination is ten percent.

$$DCGL_W = \frac{1}{\left(\frac{f_1}{DCGL_1}\right) + \left(\frac{f_2}{DCGL_2}\right) + \left(\frac{f_3}{DCGL_3}\right)}$$

Where: $DCGL_w$= Combined gross activity DCGL (i.e., release limit).

f = Activity fraction of radionuclide

DCGL = DCGL of radionuclide

4.2 Action Levels

The total uranium $DCGL_W$ of 100 dpm alpha/100cm^2 will be used as the action level for both static and scanning measurements. If any survey measurement results in readings above the $DCGL_W$, the Field Supervisor shall be notified and the detector and survey location shall be evaluated. Following evaluation, a follow-up measurement shall be performed at the measurement location to verify the initial result.

4.3 General Area Classification Based on Contamination Potential

Using MARSSIM Section 5.3 as guidance, the WRFs will be divided into individual survey units and classified by contamination potential. Initially, WRF #2 will be divided into three Class 1

Survey Units (SUs) and one Class 2 SU as listed in Table 4.3-1. WRF #3 also be divided into three Class 1 SUs and one Class 2 SU as listed in Table 4.3-1.

The initial classifications are based on contamination potential and area size. MARSSIM identifies Class 1 areas as having, or had prior to remediation, a potential for radioactive contamination or known contamination. MARSSIM suggests that interior Class 1 SUs be less than 100 square meters in size. The floor and lower walls of the WRFs share a similar history of contamination and contamination potential because these facilities were used to store DU waste. DU contamination has been identified previously on the floors of these facilities during past routine surveys. The floor area in WRF #2 was remediated for DU contamination prior to the initiation of the FFS.

MARSSIM identifies Class 2 areas as having, or had prior to remediation, a potential for radioactive contamination or known contamination but are not expected to exceed the $DCGL_W$. MARSSIM suggests that interior Class 2 SUs be less than 1000 square meters in size. The ceiling and upper walls of WRFs are initially classified as Class 2 due to remediation activities being performed previously on the floor of these facilities.

Maps presenting the WRFs SU delineations and the reference coordinate system are presented in Appendix C.

Table 4.3-1: Survey Units

SU #	Description	Material	Class	Area (m^2)	# of Samples	L (ft)
1	WRF #2 Floor South Side	Metal	1	68	20	6.1
2	WRF #2 Floor North Side	Metal	1	68	20	6.1
3	WRF #2 Lower Walls	Metal	1	90	24	7.0
4	WRF #2 Ceiling and Upper Walls	Metal	2	346	20	13.7
1	WRF #3 Floor South Side	Metal	1	68	20	6.1
2	WRF #3 Floor North Side	Metal	1	68	20	6.1
3	WRF #3 Lower Walls	Metal	1	90	24	7.0
4	WRF #3 Ceiling and Upper Walls	Metal	2	346	20	13.7

4.4 Number of Static Measurements

MARSSIM provides a method to determine the number of measurement locations required in a given survey unit. A minimum number of measurement locations are required in each survey unit to obtain sufficient statistical confidence that the conclusions drawn from the measurements are correct. The following subsections describe the bases for and derivation of the minimum required measurement locations per survey unit.

4.4.1 Estimation of Relative Shift

The minimum number of measurement locations required is dependent on the distribution of site residual radionuclide concentrations relative to the $DCGL_w$ and acceptable decision error limits (α and β).

The relative shift describes the relationship of site residual radionuclide concentrations to the $DCGL_w$ and is calculated using the guidance found in Section 5.5.2.3 of MARSSIM. The relative shift is calculated as follows:

$$\Delta/\sigma = \frac{DCGL_w - LBGR}{\sigma}$$

Where: $DCGL_w$ = Derived Concentration Guideline Level

LBGR = concentration at the lower bound of the gray region. The Lower Bound of the Grey Region (LBGR) is the concentration at which the survey unit has an acceptable probability of passing the statistical tests.

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).

As previously stated, the $DCGL_w$ for surface alpha radioactivity is 100 dpm/100cm^2. The LBGR was conservatively estimated at 70 dpm alpha/100 cm^2 based on previous studies with similar instruments on concrete. Without prior survey, it is reasonable to assume a coefficient of variation on the order of 30 percent (MARSSIM Section 5.5.2.2). Using a coefficient of variation of 30 percent and the LBGR as an estimate of the sample mean, a sigma value of 21 dpm/100cm^2 is estimated. Using the parameters discussed above, the relative shift is calculated as 1.4.

4.4.2 Determination of N (Number of Required Measurement Locations)

The final number of required measurement locations per survey unit is 20 as per MARSSIM (Table 5.5) given a relative shift of 1.4 and an error rate for both Type I and Type II errors of five percent (i.e., $\alpha = \beta = 0.05$). The actual number of measurements to be performed in each survey unit ranges from 20 to 24 samples based on the size of the survey area (Section 4.6).

4.5 Elevated Measurement Criterion ($DCGL_{EMC}$)

MARSSIM states that, for Class 1 survey units, a dose area factor should 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. For the purpose of ALARA, the $DCGL_W$ will be used as the $DCGL_{EMC}$, which corresponds to an area factor of one. Since the scan MDC of the instrumentation is sensitive enough to identify the $DCGL_W$ at least ninety percent of the time (see Section 3.1), it is unlikely that small areas of elevated activity exceeding the release criterion would be missed during scanning.

4.6 Static Measurement Locations

Measurement locations in Class 1 and Class 2 survey units have been established using a random start point in a systematic rectangular grid. The grid spacing for Class 1 and Class 2 survey units will be determined, based on the measured area of the survey unit, using the following equation (Equation 5-7 from MARSSIM).

$$L = \sqrt{\frac{A}{N}}$$

Where: L = rectangular grid spacing for survey unit
A = area of survey unit
N = number measurement locations

Measurement spacing results (L) using the equation above are presented in Table 4.3-1. Maps presenting the WRFs SU delineations and the reference coordinate system are presented in Appendix C.

4.7 Surface Alpha Radioactivity Scan Surveys

Class 1 SU scan surveys will be performed as described in Section 4.1 and will cover 100% of reasonably accessible surfaces. Areas of elevated radioactivity identified during scanning will be physically marked, and biased integrated measurements will be performed to quantify surface alpha activity concentrations for direct comparison to the $DCGL_W$. Survey areas in excess of the $DCGL_W$ will be investigated by the Field Supervisor and flagged for additional biased sampling (e.g., smear sampling). Beta scans will be performed in tandem with alpha measurements and recorded for qualitative purposes.

Scan surveys in Class 2 SUs will cover at least 10% of accessible surface areas and, when possible, will be biased toward areas with high potential for the presence of contamination. Examples of areas with potentially higher concentrations of contamination include horizontal and difficult to access areas where DU contamination may have accumulated, such as trusses and floor joints. Areas of elevated radioactivity identified during scanning will be physically marked, and biased integrated measurements will be performed to quantify surface alpha activity concentrations for direct comparison to the $DCGL_W$. Since contamination in excess of the $DCGL_W$ is not expected in Class 2 areas, any biased measurements confirmed to be in excess of the $DCGL_W$ will trigger investigation by the Field Supervisor and a re-evaluation of the area classification. Beta scans will be performed in tandem with alpha measurements and recorded for qualitative purposes.

4.8 Integrated Direct Surface Alpha Radioactivity Measurements

Measurements of surface alpha radioactivity will be performed in SUs at locations selected for MARSSIM statistical testing and at biased locations identified prior to and during scanning activities. Such measurements will be performed as described in Section 3.2. Beta measurements will be performed in tandem with alpha measurements and recorded for qualitative purposes.

4.9 Smear Sample Collection and Analysis

Smear samples will be collected at biased survey locations and at least 10% of systematic survey locations. Smear samples will be collected as described in Section 3.3. Beta measurements will be performed in tandem with alpha measurements and recorded for qualitative purposes.

4.10 Gamma Exposure Rate Measurements

Gamma exposure rate measurements may be performed to ensure worker safety and to identify unusual exposure rate conditions. Gamma exposure rate measurements will be performed as described in Section 3.4.

5.0 EQUIPMENT RELEASE

5.1 Survey of Equipment for Release Without Restriction

All equipment inside the WRFs should have been removed prior to FFS. If equipment is present that requires survey for unrestricted release, CABRERA will follow the surface release limits of 1,000 dpm/100 cm^2 of DU alpha activity per Army Regulation 11-9 *The Army Radiation Safety Program*. It is expected that all final release surveys of equipment will be performed by the licensee and these surveys will follow APG procedures. If CABRERA performs these release surveys for APG, then CABRERA will follow the APG procedures.

6.0 DATA PROCESSING

This section describes how project events and data will be retained for this FSS.

6.1 Project Log Book

All significant events which occur during this FSS be documented and retained for future reference. While many types of project events have specific forms on which they are documented, many events occur on a routine basis during survey field activities that must be documented as they occur. Additionally, project data transactions must also be recorded as they occur. To provide a practical means of capturing this information, a project logbook will be initiated upon project commencement.

Significant project events, including data transactions involving project electronic data, shall be recorded in the Project Logbook. Data transactions are defined as any transfer, download, export, copy, differential correction, sort, or other manipulation performed on project electronic data. Project Logbook records shall be sufficient to allow data transactions to be reconstructed after the project is completed. The Field Supervisor shall be responsible for maintaining the Project Data Logbook and will review the Project Data Logbook at least daily to report significant issues.

The Project Logbook is considered a legal record and will be permanently bound and the pages will be pre-numbered. Pages may not be removed from the logbook under any circumstances. Entries shall be legible, factual, detailed, and complete and shall be signed and dated by the individual(s) making the entries. If a mistake is made, the individual making the entry shall place a single line through the erroneous entry and shall initial and date the deletion. Under no circumstances shall any previously entered information be completely obliterated. Use of whiteout in the Project Logbook is not permitted for any reason. Only one Project Logbook will be maintained. If a Project Logbook is completely filled, another volume shall be initiated. In this case, each volume shall be sequentially numbered.

6.2 Project Electronic Data

Much of this FSS will rely on data collected and stored electronically. Electronic data is subject to damage and/or loss if not properly protected. As such, all project electronic data shall be downloaded from its collection device (e.g., laptop computers, data loggers, etc.) on at least a daily basis. At the conclusion of each day's survey activities, the Field Supervisor shall back up all electronic data collected that day to appropriate removable media (e.g., CD, zip disk, or equivalent) and shall ensure the backup is removed from site. Under no circumstances shall the backup be stored in the same building in which the original project electronic data is stored.

Data files shall be named according to a naming protocol designated by the field supervisor. No variations from this protocol shall occur without the prior concurrence of the field supervisor. During data download and transfer transactions, the applicable data file name(s) shall be included in project data logbook entries.

7.0 INTERPRETATION OF SURVEY RESULTS

The results of individual integrated static measurements performed for this FSS will be evaluated to compare the residual radioactivity present in the WRFs SU's to the release criteria ($DCGL_W$). This comparison will determine if the WRFs can be considered for release without radiological restriction. If all of the SU's of a WRF meet the criteria for unrestricted release, the WRF as a whole will be considered a viable candidate for unrestricted release.

In accordance with MARSSIM guidance, a preliminary data review will be performed to identify patterns, relationships, and potential anomalies present in the survey data. In this review, basic statistics including the mean, median, standard deviation, maximum and minimum values will be calculated for each SU. A graphical review of the alpha data will be performed consisting of posting plots and histograms. Posting plots will be used to review the spatial independence of measurements within survey units, while histograms will be employed to review the overall symmetry of the data.

Once the data have been reviewed, all of the static alpha measurements for each SU will be compared to the $DCGL_W$. If all of the static alpha measurements for a SU are below the $DCGL_W$, the survey unit meets the release criteria. If the average residual radioactivity in an individual SU is greater than the $DCGL_W$, the SU does not meet the release criteria. If any alpha measurements in a SU are greater than the $DCGL_W$ and the average residual radioactivity in that survey unit is below the $DCGL_W$, the Sign test will be performed as described in MARSSIM to compare the median concentration of residual radioactivity in individual survey units to the $DCGL_W$. If the results of that survey unit pass the Sign test, that SU meets the release criteria. Finally, a retrospective power curve will be computed to measure the power of the Sign test based on the results of the measurements performed. The results of all of these statistical processes will be provided in the FSS Report.

8.0 SURVEY QUALITY ASSURANCE/QUALITY CONTROL

Activities associated with this work plan shall be performed in accordance with written procedures and/or protocols in order to ensure consistent, repeatable results. Topics covered in project procedures and protocols may include proper use of instrumentation, Quality Control (QC) requirements, equipment limitation, etc. Quality Assurance (QA) measures for this FSS are described herein.

8.1 Instrumentation Requirements

The Field Supervisor is responsible for selecting the instrumentation required to complete the requirements of this work plan. Only instrumentation approved by the Field Supervisor will be used to collect radiological data. The Field Supervisor is responsible for ensuring individuals are appropriately trained to use project instrumentation and other equipment, and that instrumentation meets the required detection sensitivities. Instrumentation shall be operated in accordance with either a written procedure or manufacturers' manual, as determined by the Field Supervisor. The procedure and/or manual will provide guidance to field personnel on the proper use and limitations of the instrument.

8.1.1 Calibration Requirements

Instruments used during the FSS shall have current calibration/maintenance records kept on site for review and inspection. The records will include, at a minimum, the following:

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

Instrumentation shall be maintained and calibrated to manufacturers' specifications to ensure that required traceability, sensitivity, accuracy and precision of the equipment/instruments are maintained. Instruments will be calibrated at a facility possessing appropriate NRC and/or Agreement State licenses for performing calibrations using National Institute of Standards and Technology (NIST) traceable sources.

8.1.2 Instrument QC Source and Background Checks

Prior to and after daily use, alpha and gamma measuring instruments will be QC checked by comparing the instruments' response to a designated alpha or gamma radiation source and to ambient background. QC source checks will be performed with the designated source positioned in a reproducible geometry. Background checks will be performed in an identical fashion with the source removed. During QC checks, instruments will be inspected for physical damage, current calibration and erroneous responses. The individual performing these tasks shall document the results in accordance with the associated instrument procedure and/or protocols. Instrumentation that does not meet the specified requirements of calibration, inspection, or response check will be removed from service. If an instrument is removed from service, any data obtained after the last successful QC check will be considered suspect due to faulty instrumentation.

Quality control source checks for the Eberline FCM4M, Ludlum 43-37, Ludlum 43-89, and Ludlum 43-93 will consist of a one-minute integrated count with the designated Thorium–230 (^{230}Th) and Technetium-99 (^{99}Tc) sources. QC source checks for the Bicron® MicroRem meter will consist of observing needle deflection and estimating an average dose rate once the instrument readings have stabilized (approximately 15 seconds) using a ^{137}Cs source. The acceptance criterion for these instrument response checks is within +/- 20% of the average response generated using ten initial source checks and ten measurements of ambient background performed at the beginning of the project. A response check outside these criteria will be cause for evaluation of conditions (e.g., instrument operation, source/detector geometry), and the response check will be repeated once prior to field use of that instrument. Instruments that fail the second successive response check will be removed from service and corrective actions will be taken. Only Field Supervisors can return a failed instrument back to service after proper corrective actions are taken and documented.

Quality control source response checks for the Ludlum 2929 will be checked daily by evaluating response to designated ^{230}Th (Alpha) and ^{99}Tc (Beta) sources and ambient background. Response checks will consist of one-minute counts of a ^{230}Th, ^{99}Tc source, and a 20 minute count of ambient background. The acceptance criteria for instrument response will be set to two and three-sigma of the average response generated using ten initial source checks and ten measurements of ambient background. A daily response check outside the two-sigma, but within the three-sigma criteria will be cause for a recount prior to use. A response check outside two sigma on the second count will be cause for further evaluation and or re-performance of QC control values prior to continued use. Response checks falling outside acceptance criteria will be cause for notification of the Field Supervisor and evaluation of conditions (e.g., instrument operation, source/detector geometry) prior to further counts and/or removal of the instrument from service. Instruments must pass a response check prior to field use. Only Field Supervisors can return a failed instrument back to service after proper corrective actions are taken and documented.

Quality control for volumetric sample analysis will be performed in accordance with applicable Paragon standard operating procedures.

8.2 Direct Alpha, Smear, and Exposure Rate Measurements

Instrumentation will be operated in accordance with standard operating procedures and/or protocols.

8.2.1 Duplicate Measurements

Duplicate measurements will be required for 10% of the static measurement locations for each survey unit. Duplicate measurements will be compared to the initial analytical results by determining a Normalized Absolute Difference (NAD) value and comparing it against the performance criteria specified as follows:

Analyses of field and laboratory duplicates will be compared to the initial analytical results by determining a NAD value for each data set by the following equation (PROB, 1993):

$$\mathrm{NAD} = \frac{|\mathrm{Sample - Duplicate}|}{\sqrt{\sigma^2_{\mathrm{Sample}} + \sigma^2_{\mathrm{Duplicate}}}}$$

Where: Sample = first sample value (original),
Duplicate = second sample value (duplicate),
σ_{Sample} = 2σ counting uncertainty of the sample, and,
$\sigma_{Duplicate}$ = 2σ counting uncertainty of the duplicate

The calculated NAD results will be compared to a performance criteria of less than or equal to 1.96. Calculated NAD values less than 1.96 will be considered acceptable and values greater than 1.96 will be investigated for possible discrepancies in analytical precision, or for sources of disagreement with the following assumptions of the test:

- the sample measurement and duplicate or replicate measurement are of the same normally distributed population.
- the standard deviations, σ_{Sample} and $\sigma_{Duplicate}$, represent the true standard deviation of the measured population.

9.0 REFERENCES

(ANL, 1999) ANL Environmental Assessment Department Health Risk Report, "*Derived Uranium Guidelines for the Depleted Uranium Study Area of the Transonic Range, Aberdeen Proving Ground, Maryland*", M. Picel and S. Kamboj, Argonne National Laboratory, April 1999

(BARG, 1995) Specific Manufacturing Capability Program*, Depleted Uranium Constituents and Decay Heating*, Lockheed, Idaho presentation, dated October 3, 1995.

(CABRERA, 2000a) CABRERA OP-020, "*Operation of Contamination Survey Meters", Rev 0*

(CABRERA, 2000b) CABRERA OP-021, "*Alpha-Beta Counting Instrumentation", Rev 0*

(CABRERA, 2000c) Cabrera OP-023, "*Operation of micro-R Meters", Rev 0*

(NRC, 1999) NUREG/CR-5512, Volume 3 *Residual Radioactive Contamination from Decommissioning*, *Parameter Analysis*, Draft Report for Comment, U.S. Nuclear Regulatory Commission, dated October, 1999.

(NRC, 2000) NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM), U.S. Nuclear Regulatory Commission, dated August, 2000.

Appendix A:
Uranium 238 Decay Series

Uranium 238 Decay Series

(Excerpted from Radioactive Decay Data Tables, David Kocher, 1981)

Radionuclide	Half-Life	Emissions	Energy (MeV)	Percent Yield
U-238	4.5 x 109 y	α	4.2	75
		α	4.15	25
Th-234	24.1 d	β	0.193	79
		β	0.1	21
		γ	0.093	4
		γ	0.063	3.5
Pa-234m	1.17 min	β	2.29	98
Pa-234	6.75 h	β	0.53	<1
		β	1.13	<1
U-234	2.47 x105 y	α	4.72	28
		α	4.77	72
Th-230	8.0 x 104 y	α	4.62	24
		α	4.68	76
Ra-226	1602 y	α	4.60	6
		α	4.78	95
		γ	0.186	4
Rn-222	3.82 d	α	5.49	100
Po-218	3.05 min	α	6.0	100
Pb-214	26.8 min	β	0.65	50
		β	0.71	40
		γ	0.3	19
		γ	0.35	36
Bi-214	19.7 min	β	1.0	23
		β	1.51	40
		β	3.26	19
		γ	0.609	47

Appendix B:
Army Regulation 11-9
Army Radiation Safety Program

Appendix C:
Survey Unit Maps and Sample Locations

Appendix D: Final Status Survey Plan, Bomb Throwing Device (BTD) Site, Aberdeen Proving Ground, Aberdeen, MD

DEPARTMENT OF THE ARMY
U. S. ARMY ABERDEEN TEST CENTER
400 COLLERAN ROAD
ABERDEEN PROVING GROUND, MARYLAND 21005-5059

J-8

REPLY TO
ATTENTION OF

September 18, 2003

Office of the Commander

SUB-834
04007354

Mr. James Schmidt
Nuclear Regulatory Commission, Region I
Division of Nuclear Materials Safety
475 Allendale Road
King of Prussia, Pennsylvania 19406

Dear Mr. Schmidt:

The final Status Survey Plan for the Aberdeen Test Center Bomb Throwing Device Site is provided for your review and approval (Enclosure).

A copy of this letter with the enclosure has been furnished to the Directorate for Installation Management (CSTE-DTC-MS-S/Mr. Robert Aaserude), U.S. Army Developmental Test Command, 314 Longs Corner Road, Aberdeen Proving Ground, Maryland 21005-5055.

My point of contact at the U.S. Army Aberdeen Test Center is Mr. John C. Beckman at 410-278-9618.

Mary K. Brown
Colonel, U.S. Army
Commanding

Enclosure

FINAL

Final Status Survey Plan
Bomb Throwing Device (BTD) Site

Aberdeen Proving Ground, Aberdeen, MD

Contract Number
DAAA09-00G-0002/0039

Prepared for:

U.S.ARMY

U.S. Army Joint Munitions Command
AMSIO-ACE-D Bldg., 350 5th Floor
Rock Island, IL 61299-6000

Prepared by:

CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION
809 Main Street
East Hartford, Connecticut 06108

Cabrera Project No
01-3030.39

August 2003

Enclosure

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ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
APG	Aberdeen Proving Ground
ATC	Aberdeen Test Center
BTD	Bomb Throwing Device
CABRERA	Cabrera Services, Inc.
cpm	Counts Per Minute
DCGL or DCGLw	Derived Concentration Guideline Level
DGPS	Differential Global Positioning System
dpm	Disintegrations Per Minute
DU	Depleted Uranium
FSS	Final Status Survey
GWS	Gamma Walkover Survey
HEPA	High Efficiency Particulate Air
LBGR	Lower Bound of the Grey Region
MARSSIM	Multi-Agency Radiation Survey And Site Investigation Manual
MDC	Minimum Detectable Concentration
MDC_{scan}	Minimum Detectable Concentration for gamma Scanning
µRem	Microrem
mrem	Millirem
NAD	Normalized Absolute Difference
NIST	National Institute of Standards and Technology
NRC	U. S. Nuclear Regulatory Commission
PARAGON	Paragon Analytics, Inc.
QA	Quality Assurance
QC	Quality Control
ROPC	Radionuclides of Potential Concern
SU	Survey Unit
WESTON	Roy F. Weston

1.0 INTRODUCTION

Cabrera Services, Inc. (CABRERA) is under contract to the United States Army Joint Munitions Command (JMC) to provide support to the Aberdeen Test Center (ATC) at the Aberdeen Proving Ground (APG) in Aberdeen, MD. CABRERA will perform radiological surveys of the Bomb Throwing Device (BTD) site to support consideration for unrestricted release. The BTD site consists of approximately 46,000 square meters of land on the APG. There are several support facilities and access roads located on the BTD site that were used for the testing of Depleted Uranium (DU) munitions. This document presents the plan for the BTD site Final Status Survey (FSS) activities, which are designed in accordance with Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC, 2000) guidance. This final status survey specifically addresses the survey of approximately 46,000 square meters of BTD site soil, two concrete pads, and three steel test structures located within the boundary of the BTD site. Buildings and other enclosed structures located on the BTD site will be addressed under a separate effort.

1.1 Site History

Aberdeen Proving Ground, located in Aberdeen, MD, is an active U.S. Army testing and research facility. The Aberdeen Proving Ground (APG) lies along the western shore of the Chesapeake Bay in Harford and Baltimore Counties, MD, approximately 15 miles northeast of Baltimore. The APG covers a total of 72,516 acres (land and water) and consists of two distinct areas: the northern portion of APG, referred to as the Aberdeen Area; and the southern portion of APG, referred to as the Edgewood Area. The Aberdeen Area became a formal military post, designated as the APG, in 1917.

The BTD site was used between 1982 and 1993 for the testing of DU munitions. The site consists of the Building Armor Reclamation Facility (BARF), Building 701 (DU Test Enclosure Building which has been recently removed), Plate Storage Area (PSA), access roads and several support buildings situated on approximately 46,000 square meters of land. During use, munitions were fired at steel plate and other targets placed inside the DU Test Enclosure Building. The ATC tested DU munitions utilizing an enclosure with high efficiency particulate air (HEPA) equipment, used to collect potentially contaminated air exiting the building.

Prior to remediation of the site, approximately 40 tons of DU-contaminated armor plate was located within the building and surrounding grounds. Heavy equipment was used to transport the armor plates between the PSA and the DU Test Enclosure Building. The DU Test Enclosure Building, which was recently demolished, had dimensions of approximately 25 by 50 feet with a height of 20 feet, will be disposed of at an appropriate facility. Associated HEPA equipment including filters and ductwork are also scheduled for removal and appropriate disposition. A HEPA motor may remain on the site.

1.2 General Approach to the BTD Site FSS

The FSS investigations are designed using the approach outlined in MARSSIM (NRC, 2000).

- Development of Derived Concentrations Guideline Levels
- Selection of instrumentation and measurement techniques
- Identification of survey units and classify areas by contamination potential

- Estimation of the number of measurement locations
- Collection of Data
- Evaluation of Data

2.0 SITE ASSESSEMENT

2.1 Area of Investigation

The focus of this FSS is the radiological assessment of the top six inches of surface soil over the entire 46,000 square meters BTD site and the surface activity on unenclosed structures located within the BTD site boundaries. The land area associated with the BTD site consists of open grassy areas with one area of standing trees. Originating near the center of the BTD site is a wetland ravine. The ravine is approximately 140 meters in length and often has water covered surfaces averaging up to several meters in width. Water depths in the ravine range from several centimeters to approximately 15 centimeters.

Roy F. Weston (Weston) provided a radiological characterization for the BTD site in 2001 (Weston, 2001). The Weston characterization encompassed the BTD site and divided the site into Class 1, 2, and 3 areas. Soil samples were taken from each area and compared to the NRC soil screening value of 14 pCi/g for uranium-238. Both surface (0-0.25 ft) and subsurface samples (1-1.5 ft) were taken. All values exceeding the soil action level as described in this report were found to exist in the surface soil (0-0.25 ft). An exception was the presence of several subsurface samples taken in the vicinity of the DU Test Enclosure Building that showed levels of soil contamination in excess of the soil action level. The removal of the DU Test Enclosure building by the CABRERA remediation and subsequent soil remediation activities will ensure that these areas of soil contamination have been addressed. In addition, the Weston characterization classified the majority of the BTD site as Class 3. The CABRERA remediation and FSS conservatively assumes the entire site is a Class 1.

The BTD site structures of interest are two concrete pads and three unenclosed steel structures. A motor associated with the HEPA filtration system is expected to remain onsite at its current location. The northern concrete pad is approximately 230 square meters size while the southern concrete pad is approximately 130 square meters in size. The unenclosed structures consist of a steel gun mount, a "Sabot Stripper", and a "Back Stop Plate". The bases of these structures are approximately 25 square meters each with an additional 20-25 square meters of vertical surface area. The HEPA motor is several square meters in overall area.

The land areas surrounding the facilities and structures where testing and transport of materials was performed are expected to have a greater potential for surface soil contamination than other areas. DU contamination below the top six inches are not expected in soil due to the trajectory and containment of the targets used during ordnance testing. Prior BTD site characterization study (Weston, 2001), confirms the presence of DU contamination in the upper six inches of the soil. DU contamination below the concrete pads and steel test structures are not expected as these structures were in place prior to testing protocols.

2.2 Radionuclides of Potential Concern

Site Radionuclides of Potential Concern (ROPC) are limited to DU and short-lived uranium progeny (Appendix A). For brevity, Appendix A does not show the radionuclides from the actinium decay series as parent uranium-235 contributes a vanishingly small fraction of the radioactivity and mass. The uranium ratios are based on isotopic uranium weight ratios used for

shipments of routine DU waste from APG (BARG, 1995). The activity fractions are calculated from the isotopic weight ratios and the specific activity of each uranium isotope. The result is a Uranium-234 (^{234}U): Uranium-235 (^{235}U): Uranium-238 (^{238}U) ratio of 0.084:0.012:0.904. This composition is similar to the 0.190:0.021:0.790 average ratio from three DU soil samples described in the APG report (ANL 1999) entitled "Derived Uranium Guideline for the Depleted Uranium Study Area of the Transonic Range, Aberdeen Proving Ground, Maryland", Argonne National Laboratory Environmental Assessment Department, April 1999.

2.3 Residual Radioactivity Limit (DCGL)

As described by MARSSIM, a DCGL is a derived radionuclide activity concentration within a survey unit that corresponds to a dose-based release criterion. For this FSS, separate $DCGL_W$'s were developed for soil and structure surfaces. The release criteria for miscellaneous equipment (e.g. Back Stop Plate, HEPA Motor, etc) are discussed in Section 5.0.

Soil $DCGL_W$

A soil DCGL of 230 pCi/g total DU (resident-farmer scenario) developed for the Transonic Range is considered applicable for the BTD site based on a report prepared by CABRERA and included as Appendix B (CABRERA, 2003). The report evaluates site-specific RESRAD parameters/pathways, the similarity of both locations, and the equivalence of the radiological isotopic DU mixes at both locations. Use of the approved BTD soil DCGL will ensure that the potential dose to a hypothetical individual will not exceed 25 mrem in any one year over a 1,000 period consistent with 10 CFR Part 20 Subpart E requirements. For this FSS, a soil $DCGL_W$ of 105 pCi/g total DU in soil will be used based on the ALARA principle of as-low-as-reasonably-achievable to provide assurance that hypothetical doses are limited to a fraction of the 25 mrem/year requirement.

Structure Based $DCGL_W$

A release criterion of 25 mrem/yr per year will be used for the unenclosed structures per the requirement of 10CFR20 Subpart E. Doses from residual radioactivity will be kept as low as reasonably achievable (ALARA) whenever possible. Using MARSSIM Section 4.3.4, and the equation below, and knowing that there is one alpha decay per decay of each uranium isotope, a single total uranium $DCGL_W$ of 100 dpm alpha/100cm^2 was derived for DU. This $DCGL_W$ was calculated using the values provided by the NRC screening guidelines of 90.6 dpm/100cm^2, 97.6 dpm/100cm^2, 101 dpm/100cm^2 and for U^{234}, U^{235}, and U^{238}, respectively, as presented in Table 5.19 of NUREG/CR-5512, Volume 3, October 1999 and the DU activity fractions as presented in Section 2.2 of this FSS. As noted in the NUREG/CR-5512 document, screening level guidelines are based on the assumption that the fraction of removable surface contamination is ten percent.

$$DCGL_W = \frac{1}{\left(\frac{f_1}{DCGL_1}\right) + \left(\frac{f_2}{DCGL_2}\right) + \left(\frac{f_3}{DCGL_3}\right)}$$

Where: $DCGL_w$= Combined gross activity DCGL (i.e., release limit).

f = Activity fraction of radionuclide

DCGL = DCGL of radionuclide

2.4 Action Levels

For soil, the soil ALARA $DCGL_W$ of 105 pCi/g will be used as the action level for scanning measurements. If any scan measurement results in readings above the soil $DCGL_W$ (Section 3.1), the Field Supervisor shall be notified and the detector and survey location shall be evaluated. Following evaluation, the immediate area will be rescanned to verify the initial result. If the verified result is greater than the $DCGL_W$, the location will be marked and remediated to ensure that the soil $DCGL_W$ of 105 pCi/g is not exceeded. Additional scans of the area will be performed to verify that the additional remediation has removed soil above the action level of 105 pCi/g.

For unenclosed non-equipment structures (e.g., concrete pads), the structural $DCGL_W$ of 100 dpm alpha/100 cm^2 for total uranium will be used as the action level for both scanning and integrated measurements (Section 3.2 & 3.4). If any survey measurement results in readings above this $DCGL_W$, the Field Supervisor shall be notified and the detector and survey location shall be evaluated. Following evaluation, a follow-up measurement shall be performed at the measurement location to verify the initial result. If the result of the verification measurement is in excess of the $DCGL_W$, a biased smear sample (Section 3.6) will be performed at that location. Follow-up remediation and survey scan and integrated measurements will be provided at the subject location as necessary.

For equipment, the $DCGL_W$ will be based on equipment release criteria of 1,000 dpm alpha/100 cm^2 removable contamination and 5,000 dpm alpha/100 cm^2 total contamination in accordance with Army Regulation 11-9 (AR11-9, 1999) Table 5-2 (Section 5.0). If any survey measurement results in readings above this $DCGL_W$, the Field Supervisor shall be notified and the detector and survey location shall be evaluated. Following evaluation, a follow-up measurement shall be performed at the measurement location to verify the initial result. If the result of the verification measurement is in excess of the $DCGL_W$, a biased smear sample (Section 3.6) will be performed at that location. In certain cases, the equipment may be removed from the site and the small area beneath the equipment will be resurveyed in accordance with the soil $DCGL_W$.

3.0 SURVEY INSTRUMENTATION AND TECHNIQUES

The purpose of this section is to describe radiological survey instruments and techniques that will be used for surveys implemented during site radiological investigations. Specific measurement/sampling frequencies and approaches for the FSS are discussed in later sections.

For the soil FSS, ambient gamma scanning, discrete soil sampling, offsite laboratory analyses of the soil, and dose rate measurements will be performed to measure radioactivity concentrations of total uranium in surface soil. Implements used to collect soil samples will be cleaned and surveyed after each sample is collected to minimize cross-contamination of samples.

For unenclosed structures, scanning and integrated direct measurements will be performed to measure surface radioactivity concentrations of total uranium. These measurements will be based solely on alpha emissions. Beta measurements will be collected in tandem with alpha measurements and presented for qualitative review in an appendix of the FSS report. Prior to the initiation of alpha survey activities on unenclosed structures, surfaces of interest will be cleaned to remove dirt and grime that could shield alpha emissions from detection. The cleaning implements used to clean surfaces will be collected and stored on site and disposed in accordance with the contaminants found.

3.1 Gamma Walkover Surveys (GWS)

A GWS will be performed over soil to identify surface soil DU contamination. These surveys will provide position-correlated gross gamma count rate data proportional to the gross gamma fluence rate at the ground surface. The results of these surveys will be used to detect areas of elevated activity and select locations for biased soil sampling.

The GWS will be performed using a Ludlum Model 44-20 3" x 3" NaI gamma scintillation detector (or equivalent) coupled to a Ludlum Model 2221 rate meter (or equivalent). These instruments will be linked with differential global positioning system (DGPS) receiver/dataloggers. The gamma detection systems will be setup to measure gamma interactions in the NaI crystal that are discernable from electronic noise. Specifically, the detection systems will be calibrated with no lower level discriminator and no upper level discriminator (i.e., open window). This system will log the gross gamma reading and position every second in State Plane Coordinates.

Using NUREG-1507 as guidance, a minimum detectable scanning concentration (MDC_{SCAN}) and scanning sensitivity was calculated using Microshield®. The results of these calculations are presented in Table 3.1-1. The action level of 6,800 cpm above ambient gamma background was calculated by multiplying the instrument scanning sensitivity by the $DCGL_W$ of 105 pCi/g.

The calculations performed and the assumptions made in the sensitivity estimates are presented in Appendix C. The assumptions include an ambient gamma background of 10uR/hr and a 56 cm diameter soil source term uniformly contaminated to a depth of 15 cm as described by NUREG-1507. The Ludlum Model 44-20 instrument sensitivity and scanning evaluation incorporates 18 energy response groups covering the energy range associated with DU. The sensitivity evaluation also assumes that scanning will be performed in accordance with

MARSSIM protocol by walking straight parallel lines over an area while moving the detector in a serpentine motion, approximately 10 cm above the ground surface. Survey passes will be approximately 1 meter apart and the scan rate will be approximately 0.5 meters per second. The CABRERA General Countrate Meter QC template will be used to assure proper instrument operability prior to daily scanning.

The action level of 6,800 cpm above background, the instrument scanning sensitivity, and the MDC_{scan} values are shown in Table 3.1-1.

Table 3.1-1: NaI Scanning Sensitivities for Soil

Detector	Description	MDC_{SCAN} (pCi/g)	Scanning Sensitivity (cpm/pCi/g)	Action Level (cpm above background)
Ludlum 44-20	NaI 3"x3"	38	65	6,800

3.2 Direct Alpha Radioactivity Scan Surveys

Direct alpha scanning will be performed to identify surface locations on structures where contaminant concentrations may exceed the criterion for unrestricted release. Scanning surveys for alpha activity will also be performed to determine if radiological surface contamination is present on soil sampling equipment. Scanning will be performed using a Ludlum Model 43-93 (100 cm^2) active area scintillation detectors, or equivalent. Scanning will be performed with the active area of the detector at a height of 0.5 cm above the surface of interest using the detector specific assumptions listed in Table 3.2-1. Scanning measurements will be performed in accordance with CABRERA procedures OP-020 "*Operation of Contamination Survey Meters,*" *Rev 0* and use CABRERA General Countrate Meter QC template.

Using MARSSIM equation J-5 and the instrument specific assumptions listed in Table 3.1-2, the MDC_{SCAN} is determined to be equal to the structural $DCGL_W$. The chance of detecting a concentration equal to the $DCGL_W$ would be 90% and signified by the incidence of one alpha count occurring within the pause time of that stationary instrument.

$$P(n \geq 1) = 1 - P(n = 0) = 1 - e^{-A} \qquad \text{(MARSSIM J-5)}$$

$$\text{for } A = \frac{GEd}{60v}$$

where,

$P(n \geq 1)$ = probability of getting 1 or more counts during the time interval t
$P(n = 0)$ = probability of not getting any counts during the time interval t
G = source activity (dpm)
E = detector efficiency (4π)
d = width of the detector in the direction of scan (cm)
v = scan speed (cm/s)
A = detector area (cm^2)

Whenever an alpha count is detected during the scan, the detector will be held in place over the location where the count was detected for the duration of the pause time (approximately 7 seconds). If a second alpha count is detected over this location during the pause time, a two minute integrated count will be performed. If the result of the integrated measurement is in excess of the structural $DCGL_W$ (Section 2.3), the area will be marked and further investigated by the Field Supervisor.

The net count rate will be determined as the difference between the measurement count rate and the daily background count rate measured prior to use.

Table 3.2-1: Alpha Scan Assumptions

Model #	Probe Area (cm^2)	Probe Width (cm)	α Efficiency (cpm /dpm)	α Bkgrd (cpm)	Scan Speed (cm/sec)	Pause Time (sec)	P(n>=1)	Dwell Time (sec)	P(n>=2)
43-93	100	9	0.20	3	1	6.9	0.95	NA	NA

3.3 Soil Sampling

Soil samples will be collected to measure surface soil contaminant concentrations at discrete locations. The soil samples will be analyzed for total uranium and the results will be used to facilitate statistical testing. Discrete sampling locations will be identified using the Trimble DGPS system to get the appropriate Easting and Northing coordinates (North American Datum System). Samples will be sent to Paragon Analytics, Inc. (Paragon) for analysis for isotopic uranium and analyzed in accordance with Paragon's standard operating procedure. Volumetric samples will be collected in accordance with CABRERA procedure *OP-005 Volumetric and Material Sampling, rev 0.*

Soil samples will be collected using surface scraping tools such as trowels or spoons. In general, surface soil samples will be collected from the top six inches of soil. The sample will be transferred into a stainless steel bowl, where it will be thoroughly mixed to homogenize the sampled media. Visually identifiable non-soil components such as stones, twigs, and foreign objects will be manually separated in the field and excluded from the laboratory samples to avoid biasing results. Samples will not be preserved in the field, as there are no preservation requirements for the radiological analyses. All sampling equipment, mixing utensils, and homogenizing bowls will be decontaminated using distilled water after each sample to avoid cross contaminating the subsequent sample. A Ludlum 43-93 detector and smear sample will be used to ascertain that no cross-contamination occurs between samples. The presence of less than 1,000 dpm/100 cm^2 of DU alpha activity on a smear is sufficient to show non-contamination of volumetric samples from the sampling equipment thus limiting cross-contamination between soil samples.

Soil will be collected in 500 ml sample containers. These containers will hold sufficient sample material as to allow detection of radioactive materials at the MDC values specified (approximately 4 pCi/gram DU). The analysis lab has indicated this amount to be equivalent to

approximately 500 grams of soil. Each filled 500 ml container will hold more than 500 grams of soil.

Samples will be marked to show the sample identification number. Sample identification number, northing and easting coordinates, and other pertinent data will be recorded on appropriate field data recording sheets. Samples will be collected in accordance with the Paragon Laboratories applicable chain of custody procedures.

3.4 Integrated Direct Surface Alpha Radioactivity Measurements

Integrated direct measurements (i.e., static measurements) of surface alpha radioactivity will be performed during the FSS to compare contaminant concentrations at discrete sampling locations on construction materials (i.e., concrete pad) to the release criterion and facilitate statistical testing. Model 43-93 hand held (active area 100 cm^2) alpha scintillation detector or equivalent. The estimated detector sensitivity and the assumptions used for this detector are presented in Table 3.4-1.

Static measurements will be performed in accordance with CABRERA procedures OP-020 "*Operation of Contamination Survey Meters,*" *Rev 0,* and OP-021 *"Alpha-Beta Counting Instrumentation," Rev 0, and* CABRERA standard radiation instrumentation templates *"Alpha Beta Counting and Smear Worksheet", Rev 2.* Prior to field mobilization, FSS instrumentation will be checked for expected response using a Chi-Square distribution utilizing the CABRERA template *"Equipment Chi-Square Distribution Worksheet", Rev 0.*

The net count rate will be determined as the difference between the measurement count rate and the daily background count rate measured prior to use.

Table 3.4-1: Detector Sensitivities and Assumptions

Model #	Count/Bkg Time (min)	Probe Area (cm^2)	α[1] Efficiency (cpm /dpm)	α Background (cpm)	α Static MDC (dpm / 100 cm^2)
43-93	2	100	0.20	3	36
2929	4	smear	0.37	0.5	6

[1] Instrument efficiencies are estimated from vendor literature-based ^{230}Th and ^{239}Pu efficiencies.

3.5 Gamma Dose Rate Measurements

Gamma dose rate measurements may be qualitatively performed during the FSSs to ensure worker health and safety and to identify unusual dose rate conditions. Measurements will be performed using a Bicron MicroRem tissue-equivalent scintillation detector, or equivalent, and will be performed in accordance with CABRERA Procedure OP-023, *Operation of micro-R Meters, Rev 0.* Measurements will be performed using the "slow" response time constant setting. The detector will be positioned over the area of interest and allowed to stabilize prior to recording the measurement. The technician will use their judgment to determine when the

instrument has stabilized, it is estimated that this will take at least 15 seconds. Such measurements will typically be performed at 30 cm from and/or on contact with the surface being evaluated.

3.6 Smear Sample Collection and Analysis

For non-equipment structural smear samples (e.g., concrete pads), gross transferable alpha contamination will be collected and analyzed to determine if transferable activity is less than or equal to 10% of total activity as assumed in the NUREG/CR-5512 document for screening level guidelines.

For equipment smear samples, gross transferable alpha contamination will be collected and analyzed to ensure compliance with equipment release criterion of Army Regulation 11-9 of 1,000 dpm/100 cm^2.

Smear samples will be collected over approximately 100 cm^2 areas at systematic and biased locations identified during scanning activities. Smear samples will be analyzed for alpha and beta radioactivity using a Ludlum 2929 alpha/beta scintillation counter or equivalent in accordance with CABRERA procedure OP-021 *"Alpha-Beta Counting Instrumentation," Rev 0.* Based on the assumptions listed in Table 3.4-1, an alpha MDC of 6 dpm/100cm^2 will be achieved.

4.0 FINAL STATUS SURVEY DESIGN

The FSS to be performed at the BTD site is designed in accordance with Final Status Survey guidance from MARSSIM (NRC, 2000). FSS activities will consist of scanning surveys over 100% of the reasonable accessible surface soil and structure surfaces. Discrete soil sampling and integrated direct surface measurements will be performed at frequencies based on MARSSIM guidance. Survey activities will also include biased smear sample collection. The FSS is designed conservatively in that the radiological background present in the soil will be neglected and the measure of total activity will be used for statistical comparisons to the respective $DCGL_W$.

4.1 Area Classification Based on Contamination Potential

Using MARSSIM as guidance, the BTD site will be divided into 29 Class 1 survey units (SU). The initial SU classifications are based on sample matrix, area, and contamination potential. Table 4.1-1 lists each SU by matrix type, area, number of samples to be collected in that SU, and the distance between each sample using a triangular grid pattern.

For soil areas, MARSSIM suggests that outdoor Class 1 SUs be not more than 2,000 square meters in size. For unenclosed structures (concrete pads), SU size was limited to approximately 100 square meters that MARSSIM suggests for interior SUs. This more restrictive size was selected for unenclosed structures based on the possibility that enclosures may be built upon existing concrete pads and around test equipment in the future. To accommodate the interior SU size, concrete pads remaining in place were divided into two separate SUs of equal size.

Three pieces of steel test equipment and a HEPA motor are considered equipment and will be released based on Army Regulation 11-9 as described in sections 4.2 and 5.1.

MARSSIM identifies Class 1 areas as having, or had prior to remediation, a potential for radioactive contamination or known contamination. Initially, all survey units will be considered Class 1 survey units based on the process involved (i.e., the testing and firing of DU munitions), the amount of DU present on the BTD site (i.e., approximately 40 tons of contaminated plate armor), the on-site transport of contaminated materials, the length of time the BTD site was used to test munitions. This is a conservative assumption.

Table 4.1-1: Survey Units

SU #	Matrix	Area (m^2)	L (m)	No. of Samples	SU #	Matrix	Area (m^2)	L (m)	No. of Samples
1	Soil	1235	10.1	16	16	Soil	1970	12.8	15
2	Soil	1600	11.5	15	17	Soil	1590	11.5	15
3	Soil	1560	11.3	17	18	Soil	2000	12.8	15
4	Soil	1840	12.3	15	19	Soil	2000	12.8	15
5	Soil	1945	12.7	14	20	Soil	1935	12.6	14
6	Soil	1995	12.8	14	21	Soil	1950	12.7	15
7	Soil	2000	12.8	15	22	Soil	1970	12.8	17
8	Soil	2000	12.8	15	23	Soil	1300	10.4	17
9	Soil	1335	10.5	15	24	Soil	2000	12.8	14
10	Soil	1650	11.7	17	25	Soil	2000	12.8	15
11	Soil	1900	12.5	14	26	Concrete	65	1.94	20
12	Soil	2000	12.8	15	27	Concrete	65	1.94	20
13	Soil	1980	12.8	15	28	Concrete	115	2.58	20
14	Soil	2000	12.8	14	29	Concrete	115	2.58	20
15	Soil	2000	12.8	15					

4.2 Number of Static Measurements/Soil Samples

MARSSIM provides a method to determine the number of measurement locations required in a given survey unit. A minimum number of measurement locations are required in each survey unit to obtain sufficient statistical confidence that the conclusions drawn from the measurements are correct. The following subsections describe the bases for and derivation of the minimum required measurement locations per survey unit.

Estimation of Relative Shift

The minimum number of measurement locations required is dependent on the distribution of site residual radionuclide concentrations relative to the $DCGL_w$ and acceptable decision error limits (α and β).

The relative shift describes the relationship of site residual radionuclide concentrations to the $DCGL_w$ and is calculated using the guidance found in Section 5.5.2.3 of MARSSIM. The relative shift is calculated as follows:

$$\Delta/\sigma = \frac{DCGL_w - LBGR}{\sigma}$$

Where: $DCGL_w$ = Derived Concentration Guideline Level

LBGR = concentration at the lower bound of the gray region. The Lower Bound of the Grey Region (LBGR) is the concentration at which the survey unit has an acceptable probability of passing the statistical tests.

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).

The $DCGL_w$ for surface soil radioactivity is 105 pCi/g. The LBGR is estimated at 52.5 pCi/g which is half of the $DCGL_w$ as suggested by MARSSIM. Using an estimated coefficient of variation of 30 percent and the LBGR as an estimate of the sample mean, a sigma value of 15.8 pCi/g is calculated. Using the parameters discussed above, the relative shift is calculated as 3.3.

The unenclosed concrete pad $DCGL_w$ for surface alpha radioactivity is 100 dpm/100cm^2. The LBGR was conservatively estimated at 70 dpm alpha/100 cm^2 based on previous studies with similar instruments on concrete. Without prior survey, it is reasonable to assume a coefficient of variation on the order of 30 percent (MARSSIM Section 5.5.2.2). Using a coefficient of variation of 30 percent and the LBGR as an estimate of the sample mean, a sigma value of 21 dpm/100cm^2 is estimated. Using the parameters discussed above, the relative shift is calculated as 1.4.

The unenclosed steel structures and HEPA motor are considered equipment and will be released based on Army Regulation 11-9, submitted as part of the APG ATC NRC License document SUB-834. Table 5-2 of Army Regulation 11-9 provides for surface radioactivity values of up to 1,000 dpm/100 cm^2 removable and 5,000 dpm/100 cm^2 total activity for ^{235}U and ^{238}U and associated decay products. These values are the same as provided by Regulatory Guide 1.86.

Determination of N (Number of Required Measurement Locations)

For soil SUs, the final number of suggested measurement locations per survey unit is 14 as per MARSSIM (Table 5.5) given a relative shift of 3.7 and an error rate for both Type I and Type II errors of five percent (i.e., $\alpha = \beta = 0.05$). The actual number of measurements to be performed in each survey unit ranges from 14 to 17 samples based on the size and geometry of the SU and are presented in Table 4.1-1.

For unenclosed concrete structures, the final number of direct surface required measurement locations per survey unit is 20 as per MARSSIM (Table 5.5) given a relative shift of 1.4 and an error rate for both Type I and Type II errors of five percent (i.e., $\alpha = \beta = 0.05$). The actual number of measurements to be performed in each concrete survey unit is 20 samples based on the size and geometry of the survey area.

4.3 Elevated Measurement Criterion ($DCGL_{EMC}$)

MARSSIM states that, for Class 1 survey units, a dose area factor should 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. For the purpose of ALARA, the $DCGL_w$ will be used as the $DCGL_{EMC}$ for both soil and structures. This corresponds to an area factor of one. Since soil and structure MDC_{SCAN} values are sensitive enough to identify a concentration that is less than half of their respective $DCGL_w$, it is unlikely that small areas of elevated activity exceeding the release criterion would be missed during scanning.

4.4 Static Measurement Locations

Measurement locations in Class 1 survey units will be established using a random start point in a systematic triangular grid. The grid spacing for Class 1 survey units will be determined, based on the measured area of the survey unit, using the following equation (Equation 5-7 from MARSSIM).

$$L = \sqrt{\frac{A}{0.866\,N}}$$

Where: L = rectangular grid spacing for survey unit
A = area of survey unit
N = number measurement locations

Measurement spacing results (L) using the equation above are presented in Table 4.1-1. Maps presenting the BTD site SU delineations and the reference coordinate system are presented in Appendix D.

4.5 Gamma Walkover Surveys

GWS will be performed as described in Section 3.1 over 100% of reasonably accessible soil SU areas. If a scan measurement exceeds the soil action level, the Field Supervisor shall be notified and the detector and survey location shall be evaluated. Following evaluation, the immediate area will be rescanned to verify the initial result. If the verified result is greater than the action level, the location will be marked for further remediation followed by additional surveying of the location.

As described previously in section 2.1, the ravine area site feature has water covered surfaces that range from several centimeters to approximately 15 centimeters in depth. Scan surveys over soil areas covered by more than 13 cm of water may result in a MDC_{SCAN} sensitivity less than the soil $DCGL_W$ of 105 pCi/g. To compensate for potential reduced instrument sensitivity in these areas, streambed sediment samples will be taken. The GWS for the area will be provided up to the areas of standing water. Sediment samples will be taken in the center of the streambed ravine where GWS measurements stop. Section 4.7 provides additional details associated with the sediment sampling.

4.6 Surface Alpha Radioactivity Scan Surveys

Alpha scan surveys will be performed as described in Section 3.2 and will cover 100% of reasonably accessible structure surfaces. Areas of elevated radioactivity identified during scanning will be physically marked and biased integrated measurements will be performed to quantify surface alpha activity concentrations for direct comparison to the $DCGL_W$. Survey areas in excess of the $DCGL_W$ will be investigated by the Field Supervisor and flagged for additional biased sampling (e.g., smear sampling). Beta scans will be performed in tandem with alpha measurements and recorded for qualitative purposes only.

4.7 Soil Sampling

Sampling of surface soil will be performed in soil SUs at locations selected for MARSSIM statistical testing and at biased locations identified during the GWS. Such measurements will be performed as described in Section 3.3. Collected samples will be sent to an offsite laboratory for isotopic uranium analysis.

Sediment samples will be taken in the streambed of the ravine to provide additional assurance that the soil action levels are not exceeded for this area. The sediment samples collected may take the place of systematic soil samples that may be co-located in streambed areas covered by water. Sediment samples will be taken in the approximate center of the ravine streambed at a rate of 1 sediment sample for every 7 linear meters of the ravine. This will result in a statistically significant number of samples (20 samples) based on the estimated total length of the ravine of 140 meters. The locations for these samples will be determined in the field due to the transient nature of the water in the ravine area.

4.8 Integrated Direct Surface Alpha Radioactivity Measurements

Measurements of surface alpha radioactivity will be performed on structures at locations selected for MARSSIM statistical testing and at biased locations identified prior to and during scanning activities. Such measurements will be performed as described in Section 3.4. Beta measurements will be performed in tandem with alpha measurements and recorded for qualitative purposes.

If any alpha survey measurement results in readings above the structure $DCGL_W$, the Field Supervisor shall be notified and the detector and survey location shall be evaluated. Following evaluation, a follow-up measurement shall be performed at the measurement location to verify the initial result. If the result of the verification measurement is in excess of the $DCGL_W$, remediation of the surface followed by biased sampling will be performed at that location.

4.9 Gamma Dose Rate Measurements

Gamma dose rate measurements will be performed at locations selected for MARSSIM statistical testing and at biased locations identified during scanning. At soil locations, dose rate measurements will be prior to soil samples being drawn. Gamma dose rate measurements may be performed to ensure worker safety and to identify unusual dose rate conditions. Gamma dose rate measurements will be performed as described in Section 3.5.

4.10 Smear Sample Collection and Analysis

Smear samples will be collected at biased survey locations and at least 10% of systematic survey locations. Smear samples will be collected as described in Section 3.6. Beta measurements will be performed in tandem with alpha measurements and recorded for qualitative purposes. Smear samples will also be collected on soil sampling equipment between sampling.

5.0 EQUIPMENT RELEASE

5.1 Survey of Equipment for Release Without Restriction

Certain equipment present within the BTD site boundaries may need to be surveyed for consideration of release without restriction. CABRERA will follow the surface release limits of 1,000 dpm/100 cm^2 removable DU alpha activity and 5,000 dpm/100 cm^2 total DU alpha activity per Army Regulation 11-9, "*The Army Radiation Safety Program*". It is expected that all final release surveys of equipment will be performed by the licensee and these surveys will follow APG procedures. If CABRERA performs these release surveys for APG, then CABRERA will follow the APG procedures.

6.0 DATA PROCESSING

This section describes how project events and data will be retained for this FSS.

6.1 Project Log Book

All significant events which occur during this FSS be documented and retained for future reference. While many types of project events have specific forms on which they are documented, many events occur on a routine basis during survey field activities that must be documented as they occur. Additionally, project data transactions must also be recorded as they occur. To provide a practical means of capturing this information, a project logbook will be initiated upon project commencement.

Significant project events, including data transactions involving project electronic data, shall be recorded in the Project Logbook. Data transactions are defined as any transfer, download, export, copy, differential correction, sort, or other manipulation performed on project electronic data. Project Logbook records shall be sufficient to allow data transactions to be reconstructed after the project is completed. The Field Supervisor shall be responsible for maintaining the Project Data Logbook and will review the Project Data Logbook at least daily to report significant issues.

The Project Logbook is considered a legal record and will be permanently bound and the pages will be pre-numbered. Pages may not be removed from the logbook under any circumstances. Entries shall be legible, factual, detailed, and complete and shall be signed and dated by the individual(s) making the entries. If a mistake is made, the individual making the entry shall place a single line through the erroneous entry and shall initial and date the deletion. Under no circumstances shall any previously entered information be completely obliterated. Use of whiteout in the Project Logbook is not permitted for any reason. Only one Project Logbook will be maintained. If a Project Logbook is completely filled, another volume shall be initiated. In this case, each volume shall be sequentially numbered.

6.2 Project Electronic Data

Much of this FSS will rely on data collected and stored electronically. Electronic data is subject to damage and/or loss if not properly protected. As such, all project electronic data shall be downloaded from its collection device (e.g., laptop computers, data loggers, etc.) on at least a daily basis. At the conclusion of each day's survey activities, the Field Supervisor shall back up all electronic data collected that day to appropriate removable media (e.g., CD, zip disk, or equivalent) and shall ensure the backup is removed from site. Under no circumstances shall the backup be stored in the same building in which the original project electronic data is stored.

Data files shall be named according to a naming protocol designated by the Field Supervisor. No variations from this protocol shall occur without the prior concurrence of the field supervisor. During data download and transfer transactions, the applicable data file name(s) shall be included in project data logbook entries.

7.0 INTERPRETATION OF SURVEY RESULTS

The results of individual soil and sediment samples and direct integrated alpha measurements performed for this FSS will be evaluated statistically and compared to the release criteria. This comparison will determine if the BTD site can be considered for release without radiological restriction. If all of the SUs of the BTD site meet the criteria for unrestricted release, the entire BTD site as defined in this FSS will be considered a viable candidate for unrestricted release.

Background in the sampled matrix is not considered during interpretation of individual soil samples, concrete smear samples, or the integrated alpha count measurements associated with soil, sediment, and concrete at the BTD site. This is a conservative approach and is appropriate since the background for these media are small compared to the $DCGL_w$ levels.

In accordance with MARSSIM guidance, a preliminary data review will be performed to identify patterns, relationships, and potential anomalies present in the survey data. In this review, basic statistics including the mean, standard deviation, maximum, and minimum values will be calculated for each SU. A graphical review of the data will be performed consisting of posting plots and histograms. Posting plots will be used to review the spatial independence of measurements within survey units, while histograms will be employed to review the overall symmetry of the data.

Once the data have been reviewed, soil sample or direct integrated alpha measurement results for each SU will be compared to the respective $DCGL_W$. If all of the results for a SU are below the $DCGL_W$, the survey unit meets the release criteria. If the average residual radioactivity in an individual SU is greater than the $DCGL_W$, the SU does not meet the release criteria. If any results in a SU are greater than the $DCGL_W$ and the average residual radioactivity in that survey unit is below the $DCGL_W$, the Sign test will be performed as described in MARSSIM to compare the median concentration of residual radioactivity in individual survey units to the $DCGL_W$. If the results of that survey unit pass the Sign test, that SU meets the release criteria. Finally, a retrospective power curve will be computed to measure the power of the Sign test based on the results of the measurements performed. The results of all of these statistical processes will be provided in the FSS Report.

8.0 SURVEY QUALITY ASSURANCE/QUALITY CONTROL

Activities associated with this work plan shall be performed in accordance with written procedures and/or protocols to ensure consistent, repeatable results. Topics covered in project procedures and protocols may include proper use of instrumentation, Quality Control (QC) requirements, equipment limitation, etc. Implementations of Quality Assurance (QA) measures for this work plan are described herein.

8.1 Instrumentation Requirements

The Field Supervisor is responsible for selecting the instrumentation required to complete the requirements of this work plan. Only instrumentation approved by the Field Supervisor will be used to collect radiological data. The Field Supervisor is responsible for ensuring individuals are appropriately trained to use project instrumentation and other equipment, and that instrumentation meets the required detection sensitivities. Instrumentation shall be operated in accordance with either a written procedure or manufacturers' manual, as determined by the Field Supervisor. The procedure and/or manual will provide guidance to field personnel on the proper use and limitations of the instrument.

Calibration Requirements

Instruments used during the FSS shall have current calibration/maintenance records kept on site for review and inspection. The records will include, at a minimum, the following:

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

Instrumentation shall be maintained and calibrated to manufacturers' specifications to ensure that required traceability, sensitivity, accuracy and precision of the equipment/instruments are maintained. Instruments will be calibrated at a facility possessing appropriate NRC and/or Agreement State licenses for performing calibrations using National Institute of Standards and Technology (NIST) traceable sources.

8.2 Instrument QC Source and Background Checks

The following subsections describe the techniques that will be used to evaluate accuracy and precision of measurements obtained with project instrumentation. Daily instrument response check data and calibration certificates for each instrument will be included in an appendix of the FSS.

Sodium Iodide (NaI) Gross Gamma Systems

NaI detectors coupled to count rate meters and DGPS systems will be used to perform gamma walk-over surveys and integrated fixed location measurements. Instruments will be calibrated at

least annually at a facility possessing appropriate NRC and/or Agreement State licenses for performing calibrations using NIST-traceable standards.

Instruments will be response checked daily for quality control by comparing the instrument response to a designated ^{137}Cs source. Response checks will consist of a one-minute integrated count of the ^{137}Cs source positioned in a reproducible geometry (i.e., a jig). The acceptance criterion for these instrument response checks is within +/- 20% of the mean response generated using ten initial source checks and ten measurements of ambient background. A response check outside these criteria will be cause for evaluation of conditions (e.g., instrument operation, source/detector geometry). The response check will be repeated once prior to field use of that instrument. Instruments that fail the second response check will be removed from service. During daily response checks, instruments will be inspected for physical damage, battery voltage levels, current calibration and erroneous readings.

Background checks will be performed daily for each instrument. These checks will be performed to monitor fluctuations in ambient gamma background that could impact the interpretation of the gross gamma measurements, not to monitor the performance of the instruments. The results of the background measurements will be recorded and presented on a control chart.

MicroRem Meter

A MicroRem meter will be to provide gamma dose rate information during performance of area radiation surveys. The instrument was calibrated at least annually by a facility possessing appropriate NRC and/or Agreement State licenses for performing calibrations using NIST-traceable standards.

Instruments will be checked daily for quality control by comparing response to a designated ^{137}Cs source. Response checks will consist of exposing the instrument to a designated ^{137}Cs source positioned in a reproducible geometry and location. The acceptance criterion for these instruments is response within a +/- 20% of the mean response generated using ten initial source checks and ten measurements of ambient background. A response check outside these criteria is cause for evaluation of conditions (e.g., instrument operation, source/detector geometry). The response check is repeated once prior to field use of that instrument. Instruments that fail the second response check will be removed from service pending evaluation. During daily response checks, the instrument used to obtain radiological data was also inspected for physical damage, battery voltage levels, current calibration and erroneous readings in accordance with CABRERA procedures.

Alpha/Beta Detector

Quality control source checks for the Ludlum 43-93 will consist of a one-minute integrated count with the designated Thorium–230 (^{230}Th) and Technetium-99 (^{99}Tc) sources. The acceptance criterion for this instrument response is within +/- 20% of the average response generated using ten initial source checks and ten measurements of background performed at the beginning of the project. A response check outside these criteria will be cause for evaluation of conditions (e.g., instrument operation, source/detector geometry), and the response check will be repeated once

prior to field use of that instrument. Instruments that fail the second successive response check will be removed from service and corrective actions will be taken. Only Field Supervisors can return a failed instrument back to service after proper corrective actions are taken and documented.

Smear Counter

A Ludlum Model 2929 smear counter will be used for on site analysis of radiological contamination smears in conjunction with project soil sampling. The instrument will be calibrated at least annually at a facility possessing appropriate NRC and/or Agreement State licenses for performing calibrations using NIST-traceable standards.

Instruments will be checked daily for quality control by comparing response to designated ^{230}Th (Alpha) and ^{99}Tc (Beta) NIST-traceable sources and to ambient background. Response checks will consist of a one-minute count of the ^{230}Th and ^{99}Tc sources positioned in a reproducible geometry and location within the detector system. Background measurements will be performed in an identical fashion for a twenty-minute count, with the source removed. The acceptance criteria for instrument response will be set to two and three-sigma of the mean response generated using ten initial source checks and ten measurements of ambient background. A response check outside the two-sigma, but within the three-sigma criteria will be cause for a recount prior to further evaluation. A response check outside two sigma on the second count or three-sigma on the initial count will be cause for further evaluation prior to continued use. A response check outside these criteria is cause for notification of the Field Supervisor and evaluation of conditions (e.g., instrument operation, source/detector geometry) prior to further counts and/or removal of the instrument from service. Instruments must pass a response check prior to field use. During daily response checks, instruments used to obtain radiological data will also be inspected for physical damage, battery voltage levels, current calibration and erroneous readings in accordance with CABRERA procedures.

Digital Global Positioning System

DGPS point features will be collected at the beginning and end of the day at a fixed location established at the beginning of the FSS. Results of these feature counts will be compared to the mean of a series of sequential initial positions. This data will be entered into a spreadsheet and examined to ensure no more than one-meter variability occurs. A feature count outside these criteria is cause for notification of the Site Supervisor and evaluation of conditions prior to further counts and/or removal of the GPS from service. GPS units must pass a feature count prior to field use. During daily feature counts, GPS systems will also be inspected for physical damage, battery voltage levels and erroneous readings in accordance with SOPs.

8.3 Duplicate Measurements

Instrumentation will be operated and sampling performed in accordance with standard operating procedures and/or protocols.

Duplicate Measurements

Duplicate measurements will be required for 10% of the total soil samples collected from all survey units. Duplicate measurements will be compared to the initial analytical results by determining a Normalized Absolute Difference (NAD) value and comparing it against the performance criteria specified as follows:

Analyses of field and laboratory duplicates will be compared to the initial analytical results by determining a NAD value for each data set by the following equation:

$$NAD = \frac{|\text{Sample} - \text{Duplicate}|}{\sqrt{\sigma^2_{Sample} + \sigma^2_{Duplicate}}}$$

Where: Sample = first sample value (original),
Duplicate = second sample value (duplicate),
σ_{Sample} = 2σ counting uncertainty of the sample, and,
$\sigma_{Duplicate}$ = 2σ counting uncertainty of the duplicate

The calculated NAD results will be compared to a performance criteria of less than or equal to 1.96. Calculated NAD values less than 1.96 will be considered acceptable and values greater than 1.96 will be investigated for possible discrepancies in analytical precision, or for sources of disagreement with the following assumptions of the test:

- the sample measurement and duplicate or replicate measurement are of the same normally distributed population.
- the standard deviations, σ_{Sample} and $\sigma_{Duplicate}$, represent the true standard deviation of the measured population.

9.0 REFERENCES

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Appendix A:
Uranium 238 Decay Series

Uranium 238 Decay Series

(Excerpted from Radioactive Decay Data Tables, David Kocher, 1981)

Radionuclide	Half-Life	Emissions	Energy (MeV)	Percent Yield
U-238	4.5 x 109 y	α	4.2	75
		α	4.15	25
Th-234	24.1 d	β	0.193	79
		β	0.1	21
		γ	0.093	4
		γ	0.063	3.5
Pa-234m	1.17 min	β	2.29	98
Pa-234	6.75 h	β	0.53	<1
		β	1.13	<1
U-234	2.47 x105 y	α	4.72	28
		α	4.77	72
Th-230	8.0 x 104 y	α	4.62	24
		α	4.68	76
Ra-226	1602 y	α	4.60	6
		α	4.78	95
		γ	0.186	4
Rn-222	3.82 d	α	5.49	100
Po-218	3.05 min	α	6.0	100
Pb-214	26.8 min	β	0.65	50
		β	0.71	40
		γ	0.3	19
		γ	0.35	36
Bi-214	19.7 min	β	1.0	23
		β	1.51	40
		β	3.26	19
		γ	0.609	47

Appendix B:

Derived Concentration Guideline Level (DCGL) Determination For U. S. Army Garrison, Aberdeen Proving Grounds (APG) Bomb Throwing Device Site

U. S. ARMY GARRISON, ABERDEEN PROVING GROUND DERIVED URANIUM GUIDELINES FOR DEPLETED URANIUM AT THE BTD SOIL SAMPLE AREA

Contract Number
DAAA09-00-G-0002 / 039

Prepared for:

U.S. Army Operations Support Command
Rock Island, Illinois

Performed By:

CABRERA Services Inc.
809 Main Street
East Hartford, CT 06108

Project No. 01-3030.39

EXECUTIVE SUMMARY

The depleted uranium (DU) derived concentration guideline level (DCGL) developed for the Transonic Range is considered applicable to and adequately protective for the BTD Site on the basis of comparable site-specific RESRAD parameters/pathways, the similarity of both locations, and the equivalence of the radiological isotopic DU mixes at both locations. Use of the approved Transonic DCGL at the BTD Site will ensure that the potential dose to a hypothetical individual will not exceed 25 mrem in any one year over a 1,000 period consistent with 10 CFR Part 20 Subpart E requirements.

On these bases, the proposed DCGL for the BTD Site in soil is 230 pCi/g total DU (resident-farmer scenario). This evaluation utilizes the more conservative resident-farmer scenario. Additionally, the ALARA principle of as-low-as-reasonably-achievable is applied to provide assurance that hypothetical doses are limited. The ALARA action level has been set at 105 pCi/g.

DERIVED CONCENTRATION GUIDELINE LEVEL (DCGL) DETERMINATION FOR U. S. ARMY GARRISON, ABERDEEN PROVING GROUNDS (APG) BOMB THROWING DEVICE SITE

1.0 BACKGROUND

The Aberdeen Test Center (ATC) Bomb Throwing Device (BTD) site was used between 1982 and 1993 for the testing of Depleted Uranium (DU) munitions. The site consists of the BTD Butt Enclosure, access roads, Plate Storage Area (PSA), and several support buildings situated on approximately 4-5 acres of land. The BTD Butt Enclosure has dimensions of approximately 25 by 50 feet with a height of 20 feet. WESTON previously performed a MARSSIM type characterization at the BTD Site. Data from that characterization has been utilized in this evaluation. The total BTD site land area is approximately 10 acres.

During testing at the site, munitions were fired at either steel plate targets or vehicles placed inside the BTD Butt Enclosure. A HEPA ventilation system associated with the BTD Butt Enclosure was designed to filter potentially contaminated air exiting the building. Heavy equipment was used to transport the armor plates between the PSA and the BTD Butt Enclosure. Currently, approximately 40 tons of DU-contaminated armor plate is located within the BTD Site.

A characterization study was initiated to identify DU and other environmental contaminants currently present in the soil as well as gamma radiation levels at the site. This is in preparation for removal of the BTD Butt Enclosure and decommissioning of the BTD Site currently covered by **NRC LICENSE #**. The WESTON characterization study provided quantitative activity concentration levels of ^{235}U and ^{238}U in soil and identified MARSSIM class 1, 2, and 3 areas based on comparison of results to NRC screening derived concentration guideline levels (DCGLs).

Results from the WESTON BTD Site characterization are compared in this evaluation to characterization data from the Transonic Range. The Transonic Range Decommissioning Plan (DP) developed by ATG utilized the characterization data and DCGL dose analysis as provided by Argonne National Laboratory. NRC has approved this DP.

2.0 SCOPE/PURPOSE

The purpose of this evaluation is to contrast and compare the parameters used to develop the DU-contaminated soil (DCGL) applied at the Transonic Range to the BTD Site. This evaluation will be used to demonstrate that the DCGL used at the Transonic Range may be equally applied at the BTD Site.

3.0 DCGL EVALUATION

The DCGL for the DU Study Area of the Transonic Range is based on a site-specific uranium guideline derived on the basis of a 50-year Total Effective Dose Equivalent (TEDE) to a

hypothetical individual not exceeding 25 mrem in any one year and evaluated over a 1,000 year time interval.

3.1 DCGL Derivation from Transonic DP

The results of a previous DU DCGL developed for the Transonic Range were submitted to NRC as part of a DP for the Transonic Range and was approved. The computer code, RESRAD, Version 5.82 (ANL 1999) used to develop DCGLs for the Transonic Range. The RESRAD code parameters/pathways used in the Transonic Range evaluation was set up to consider nine exposure pathways:

1) Direct exposure from contaminated soil,

2) Internal dose from inhalation of contaminated dust,

3) Internal radiation from the inhalation of emanating radon-222,

4) Internal radiation from the ingestion of plant foodstuffs grown in contaminated soil and irrigated with groundwater drawn from a well located within the decontaminated area,

5) Internal radiation from the ingestion of meat from livestock fed fodder grown in the decontaminated area and irrigated with groundwater from the decontaminated area,

6) Ingestion of milk from milk animals raised with fodder and irrigation groundwater drawn from the decontaminated area,

7) Internal radiation from ingestion of fish from a pond drawing water from the decontaminated area,

8) Internal dose from the ingestion of on-site soil, and

9) Internal radiation from drinking water drawn from an on-site well.

Two potential exposure scenarios were considered using combinations of the above pathways. These are the industrial-worker scenario and the resident-farmer scenario. The industrial-worker scenario assumes the continued industrial use of the site. The scenario assumes 2,000 hours per year at the site with 6 hours per day spent indoors and 2 hours per day spent outdoors. No plant foodstuffs, meat, milk, fish, or water is consumed from the site. The dose is assumed to arise only from the contaminated soil. This scenario reflects the current use and is a likely future use scenario.

The resident-farmer scenario has a subsistence farmer who lives on the site and consumes foodstuffs grown on the site. This includes on-site groundwater for drinking and irrigation, vegetables, fruits, livestock meat, milk, and 50% of the farmer's fish consumption. At the present time, no agricultural activity occurs on the site. This scenario is plausible but considered an unlikely future use. Table 1 provides a summary of the exposure pathways by scenario.

TABLE 1 - Applicable Pathways for Industrial-Worker and Resident-Farmer Scenarios		
	Applicable Pathways	
Pathway	Industrial-worker	Resident-Farmer
External gamma exposure	Yes	Yes
Inhalation of soil	Yes	Yes
Inhalation of radon	Yes	Yes
Ingestion of soil	Yes	Yes
Ingestion of plant foodstuffs	No	Yes
Ingestion of meat	No	Yes
Ingestion of milk	No	Yes
Ingestion of fish	No	Yes
Ingestion of water	No	Yes

3.2 Evaluation of Applicability of Transonic Range DCGL to BTD Site

Since the BTD Site and the Transonic Range are within a few miles of each other at APG, the climate, meteorology, irrigation rates, the type, growth rate, and root depths of vegetation, type of meat and milk producing animals, fish and aquatic organisms, and the geology and soil characteristics are considered to be similar in nature for purposes of this evaluation. Additionally, the types of work activities causing the contamination of the soil are similar and result in like soil surface and vertical distributions. Table 2 provides a summary comparison of the parameters.

The DU contaminated soil at the Transonic Range was characterized from the analysis of 100 total soil samples collected from 1-3 inch and 3-6 inch depths. The samples were analyzed for ^{234}U, ^{235}U, and ^{238}U isotopes by alpha spectroscopy.

TABLE 2 - RESRAD Parameters for Transonic Range and BTD Site												
Region	Area	Soil Cover	Vegetation	Water	Meat	Milk	Fish Pond	Radon	Direct Soil Irrad.	Soil Inhal	Meteor-ology	Geology/ Soil Char.
Transonic Range	12 acre	none	Site parameters are those indigenous to the eastern shore area of Maryland at APG									
BTD Site	10.5 acre	none	Due to geographic proximity of both sites and type of work activities causing soil activity, BTD Site parameters are considered the same									

A soil characterization (WESTON) was completed at the BTD Site in 2001. As with the Transonic Range soil samples, soil was collected from the surface and near surface. At the BTD Site soil was collected from the surface to a depth of 3 inches. Samples were collected in areas designated as class 1, class 2, and class 3 areas following MARSSIM definition and an assumed NRC screening DCGL. A total of 44 samples from the class 1 area had detectable ^{235}U; 36 samples from the class 2 area had detectable ^{235}U; and 20 samples from the class 3 area had detectable ^{235}U activity concentrations. In addition, 13 samples from a background area had detectable ^{235}U activity concentrations.

For the purpose of contaminant magnitude and isotopic mixture evaluation, the BTD Site class 1 and class 2 area characterization results were lumped together as one category because of the significant levels of uranium identified in these areas. The listed class 3 area results were similar in magnitude to that observed in the background area and had $^{235}U/^{238}U$ ratios that are indicative of natural uranium concentrations as opposed to typical DU ratios. These areas are not considered further in this evaluation.

The BTD Site class 1 and class 2 area data was analyzed in the same fashion as the Transonic Range soil samples, namely case 1 included all samples, case 2 included samples greater than 1 pCi/g, and case 3 excluded samples greater than 1,000 pCi/g ^{238}U. Since the BTD Site analysis was based on gamma spectroscopy, only the ^{235}U and ^{238}U isotopes are identified. A comparison of the soil concentration activity ranges and $^{235}U/^{238}U$ activity ratios at the Transonic Range and the BTD Site for the 3 cases is shown in Table 3.

The comparison indicates that the $^{235}U/^{238}U$ activity concentration ratio at the BTD Site is similar to that detected at the Transonic Range. This is expected because the DU utilized at both locations has the same ^{235}U depletion. At both the Transonic Range and the BTD Site the activity ratio of $^{235}U/^{238}U$ indicates that the uranium is in fact DU since the activity ratio ranges from 0.013 to 0.028 while natural uranium has a $^{235}U/^{238}U$ activity ratio of 0.045.

TABLE 3 – Transonic Range and BTD Site Soil Data Activity Ratio Comparison									
		Transonic Range				BTD Site			
Case No.	Item	^{234}U	^{235}U	^{238}U	$^{235}U/^{238}U$	^{234}U	^{235}U	^{238}U	$^{235}U/^{238}U$
1[a]	Activity Range, pCi/g	0.19 - 49,000	0.001 - 8,300	0.19 - 370,000	-	No results provided	0.055- 31.7	0.974- 1,470	-
1[a]	Average Activity Fraction	0.211	0.0205	0.768	0.027	-	-	-	0.027
2[b]	Activity Range, pCi/g	6.7 - 49,000	1.2 - 8,300	45 – 370,000	-	No results provided	1.05 – 31.7	70.6 – 1470	-
2[b]	Average Activity Fraction	0.138	0.0234	0.839	0.028	-	-	-	0.013
3[c]	Activity Range, pCi/g	0.19 - 46	0.001 – 6.3	0.19 - 290	-	No results provided	0.055- 5.99	0.974- 528	-
3[c]	Average Activity Fraction	0.222	0.0193	0.759	0.025	-	-	-	0.027
Nat. U	Activity Fraction	0.489	0.022	0.489	0.045	0.489	0.022	0.489	0.045

[a] For case 1, all samples were grouped together
[b] For case 2, only samples with ^{235}U activity greater than 1 pCi/g were grouped together
[c] For case 3, hot samples were removed, and the remaining samples were grouped together

The ^{234}U soil activity concentrations were not determined for the BTD Site since analysis was performed using gamma spectroscopy. However, the dose fraction assigned to a hypothetical individual from the ^{234}U isotope is a small fraction of the total dose. Tables 4 and 5 summarize the maximum dose-to-source concentration ratio (dose conversion factor or DCF) as a function of pathway and scenario at Transonic range as derived from ANL 1999. Since the maximum dose occurs immediately after remediation, the dose from the inhalation of radon, water ingestion, and fish ingestion pathways are zero (ANL 1999). Since the BTD Site depth to ground water is deeper than at the Transonic Range, it is logical that the breakthrough time for the BTD area would be longer than at Transonic. The breakthrough time (i.e., time it takes the uranium to reach the water table) does not occur within 1,000 years (ANL 1999).

The ^{234}U dose contribution DCF for the industrial-worker and the resident-farmer scenarios immediately following remedial action is small, being on the order of 3.4% and 6.5% of the total uranium DCF respectively. Tables 4 and 5 list the fractional DCF for ^{234}U compared to total uranium DCF for the Transonic Range. Based on the information in these two tables, the ^{234}U DCF components are expected to be generally smaller or comparable to the ^{235}U and ^{238}U DCFs. Therefore the ^{234}U DCF may be estimated for the BTD Site as being the same as the Transonic Range without incurring any significant calculation differences.

TABLE 4 – Maximum Dose/Source Concentration Ratios for the Industrial-Worker Scenario at the Depleted Uranium Study Area of the Transonic Range

	Maximum Dose/Source Concentration Ratios[a] (mrem/yr)/(pCi/g)			
Pathway	^{234}U	^{235}U	^{238}U	^{234}U/Total U
External gamma exposure	8.3E-5	1.5E-1	2.6E-2	4.7E-4
Inhalation of dust	4.3E-3	4.0E-3	3.8E-3	3.6E-1
Inhalation of radon	0	0	0	-
Ingestion of soil	2.4E-3	2.2E-3	2.3E-3	3.5E-1
Total	6.7E-3	1.6E-1	3.2E-2	3.4E-2

[a] All values are reported to two significant figures. Maximum dose/source concentration ratios would occur immediately following remedial action for all uranium isotopes. This value is the dose conversion factor, DCF.

TABLE 5 – Maximum Dose/Source Concentration Ratios for the Resident-Farmer Scenario at the Depleted Uranium Study Area of the Transonic Range				
	Maximum Dose/Source Concentration Ratios[a] (mrem/yr)/(pCi/g)			
Pathway	^{234}U	^{235}U	^{238}U	^{234}U/Total U
External gamma exposure	2.4E-4	4.3E-1	7.2E-2	4.8E-4
Inhalation of dust	9.9E-3	9.2E-3	8.9E-3	3.5E-1
Inhalation of radon	0	0	0	-
Ingestion of plant foods	1.0E-2	9.7E-3	9.8E-3	3.4E-1
Ingestion of meat	3.2E-3	3.0E-3	3.0E-3	3.5E-1
Ingestion of water	0	0	0	-
Ingestion of milk	8.2E-3	7.7E-3	7.8E-3	3.5E-1
Ingestion of fish	0	0	0	-
Ingestion of soil	7.7E-3	7.3E-3	7.4E-3	3.4E-1
Total	4.0E-2	4.7E-1	1.1E-1	6.5E-2

[a] All values are reported to two significant figures. Maximum dose/source concentration ratios would occur immediately following remedial action for all uranium isotopes. This value is the dose conversion factor, DCF.

The residual radioactive material guideline is the concentration of contaminated material that may remain in a decontaminated area and still allow for unrestricted use of the area. The residual radioactive material guideline, or derived concentration guideline level (DCGL) for a given dose limit, DL, to a hypothetical individual derived from the soil data at the Transonic Range may be calculated as

$$DCGL = DL/DCF$$

Where,

DCGL = Derived Concentration Guideline Level, pCi/g in soil

DL = NRC Dose Limit for unrestricted use, 25 mrem/year for both industrial-worker and resident-farmer

DCF = Dose conversion factor to transform volumetric concentration to dose rate, (mrem/year)/(pCi/g)

The DCF ratios listed in Table 6 were used in turn to determine the allowable residual radioactivity for uranium in soil at the Transonic Range using the above relationship. The resulting DCGL for each radionuclide is shown in Table 7. The ^{238}U isotope may be used as an indicator radionuclide by multiplying the Table 7 individual depleted uranium DCGL guideline by the appropriate ^{238}U activity concentration fraction. This allows for use of the readily identified field indicator, ^{238}U, to be used as the indicator radionuclide DCGL.

TABLE 6 – Total Dose/Source Concentration Ratios for Uranium at the Depleted Uranium Study Area of the Transonic Range

	Maximum Dose/Source Concentration Ratios[a] (mrem/yr)/(pCi/g)	
Radionuclide	Industrial-Worker[b]	Resident-Farmer[c]
^{234}U	6.7E-3	4.0E-2
^{235}U	1.6E-1	4.7E-1
^{238}U	3.2E-2	1.1E-1
Natural Uranium	2.2E-2	8.3E-2
Depleted Uranium[d]	2.9E-2	1.0E-1
Depleted Uranium[e]	3.1E-2	1.1E-1
Depleted Uranium[f]	2.9E-2	1.0E-1

[a] All values are reported to two significant figures. Maximum dose/source concentration ratios would occur immediately following remedial action for all uranium isotopes
[b] Industrial-Worker: no consumption of water or food obtained on the site (current use scenario)
[c] Resident-Farmer : Water used for drinking, household purposes, livestock, watering, and irrigation assumed to be from an on-site well (an unlikely but plausible future use scenario)
[d] The uranium isotopes (^{238}U, ^{234}U, and ^{235}U) are present in the activity ratio of 0.768:0.211:0.0205
[e] The uranium isotopes (^{238}U, ^{234}U, and ^{235}U) are present in the activity ratio of 0.839:0.138:0.0234
[f] The uranium isotopes (^{238}U, ^{234}U, and ^{235}U) are present in the activity ratio of 0.759:0.222:0.0193

TABLE 7 – Residual Radioactive material DCGL for Depleted Uranium Study Area of the Transonic Range (25 mrem)		
	DCGL Guideline, pCi/g[a]	
Radionuclide	Industrial-Worker[b]	Resident-Farmer[c]
^{234}U	3,700	630
^{235}U	160	54
^{238}U	790	230
Natural Uranium	1,100	300
Depleted Uranium[d]	860; (660)[g]	250; (190)[g]
Depleted Uranium[e]	800; (670)[g]	230; (190)[g]
Depleted Uranium[f]	880; (670)[g]	250; (190)[g]

[a] All values are reported to two significant figures.
[b] Industrial-Worker: no consumption of water or food obtained on the site (current use scenario, dose constraint 25 mrem/yr)
[c] Resident-Farmer : Water used for drinking, household purposes, livestock, watering, and irrigation assumed to be from an on-site well (an unlikely but plausible future use scenario, dose constraint 25 mrem/yr)
[d] The uranium isotopes (^{238}U, ^{234}U, and ^{235}U) are present in the activity ratio of 0.768:0.211:0.0205
[e] The uranium isotopes (^{238}U, ^{234}U, and ^{235}U) are present in the activity ratio of 0.839:0.138:0.0234
[f] The uranium isotopes (^{238}U, ^{234}U, and ^{235}U) are present in the activity ratio of 0.759:0.222:0.0193
[g] First number is the total DU DCGL; number in parenthesis is the indicator radionuclide ^{238}U value

4.0 SUMMARY

Since the BTD Site and the Transonic Range are within close proximity of each other, the climate, meteorology, irrigation rates, the type, growth rate, and root depths of vegetation, type of meat and milk producing animals, fish and aquatic organisms, and the geology and soil characteristics are considered to be similar in nature. Additionally, since the type of work activities and the DU isotopic activity fractions at both locations are similar they result in surface and vertical distributions of DU that are comparable at both the Transonic Range and the BTD Site.

The DCGL developed at the Transonic Range is considered applicable to and adequately protective for the BTD Site on the basis of comparable site-specific RESRAD parameter/pathways, the similarity of both locations, and the equivalence of the radiological isotopic DU mixes. Use of the approved Transonic DCGL at the BTD Site will ensure that the potential dose to a hypothetical individual will not exceed 25 mrem in any one year over a 1,000-year period. The DCGL for the BTD Site soil is 230 pCi/g total DU (resident-farmer scenario). Additionally, the ALARA principle of as-low-as-reasonably-achievable is applied to provide

assurance that hypothetical doses are limited. The ALARA action level DCGL has been set at 105 pCi/g total DU.

5.0 REFERENCES

1. ANL 1999 *Derived Uranium Guidelines for the Depleted Uranium Study Area of the Transonic Range, Aberdeen Proving Ground, Maryland,* ANL Rad Health Risk Study, M. Picel and S. Kamboj, April 16, 1999

2. WESTON *Radiological Characterization for the Bomb Throwing Device Interim Report Aberdeen Test Center Aberdeen Proving Ground, MD,* Addendum to the BEST Contract General Safety and Health Program, Rev. 2 September 1999, Contract No. DAAD05-97-D-7004, Delivery Order No. 191, dated September 2001

Appendix C:

Ludlum NaI 3"x3" MDC_{SCAN} and Instrument Sensitivity Results Calculated Using Microshield®

Bomb Throwing Device Area 3x3 NaI Calibration Factor (DU)

MDC_{SCAN}: 38 pCi/g
Sensitivity: 65 cpm per pCi/g
Assumed bkg: 10 uR/hr
Source Distribution per: NUREG-1507 (56 cm dia soil uniformly contaminated to a depth of 15 cm)
DU Activity fractions: 84.7% U238; 14.2% U234; 1.1% U235

BTDA 3x3 NaI Scan for DU @ 1pCi/g total Uranium w/ no soil cover at 15 cm thick x 28 cm RADIUS

Fluence rate to exposure rate (FRER, no units) = ~ (1 uR/h)/(Eγ)(u_{en}/ρ)air

TABLE 1		
Energy$_\gamma$, keV	$(u_{en}/\rho)_{air}$, cm^2/g	FRER
15	1.29	0.0517
20	0.516	0.0969
30	0.147	0.2268
40	0.064	0.3906
50	0.0384	0.5208
60	0.0292	0.5708
80	0.0236	0.5297
100	0.0231	0.4329
150	0.0251	0.2656
200	0.0268	0.1866
300	0.0288	0.1157
400	0.0296	0.0845
500	0.0297	0.0673
600	0.0296	0.0563
800	0.0289	0.0433
1,000	0.0280	0.0357
1,500	0.0255	0.0261
2,000	0.0234	0.0214

Probability of interaction (P) through end of detector for given energy is

Probability = $1 - e^{-(\mu/\rho)NaI\ (x)\ (\rho NaI)}$

TABLE 2		
Energy$_\gamma$, keV	$(\mu/\rho)_{NaI}$, cm^2/g	P
15	47.4	1.00
20	22.3	1.00
30	7.45	1.00
40	19.3	1.00
50	10.7	1.00
60	6.62	1.00
80	3.12	1.00
100	1.72	1.00
150	0.625	1.00
200	0.334	1.00
300	0.167	0.99
400	0.117	0.96
500	0.0955	0.93
600	0.0826	0.90
800	0.0676	0.85
1,000	0.0586	0.80
1,500	0.0469	0.73
2,000	0.0413	0.68

for Ludlum 3x3 Model 44-20 7.6 cm dia x 7.6 cm thick NaI crystal

aluminum window per Ludlum ~0.05 inch thick

$x = 7.6$ cm

$\rho = 3.67\ g/cm^3$

Relative Detector Response (RDR) = relative fluence-to-exposure rate (FRER) times probability (P) of interaction

TABLE 3

Energy$_\gamma$, keV	FRER	P	RDR
15	0.0517	1.00	0.0517
20	0.0969	1.00	0.0969
30	0.2268	1.00	0.2268
40	0.3906	1.00	0.3906
50	0.5208	1.00	0.5208
60	0.5708	1.00	0.5708
80	0.5297	1.00	0.5297
100	0.4329	1.00	0.4329
150	0.2656	1.00	0.2656
200	0.1866	1.00	0.1866
300	0.1157	0.99	0.1146
400	0.0845	0.96	0.0812
500	0.0673	0.93	0.0626
600	0.0563	0.90	0.0507
800	0.0433	0.85	0.0367
1,000	0.0357	0.80	0.0287
1,500	0.0261	0.73	0.0191
2,000	0.0214	0.68	0.0146

Estimated Ludlum 44-20 7.6 cm dia x 7.6 cm thick NaI response for Cs-137 i: 2700 cpm/uR/hr

Use same methodology and interpolating for Cs-137 response have:

Energy$_\gamma$, keV	$(u_{en}/\rho)_{air}$, cm^2/g		
662	0.0294	FRER ~	0.0514

Energy$_\gamma$, keV	$(\mu/\rho)_{NaI}$, cm^2/g		
662	0.0780	Probability =	0.89
		RDR =	0.0455

For this detector the response to another energy is based on the ratio of the relative detector response, RDR, to the Cs-137 energy cpm/μR/h, $E_i = (cpm_{cs\text{-}137})*(RDR_{Ei})/(RDR_{Cs\text{-}137})$

TABLE 4		
Energy$_\gamma$, keV	RDR_{Ei}	Ludlum 44-20 3x3 NaI Detector, E_i, cpm per μR/hr
15	0.0517	3064
20	0.0969	5745
30	0.2268	13445
40	0.3906	23161
50	0.5208	30881
60	0.5708	33842
80	0.5297	31404
100	0.4329	25667
150	0.2656	15748
200	0.1866	11061
300	0.1146	6797
400	0.0812	4816
500	0.0626	3714
600	0.0507	3005
662	0.0455	2700
800	0.0367	2175
1,000	0.0287	1704
1,500	0.0191	1131
2,000	0.0146	867

MDC for Cs-137 energy

Assume 10 μR/hr bkg then have 27,000 cpm

b_i =	450	counts
MDCR =	1756	cpm
$MDCR_{surveyor}$ =	2484	cpm

minimum detectable exposure rate = 0.92 μR/hr

Table 5				
keV	MicroShield Exposure Rate, μR/hr (with buildup)	cpm/μR/hr	cpm/μR/hr (weighted)	Percent of NaI detector response
15	8.274E-09	3064	0	0.0%
20	6.657E-11	5745	0	0.0%
30	4.852E-06	13445	9	0.1%
40	7.972E-09	23161	0	0.0%
50	1.133E-06	30881	5	0.1%
60	3.234E-04	33842	1483	16.8%
80	4.275E-05	31404	182	2.1%
100	1.398E-03	25667	4863	55.0%
150	1.108E-04	15748	236	2.7%
200	5.489E-04	11061	823	9.3%
300	1.301E-05	6797	12	0.1%
400	1.473E-05	4816	10	0.1%
500	2.694E-05	3714	14	0.2%
600	1.309E-04	3005	53	0.6%
800	9.470E-04	2175	279	3.2%
1000	3.690E-03	1704	852	9.6%
1500	1.083E-04	1131	17	0.2%
2000	1.755E-05	867	2	0.0%
Total	7.378E-03		8840	100%

Minimum Detectable Exposure Rate =

MDCR surveyor/(cpm/μr/hr)
0.281 μr/hr

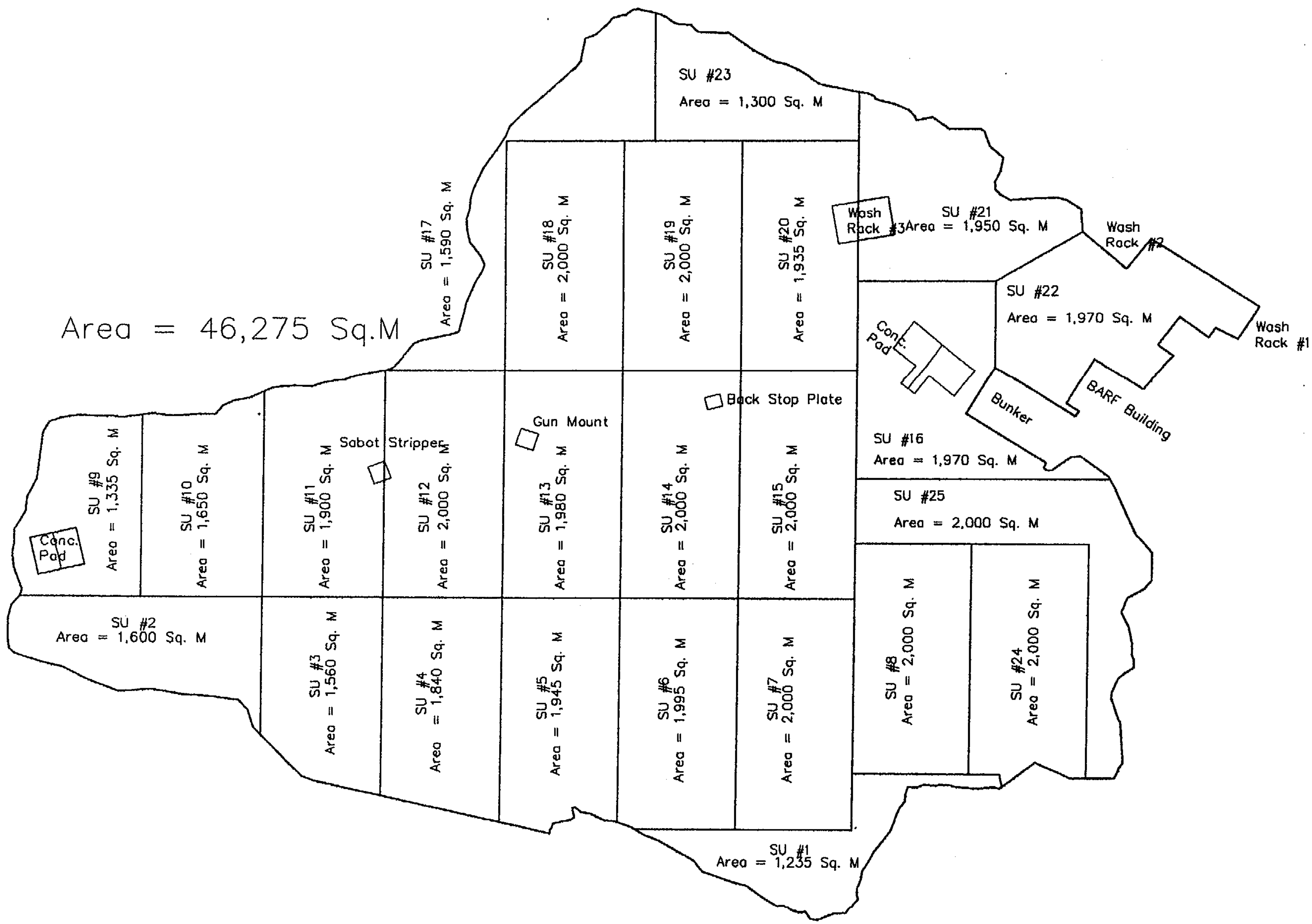
and MDC for DU and 50-year equilibrium progeny based on a normalized 1 pCi/g total uranium

Scan MDC = (Assumed MDC U_{TOTAL}Conc) x (Exposure Rate $MDCR_{Surveyor}$)/(Exposure $Rate_{assumed\ U\ Conc}$)

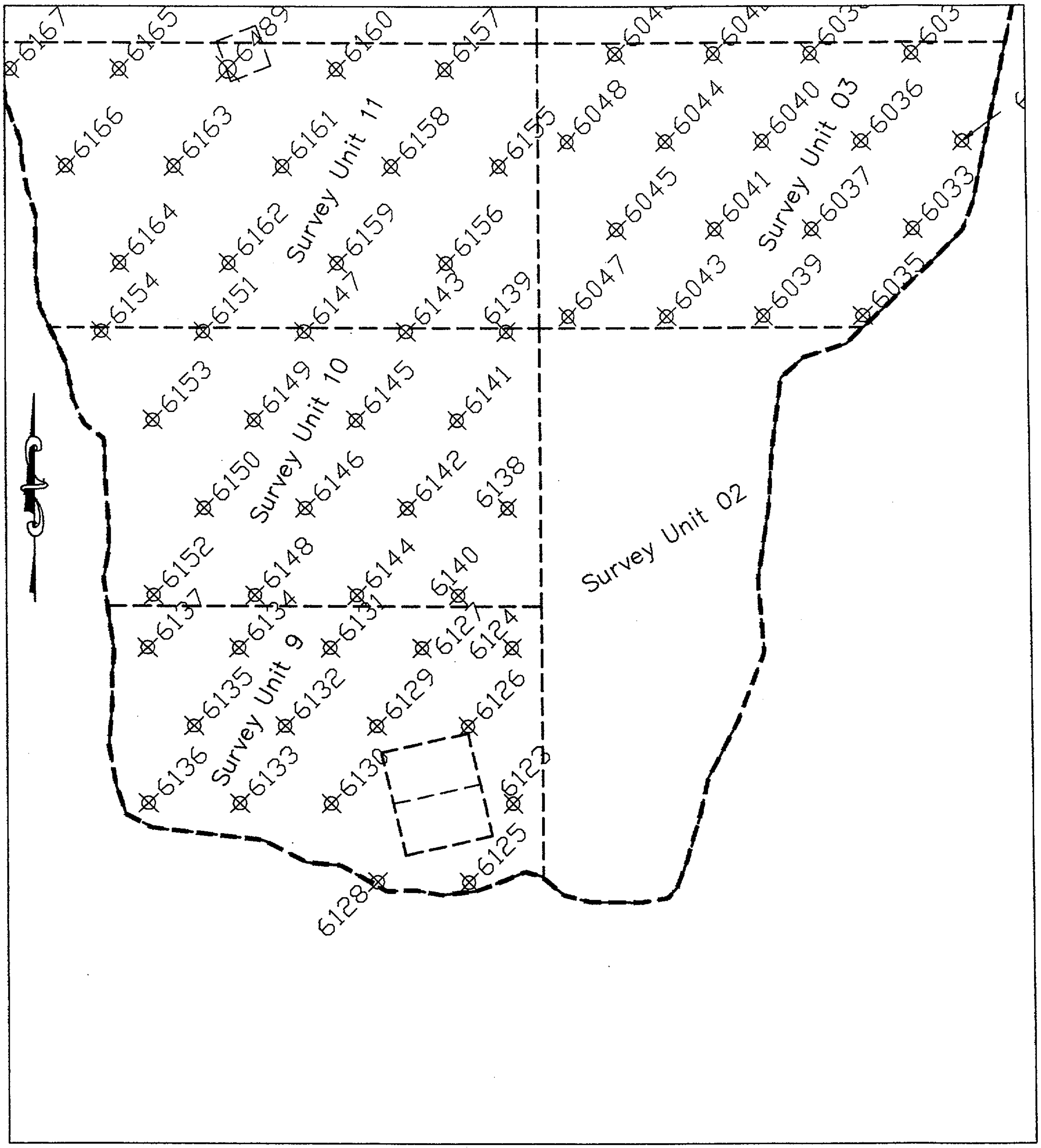
Scan MDC = 38.08 pCi/g

Appendix D:

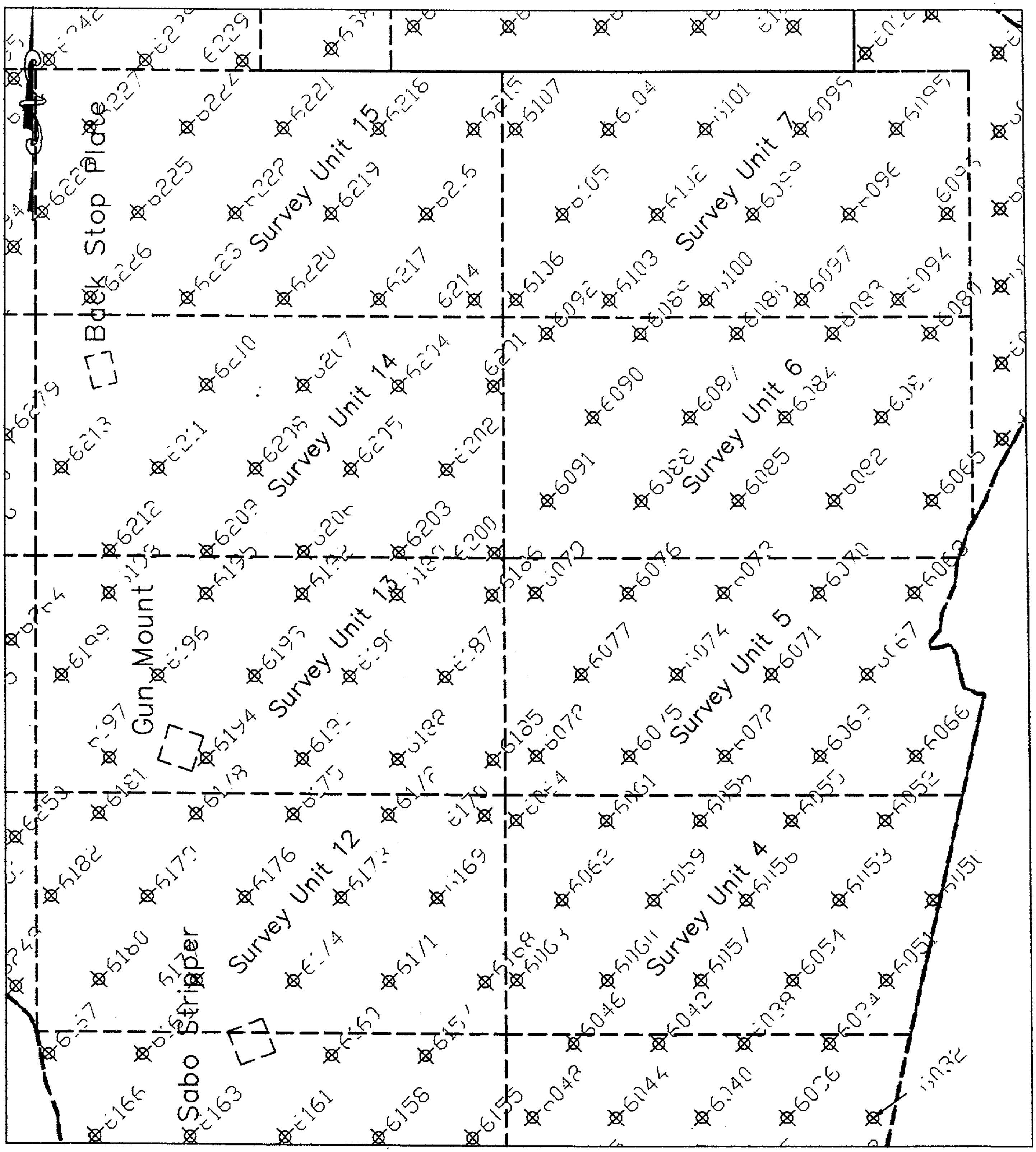
Survey Unit Maps and Sample Locations



Area = 46,275 Sq.M
SU #23 Area = 1,300 Sq. M
SU #17 Area = 1,590 Sq. M
SU #18 Area = 2,000 Sq. M
SU #19 Area = 2,000 Sq. M
SU #20 Area = 1,935 Sq. M
Wash Rack #3
SU #21 Area = 1,950 Sq. M
Wash Rack #2
SU #22 Area = 1,970 Sq. M
Wash Rack #1
Conc. Pad
Bunker
BARF Building
Back Stop Plate
Gun Mount
Sabot Stripper
SU #16 Area = 1,970 Sq. M
SU #25 Area = 2,000 Sq. M
SU #9 Area = 1,335 Sq. M
Conc. Pad
SU #10 Area = 1,650 Sq. M
SU #11 Area = 1,900 Sq. M
SU #12 Area = 2,000 Sq. M
SU #13 Area = 1,980 Sq. M
SU #14 Area = 2,000 Sq. M
SU #15 Area = 2,000 Sq. M
SU #2 Area = 1,600 Sq. M
SU #3 Area = 1,560 Sq. M
SU #4 Area = 1,840 Sq. M
SU #5 Area = 1,945 Sq. M
SU #6 Area = 1,995 Sq. M
SU #7 Area = 2,000 Sq. M
SU #8 Area = 2,000 Sq. M
SU #24 Area = 2,000 Sq. M
SU #1 Area = 1,235 Sq. M



6167
6165
6160
6157
6166
6163
6161
Survey Unit 11
6158
6155
6048
6044
6040
Survey Unit 03
6036
6164
6162
6159
6156
6045
6041
6037
6033
6154
6151
6147
6143
6139
6047
6043
6039
6035
6153
6149
Survey Unit 10
6145
6141
6150
6146
6142
6138
Survey Unit 02
6152
6148
6144
6140
6137
6134
6131
6127
6124
6135
Survey Unit 9
6132
6129
6126
6136
6133
6130
6123
6125
6128


Survey Unit 15
Survey Unit 7
Survey Unit 14
Survey Unit 6
Survey Unit 13
Survey Unit 5
Survey Unit 12
Survey Unit 4
Back Stop Plate
Gun Mount
Sabo Stripper
6229
6221
6218
6219
6217
6214
6107
6095
6103
6097
6094
6090
6091
6085
6212
6203
6200
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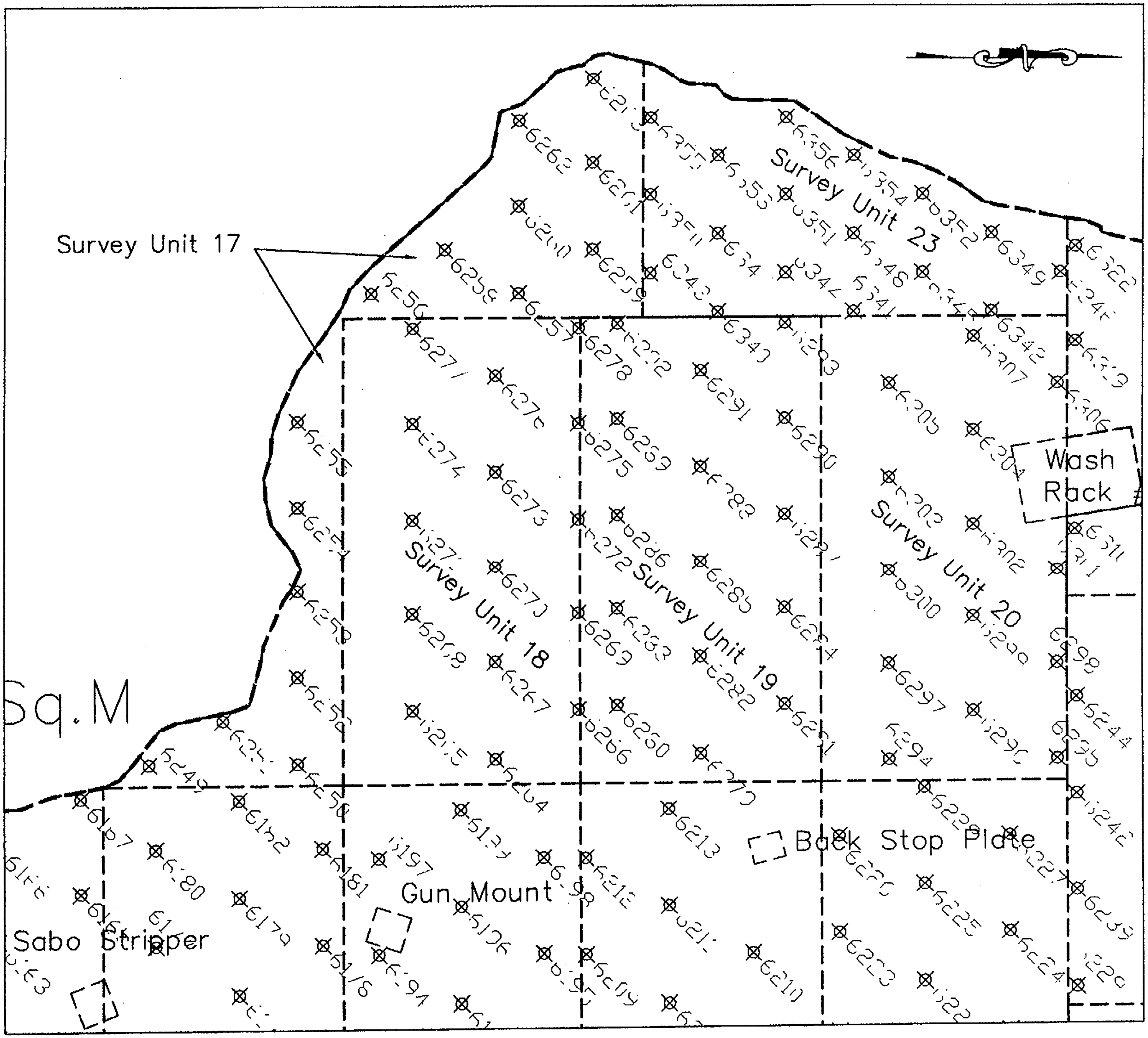
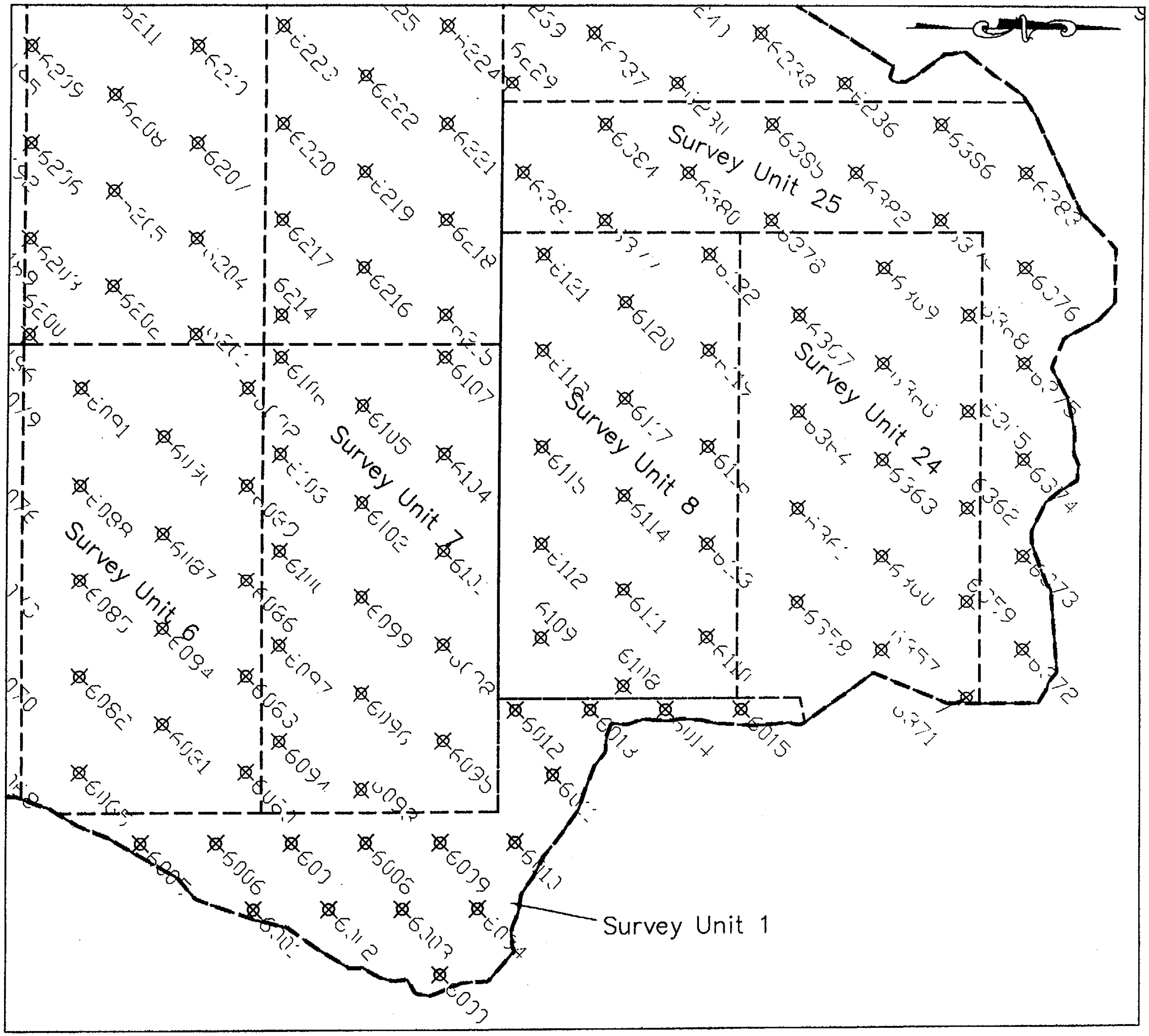
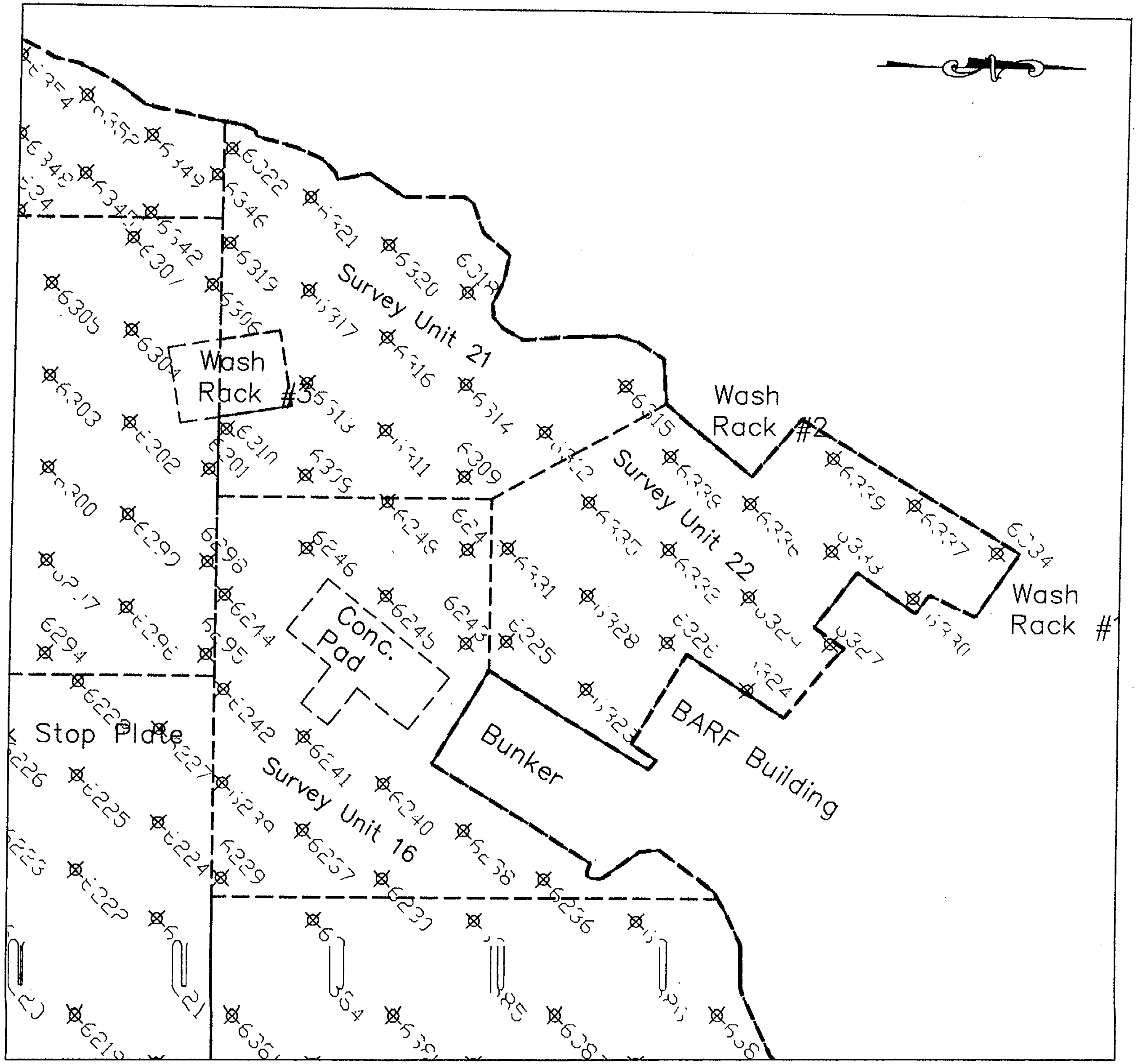
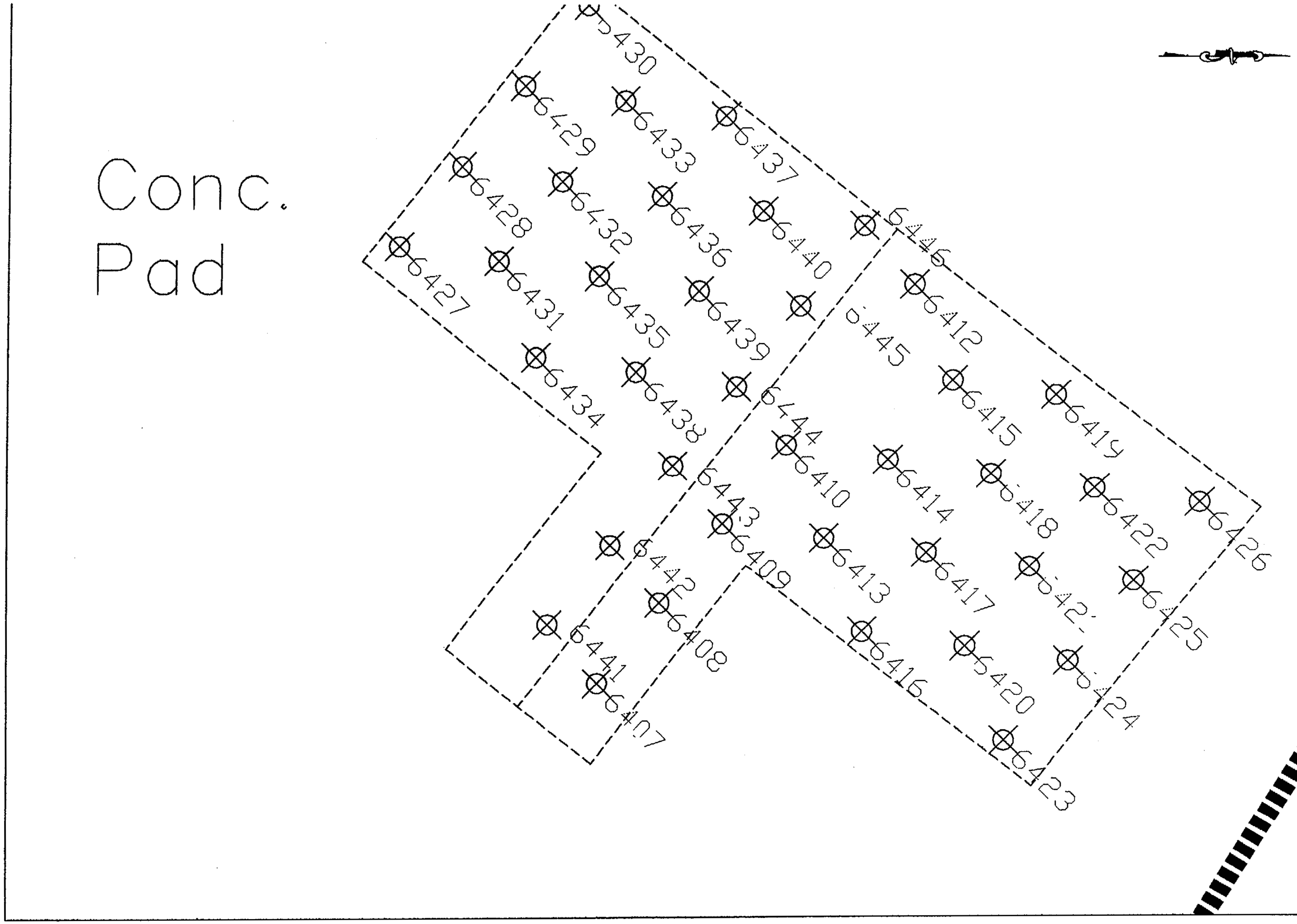
6144
6046
6161
6163



Survey Unit 17
Survey Unit 18
Survey Unit 19
Survey Unit 20
Survey Unit 23
Wash Rack
Back Stop Plate
Gun Mount
Sabo Stripper
Sq.M


Survey Unit 25
Survey Unit 24
Survey Unit 8
Survey Unit 7
Survey Unit 6
Survey Unit 1


Wash Rack #1
Wash Rack #2
Wash Rack #3
Survey Unit 21
Survey Unit 22
Survey Unit 16
BARF Building
Bunker
Conc. Pad
Stop Plate



Conc.
Pad
6430
6429
6433
6437
6428
6432
6436
6440
6446
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6439
6445
6412
6434
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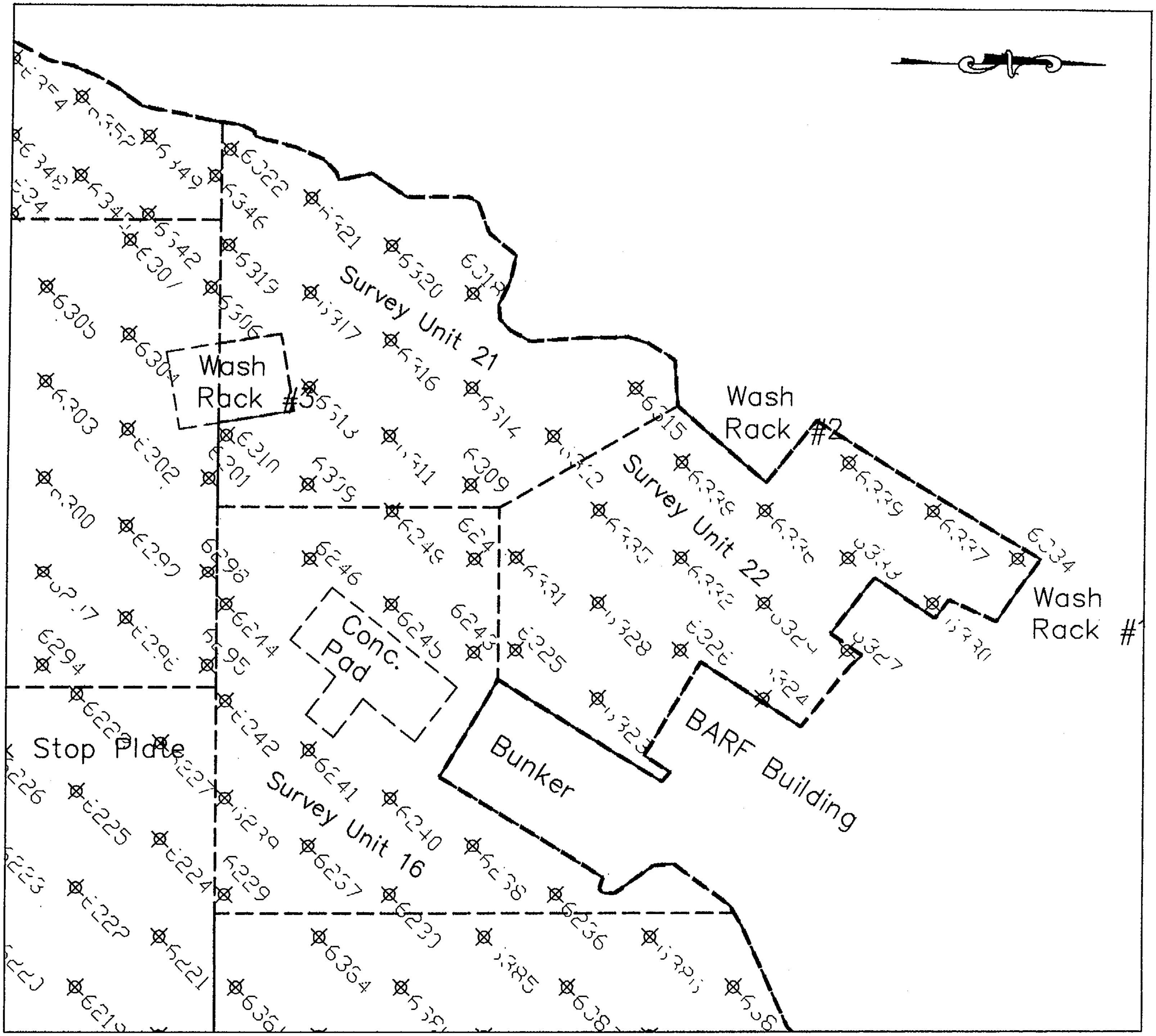
6420
6424
6423



Survey Unit 21
Survey Unit 22
Survey Unit 16
Wash Rack #1
Wash Rack #2
Wash Rack #3
BARF Building
Bunker
Conc. Pad
Stop Plate

BETWEEN:

License Fee Management Branch, ARM
and
Regional Licensing Sections

: (FOR LFMS USE)
: INFORMATION FROM LTS
: --------------------
:
: Program Code: 11221
: Status Code: 0
: Fee Category: EX 2B 2C
: Exp. Date: 20080930
: Fee Comments: SHIELDING AND OTHER
: Decom Fin Assur Reqd: Y
::

LICENSE FEE TRANSMITTAL

A. REGION I

1. APPLICATION ATTACHED
   Applicant/Licensee: ARMY, DEPARTMENT OF THE
   Received Date: 20031117
   Docket No: 4007354
   Control No.: 133995
   License No.: SUB-834
   Action Type: Notifications

2. FEE ATTACHED
   Amount: /
   Check No.: /

3. COMMENTS

Signed M. A. Perkins
Date 11/17/2003

B. LICENSE FEE MANAGEMENT BRANCH (Check when milestone 03 is entered /__/)

1. Fee Category and Amount: ______________________

2. Correct Fee Paid. Application may be processed for:
   Amendment ______
   Renewal ______
   License ______

3. OTHER ______________________
   ____

Signed ______________________
Date ______________________

ATTACHMENT
CABRERA OPERATIONAL PROCEDURES

CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

Radiation Safety Procedure

For

Volumetric and Material Sampling

OP-005

Revision 0

Reviewed By: ______________________ Date: 1/24/00
David Watters, Radiological Safety Engineer

Approved By: ______________________ Date: 1/24/00
Steven Masciulli CHP, CSP, Radiation Safety Officer

Approved By: ______________________ Date: 1/24/00
Henry Siegrist CHP, P.E., Corporate Health Physicist

1.0 PURPOSE

This procedure establishes the requirements Cabrera Services, Inc. (CABRERA) implements for the collection of volumetric and material samples for analysis.

2.0 APPLICABILITY

The applicability of this procedure is limited to collecting volumetric and material samples on CABRERA field projects. It also applies to volumetric samples taken for the purpose of analysis for radioactivity. This procedure is applicable to all volumetric and material samples taken by CABRERA to fulfill a requirement for sampling.

3.0 PRECAUTIONS, LIMITATIONS AND REQUIREMENTS

3.1 Precautions

3.1.1 Special situations such as evaluating trends or airborne deposition, determining contamination profiles, and measuring non-radiological contaminants, necessitates special sampling procedures. These special situations are evaluated and incorporated into site specific survey plans as the need arises.

The shipping container (e.g., box, cooler, or equivalent) should be lined with plastic and approved absorbent material prior to placing samples inside the shipping container if the samples are to be shipped for analysis. A load rating stamped o the bottom of the shipping container should be noted. This rating shall not be exceeded to prevent degradation of the box during shipment. The PM or designee shall approve packaging material and method.

3.2 Limitations

3.2.1 Do not exceed load rating for containers when shipping samples to prevent degradation of the container during shipping.

3.3 Requirements

3.3.1 Direct surface radiation measurements are to be performed at each location before initiating sampling. This may identify the presence of gross contamination, which may require that samples and equipment be treated as radioactive and handled in accordance with appropriate procedures.

3.3.2 Material sampling requires documentation as follows:

- Record forms
- Sample Chain of Custody forms
- Field Sample Logbook

4.0 REFERENCES

- RSP Radiation Safety Program
- SHSP Site Health and Safety Plan
- SWP Site Work Plan
- NUREG/CR-5512 Residual Radioactive Contamination from Decommissioning
- 40 CFR 192 Code of Federal Regulations
- AP-001 Record Retention
- OP-008 Chain of Custody
- MARSSIM Multi-Agency Radiation Survey and Site Investigation Manual

5.0 DEFINITIONS AND ABBREVIATIONS

5.1 Sediment – Sediment is solid material that has settled to the bottom of a liquid, usually water (MARSSIM).

5.2 Surface Soil – The top layer of soil that is available for direct exposure, growing plants, re-suspension of particles for inhalation, and mixing from human disturbances (MARSSIM). Surface soil may also be defined as the thickness of soil that can be measured using direct measuring techniques (MARSSIM). Typically, this layer is represented as the top 15 cm (6 inches) of soil (40 CFR 192).

5.3 Subsurface Soil – Subsurface soil is any soil not considered surface soil, typically anything greater than 15 cm (6 inches) below the ground surface (MARSSIM).

5.4 Volumetric Sample – A sample of material, taken for the purpose of determining the radioactivity content in units of activity per unit volume or mass. This does not apply to loose surface material sampled using a cloth smear/swipe, or to activity present only on the surface of solid materials.

6.0 EQUIPMENT

6.1 Volumetric Sampling

The following is a list of the minimum equipment required to perform field volumetric sampling under this procedure.

- A Lietz level log book 8152-50 or the equivalent;
- Survey map(s);
- Chain of Custody and Record Forms;
- Decontamination detergent (e.g., Alconox);
- Sample Containers;
- Indelible marker;
- Distilled Water;
- Clean towels (paper);
- Brushes for decontamination;
- Sample location markers; and
- Digging implement: garden trowel, shovel, spoons, post-hole digger, etc.
- Special sampling apparatus (cup cutter, shelby tube, etc.) as required
- Plastic bags, approximately 10 cm diameter x 30 cm long
- Cardboard “ice cream” containers (1 quart size) or geology sample bags
- Twist-ties
- Masking or duct tape
- Record forms
- Labels and security seals
- Applicable sample collection equipment.

For collecting water samples, the following may also be required:

- pH meter; and
- Nitric acid preservative.

For sample packing and shipping, at a minimum, the following may be required:

- Box, Coolers, or the equivalent;
- Clear packing tape;
- Zipper locking plastic bags;
- Packaging material (vermiculite or use preformed poly-foam liner or equivalent)
- Self adhesive labels;
- “Fragile” and “This Side Up” stickers;
- Chain of Custody and Record Forms as required;
- Ice and;
- Mailing labels.

Equipment is chosen based on the type of material to be sampled. The following list represents some possibilities:

- Paint sampling: heat gun, paint stripper solution, hammer and chisel
- Drains or pipes: plumber’s snake, swabs
- Residues: trowels, scoops
- Concrete or asphalt: core boxes, hammer, and chisel
- Metals: emery cloth or scraping tool
- Dusts: scraping tool and plastic bags

7.0 RESPONSIBILITIES

7.1 Project Manager (PM) – The PM is responsible for ensuring that personnel assigned the task of collecting volumetric and material samples 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 obtaining material samples 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 collecting volumetric and/or material samples is responsible for knowing and complying with this procedure.

7.5 Sample Collectors - Sample Collectors are responsible to follow the instructions of the RFS and Health Physics technicians and to ensure compliance with this procedure.

8.0 INSTRUCTIONS

8.1 General - Collection of Samples

This section is applicable to surface subsurface, sediment, surface water, ground water, and other sample collections.

8.1.1 Survey maps shall be used to document soil sample location, and any survey results related to the particular sample (i.e. loose surface activity of sample container or sampling equipment).

8.1.2 Sample locations should be clearly identified with a stake or other appropriate marker, and labeled with a corresponding sample number when available.

8.1.3 Ensure that the sample container is of adequate type and size prior to collecting a sample. The sample size may depend on the type of analysis being performed, and the desired detection sensitivity. Consult with the laboratory performing the analysis for proper sample container type and size.

8.1.4 If multiple samples are taken, bring appropriate cleaning materials along for cleaning the sampling equipment. Refer to the applicable section of this procedure for instructions regarding sampling equipment decontamination.

8.1.5 A field-sampling logbook shall be used to document pertinent information about the sampling event. Note any significant observations during the sampling event in the field-sampling logbook.

8.1.6 Seal the container with a tamper proof seal. The sampling technician shall initial and date the seal.

8.1.7 Initiate the sample chain of custody record for the sample.

8.1.8 Identify the sample location with a stake or other appropriate marker. Document the sample location on a survey in such a manner that the location can be easily and accurately re-identified.

8.1.9 Clean the sampling equipment prior to collecting another sample in accordance with requirements of this procedure.

8.1.10 Survey sampling equipment to ensure no removable contamination exists, which could result in cross-contamination of samples.

8.1.10.1 Samples that require gamma, beta, or alpha spectroscopy or isotopic discrimination of any type shall be sent to an approved laboratory for analysis.

8.1.10.2 Samples that can fit into a 1/8” x 2” planchette that require gross alpha and/or beta/gamma results may be counted in a Ludlum 2929 or equivalent.Ensure that minimum counting system sensitivity requirements are met by calculating MDA values for alpha and beta, as applicable.

8.1.10.2.1 Place the sample into a planchette with the surface to be measured facing upward.

8.1.10.2.2 Count sample for an appropriate length of time.

8.1.10.2.3 Record count and counting time data, and calculate activity estimates. Record information and data on appropriate Survey Form.

8.1.11 If the collected sample is suspected to contain radioactivity above background levels, survey the sampling equipment for loose surface activity prior to using the equipment to collect another sample. Document the results on a survey map.

8.2 Collection of Surface Samples

8.2.1 Surface Soil Samples shall be collected using appropriate equipment (stainless-steel hand auger, post-hole digger, shovel, etc.)

8.2.2 Ensure that the sampling equipment which makes contact with the soil (i.e. split-spoon sampler, shovels, post-hole digger, sieves, sample containers, etc.) is free from radioactive material contamination. Perform a loose surface activity survey of the sampling equipment if necessary. Document the results on the survey map corresponding to the sample.

8.2.3 Fill the sample container to the top with surface soil.

8.2.4 Remove large rocks, vegetation, and foreign objects (these items may also be collected as separate samples, if directed). It may be necessary to use a sieve or screen to remove large objects.

8.2.5 Assign a unique sample identification number to the sample. For surface samples, the identifier shall begin with “SS” followed by a series of numbers, where “SS” indicates surface soil as the sample matrix. Additional numerical/alphanumerical designators will be added to indicate the sampling location and number. Label the sample container with the sample number using a permanent marker.

8.2.6 Ensure that the sample is properly labeled and secure the sample container.

8.3 Collection of Subsurface Samples

8.3.1 Subsurface Soil Samples shall be collected using appropriate equipment (stainless-steel hand auger, post-hole digger, shovel, etc.)

8.3.2 Ensure that the sampling equipment which makes contact with the soil (i.e. split-spoon sampler, shovels, post-hole digger, sieves, sample containers, etc.) is free from radioactive material contamination. Perform a loose surface activity survey of the sampling equipment if necessary. Document the results on the survey map corresponding to the sample.

8.3.3 Fill the sample container to the top with surface soil.

8.3.4 Remove large rocks, vegetation, and foreign objects (these items may also be collected as separate samples, if directed). It may be necessary to use a sieve or screen to remove large objects.

8.3.5 Assign a unique sample identification number to the sample. For surface samples, the identifier shall begin with "SS" followed by a series of numbers, where "SS" indicates surface soil as the sample matrix. Additional numerical/alphanumerical designators will be added to indicate the sampling location and number. Label the sample container with the sample number using a permanent marker.

8.4 Collection of Sediment Samples

8.4.1 Sediment samples shall be collected using the appropriate equipment (i.e. stainless steel Ponar dredge, sample containers, etc.).

8.4.2 Ensure that the sampling equipment which makes contact with the sediment (i.e. stainless steel Ponar dredge, sample containers, etc.) is free from radioactive material contamination. Perform a loose surface activity survey of the sampling equipment if necessary. Document the results on the survey map corresponding to the sample.

8.4.3 It is important to minimize disturbance of the sediment caused by sampling activities. Move slowly when approaching the sample location. Approach the sampling location from downstream (for moving water) and downwind (for stationary water).

8.4.4 Remove the sediment slowly and gently from the water using the appropriate sampling equipment. Fill the sample container.

8.4.5 Remove large rocks, vegetation, and foreign objects (these items may also be collected as separate samples, if directed). It may be necessary to use a sieve or screen to remove large objects.

8.4.6 Assign a unique sample identification number to the sample. For surface samples, the identifier shall begin with "SS" followed by a series of numbers, where "SS" indicates surface soil as the sample matrix. Additional numerical/alphanumerical designators will be added to indicate the sampling location and number. Label the sample container with the sample number using a permanent marker.

8.5 Collection of Surface Water Samples

8.5.1 Surface water samples shall be collected using the appropriate equipment (i.e. ladle, scoop, pond sampler, funnel, etc.) or by submerging the sample container.

8.5.2 Ensure that the sampling equipment which makes contact with the surface water (i.e. ladle, scoop, pond sampler, funnel, etc.) is free from radioactive material contamination. Perform a loose surface activity survey of the sampling equipment if necessary. Document the results on the survey map corresponding to the sample.

8.5.3 It is important to minimize disturbance of the sediment caused by sampling activities. Move slowly when approaching the sample location. Approach the sampling location from downstream (for moving water) and downwind (for stationary water).

8.5.4 Rinse the sampling equipment and sampling container with distilled water, or in the same water to be sampled if possible. Remove the water slowly and gently using the appropriate sampling equipment, and fill the sample container. If the water is deep enough, surface water samples can be collected by dipping the polyethylene sample container directly into the water body.

8.5.5 Test the pH of the water sample. If the pH is greater than 2.0, add nitric acid to reduce the pH to 2.0 or less.

8.5.6 Assign a unique sample identification number to the sample. For surface samples, the identifier shall begin with “SS” followed by a series of numbers, where “SS” indicates surface soil as the sample matrix. Additional numerical/alphanumerical designators will be added to indicate the sampling location and number. Label the sample container with the sample number using a permanent marker.

8.6 Collection of Ground Water Samples

8.6.1 Ground water samples shall be collected using the appropriate equipment (i.e. peristaltic pump, bailer, etc.).

8.6.2 Ensure that the sampling equipment which makes contact with the surface water (i.e. tubing, sample containers, pH probe, etc.) is free from radioactive material contamination. It may be helpful to dedicate sampling equipment, such as Teflon tubing, to each monitoring well. Perform a loose surface activity survey of the sampling equipment if necessary. Document the results on the survey map corresponding to the sample.

8.6.3 It is important to minimize disturbance of the sediment caused by sampling activities. Use a low flow peristaltic pump, or slowly sample with a bailer, to avoid increased sample turbidity.

8.6.4 Rinse the sampling equipment and sampling container with distilled water.

8.6.5 Purge standing water in the well until flow from the surrounding aquifer is established. Draw water into an intermediate container and test periodically for pH, conductivity, and temperature during the purging.

8.6.6 Repeat step 8.6.5 until the pH, conductivity, and temperature readings are within ± 10% of the previous reading for three consecutive measurements.

8.6.7 When the criteria in Step 8.6.6 are met, the sample container can be filled.

8.6.8 Test the pH of the water sample. If the pH is greater than 2.0, add nitric acid to reduce the pH to 2.0 or less.

8.6.9 Assign a unique sample identification number to the sample. For surface samples, the identifier shall begin with “SS” followed by a series of numbers, where “SS” indicates surface soil as the sample matrix. Additional numerical/alphanumerical designators will be added to indicate the sampling location and number. Label the sample container with the sample number using a permanent marker.

8.7 Collection of Other Samples

8.7.1 For the purposes of this procedure, “other” refers to any type of sample not previously defined in this document.

8.7.2 Other samples shall be collected using the appropriate equipment (i.e. peristaltic pump, bailer, etc.).

8.7.3 Consult with the analytical laboratory, and the responsible radiological engineer, prior to collecting the sample, for specific instructions on taking any other sample types.

8.7.4 Ensure that the sampling equipment which makes contact with the media is free from radioactive material contamination. Perform a loose surface activity survey of the sampling equipment if necessary. Document the results on the survey map corresponding to the sample.

8.7.5 Obtain the sample using appropriate techniques. Transfer the sample to the appropriate sample container.

8.7.6 Foreign objects, which are not representative of the desired sample matrix, or which may effect the laboratory analysis, shall be removed from the sample.

8.7.7 Assign a unique number to the sample. The unique sample number shall identify the media sampled, the location, and the number as appropriate. Label the sample container with the sample numbers using a permanent marker.

8.8 Material Sampling

Methods for collecting miscellaneous samples should be determined based upon the characteristics of the sample media. Care should be taken to limit the potential for spreading contamination during sample collection. Sample quantities should be determined based upon the following:

8.8.1 Type of analyses required

8.8.2 Number of analyses requested

8.8.3 Detection sensitivity required of analytical result

8.8.4 Estimated activity level of material

8.8.5 Consult with the analytical laboratory, and the responsible radiological engineer, prior to collecting the sample, for specific instructions on taking any other sample types.

8.8.6 Ensure that the sampling equipment which makes contact with the media is free from radioactive material contamination. Perform a loose surface activity survey of the sampling equipment if necessary. Document the results on the survey map corresponding to the sample.

8.8.7 Remove material to be sampled by using the tools required and contamination control techniques to prevent loss of material from the sampled area.

8.8.8 Assign a unique number to the sample. The unique sample number shall identify the media sampled, the location, and the number as appropriate. Label the sample container with the sample numbers using a permanent marker.

8.8.9 Clean all sampling tools before proceeding to the next sampling location.

8.9 Sample Equipment Decontamination

8.9.1 Sample equipment must be clean before use. Used sample equipment must be decontaminated before a sample is taken to prevent cross contamination between samples. Perform the following steps, in order, to properly decontaminate sampling equipment.

8.9.1.1 Remove loose debris from the subject sampling equipment.

8.9.1.2 Wash the sample equipment with an inert detergent solution such as Alconox or the equivalent.

8.9.1.3 Rinse the sample equipment several times with distilled water.

8.9.1.4 Allow the sample equipment to dry prior to use. Perform a loose surface activity survey of the sampling equipment if necessary. Document the results on the survey map corresponding to the sample.

8.9.1.5 Collect the rinsate in a drum or authorized container. Label the drum or container “Rinsate-Awaiting Sampling Results” and “Possible Internal Contamination”.

8.10 Sample Packing and Shipping

8.10.1 Sample Labeling Instructions

8.10.1.1.1 Place self-adhesive labels on appropriate sample containers.

8.10.1.2 Record sample identification, date, and time of sample collection on label.

8.10.1.3 If sample containers contain water (e.g., preserved with ice) place clear plastic tape around the label.

8.10.1.4 Collect sample as per appropriate section of this procedure.

8.10.1.5 If necessary, wipe the outside of the sample container to decontaminate prior to packing.

8.11 Packaging and Shipping

8.11.1 Prepare coolers for shipment as follows:

8.11.1.1 Tape container openings such as box seams and cooler drains (when used) shut.

8.11.1.2 Affix "This Side Up" labels on all four sides, and "Fragile" labels on at least two (2) sides of each shipping container.

8.11.1.3 Place mailing label with laboratory address on the top of container(s).

8.11.1.4 Fill bottom of container(s) with about three inches of absorbent material (e.g.,Vermiculite) or use preformed poly-foam liner or an equivalent and authorized packing material.

8.11.2 Arrange decontaminated sample containers in groups by sample number.

8.11.3 Arrange samples in shipping containers so that they do not touch and the potential for motion is minimized.

8.11.4 If ice is required to preserve the samples, cubes should be repackaged in double zipper locking bags and placed on and around the sample containers.

8.11.5 Fill remaining spaces with absorbent material.

8.11.6 Sign chain-of-custody form (or obtain signature) and indicate air bill number if applicable.

8.11.7 Separate copies of forms. Seal proper copies in large zipper lock plastic bags and tape to the inside of the appropriate container top or lid as necessary.

8.11.8 If a cooler serves as the shipping container, close the lid and secure latch.

8.11.9 Tape the container shut on both ends, making several complete revolutions with strapping tape.

8.11.10 Relinquish samples to the shipper.

8.11.11 Sample collection and shipment documentation is kept for the project file.

8.12 Shipment of Samples

Shipments of samples containing potentially hazardous or radioactive materials may require specific packaging and shipping precautions not specified above. Consult the RSO or duly authorized representative, the analytical laboratory, or other pertinent resources for instruction when shipping these samples.

NOTE: Do not exceed load rating for containers when shipping samples to prevent degradation of the container during shipping.

CAUTION: Samples should be contained within an outer protective cover to prevent cross-contamination of samples.

9.0 QUALITY ASSURANCE/RECORDS

9.1 Quality Assurance

9.1.1 Instruments used for measurements required by this procedure shall be checked with standards and verified to have current calibration.

9.1.2 Surveillance of this procedure (in use) shall be performed at least annually to verify that operations are within the guidelines of this procedure. Any time this procedure is in effect, the PM should ensure by personal observation that samples are collected and controlled appropriately.

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 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

OP-005-01 Sample Status Log

OP-005-01

Sample Status Log

Project/Location:____

Sample ID #	Sampling Location	Date and Time Sample Was Obtained	Requested Analysis	Technician Initials	Sample Status

Reviewed By: ____
Name Title Date

CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

Radiation Safety Procedure

For

Operation of Contamination Survey Meters

OP-020

Revision 0

Reviewed By: ______________________ Date: 1/24/00
David Watters, Radiological Safety Engineer

Approved By: ______________________ Date: 1/24/00
Steven Masciulli CHP, CSP, Radiation Safety Officer

Approved By: ______________________ Date: 1/24/00
Henry Siegrist CHP, P.E., Corporate Health Physicist

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: _______________

CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

Radiation Safety Procedure

For

Alpha – Beta Counting Instrumentation

OP-021

Revision 0

Reviewed By: ________________ Date: 1/24/00
David Watters, Radiological Safety Engineer

Approved By: ________________ Date: 1/24/00
Steven Masciulli CHP, CSP, Radiation Safety Officer

Approved By: ________________ Date: 1/24/00
Henry Siegrist CHP, P.E., Corporate Health Physicist

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".

Net Source CPM = CPM – 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

CABRERA SERVICES
RADIOLOGICAL · ENVIRONMENTAL · REMEDIATION

Radiation Safety Procedure

For

Operation of Micro-R Meters

OP-023

Revision 0

Reviewed By: ______________________ Date: 1/24/00
David Watters, Radiological Safety Engineer

Approved By: ______________________ Date: 1/24/00
Steven Masciulli CHP, CSP, Radiation Safety Officer

Approved By: ______________________ Date: 1/24/00
Henry Siegrist CHP, P.E., Corporate Health Physicist

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.

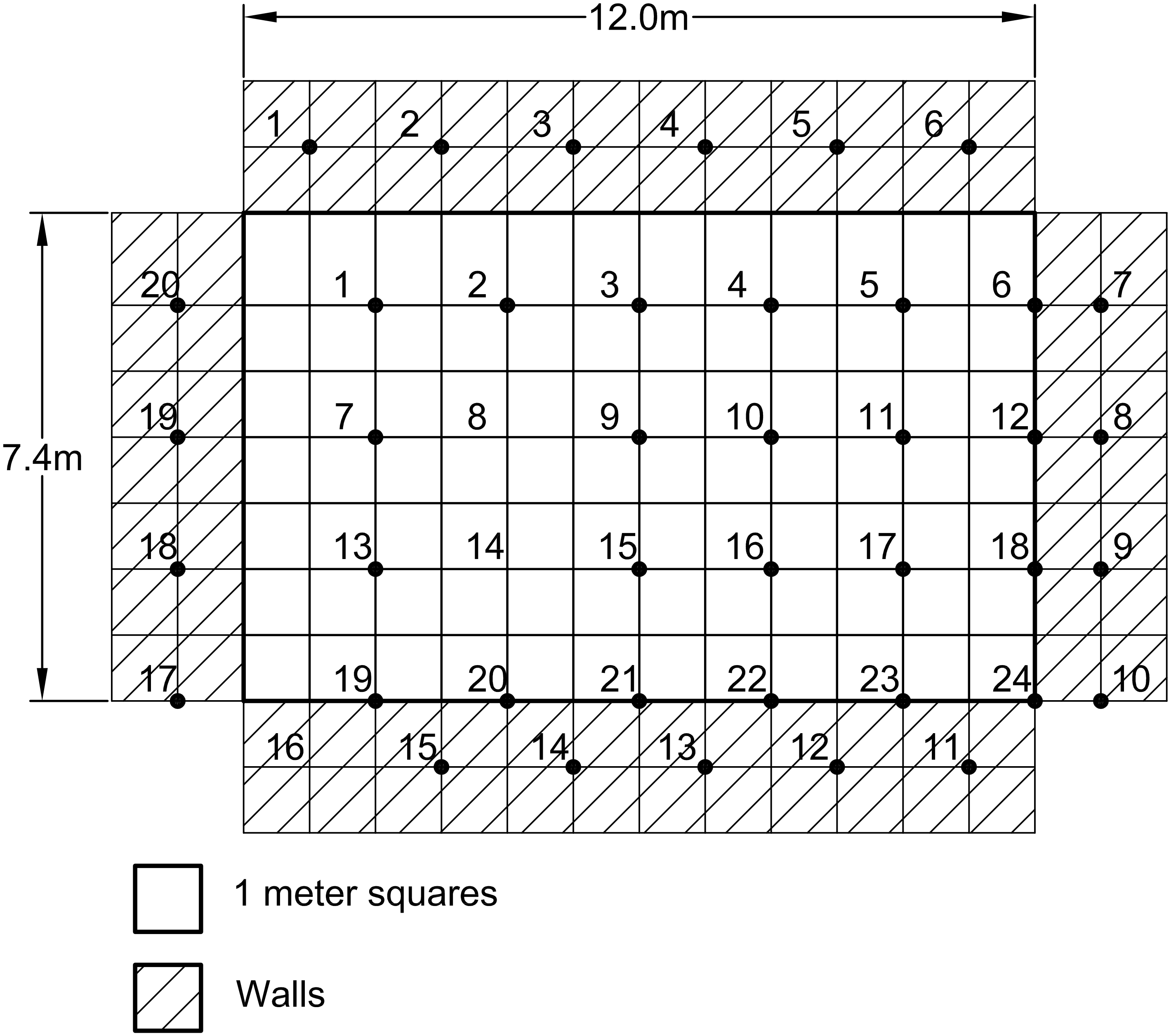
9.2.5 The RSO or duly authorized representative shall review any applicable completed forms. The review shall be for accuracy and completeness.

10.0 ATTACHMENTS

None

Appendix E: Survey Unit Maps and Sample Locations

BARF - North Room Floor and Lower Walls



Date: 11/2/2004
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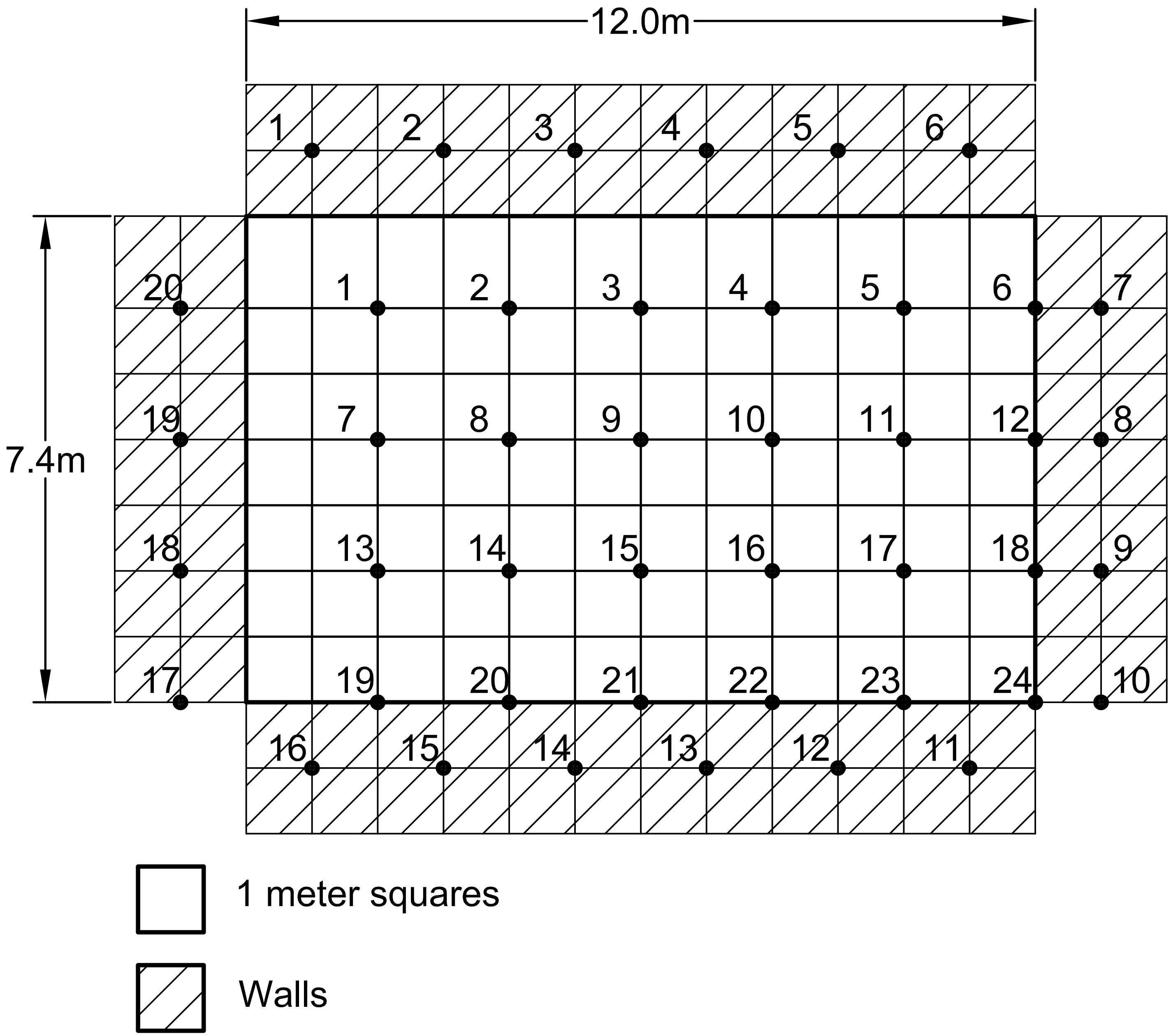
Figure: E-1

BARF - South Room Floor and Lower Walls



Date: 11/2/2004
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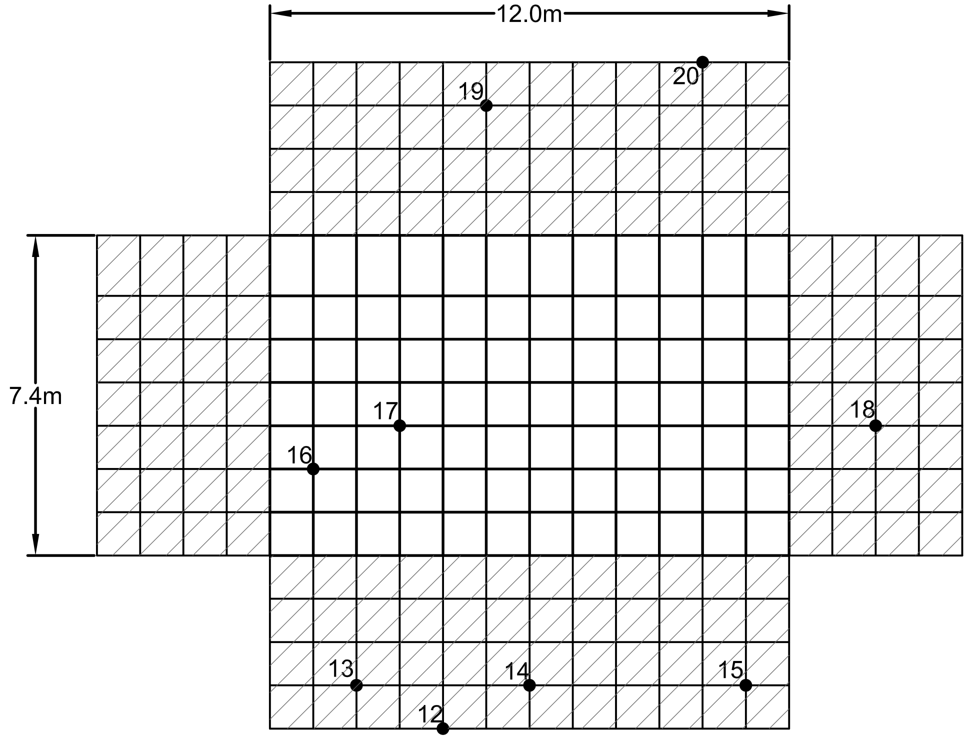
Figure: E-2

BARF - North Room Ceiling and Upper Walls



BARF - South Room Ceiling and Upper Walls

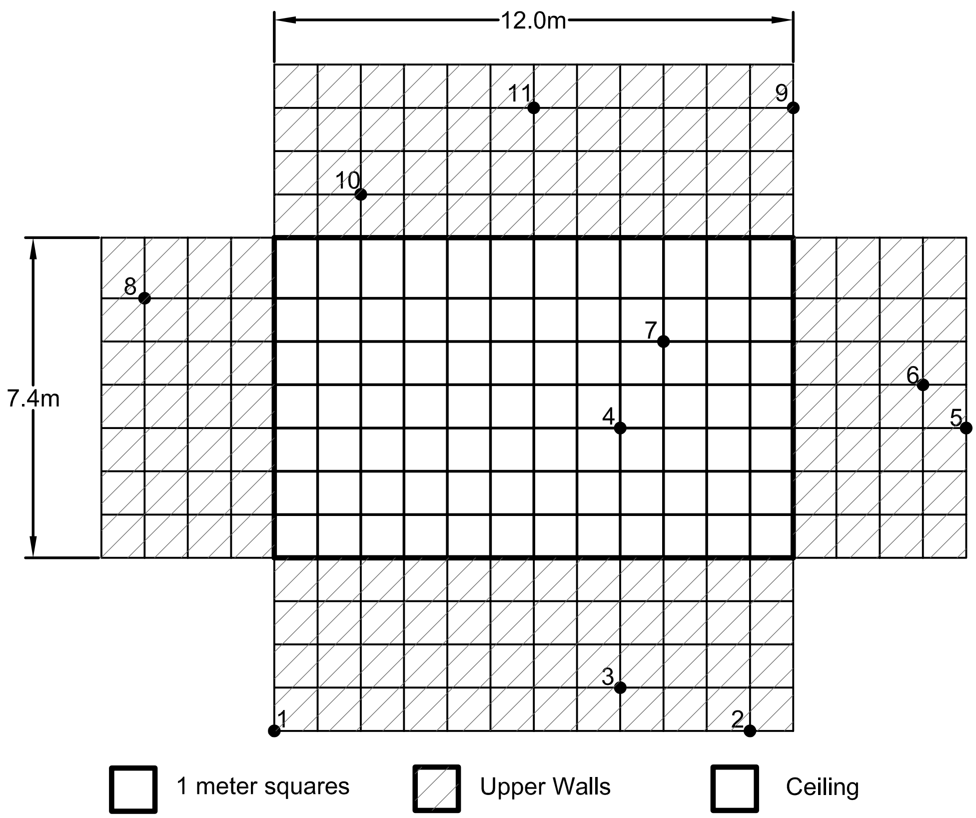
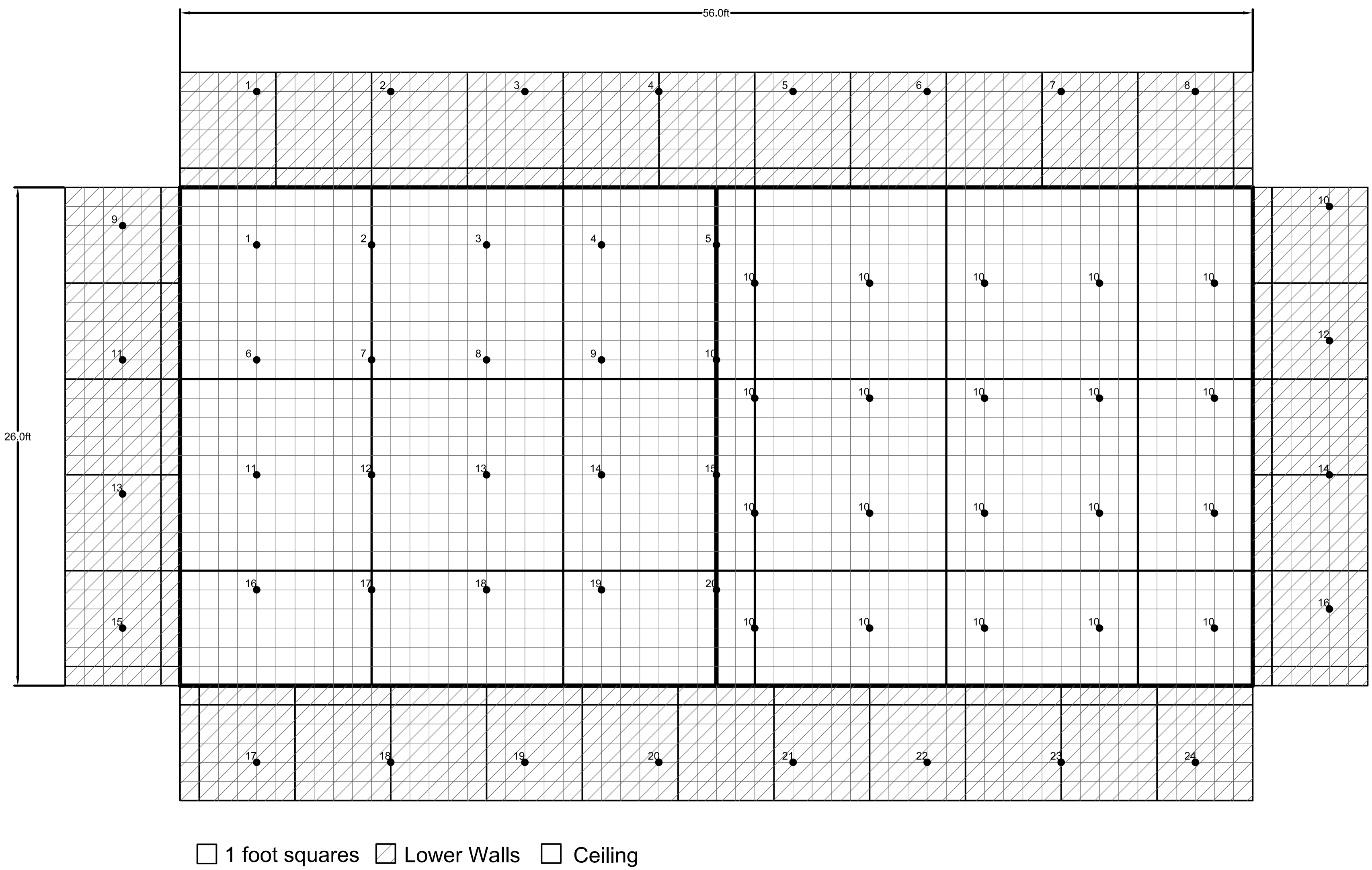


Figure: E-3	Remediation and FSS BTD - Buildings Aberdeen Proving Ground, MD	CABRERA SERVICES RADIOLOGICAL • ENVIRONMENTAL • REMEDIATION WWW.CABRERASERVICES.COM	Date: 11/2/2004 Created by: JTM

Wash Rack 2 Floor and Lower Walls



Date: 11/2/2004

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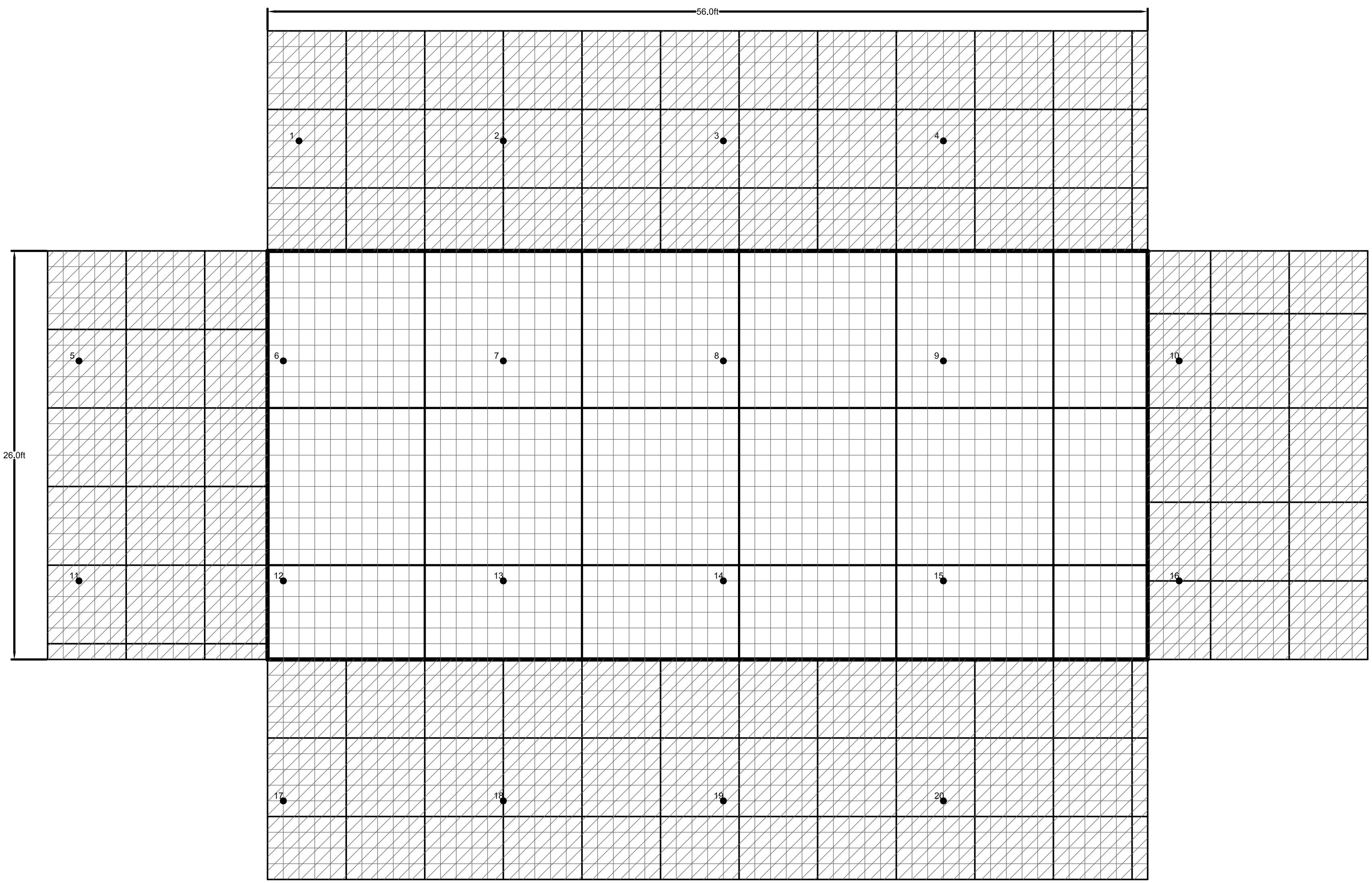
Figure: E-4

Wash Rack 2 Ceiling and Upper Walls



☐ 1 foot squares ☐ Upper Walls ☐ Ceiling

Date: 11/2/2004

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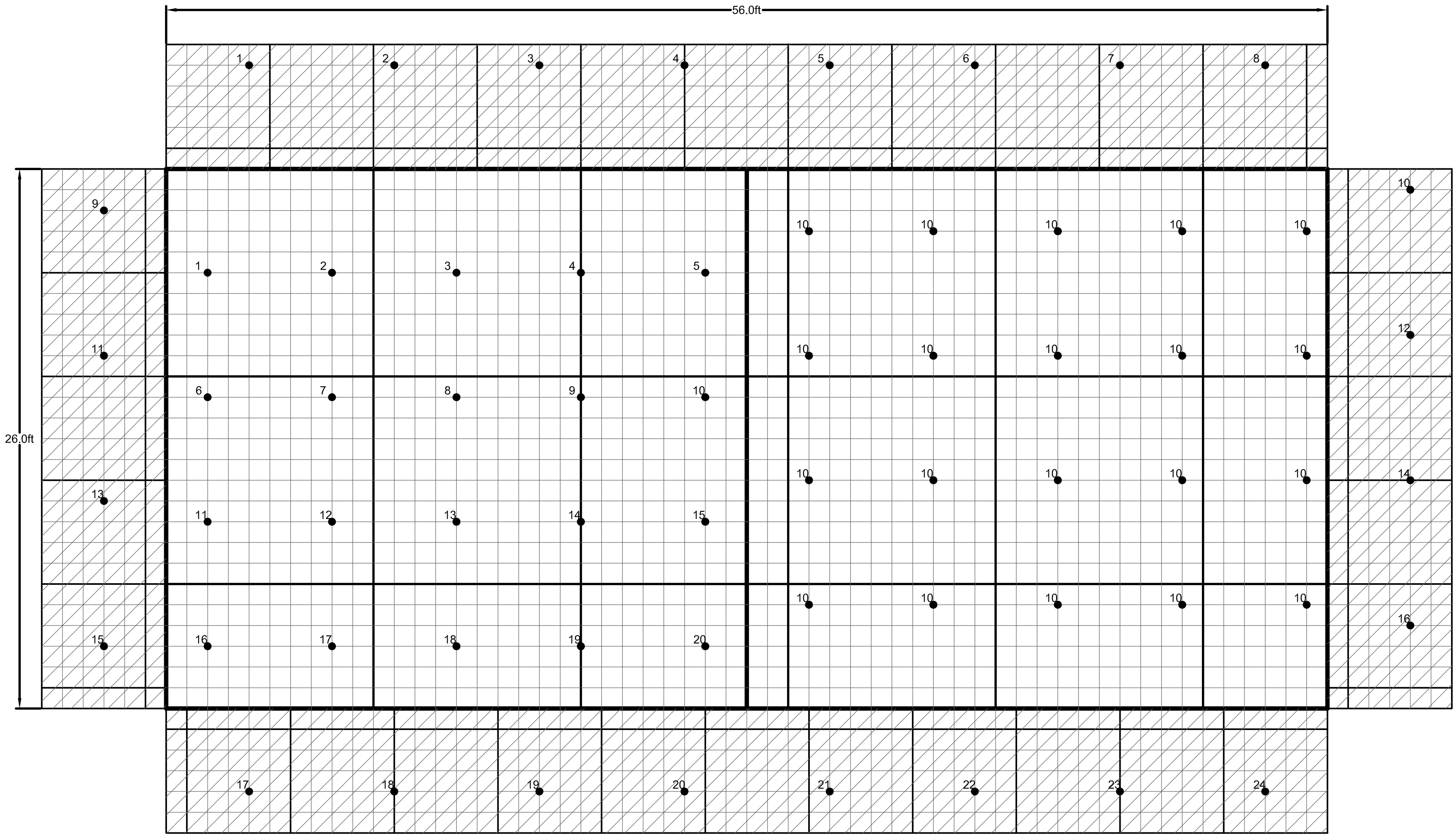
Figure: E-5

Wash Rack 3 Floor and Lower Walls



☐ 1 foot squares ▨ Lower Walls ☐ Ceiling

Date: 11/2/2004

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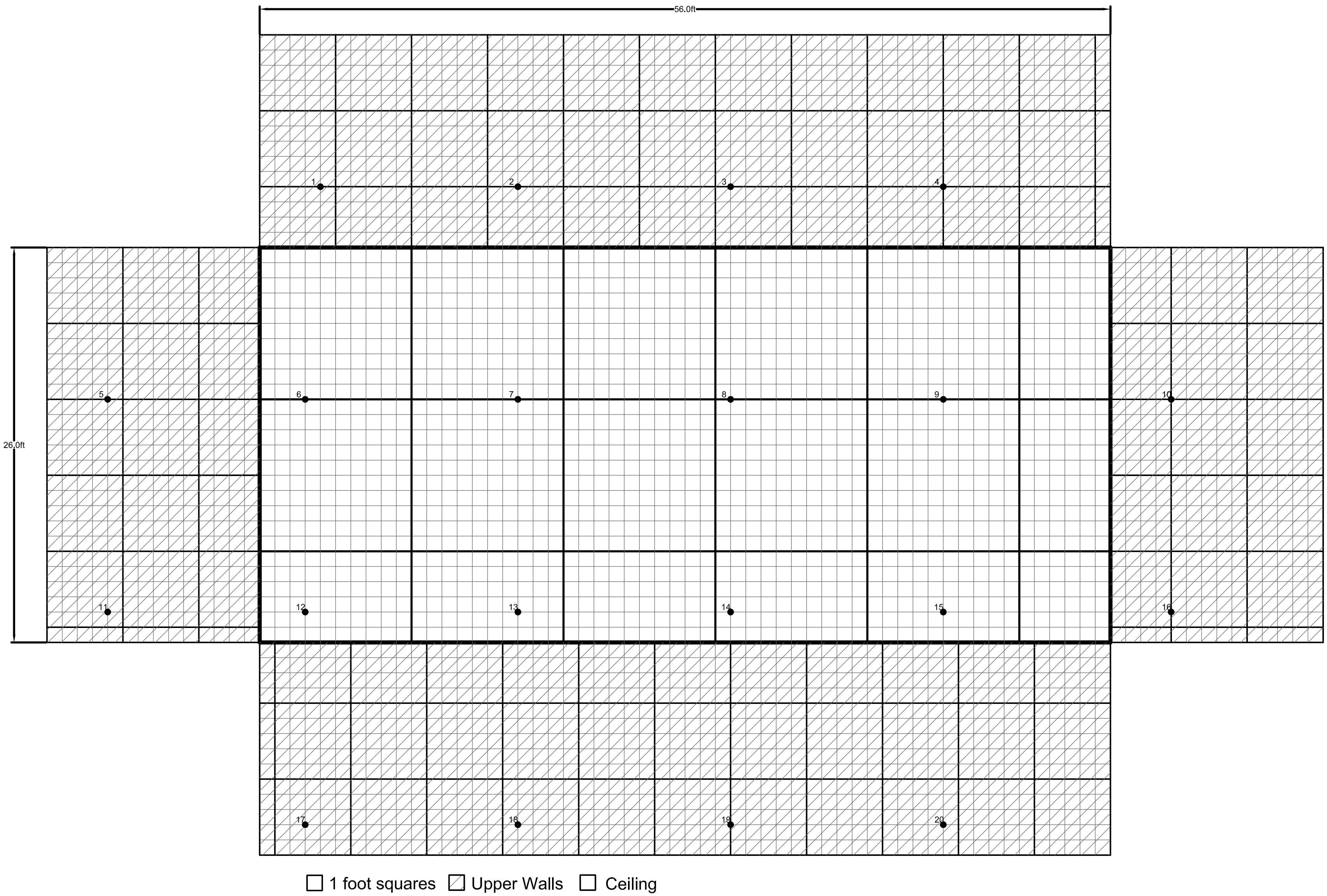
Figure: E-6

Wash Rack 3 Ceiling and Upper Walls



Date: 11/2/2004
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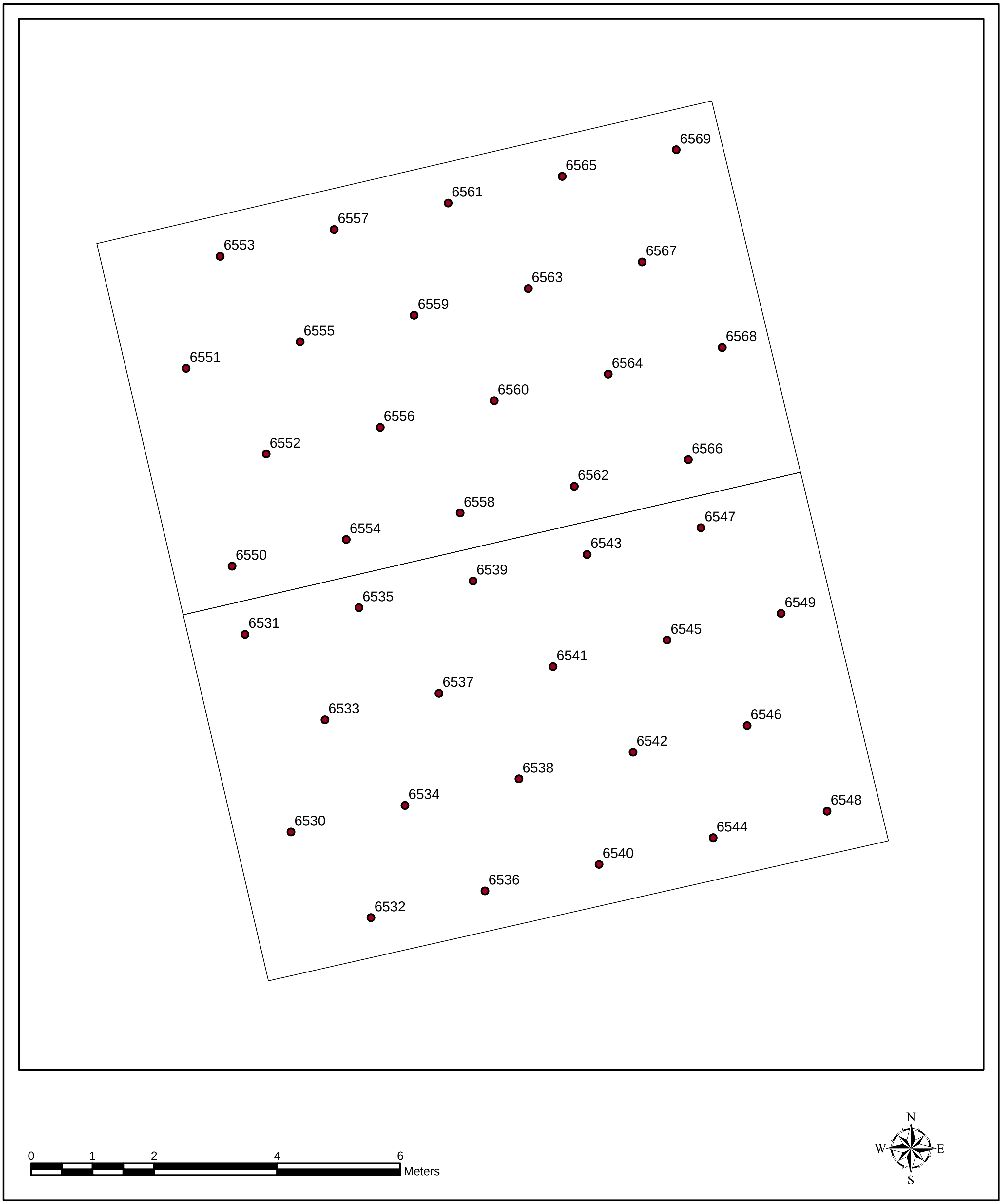
Figure: E-7



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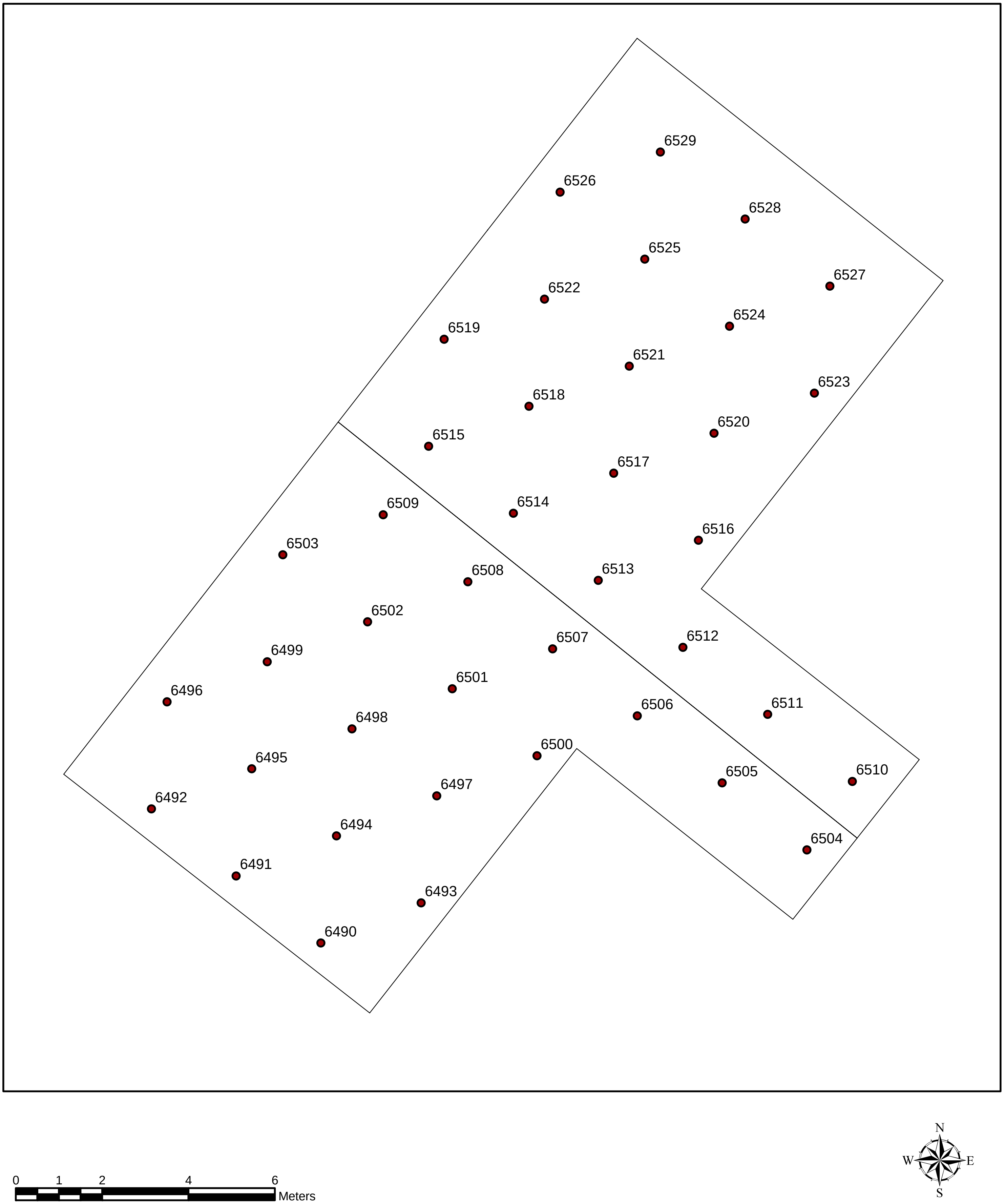
Concrete Pad #1
Systematic Sample Points

BTD-APG

Date: 11-2-04
Project #: 01-3030-39
File Name:
Prepared By: JTM

Figure E-8



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Concrete Pad #2
Systematic Sample Points

BTD-APG

Date: 11-2-04
Project #: 01-3030-39
File Name:
Prepared By: JTM

Figure E-9

Appendix F: Daily Instrument/Building Summary

BTD Daily Instrument and Building Summary

Date	Instrument	S/N	Detector	S/N	QC File	Source of Info	Field Activity
5/3/2003	2929	163827	43-10-1	171322	Y	Instrument QC Files	Daily QC/response checks
5/5/2003	2929	163827	43-10-1	171322	Y	Instrument Log	Building Armor Reclamation Facility (BARF) setup
5/5/2003	Model 3	79511	44-9	137499	Y	Instrument Log	BARF setup
5/5/2003	Model 3	89973	44-9	084781	Y	Instrument Log	BARF setup
5/5/2003	2224-1	162426	43-93	193921	Y	Instrument Log	BARF setup
5/6/2003	Model 3	89973	44-9	084781	Y	Instrument Log	BARF setup
5/7/2003	Model 3	89973	44-9	084781	Y	Instrument Log	BARF setup
5/7/2003	2360	193675	43-37	161687	Y	Instrument Log	BARF setup; Chi-square counts
5/8/2003	2929	163827	43-10-1	171322	Y	Instrument Log	BARF setup
5/8/2003	Model 3	89973	44-9	084781	Y	Instrument Log	BARF setup
5/8/2003	2360	193675	43-37	161687	Y	Instrument Log	BARF setup
5/8/2003	2224	183048	43-68	161781	Y	Instrument Log	BARF setup
5/9/2003	Model 3	89973	44-9	084781	Y	Instrument Log	BARF setup
5/9/2003	2360	193675	43-37	161687	Y	Instrument Log	BARF setup
5/9/2003	Model 3	79511	44-9	137499	Y	Instrument Log	BARF setup
5/9/2003	2929	163827	43-10-1	171322	Y	Instrument Log	BARF setup
5/12/2003	2929	163827	43-10-1	171322	Y	Instrument Log	BARF static, smears, floors N & S rooms; floor surveys N & S rooms; smears S room and lower 2m of E, S, W walls of S room.
5/12/2003	Model 3	89973	44-9	084781	Y	Instrument QC Files	
5/12/2003	2360	193675	43-37	161687	Y	Instrument Log	BARF static, smears, floors N & S rooms; floor surveys N & S rooms; smears S room and lower 2m of E, S, W walls of S room.
5/12/2003	Micro Rem	C853F	--	--	Y	Instrument QC Files	
5/12/2003	Model 3	79511	44-9	137499	Y	Instrument Log	BARF static, smears, floors N & S rooms; floor surveys N & S rooms; smears S room and lower 2m of E, S, W walls of S room.
5/13/2003	2929	163827	43-10-1	171322	Y	Instrument Log	BARF Finish N room floor survey, static readings on lower 2m of walls S & N rooms; S room lower 2m west wall , half of lower 2m S wall survey complete
5/13/2003	2360	193675	43-37	161687	Y	Instrument Log	BARF Finish N room floor survey, static readings on lower 2m of walls S & N rooms; S room lower 2m west wall , half of lower 2m S wall survey complete
5/13/2003	Model 3	79511	44-9	137499	Y	Instrument QC Files	
5/13/2003	Model 3	89973	44-9	084781	Y	Instrument QC Files	
5/13/2003	Micro Rem	C853F	--	--	Y	Instrument QC Files	
5/14/2003	2929	163827	43-10-1	171322	Y	Instrument Log	BARF finish S room S, N, E walls lower 2m; plus N room N, E, W wall lower 2m; upper wall /ceiling surveys completed S room
5/14/2003	2360	193675	43-37	161687	Y	Instrument Log	BARF finish S room S, N, E walls lower 2m; plus N room N, E, W wall lower 2m; upper wall /ceiling surveys completed S room
5/14/2003	2224-1	162426	43-93	193921	Y	Instrument Log	BARF finish S room S, N, E walls lower 2m; plus N room N, E, W wall lower 2m; upper wall /ceiling surveys completed S room
5/14/2003	Model 3	89973	44-9	084781	Y	Instrument QC Files	
5/14/2003	Micro Rem	C853F	--	--	Y	Instrument QC Files	
5/15/2003	2360	193675	43-37	161687	Y	Instrument Log	BARF Wash Rack (WR) #2 Survey lower 2m S wall of N room (BARF); upper walls & ceiling of N room (BARF); lower 2m wall (WR#2)
5/15/2003	2224-1	162426	43-93	193921	Y	Instrument QC Files	
5/15/2003	2929	163827	43-10-1	171322	Y	Instrument Log	BARF WR#2 Survey lower 2m S wall of N room (BARF); upper walls & ceiling of N room (BARF); lower 2m wall (WR#2)
5/15/2003	Model 3	89973	44-9	084781	Y	Instrument QC Files	
5/15/2003	Micro Rem	C853F	--	--	Y	Instrument QC Files	
5/19/2003	2929	163827	43-10-1	171322	Y	Instrument Log	Disassemble WR#2
5/19/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Disassemble WR#2
5/19/2003	2224-1	162426	43-93	193921	Y	Instrument Log	Disassemble WR#2
5/19/2003	Micro Rem	C853F	--	--	Y	Instrument QC Files	

BTD Daily Instrument and Building Summary

Date	Instrument	S/N	Detector	S/N	QC File	Source of Info	Field Activity
5/20/2003	2929	163827	43-10-1	171322	Y	Instrument Log	Disassemble WR#2
5/20/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Disassemble WR#2
5/20/2003	Model 3	89973	44-9	084781	Y	Instrument Log	Disassemble WR#2
5/20/2003	2224-1	162426	43-93	193921	Y	Instrument Log	Disassemble WR#2
5/21/2003	2929	163827	43-10-1	171322	Y	Instrument Log	Disassemble WR#2
5/21/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Disassemble WR#2
5/21/2003	Model 3	89973	44-9	084781	Y	Instrument Log	Disassemble WR#2
5/22/2003	2929	163827	43-10-1	171322	Y	Instrument Log	Disassemble WR#2
5/22/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Disassemble WR#2
5/22/2003	Model 3	89973	44-9	084781	Y	Instrument Log	Disassemble WR#2
5/22/2003	2224-1	162426	43-93	193921	Y	Instrument Log	Disassemble WR#2
5/28/2003	2929	163827	43-10-1	171322	Y	Instrument Log	Continue disassemble WR#2
5/28/2003	Model 3	89973	44-9	084781	Y	Instrument QC Files	
5/28/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Continue disassemble WR#2
5/28/2003	2224-1	162426	43-93	193921	Y	Instrument Log	Continue disassemble WR#2
5/28/2003	2224-1	162425	43-93	182403	Y	Instrument Log	Continue disassemble WR#2
5/29/2003	2224-1	162425	43-93	182403	Y	Instrument Log	Continue disassemble WR#2
5/29/2003	2224-1	162426	43-93	193921	Y	Instrument QC Files	
5/29/2003	2929	163827	43-10-1	171322	Y	Instrument Log	Continue disassemble WR#2
5/29/2003	Model 3	79511	44-9	137499	Y	Instrument QC Files	
5/29/2003	Model 3	89973	44-9	084781	Y	Instrument QC Files	
5/30/2003	2929	163827	43-10-1	171322	Y	Instrument Log	Continue disassemble WR#2 (note out of scope work items in wkly SRs
6/2/2003	2929	163827	43-10-1	171322	Y	Instrument Log	BARF bias fixed rate counts 13 locations, DU Test Enclosure Building demo
6/2/2003	2360	193675	43-37	161687	Y	Instrument Log	
6/3/2003	2929	163827	43-10-1	171322	Y	Instrument Log	WR#2, DU Test Enclosure Building demo
6/4/2003	2929	163827	43-10-1	171322	Y	Instrument Log	WR#2, 100% scan walls (EW, 1/2 WW); DU Test Enclosure Building demo
6/4/2003	2360	193675	43-37	161687	Y	Instrument Log	WR#2, 100% scan walls (EW, 1/2 WW); DU Test Enclosure Building demo
6/4/2003	Model 3	79511	44-9	137499	Y	Instrument Log	WR#2, 100% scan walls (EW, 1/2 WW); DU Test Enclosure Building demo
6/4/2003	Model 3	89973	44-9	084781	Y	Instrument Log	WR#2, 100% scan walls (EW, 1/2 WW); DU Test Enclosure Building demo
6/4/2003	2224-1	162425	43-93	182403	Y	Instrument Log	WR#2, 100% scan walls (EW, 1/2 WW); DU Test Enclosure Building demo
6/5/2003	2360	193675	43-37	161687	Y	Instrument Log	WR#2 plasma cutter hot spots + scan WW & NW; DU Test Enclosure Building demo
6/6/2003	2360	193675	43-37	161687	Y	Instrument Log	WR#2 scan floor; DU Test Enclosure Building demo EW & WW
6/6/2003	2224-1	162426	43-93	193921	Y	Instrument Log	WR#2 scan floor; DU Test Enclosure Building demo EW & WW
6/6/2003	Model 3	79511	44-9	137499	Y	Instrument Log	WR#2 scan floor; DU Test Enclosure Building demo EW & WW
6/6/2003	Model 3	89973	44-9	084781	Y	Instrument Log	WR#2 scan floor; DU Test Enclosure Building demo EW & WW
6/6/2003	2929	163827	43-10-1	171322	Y	Instrument Log	WR#2 scan floor; DU Test Enclosure Building demo EW & WW
6/9/2003	2360	193675	43-37	161687	Y	Instrument Log	WR#2 scan floor, walls; equip moved to WR#3, scan 1/2 WW; DU Test Enclosure Building demo
6/9/2003	2224-1	162426	43-93	193921	Y	Instrument Log	WR#2 scan floor, walls; equip moved to WR#3, scan 1/2 WW; DU Test Enclosure Building demo
6/9/2003	Model 3	79511	44-9	137499	Y	Instrument Log	WR#2 scan floor, walls; equip moved to WR#3, scan 1/2 WW; DU Test Enclosure Building demo
6/9/2003	Model 3	89973	44-9	084781	Y	Instrument Log	WR#2 scan floor, walls; equip moved to WR#3, scan 1/2 WW; DU Test Enclosure Building demo
6/9/2003	2929	163827	43-10-1	171322	Y	Instrument Log	WR#2 scan floor, walls; equip moved to WR#3, scan 1/2 WW; DU Test Enclosure Building demo
6/10/2003	2224-1	162426	43-93	193921	Y	Instrument Log	DU Test Enclosure Building demo
6/10/2003	Model 3	79511	44-9	137499	Y	Instrument Log	DU Test Enclosure Building demo
6/10/2003	Model 3	89973	44-9	084781	Y	Instrument Log	taken out of service, light leak
6/10/2003	2929	163827	43-10-1	171322	Y	Instrument Log	DU Test Enclosure Building demo
6/11/2003	2360	193675	43-37	161687	Y	Instrument Log	WR#3 complete scan WW, 1/2 EW; continue DU Test Enclosure Building demo
6/11/2003	2224-1	162425	43-93	182403	Y	Instrument Log	WR#3 complete scan WW, 1/2 EW; continue DU Test Enclosure Building demo
6/11/2003	2224-1	162426	43-93	193921	Y	Instrument Log	WR#3 complete scan WW, 1/2 EW; continue DU Test Enclosure Building demo
6/11/2003	Model 3	79511	44-9	137499	Y	Instrument Log	WR#3 complete scan WW, 1/2 EW; continue DU Test Enclosure Building demo

BTD Daily Instrument and Building Summary

Date	Instrument	S/N	Detector	S/N	QC File	Source of Info	Field Activity
6/11/2003	2929	163827	43-10-1	171322	Y	Instrument Log	WR#3 complete scan WW, 1/2 EW; continue DU Test Enclosure Building demo
6/12/2003	2360	193675	43-37	161687	Y	Instrument Log	WR#3 finish scan EW, NW, SW; continue DU Test Enclosure Building demo
6/12/2003	2224-1	162425	43-93	182403	Y	Instrument Log	WR#3 finish scan EW, NW, SW; continue DU Test Enclosure Building demo
6/12/2003	2224-1	162426	43-93	193921	Y	Instrument Log	WR#3 finish scan EW, NW, SW; continue DU Test Enclosure Building demo
6/12/2003	Model 3	79511	44-9	137499	Y	Instrument Log	WR#3 finish scan EW, NW, SW; continue DU Test Enclosure Building demo
6/12/2003	2929	163827	43-10-1	171322	Y	Instrument Log	WR#3 finish scan EW, NW, SW; continue DU Test Enclosure Building demo
6/13/2003	2224-1	162425	43-93	182403	Y	Instrument Log	continue DU Test Enclosure Building demo, clean floor WR#3 (out of scope)
6/13/2003	2224-1	162426	43-93	193921	Y	Instrument Log	continue DU Test Enclosure Building demo, clean floor WR#3 (out of scope)
6/13/2003	Model 3	79511	44-9	137499	Y	Instrument Log	continue DU Test Enclosure Building demo, clean floor WR#3 (out of scope)
6/16/2003	2929	163827	43-10-1	171322	Y	Instrument Log	WR#3 finish 25% of floor scan; continue DU Test Enclosure Building demo
6/16/2003	2360	193675	43-37	161687	Y	Instrument Log	WR#3 finish 25% of floor scan; continue DU Test Enclosure Building demo
6/19/2003	2360	193675	43-37	161687	Y	Instrument Log	WR#3 finish 50% of floor scan
6/19/2003	2224-1	162425	43-93	182403	Y	Instrument Log	WR#3 finish 50% of floor scan
6/19/2003	2224-1	162426	43-93	193921	Y	Instrument Log	WR#3 finish 50% of floor scan
6/19/2003	Model 3	79498	44-9	073106	Y	Instrument Log	WR#3 finish 50% of floor scan
6/19/2003	Model 3	79511	44-9	137499	Y	Instrument Log	WR#3 finish 50% of floor scan
6/19/2003	Micro Rem	C853F	--	--	Y	Instrument Log	WR#3 finish 50% of floor scan
6/20/2003	2360	193675	43-37	161687	Y	Instrument Log	WR#3 finish 100% floor scan; continue DU Test Enclosure Building demo
6/20/2003	2224-1	162425	43-93	182403	Y	Instrument Log	WR#3 finish 100% floor scan; continue DU Test Enclosure Building demo
6/20/2003	2224-1	162426	43-93	193921	Y	Instrument Log	WR#3 finish 100% floor scan; continue DU Test Enclosure Building demo
6/20/2003	Model 3	79498	44-9	073106	Y	Instrument Log	WR#3 finish 100% floor scan; continue DU Test Enclosure Building demo
6/20/2003	Model 3	79511	44-9	137499	Y	Instrument Log	WR#3 finish 100% floor scan; continue DU Test Enclosure Building demo
6/23/2003	2360	193675	43-37	161687	Y	Instrument Log	WR#3 complete scans, start static counts
6/24/2003	2360	193675	43-37	161687	Y	Instrument Log	WR#3 complete 1/2 static counts
6/25/2003	2360	193675	43-37	161687	Y	Instrument Log	WR#3 complete static counts & those accessible in WR#2; continue demo Rust Vault
6/26/2003	2224-1	162426	43-93	193921	Y	Instrument Log	WR#2/3 static counts upper walls/ceilings; demo Rust Vault; Transonic X-Ray2 roof
6/26/2003	Model 3	79511	44-9	137499	Y	Instrument Log	WR#2/3 static counts upper walls/ceilings; demo Rust Vault; Transonic X-Ray2 roof
6/26/2003	2929	163827	43-10-1	171322	Y	Instrument Log	WR#2/3 static counts upper walls/ceilings; demo Rust Vault; Transonic X-Ray2 roof
6/27/2003	2224-1	162425	43-93	182403	Y	Instrument Log	WR#2/3 complete all static counts; police junk around both vaults; transonic X-Ray2 roof
6/27/2003	2224-1	162426	43-93	193921	Y	Instrument Log	WR#2/3 complete all static counts; police junk around both vaults; transonic X-Ray2 roof
6/27/2003	Model 3	79498	44-9	073106	Y	Instrument Log	WR#2/3 complete all static counts; police junk around both vaults; transonic X-Ray2 roof
6/27/2003	Model 3	79511	44-9	137499	Y	Instrument Log	WR#2/3 complete all static counts; police junk around both vaults; transonic X-Ray2 roof
6/27/2003	2929	163827	43-10-1	171322	Y	Instrument Log	WR#2/3 complete all static counts; police junk around both vaults; transonic X-Ray2 roof
7/8/2003	2929	163827	43-10-1	171322	Y	Instrument Log	Crane/WashRack#2 scanned; continue demo Vaults
7/9/2003	2224-1	162425	43-93	182403	Y	Instrument Log	WR#3 count smears; continue demo Vaults; survey Sabot Stripper and Backstop Plate
7/9/2003	2224-1	162426	43-93	193921	Y	Instrument Log	WR#3 count smears; continue demo Vaults; survey Sabot Stripper and Backstop Plate
7/9/2003	Model 3	79498	44-9	073106	Y	Instrument Log	WR#3 count smears; continue demo Vaults; survey Sabot Stripper and Backstop Plate
7/9/2003	Model 3	79511	44-9	137499	Y	Instrument Log	WR#3 count smears; continue demo Vaults; survey Sabot Stripper and Backstop Plate
7/9/2003	2929	163827	43-10-1	171322	Y	Instrument Log	WR#3 count smears; continue demo Vaults; survey Sabot Stripper and Backstop Plate
7/10/2003	2224-1	162425	43-93	182403	Y	Instrument Log	Survey of electrical boxes; complete demo of Vaults; cut first section of HEPA removed
7/10/2003	2224-1	162426	43-93	193921	Y	Instrument Log	Survey of electrical boxes; complete demo of Vaults; cut first section of HEPA removed
7/10/2003	Model 3	79498	44-9	073106	Y	Instrument Log	Survey of electrical boxes; complete demo of Vaults; cut first section of HEPA removed
7/10/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Survey of electrical boxes; complete demo of Vaults; cut first section of HEPA removed
7/10/2003	2929	163827	43-10-1	171322	Y	Instrument Log	Survey of electrical boxes; complete demo of Vaults; cut first section of HEPA removed
7/11/2003	Model 3	79511	44-9	137499	Y	Instrument Log	second section of HEPA removed and loadeed into intermodal container
7/14/2003	Model 3	79511	44-9	137499	Y	Instrument Log	remove plywood from interior of shed east of DU Test Enclosure Bldg; cut up HEPA system from BARF
7/15/2003	Model 3	79511	44-9	137499	Y	Instrument Log	prepare for gamma walkover surveying (GWS); continue demo
7/16/2003	Model 3	79511	44-9	137499	Y	Instrument Log	prepare for GWS; continue demo
7/17/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU20/part of SU17; continue demo

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Date	Instrument	S/N	Detector	S/N	QC File	Source of Info	Field Activity
7/18/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU17, straighten out Super Sacks
7/21/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU7; start excavation DU Test Enclosure Building
7/22/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Down (range activities)
7/23/2003	Model 3	79511	44-9	137499	Y	Instrument Log	DU Test Enclosure Building excavation stop (found 105mm HEAT round); down rest of day after 0930
7/24/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Down (range activities)
7/25/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Excavate DU Test Enclosure Building (200 cubic yards of soil)
7/28/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Daily QC
7/29/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU24 75% complete; continue excavation DU Test Enclosure Building
7/30/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU24 & 28; expose concrete footers DU Test Enclosure Building
7/31/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU 6; hand dig hot spots SU7; excavation DU Test Enclosure Building
8/7/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU6; soil samples from SU17 & 23; excavation, grading DU Test Enclosure Building
8/8/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU1; soil samples from SU7 & 8 & 24; hot spots SU6 removed, ready to be resurveyed
8/11/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU6 after remediation; soil sampling SU1
8/12/2003	2224-1	162425	43-93	182403	Y	Instrument Log	GWS SU6 complete; continue demo footers DU Test Enclosure Building
8/12/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU6 complete; continue demo footers DU Test Enclosure Building
8/12/2003	Micro Rem	C853F	--	--	Y	Instrument Log	GWS SU6 complete; continue demo footers DU Test Enclosure Building
8/13/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Soil sampling SU6; continue demo footers DU Test Enclosure Building
8/13/2003	Micro Rem	C853F	--	--	Y	Instrument Log	Soil sampling SU6; continue demo footers DU Test Enclosure Building
8/14/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU5 done, start SU3; soil sampling SU4&5
8/14/2003	Micro Rem	C853F	--	--	Y	Instrument Log	GWS SU5 done, start SU3; soil sampling SU4&5
8/15/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU2&3&12 complete, GWS SU11 60% complete
8/15/2003	Micro Rem	C853F	--	--	Y	Instrument Log	GWS SU2&3&12 complete, GWS SU11 60% complete
8/18/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU11&13&14&15 complete
8/18/2003	Micro Rem	C853F	--	--	Y	Instrument Log	GWS SU11&13&14&15 complete
8/19/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU21-25 complete
8/19/2003	Micro Rem	C853F	--	--	Y	Instrument Log	GWS SU21-25 complete
8/20/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Remediate hot spots SUs 11 to 15; sampled SU21 &15; continue demo footers/stockpile
8/21/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Sample soil SUs 13&14; demo crew found 4.2 chemical mortar (phosgene, CNS, or Chlorine); wait for EOD
8/22/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Remediate SUs 2, 9, 10; sampled SU11 &12
8/23/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Daily QC
8/24/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Daily QC
8/25/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Finish remediation SU9, GWS SU9, sample SU3, remediate SU2
8/26/2003	Model 3	79511	44-9	137499	Y	Instrument Log	Sample SU9, GWS SU10, remediate SU10
8/26/2003	2929	163827	43-10-1	171322	Y	Instrument Log	Sample SU9, GWS SU10, remediate SU10
8/27/2003	Model 3	79511	44-9	137499	Y	Instrument Log	GWS SU2, remediate SU2 & SU25; post GWS SU2 & SU25; sample SU2
2/10/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/10/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/10/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/10/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/11/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/11/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/11/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/11/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/12/2004	2929	180830	43-10-1	207849	N	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/12/2004	Model 3	135696	44-9	145224	N	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/12/2004	Model 3	89973	44-9	084781	N	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/12/2004	Micro Rem	B837Y	--	--	N	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/16/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5

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Date	Instrument	S/N	Detector	S/N	QC File	Source of Info	Field Activity
2/16/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/17/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/17/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/17/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/17/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/18/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/18/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/18/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/18/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/19/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/19/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/19/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/20/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/20/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/20/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/20/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/23/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/23/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/23/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/23/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/24/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/24/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/24/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/24/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/25/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/25/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/25/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/25/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/26/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/26/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/26/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/26/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/27/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/27/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/27/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
2/27/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/1/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/1/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/1/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/1/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/2/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/2/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/2/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/2/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/3/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/3/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/3/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/3/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/4/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5

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Date	Instrument	S/N	Detector	S/N	QC File	Source of Info	Field Activity
3/4/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/4/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/4/2004	Micro Rem	B837Y	--	--	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/5/2004	Model 3	135696	44-9	145224	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/5/2004	Model 3	89973	44-9	084781	Y	Instrument Log	Soil removal, rail shipments, handling RAD waste to demob 3/5
3/29/2004	2224-1	162426	43-93	193921	Y	Instrument Log	excavate SU16 & SU22
3/29/2004	2360	193675	43-37	161687	Y	Instrument Log	excavate SU16 & SU22
3/30/2004	2360	193675	43-37	161687	Y	QC Files, Radiological Survey Maps	Wash Rack #3 survey, smear counting
3/30/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Wash Rack #3 survey, smear counting
3/30/2004	2224-1	162426	43-93	193921	Y	Instrument Log	Wash Rack #3 survey, smear counting
3/31/2004	2360	193675	43-37	161687	Y	QC Files, Radiological Survey Maps	Wash Rack #2 smear survey, Demob
3/31/2004	2929	180830	43-10-1	207849	Y	Instrument Log	Wash Rack #2 smear survey, Demob
3/31/2004	2224-1	162426	43-93	193921	Y	Instrument Log	Wash Rack #2 smear survey, Demob
6/2/2004	Model 3	79498	44-9	073106	Y	QC Files, Daily reports	Project mobilization, set-up, and logistics
6/2/2004	Model 3	166511	44-9	073107	Y	QC Files, Daily reports	Project mobilization, set-up, and logistics
6/2/2004	2360	184938	43-37	178371	Y	QC Files, Daily reports	Project mobilization, set-up, and logistics
6/2/2004	2360	202398	43-93	211706	Y	QC Files, Daily reports	Project mobilization, set-up, and logistics
6/2/2004	Micro Rem	B985Y	--	--	Y	QC Files, Daily reports	Project mobilization, set-up, and logistics
6/3/2004	Model 3	79498	44-9	073106	Y	QC Files, Daily reports	Health & Safety audit, receive and inspect rental equipment, project logistics
6/3/2004	Model 3	166511	44-9	073107	Y	QC Files, Daily reports	Health & Safety audit, receive and inspect rental equipment, project logistics
6/3/2004	2360	184938	43-37	178371	Y	QC Files, Daily reports	Health & Safety audit, receive and inspect rental equipment, project logistics
6/3/2004	2360	202398	43-93	211706	Y	QC Files, Daily reports	Health & Safety audit, receive and inspect rental equipment, project logistics
6/3/2004	Micro Rem	B985Y	--	--	Y	QC Files, Daily reports	Health & Safety audit, receive and inspect rental equipment, project logistics
6/4/2004	Model 3	79498	44-9	073106	Y	QC Files, Daily reports	Gamma walkover survey in SU #25, remediate hotspots within SU #16
6/4/2004	Model 3	166511	44-9	073107	Y	QC Files, Daily reports	Gamma walkover survey in SU #25, remediate hotspots within SU #16
6/4/2004	2360	184938	43-37	178371	Y	QC Files, Daily reports	Gamma walkover survey in SU #25, remediate hotspots within SU #16
6/4/2004	2360	202398	43-93	211706	Y	QC Files, Daily reports	Gamma walkover survey in SU #25, remediate hotspots within SU #16
6/4/2004	Micro Rem	B985Y	--	--	Y	QC Files, Daily reports	Gamma walkover survey in SU #25, remediate hotspots within SU #16
6/6/2004	Model 3	79498	44-9	073106	Y	QC Files, Daily reports	Attempt water removal and drying of SU #16 and concrete pad, partial GWS of SU #25
6/6/2004	Model 3	166511	44-9	073107	Y	QC Files, Daily reports	Attempt water removal and drying of SU #16 and concrete pad, partial GWS of SU #25
6/6/2004	2360	184938	43-37	178371	Y	QC Files, Daily reports	Attempt water removal and drying of SU #16 and concrete pad, partial GWS of SU #25
6/6/2004	2360	202398	43-93	211706	Y	QC Files, Daily reports	Attempt water removal and drying of SU #16 and concrete pad, partial GWS of SU #25
6/6/2004	Micro Rem	B985Y	--	--	Y	QC Files, Daily reports	Attempt water removal and drying of SU #16 and concrete pad, partial GWS of SU #25
6/7/2004	Model 3	79498	44-9	073106	Y	QC Files, Daily reports	Surface clean concrete pads, complete GWS of SU #25
6/7/2004	Model 3	166511	44-9	073107	Y	QC Files, Daily reports	Surface clean concrete pads, complete GWS of SU #25
6/7/2004	2360	184938	43-37	178371	Y	QC Files, Daily reports	Surface clean concrete pads, complete GWS of SU #25
6/7/2004	2360	202398	43-93	211706	Y	QC Files, Daily reports	Surface clean concrete pads, complete GWS of SU #25
6/7/2004	Micro Rem	B985Y	--	--	Y	QC Files, Daily reports	Surface clean concrete pads, complete GWS of SU #25
6/8/2004	Model 3	79498	44-9	073106	Y	QC Files, Daily reports	Sand-blasting concrete pads, concrete pad surveying SU #9, pad layout and hotspot flagging
6/8/2004	Model 3	166511	44-9	073107	Y	QC Files, Daily reports	Sand-blasting concrete pads, concrete pad surveying SU #9, pad layout and hotspot flagging
6/8/2004	2360	184938	43-37	178371	Y	QC Files, Daily reports	Sand-blasting concrete pads, concrete pad surveying SU #9, pad layout and hotspot flagging
6/8/2004	2360	202398	43-93	211706	Y	QC Files, Daily reports	Sand-blasting concrete pads, concrete pad surveying SU #9, pad layout and hotspot flagging
6/8/2004	Micro Rem	B985Y	--	--	Y	QC Files, Daily reports	Sand-blasting concrete pads, concrete pad surveying SU #9, pad layout and hotspot flagging
6/9/2004	Model 3	79498	44-9	073106	Y	QC Files, Daily reports	Survey concrete pads of SUs #9 and #16, GWS of SU #16, soil sampling of SUs #25, #22, #2, #9, and #10
6/9/2004	Model 3	166511	44-9	073107	Y	QC Files, Daily reports	Survey concrete pads of SUs #9 and #16, GWS of SU #16, soil sampling of SUs #25, #22, #2, #9, and #10
6/9/2004	2360	184938	43-37	178371	Y	QC Files, Daily reports	Survey concrete pads of SUs #9 and #16, GWS of SU #16, soil sampling of SUs #25, #22, #2, #9, and #10
6/9/2004	2360	202398	43-93	211706	Y	QC Files, Daily reports	Survey concrete pads of SUs #9 and #16, GWS of SU #16, soil sampling of SUs #25, #22, #2, #9, and #10

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Date	Instrument	S/N	Detector	S/N	QC File	Source of Info	Field Activity
6/9/2004	Micro Rem	B985Y	--	--	Y	QC Files, Daily reports	Survey concrete pads of SUs #9 and #16, GWS of SU #16, soil sampling of SUs #25, #22, #2, #9, and #10
6/10/2004	Model 3	79498	44-9	073106	Y	QC Files, Daily reports	Remediate hotspots in SUs #25 and #22, collect additional data and flag bias locations in SU #16, scan smear samples
6/10/2004	Model 3	166511	44-9	073107	Y	QC Files, Daily reports	Remediate hotspots in SUs #25 and #22, collect additional data and flag bias locations in SU #16, scan smear samples
6/10/2004	2929	171590	43-10-1	174813	Y	QC Files, Daily reports	Remediate hotspots in SUs #25 and #22, collect additional data and flag bias locations in SU #16, scan smear samples
6/10/2004	2360	184938	43-37	178371	Y	QC Files, Daily reports	Remediate hotspots in SUs #25 and #22, collect additional data and flag bias locations in SU #16, scan smear samples
6/10/2004	2360	202398	43-93	211706	Y	QC Files, Daily reports	Remediate hotspots in SUs #25 and #22, collect additional data and flag bias locations in SU #16, scan smear samples
6/10/2004	Micro Rem	B985Y	--	--	Y	QC Files, Daily reports	Remediate hotspots in SUs #25 and #22, collect additional data and flag bias locations in SU #16, scan smear samples
6/11/2004	Model 3	79498	44-9	073106	Y	QC Files, Daily reports	Complete GWS of remediated hotspots in SUs #2, #9, and #10, remediate hotspot and finish soil sampling in SU #16
6/11/2004	Model 3	166511	44-9	073107	Y	QC Files, Daily reports	Complete GWS of remediated hotspots in SUs #2, #9, and #10, remediate hotspot and finish soil sampling in SU #16
6/11/2004	2360	184938	43-37	178371	Y	QC Files, Daily reports	Complete GWS of remediated hotspots in SUs #2, #9, and #10, remediate hotspot and finish soil sampling in SU #16
6/11/2004	2360	202398	43-93	211706	Y	QC Files, Daily reports	Complete GWS of remediated hotspots in SUs #2, #9, and #10, remediate hotspot and finish soil sampling in SU #16
6/11/2004	Micro Rem	B985Y	--	--	Y	QC Files, Daily reports	Complete GWS of remediated hotspots in SUs #2, #9, and #10, remediate hotspot and finish soil sampling in SU #16
6/14/2004	Model 3	79498	44-9	073106	Y	QC Files, Daily reports	Identify and fill data gaps via additional GWS in 12 areas, collect duplicate soil samples in four areas, scan smear samples
6/14/2004	Model 3	166511	44-9	073107	Y	QC Files, Daily reports	Identify and fill data gaps via additional GWS in 12 areas, collect duplicate soil samples in four areas, scan smear samples
6/14/2004	2360	184938	43-37	178371	Y	QC Files, Daily reports	Identify and fill data gaps via additional GWS in 12 areas, collect duplicate soil samples in four areas, scan smear samples
6/14/2004	2360	202398	43-93	211706	Y	QC Files, Daily reports	Identify and fill data gaps via additional GWS in 12 areas, collect duplicate soil samples in four areas, scan smear samples
6/14/2004	Micro Rem	B985Y	--	--	Y	QC Files, Daily reports	Identify and fill data gaps via additional GWS in 12 areas, collect duplicate soil samples in four areas, scan smear samples
6/15/2004	Model 3	79498	44-9	073106	Y	QC Files, Daily reports	Complete data gap GWS, identify obstructed survey areas, intermodal container logistics
6/15/2004	Model 3	166511	44-9	073107	Y	QC Files, Daily reports	Complete data gap GWS, identify obstructed survey areas, intermodal container logistics
6/15/2004	2360	184938	43-37	178371	Y	QC Files, Daily reports	Complete data gap GWS, identify obstructed survey areas, intermodal container logistics
6/15/2004	2360	202398	43-93	211706	Y	QC Files, Daily reports	Complete data gap GWS, identify obstructed survey areas, intermodal container logistics
6/15/2004	Micro Rem	B985Y	--	--	Y	QC Files, Daily reports	Complete data gap GWS, identify obstructed survey areas, intermodal container logistics

Appendix G: Radiological Survey Maps

RADIOLOGICAL SURVEY MAP

Location:	North Floor (BARF)	RWP# PC-RP64A	Survey #	2	Survey Type:	Fixed -Smears

Smear Results DPM/100cm^2						1 Min Fixed Result			1 Min Fixed Result			
No.	α	β	No.	α	β		α (cpm)	β (cpm)		α (cpm)	β (cpm)	Comments
NF1	4.06	31.67				NF1	10	648				
NF2	5.30	40.00				NF2	12	661				
NF3	4.06	81.67				NF3	7	847				
NF4	0.37	21.25				NF4	11	878	NF4 Dup	3	889	
NF5	0.37	0.00				NF5	30	800				
NF6	4.06	4.58				NF6	4	675				
NF7	6.53	42.08				NF7	17	992				
NF8	0.37	27.50				NF8	12	689				
NF9	0.37	46.25				NF9	6	670				
NF10	0.37	27.50				NF10	12	944				
NF11	1.60	37.92				NF11	13	828				
NF12	0.37	48.33				NF12	10	673				
NF13	4.06	52.50				NF13	7	815				
NF14	1.60	46.25				NF14	4	719				
NF15	4.06	0.00				NF15	7	755	NF15 Dup	1	803	
NF16	0.00	2.50				NF16	3	842				
NF17	1.60	21.25				NF17	10	926				
NF18	0.37	23.33				NF18	17	721				
NF19	0.37	21.25				NF19	10	1131				
NF20	0.37	15.00				NF20	6	808				
NF21	0.00	21.25				NF21	4	758				
NF22	1.60	29.58				NF22	9	722	NF22 Dup	5	724	
NF23	4.06	8.75				NF23	8	699				
NF24	1.60	0.00				NF24	6	606				

Surveyed By: kp Date: 5/12/2003

Reviewed By: [signature] Date: 11/8/04

Instrument	Serial #	a Eff.	b Eff.	a Bkg.	b Bkg.	Cal. Due
2929	163827	~~0.4060~~	0.2400	7	828	1/21/2004
2360	193675	0.1207	0.2685	4	478	4/29/2004
2224-1	162425	0.20	0.20			

Key			
⬭	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
•	Direct Reading DPM/100 cm^2		
△	Grab Sample		

RADIOLOGICAL SURVEY MAP

Location: North Room North Wall	RWP#	Survey # 7	Survey Type: Fixed -Smears

Smear Results DPM/100cm^2							1 Min Fixed Result				1 Min Fixed Result		Comments
No.	α	β	No.	α	β			α (cpm)	β (cpm)		α (cpm)	β (cpm)	
NRNW1	1.52	5.42					NRNW1	12	697				
NRNW2	3.70	36.67					NRNW2	4	663				
NRNW3	1.52	26.25					NRNW3	4	624				
NRNW4	2.61	-0.83					NRNW4	2	635				
NRNW5	2.61	24.17					NRNW5	1	591				
NRNW6	0.43	45.00					NRNW6	3	560				
							D-NRNW1	10	619				
							NRNWU19	2	89				SCAN 0/90
							NRNWU20	2	97				SCAN 0/100

Surveyed By: by K Pagliaro Date: 5/13/2003

Reviewed By: [signature] Date: 11/5/04

Instrument	Serial #	a Eff.	b Eff.	a Bkg.	b Bkg	Cal. Due
2929	163827	0.4000	0.2400	6	844	1/24/2004
2360	193675	0.1100 (circled; → 0.17)	0.2500	3	560	4/29/2004
2224-1	162425	0.20	0.20	3	560	4/15/2004

Key			
○	Smear	⁺-⁺	Boundary
□	Dose Rate mr/hr	■	A/S Location
•	Direct Reading DPM/100 cm^2		
△	Grab Sample		

RADIOLOGICAL SURVEY MAP

Location: North Room South Wall | RWP# | Survey # 9 | Survey Type: Fixed -Smears

Smear Results DPM/100cm^2							1 Min Fixed Result				1 Min Fixed Result		Comments
No.	α	β	No.	α	β			α (cpm)	β (cpm)			α (cpm)	β (cpm)	
NRSW11	-0.65	17.92					NRSW11	4	678					
NRSW12	3.70	84.58					NRSW12	9	639					
NRSW13	-0.65	30.42					NRSW13	5	632					
NRSW14	2.61	61.67					NRSW14	3	583					
NRSW15	0.43	38.75					NRSW15	4	589					
NRSW16	1.52	34.58					NRSW16	5	659					
							D-NRSW12	10	677					
NRSWU12	1.72	17.50					NRSWU12	1	94					SCAN 0/80
NRSWU13	2.96	-17.92					NRSWU13	1	86					SCAN 0/90
NRSWU14	0.49	52.92					NRSWU14	2	84					SCAN 0/100
NRSWU15	2.96	27.92					NRSWU15	1	91					SCAN 0/100

Surveyed By: by K. Pagliaro
Date: 5/13/2003

Reviewed By: [signature] Date: 11/5/04

Instrument	Serial #	a Eff.	b Eff.	a Bkg.	b Bkg	Cal. Due
2929	163827	0.4060	0.2400	6	844	1/24/2004
2360	193675	0.1100 (0.17)	0.2500	3	560	4/29/2004
22241	162725	0.20	0.20	3	560	4/15/04

Key:
- ○ Smear
- ☐ Dose Rate mr/hr
- • Direct Reading DPM/100 cm^2
- △ Grab Sample
- Boundary
- ■ A/S Location

RADIOLOGICAL SURVEY MAP

Location: North Room East Wall | RWP# | Survey # 8 | Survey Type: Fixed -Smears

Smear Results DPM/100cm^2							1 Min Fixed Result					1 Min Fixed Result		Comments
No.	α	β	No.	α	β			α (cpm)	β (cpm)			α (cpm)	β (cpm)	
NREW7	2.61	30.42					NREW7	2	711					
NREW8	0.43	34.58					NREW8	5	676					
NREW9	1.52	15.83					NREW9	6	673					
NREW10	-0.65	3.33					NREW10	7	691					
							D-NREW10	4	594					
NREWU18	0.5	7.1					NREWU18	2	94					SCAN 0/80

Surveyed By: K. Pagliaro Date: 5/13/2003

Reviewed By: HW Siegrist Date: ~~11/4/04~~ 11/5/04

Instrument	Serial #	a Eff.	b Eff.	a Bkg.	b Bkg	Cal. Due
2929	163827	0.4060	0.2400	6	844	1/24/2004
2360	193675	0.1100 (0.17)	0.2500	3	560	4/29/2004
2224-1	162425	0.20	0.20	3	560	4/15/04

Key

○	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
•	Direct Reading DPM/100 cm^2		
△	Grab Sample		

RADIOLOGICAL SURVEY MAP

Location:	NorthRoom West Wall	RWP#	Survey #	10	Survey Type:	Fixed -Smears

Smear Results DPM/100cm^2							1 Min Fixed Result				1 Min Fixed Result		Comments
No.	α	β	No.	α	β			α (cpm)	β (cpm)		α (cpm)	β (cpm)	
NRWW17	2.61	9.58					NRWW17	7	699				
NRWW18	3.70	49.17					NRWW18	5	709				
NRWW19	-0.65	9.58					NRWW19	7	644				
NRWW20	3.70	32.50					NRWW20	4	547				
							D-NRWW17	4	699				

Surveyed By: by K. Pagliaro Date: 5/13/2003

Reviewed By: HW Sigrist Date: 11/5/04

0,17

Instrument	Serial #	a Eff.	b Eff.	a Bkg.	b Bkg	Cal. Due
2929	163827	0.4060	0.2400	6	844	1/24/2004
2360	193675	0.1100	0.2500	3	560	4/29/2004

Key			
○	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

RADIOLOGICAL SURVEY MAP

Location: North Room Ceiling	RWP#	Survey # 12	Survey Type: Fixed -Smears

Smear Results DPM/100cm^2						1 Min Fixed Result			1 Min Fixed Result		Comments
No.	α	β	No.	α	β		α (cpm)	β (cpm)	α (cpm)	β (cpm)	
NRCU16	-0.74	9.17				NRCU16	0	85			SCAN 0/80
NRCU17	2.96	2.92				NRCU17	0	112			SCAN 0/100

Surveyed By: K. Pagliero Date: 5/15/03

Reviewed By: HW Siegrist Date: 11/5/04

Instrument	Serial #	a Eff.	b Eff.	a Bkg.	b Bkg	Cal. Due
2929	163827	0.4060	0.2400	7	828	1/24/2004
2224-1	162426	0.1919 (0.20)	0.1165 (0.20)	~~4~~ 3	~~99~~ 560	1/15/2004

Key			
○	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

RADIOLOGICAL SURVEY MAP

Location: South Floor (BARF)

RWP# PC-RP64A

Survey # 1

Survey Type: Fixed -Smears

Smear Results DPM/100cm^2 No.	α	β	1 Min Fixed Result No.	α (cpm)	β (cpm)	Dup No.	1 Min Fixed Result α (cpm)	β (cpm)	Comments
SF1	5.30	50.42	SF1	4	791	SF1 Dup	14	764	
SF2	0.00	42.08	SF2	20	779				
SF3	0.37	25.42	SF3	9	700				
SF4	1.60	56.67	SF4	18	665				
SF5	1.60	27.50	SF5	10	681				
SF6	6.53	46.25	SF6	16	675				
SF7	0.37	17.08	SF7	9	660				
SF8	1.60	25.42	SF8	10	734				
SF9	1.60	42.08	SF9	8	819				
SF10	4.06	69.17	SF10	9	864				
SF11	5.30	71.25	SF11	11	922				
SF12	0.00	0.00	SF12	6	686	SF12 Dup	4	695	
SF13	0.37	71.25	SF13	10	687				
SF14	1.60	50.42	SF14	4	696				
SF15	1.60	15.00	SF15	9	783				
SF16	0.37	4.58	SF16	6	846				
SF17	0.00	40.00	SF17	11	730				
SF18	4.06	4.58	SF18	7	713				
SF19	1.60	21.25	SF19	11	633				
SF20	1.60	0.42	SF20	10	720				
SF21	1.60	4.58	SF21	10	1029				
SF22	0.37	42.08	SF22	5	853				
SF23	1.60	27.50	SF23	9	761				
SF24	2.83	25.42	SF24	7	734	SF24 Dup	10	745	

Surveyed By: kp Date: 5/12/2003

Reviewed By: [signature] Date: 11/8/04

Instrument	Serial #	a Eff.	b Eff.	a Bkg	b Bkg	Cal. Due
2929	163827	0.4060	0.2400	7	828	1/21/2004
2360	193675	0.1207	0.2685	4	478	4/29/2004
2224-1	162 425	0.120	0.120	3	560	4/15/2004

0.17

0.25

Key

⬭	Smear	⁘	Boundary
☐	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

RADIOLOGICAL SURVEY MAP

Location: South Room North Wall	RWP#	Survey # 3	Survey Type: Fixed -Smears

Smear Results DPM/100cm^2					
No.	α	β	No.	α	β
SRNW1	1.52	22.08			
SRNW2	2.61	-7.08			
SRNW3	0.43	24.17			
SRNW4	0.43	7.50			
SRNW5	-0.65	20.00			
SRNW6	1.52	-2.92			
SRNWU9	-0.87	-14.38			
SRNWU10	0.22	-14.38			
SRNWU11	0.22	8.54			

	1 Min Fixed Result 641	β (cpm)			1 Min Fixed Result α (cpm)	β (cpm)	Comments
SRNW1	7	642					
SRNW2	4	616					
SRNW3	4	586					
SRNW4	5	641					
SRNW5	4	620					
SRNW6	3	604					
D-SRNW1	5	655					
SRNWU9	0	70					Scan: 0/50
SRNWU10	3	87					Scan: 0/75
SRNWU11	0	77					Scan: 0/75
D-SRNWU11	1	89					

Surveyed By: by K. Pagliaro Date: 5/13/2003

Reviewed By: [signature] Date: 11/5/04

Instrument	Serial #	a Eff.	b Eff.	a Bkg.	b Bkg	Cal. Due
2929	163827	0.4060 (0.17)	0.2400	7	828	1/24/2004
2360	193675	0.1100	0.2500	3	560	4/29/2004
2224-1	162426	0.1919 (0.20)	0.1165 (0.120)	~~1~~ 3	~~99~~ 560	1/15/2004

Key			
⬭	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
•	Direct Reading DPM/100 cm^2		
△	Grab Sample		

RADIOLOGICAL SURVEY MAP

Location:	South Room South Wall	RWP#	Survey #	5	Survey Type:	Fixed -Smears

Smear Results DPM/100cm^2 No.	α	β	No.	α	β	1 Min Fixed Result No.	α (cpm)	β (cpm)	1 Min Fixed Result α (cpm)	β (cpm)	Comments
SRSW11	1.41	-10.00				SRSW11	2	609			
SRSW12	0.33	33.75				SRSW12	3	686			
SRSW13	2.50	29.58				SRSW13	3	599			
SRSW14	2.50	21.25				SRSW14	1	606			
SRSW15	1.41	-7.92				SRSW15	3	626			
SRSW16	2.50	31.67				SRSW16	2	596			
SRSWU1	-1	-10				D-SRSW12	10	731			
SRSWU2	0	-31				SRSWU1	2	88			Scan : 0/90
SRSWU3	2	-14				SRSWU2	2	97			Scan: 0/90
						SRSWU3	1	92			Scan: 0/85

Surveyed By: by K. Pagliaro Date: ~~5/13/2003~~ 5/12/03

Reviewed By: [signature] Date: 11/5/04

Instrument	Serial #	a Eff.	b Eff.	a Bkg.	b Bkg	Cal. Due
2929	163827	0.4060	0.2400	7	828	1/24/2004
2360	193675	~~0.1100~~ 0.117	0.2500	3	560	4/29/2004
2224-1	162426	0.1919	0.1165	~~7~~ 3	~~99~~ 560	1/15/2004

Key:
- ⬭ Smear
- ☐ Dose Rate mr/hr
- • Direct Reading DPM/100 cm^2
- △ Grab Sample
- Boundary
- ■ A/S Location

RADIOLOGICAL SURVEY MAP

Location: South Room East Wall | RWP#: | Survey #: 4 | Survey Type: Fixed -Smears

Smear Results DPM/100cm^2					
No.	α	β	No.	α	β
SREW7	1.41	25.42			
SREW8	-0.76	-3.75			
SREW9	3.59	44.17			
SREW10	0.33	12.92			
SREWU5	0	-2			
SREWU6	2	2			

	1 Min Fixed Result α (cpm)	β (cpm)			1 Min Fixed Result α (cpm)	β (cpm)	Comments
SREW7	1	649					
SREW8	0	691					
SREW9	3	700					
SREW10	7	675					
D - SREW10	6	674					
SREWU5	0	94					Scan : 0/100
SREWU6	1	104					Scan : 0/100

Surveyed By: K Pugliaro (signature) Date: 5/13/2003

Reviewed By: (signature) Date: 11/5/04

Instrument	Serial #	a Eff.	b Eff.	a Bkg.	b Bkg	Cal. Due
2929	163827	0.4060	0.2400	7	828	1/24/2004
2360	193675	0.1100 0.17	0.2500	3	560	4/29/2004
2224-1	162426	0.1919	0.1165	~~1~~ 3	~~99~~ 560	1/15/2004

Key			
⬭	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

RADIOLOGICAL SURVEY MAP

Location:	South Room West Wall	RWP#	Survey #	6	Survey Type:	Fixed -Smears

Smear Results DPM/100cm^2

No.	α	β	No.	α	β
SRWW17	-0.76	15.00			
SRWW18	1.41	42.08			
SRWW19	1.41	19.17			
SRWW20	-0.76	2.50			
SRWWU8	-1	-41			

1 Min Fixed Result

	α (cpm)	β (cpm)			α (cpm)	β (cpm)	Comments
SRWW17	1	750					
SRWW18	3	681					
SRWW19	7	647					
SRWW20	2	702					
D-SRWW19	8	566					
SRWWU8	0	80					Scan: 0/75

Bkg
α β
8/819 for 5/14/03
for 5/12/03

0.17

Surveyed By: Jay K. Peghiaro Date: ~~5/13/2003~~ 5/12/03 + 5/14/03

Reviewed By: [signature] Date: 11/5/04

Instrument	Serial #	a Eff.	b Eff.	a Bkg.	b Bkg	Cal. Due
2929	163827	0.4060	0.2400	7	828	1/24/2004
2360	193675	0.1100	0.2500	3	560	4/29/2004
2224-1	162426	0.1919	0.1165	~~1~~ 3	~~99~~ 300	1/15/2004

0.20 0.20

Key

○	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
•	Direct Reading DPM/100 cm^2		
△	Grab Sample		

RADIOLOGICAL SURVEY MAP

Location:	South Room Ceiling	RWP#	Survey #	11	Survey Type:	Fixed -Smears

Smear Results DPM/100cm^2							1 Min Fixed Result					1 Min Fixed Result		Comments
								α (cpm)	β (cpm)			α (cpm)	β (cpm)	
No.	α	β	No.	α	β									
SRC4	1.30	-12.29					SRC4	0	105					Scan : 0/90
SRC7	-0.87	10.63					SRC7	1	100					Scan: 0/100

Surveyed By:	Date:	Instrument	Serial #	a Eff.	b Eff.	a Bkg	b Bkg	Cal. Due	Key			
by K Pagliaro	5/14/2003	2929	163827	0.4060	0.2400	7 (8)	828 (819)	1/24/2004	⬭	Smear	*-*	Boundary
		2224-1	162426	0.1919	0.1165	1	99	1/15/2004	☐	Dose Rate mr/hr	■	A/S Location
Reviewed By: [signature]	Date: 11/5/04			0.120	0.120				*	Direct Reading DPM/100 cm^2		
									△	Grab Sample		

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 2 North Floor	RWP#	Survey # 20	Survey Type: Static/Smear

Smear Results DPM/100cm^2

No.	α	β	No.	α	β
1	-0.3	11.8	26		
2	1.2	-0.7	27		
3	2.7	-9.7	28		
4	-0.3	-4.3	29		
5	-0.3	6.5	30		
6	-0.3	-0.7	31		
7	1.2	-11.5	32		
8	-0.3	-9.7	33		
9	1.2	15.4	34		
10	1.2	-13.3	35		
11	2.7	-4.3	36		
12	-0.3	-15.1	37		
13	1.2	19.0	38		
14	-0.3	6.5	39		
15	-0.3	-11.5	40		
16	-0.3	15.4	41		
17	1.2	-11.5	42		
18	-0.3	-15.1	43		
19	-0.3	-6.1	44		
20	-0.3	-13.3	45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

AVG Scan Result / 1 Min Fixed Result

AVG Scan α (cpm)	AVG Scan β (cpm)	No.	1 Min Fixed α (cpm)	1 Min Fixed β (cpm)	Comments
		1	8	829	WR2-NF-1
		2	7	1121	NF-2
		3	10	1345	NF-3
		4	9	1500	NF-4
		5	5	729	NF-5
		6	7	659	NF-6
		7	5	580	NF-7
		8	12	857	NF-8
		9	5	871	NF-9
		10	6	917	NF-10
		11	4	593	NF-11
		12	5	556	NF-12
		13	4	696	NF-13
		14	9	686	NF-14
		15	15	778	NF-15
		16	11	689	NF-16
		17	7	627	NF-17
		18	6	698	NF-18
		19	12	612	NF-19
		20	5	713	NF-20

STET HWS 8/19

Surveyed By: KP Date: 3/31/2004*

By KP 6/27/2003*

Reviewed By: HW Seigrist Date: 11/8/04

Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
2929	180830	0.33	0.28	2	994	12/15/04
2360	193675	0.17	0.25	4	854	4/29/04

Key

Symbol	Meaning	Symbol	Meaning
○	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

* Note: Smear sample analysis via 2929 were ~~taken and~~ HWS analyzed March 2004
Direct Frisk using floor monitor 43-37 probe were taken and analyzed during work in June 2003

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 2 South Floor	RWP#	Survey # 19	Survey Type: Static/Smear

Smear Results DPM/100cm^2

No.	α	β	No.	α	β
1	-0.3	-6.1	26		
2	-0.3	4.7	27		
3	-0.3	-7.9	28		
4	1.2	-11.5	29		
5	2.7	-31.2	30		
6	-0.3	-2.5	31		
7	-0.3	-9.7	32		
8	-0.3	-13.3	33		
9	-0.3	11.8	34		
10	-0.3	-0.7	35		
11	-0.3	-27.6	36		
12	-0.3	-4.3	37		
13	-0.3	-0.7	38		
14	2.7	8.2	39		
15	2.7	-7.9	40		
16	-0.3	-11.5	41		
17	-0.3	-4.3	42		
18	-0.3	-9.7	43		
19	1.2	-15.1	44		
20	1.2	-24.0	45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

AVG Scan Result: α (cpm) | β (cpm)

1 Min Fixed Result

	α (cpm)	β (cpm)	Comments
1	5	594	WR2-SF-1
2	7	703	SF-2
3	4	687	SF-3
4	10	673	SF-4
5	9	692	SF-5
6	7	694	SF-6
7	7	741	SF-7
8	12	1272	SF-8
9	7	1147	SF-9
10	5	921	SF-10
11	8	827	SF-11
12	3	712	SF-12
13	9	802	SF-13
14	6	753	SF-14
15	11	769	SF-15
16	10	652	SF-~~1~~16
17	5	696	SF-17
18	6	723	SF-18
19	4	649	SF-19
20	8	698	SF-20

STET HWS

Surveyed By	Date	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
KP	3/31/2004* →	2929	180830	0.33	0.28	2	~~994~~ 819	12/15/04
by KP	6/27/04* →	2360	193675	0.17	0.25	~~4~~ 5	~~854~~	4/29/04

Reviewed By: HW Seeguist Date: 11/8/04

Key

○	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

*Note: Smear Sample analysis via 2929 were ~~taken and~~ analyzed March 2004 HWS

Direct Frisk using Floor Monitor 43-37 Probe were taken & analyzed during work in June 2003

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 2 North Wall	RWP#	Survey # 21	Survey Type: Static/Smear

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	-0.3	26.2	34		
10			35		
11	1.2	-11.5	36		
12			37		
13	-0.3	-27.6	38		
14			39		
15	-0.3	-2.5	40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

AVG Scan Result

	α (cpm)	β (cpm)
WR2-NW-1		
WR2-NW-2		
WR2-NW-3		
WR2-NW-4		

1 Min Fixed Result

No.	α (cpm)	β (cpm)	Comments
1			
2			
3			
4			
5			
6			
7			
8			
9	14	543	North Wall
10			
11	9	523	North Wall
12			
13	8	530	North Wall
14			
15	7	517	North wall
16			
17			
18			
19			
20			

Surveyed By: KP Date: 3/31/2004*
by KP 6/27/04*
Reviewed By: HWkrogrist Date: 11/8/04

Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
2929	180830	0.33	0.28	2	994	12/15/04
2360	193675	0.17	0.25	(4) 5	854	4/29/04

Key

○	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

* Note: Smear sample analysis via 2929 were ~~taken~~ HWS analyzed MARCH 2004
Direct Frisk using floor monitor 43-37 probe were taken + analyzed during work in June 2003

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 2 South Wall	RWP#	Survey # 23	Survey Type: Static/Smear

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	-0.3	-36.6	35		
11			36		
12	-0.3	-9.7	37		
13			38		
14	1.2	-4.3	39		
15			40		
16	1.2	-13.3	41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

AVG Scan Result / 1 Min Fixed Result

AVG Scan	α (cpm)	β (cpm)	No.	α (cpm)	β (cpm)	Comments
			1			
			2			
			3			
			4			
			5			
			6			
			7			
			8			
			9			
			10	6	545	South wall
WR2-SW-1			11			
			12	5	525	South wall
WR2-SW-2			13			
			14	9	499	South wall
WR2-SW-3			15			
			16	11	573	South wall
WR2-SW-4			17			
			18			
			19			
			20			
			21			
			22			
			23			
			24			
			25			

Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
KP	3/31/2004* →	2929	180830	0.33	0.28	2	994	12/15/04
by KP	6/27/2003* →	2360	193675	0.17	0.25	(4) 5	854	4/29/04
Reviewed By: HW [signature]	Date: 11/8/04							

Key

Symbol	Meaning	Symbol	Meaning
⬭	Smear	*_*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

* Note: Smear sample analysis via 2929 were ~~taken &~~ HW analyzed March 2004

Direct Frisk using floor monitor 43-37 probe were taken & analyzed during work in June 2003

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 2 East Wall	RWP#	Survey # 22	Survey Type: Static/Smear

Smear Results DPM/100cm^2						AVG Scan Result				1 Min Fixed Result			Comments
No.	α	β	No.	α	β		α (cpm)	β (cpm)			α (cpm)	β (cpm)	
										1			
1			26							2			
2			27							3			
3			28							4			
4			29							5			
5			30							6			
6			31							7			
7			32							8			
8			33							9			
9			34							10			
10			35							11			
11			36							12			
12			37							13			
13			38							14			
14			39							15			
15			40							16			
16			41							17	11	561	East Wall
17	1.2	6.5	42			WR2-EW-1				18	9	602	East Wall
18	1.2	-29.4	43			WR2-EW-2				19	14	581	East Wall
19	-0.3	-0.7	44			WR2-EW-3				20	9	574	East Wall
20	-0.3	-7.9	45			WR2-EW-4				21	6	550	East Wall
21	2.7	-15.1	46			WR2-EW-5				22	7	568	East Wall
22	1.2	-6.1	47			WR2-EW-6				23	8	578	East Wall
23	1.2	-11.5	48			WR2-EW-7				24	5	583	East Wall
24	-0.3	-9.7	49			WR2-EW-8				25			
25			50										

Comments

Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
KP	3/31/2004* →	2929	180830	0.33	0.28	2	994	12/15/04
by KP	6/27/03* →	2360	193675	0.17	0.25	4 (5)	854	4/29/04
Reviewed By: [signature]	Date: 11/8/04							

Key			
○	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

* Note: Smear sample analysis via 2929 were ~~taken~~ & analyzed March 2004
Direct Frisk using Floor Monitor 43-37 probe were taken & analyzed during work in June 2003

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 2 West Wall	RWP#	Survey # 24	Survey Type: Static/Smear

Smear Results DPM/100cm^2						AVG Scan Result				1 Min Fixed Result		Comments
No.	α	β	No.	α	β		α (cpm)	β (cpm)			α (cpm)	β (cpm)	
1	-0.3	-0.7	26			WR2-WW-1				1	8	581	West Wall
2	-0.3	-2.5	27			-WW-2				2	12	589	↓
3	-0.3	-11.5	28			-WW-3				3	10	545	
4	1.2	-4.3	29			-WW-4				4	11	503	
5	-0.3	10.0	30			-WW-5				5	5	574	
6	1.2	-7.9	31			-WW-6				6	10	560	
7	-0.3	-11.5	32			-WW-7				7	8	582	
8	1.2	-6.1	33			-WW-8				8	8	555	
9			34							9			
10			35							10			
11			36							11			
12			37							12			
13			38							13			
14			39							14			
15			40							15			
16			41							16			
17			42							17			
18			43							18			
19			44							19			
20			45							20			
21			46							21			
22			47							22			
23			48							23			
24			49							24			
25			50							25			

Comments

Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
KP	3/31/2004* →	2929	180830	0.33	0.28	~~2~~ 5	994	12/15/04
by KP	6/27/03* →	2360	193675	0.17	0.25	(4)	854	4/29/04
Reviewed By:	Date:							
[signature]	11/8/04							

Key

Symbol	Meaning	Symbol	Meaning
○	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

* Note: Smear sample analysis via 2929 were ~~taken and~~ they analyzed March 2004
Direct Frisk using floor monitor 43-37 probe were taken & analyzed during work in June 2003

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 2 Ceiling	RWP#	Survey # 25	Survey Type: Static/Smear

Smear Results DPM/100cm^2

No.	α	β	No.	α	β
1	-0.3	-16.8	26		
2	1.2	-18.6	27		
3	-0.3	-15.0	28		
4	-0.3	-16.8	29		
5	2.7	-29.3	30		
6	-0.3	-18.6	31		
7	1.2	8.2	32		
8	-0.3	15.4	33		
9	-0.3	-6.1	34		
10	1.2	-2.5	35		
11	1.2	-16.8	36		
12	-0.3	-0.7	37		
13	-0.3	-11.4	38		
14	-0.3	-27.5	39		
15	-0.3	-40.0	40		
16	1.2	-38.2	41		
17	-0.3	-18.6	42		
18	1.2	-9.6	43		
19	-0.3	-7.9	44		
20	-0.3	-6.1	45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

AVG Scan Result α (cpm)	AVG Scan Result β (cpm)	No.	1 Min Fixed Result α (cpm)	1 Min Fixed Result β (cpm)	Comments
		1	0	79	East Wall
		2	0	104	East Wall
		3	2	86	East Wall
		4	1	78	East Wall
		5	1	100	North Wall
		6	2	77	Ceiling
		7	0	84	Ceiling
		8	0	93	Ceiling
		9	0	96	Ceiling
		10	1	82	South Wall
		11	0	85	North Wall
		12	0	91	Ceiling
		13	1	92	Ceiling
		14	1	98	Ceiling
		15	2	97	Ceiling
		16	0	92	South Wall
		17	0	91	West Wall
		18	2	105	West Wall
		19	0	98	West Wall
		20	1	72	West Wall
		21			
		22			
		23			
		24			
		25			

0.20 0 0 No Bkg determined in field & conservatively use 0 bkg

Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
KP	3/31/2004* →	2929	180830	0.33	~~0.28~~	~~2~~	~~994~~	12/15/04
by KP	6/26/03* →	2224	162426	0.2	0.15	4	819	12/27/04

Reviewed By: [signature] Date: 11/8/04

Key

Symbol	Meaning	Symbol	Meaning
⬭	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

* Note: Smear sample analysis via 2929 were analyzed March 2004
direct frisk using floor monitor 43-89 probe were taken & analyzed during work in March 2003

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 3 North Floor	RWP#	Survey # 27	Survey Type: Static/Smear

Smear Results – DPM/100cm^2

No.	α	β	No.	α	β
1	0.9	-8.1	26		
2	-0.6	0.9	27		
3	-0.6	8.1	28		
4	-0.6	-11.7	29		
5	0.9	-13.4	30		
6	-0.6	-0.9	31		
7	-0.6	0.9	32		
8	-0.6	9.9	33		
9	-0.6	8.1	34		
10	-0.6	-9.9	35		
11	0.9	-13.4	36		
12	-0.6	-4.5	37		
13	0.9	20.6	38		
14	0.9	-6.3	39		
15	-0.6	-15.2	40		
16	0.9	-36.8	41		
17	-0.6	-11.7	42		
18	-0.6	-4.5	43		
19	0.9	-13.4	44		
20	-0.6	-2.7	45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

AVG Scan Result — α (cpm) | β (cpm)

1 Min Fixed Result

	α (cpm)	β (cpm)	Comments
1	3	525	WR3 -NF-1
2	1	605	NF-2
3	2	548	NF-3
4	4	606	NF-4
5	3	613	NF-5
6	8	637	NF-6
7	10	634	NF-7
8	8	588	NF-8
9	6	589	NF-9
10	11	621 → 640	NF-10
11	8	621	NF-11
12	7	602	NF-12
13	6	617	NF-13
14	5	740	NF-14
15	5	569	NF-15
16	8	552	NF-16
17	12	558	NF-17
18	10	781	NF-18
19	8	601	NF-19
20	15	639	NF-20

STET HWS 5

Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
KP	3/30/2004* →	2929	180830	0.33	0.28	4	965	12/15/04
by KP	6/25/03* →	2360	193675	0.17	0.25	4	854	4/29/04

Reviewed By: HWS [signature] Date: 11/8/04

Key

○	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

* Note: smear sample analysis via 2929 were ~~taken~~ HWS + analyzed MARCH 2004
Direct Frisk using floor monitor 43-37 probe were taken + analyzed during work in June 2003

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 3 South Floor	RWP#	Survey # 26	Survey Type: Static/Smear

Smear Results (DPM/100cm^2)

No.	α	β	No.	α	β
1	-0.6	9.9	26		
2	-0.6	0.9	27		
3	-0.6	6.3	28		
4	-0.6	-36.8	29		
5	-0.6	-26.0	30		
6	-0.6	-6.3	31		
7	-0.6	-42.1	32		
8	-0.6	-29.6	33		
9	-0.6	24.2	34		
10	-0.6	-0.9	35		
11	-0.6	8.1	36		
12	-0.6	4.5	37		
13	-0.6	-18.8	38		
14	-0.6	-31.4	39		
15	-0.6	11.7	40		
16	-0.6	-33.2	41		
17	-0.6	-8.1	42		
18	-0.6	9.9	43		
19	-0.6	-0.9	44		
20	-0.6	-4.5	45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

AVG Scan Result α (cpm)	AVG Scan Result β (cpm)		No.	1 Min Fixed Result α (cpm)	1 Min Fixed Result β (cpm)	Comments
			1	5	808	WR3 -SF-1
			2	3	758	-2
			3	6	561	-3
			4	7	1005	-4
			5	2	258	-5
			6	2	647	-6
			7	3	665	-7
			8	1	569	-8
			9	6	880	-9
			10	4	940	-10
			11	2	558	-11
			12	3	551	-12
			13	2	434	-13
			14	4	1283	-14
			15	7	1076	-15
			16	4	572	-16
			17	4	620	-17
			18	4	576	-18
			19	7	683	-19
			20	4	664	-20
			21			
			22			
			23			
			24			
			25			

5 866

Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
KP	3/30/2004*	2929	180830	0.33	0.28	4	965	12/15/04
by KP	6/23/03*	2360	193675	0.17	0.25	4	854	4/29/04
Reviewed By:	Date:							
HW [signature]	11/8/04							

Key

Symbol	Meaning	Symbol	Meaning
⬭	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

* Note: Smear sample analysis via 2929 were ~~taken~~ HWS & analyzed March 2004
Direct frisk using floor monitor 43-37 were taken & analyzed during work in 2003

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 3 North Wall	RWP#	Survey # 28	Survey Type: Static/Smear

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	-0.6	-164	34		
10			35		
11	-0.6	-26.0	36		
12			37		
13	2.4	-20.6	38		
14			39		
15	-0.6	2.7	40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

AVG Scan Result α (cpm) | β (cpm)

1 Min Fixed Result

	α (cpm)	β (cpm)	Comments
1			
2			
3			
4			
5			
6			
7			
8			
9	4	757	North Wall
10			
11	5	781	North Wall
12			
13	9	988	North Wall
14			
15	6	794	North Wall
16			
17			
18			
19			
20			

Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
KP	3/30/2004* →	2929	180830	0.33	0.28	4	965	12/15/04
by KP	6/25/04* →	2360	193675	0.17	0.25	(4) 5	854	4/29/04
Reviewed By:	Date:							
HW Siegrist	11/8/04							

Key

Symbol	Meaning	Symbol	Meaning
⬭	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

* Note: Smear sample analysis via 2929 analyzed in March 2004
direct frisk using floor monitor 43-37 probe were taken & analyzed during work in June 2003

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 3 South Wall	RWP#	Survey # 30	Survey Type: Static/Smear

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	-0.6	-4.5	35		
11			36		
12	-0.6	-8.1	37		
13			38		
14	2.4	-2.7	39		
15			40		
16	0.9	-27.8	41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

AVG Scan Result	α (cpm)	β (cpm)		No.	1 Min Fixed Result α (cpm)	β (cpm)	Comments
				1			
				2			
				3			
				4			
				5			
				6			
				7			
				8			
				9			
				10	5	861	South wall
WR3 -SW -1				11			
				12	9	1206	South wall
-2				13			
				14	4	1102	South wall
-3				15			
				16	5	974	South wall
-4				17			
				18			
				19			
				20			
				21			
				22			
				23			
				24			
				25			

Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
KP	3/30/2004* →	2929	180830	0.33	0.28	4	965	12/15/04
By KP	6/25/04* →	2360	193675	0.17	0.25	(4) 5	854	4/29/04
Reviewed By:	Date:							
Hvstegnist	11/8/04							

Key

Symbol	Meaning	Symbol	Meaning
○	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

* Note: Smear Samples analyzed via 2929 were analyzed in March 2004
Direct frisk using floor monitor 43-37 probe were taken & analyzed during work in June 2003

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 3 East Wall	RWP#	Survey # 29	Survey Type: Static/Smear

Smear Results — DPM/100cm^2

No.	α	β	No.	α	β
1	-0.6	38.5	26		
2	0.9	4.5	27		
3	2.4	-17.0	28		
4	-0.6	8.1	29		
5	-0.6	-8.1	30		
6	0.9	17.0	31		
7	-0.6	-6.3	32		
8	-0.6	-13.4	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

AVG Scan Result / 1 Min Fixed Result

	AVG Scan α (cpm)	AVG Scan β (cpm)		No.	1 Min Fixed α (cpm)	1 Min Fixed β (cpm)	Comments
WR3-EW-1				1	7	516	East wall
-2				2	5	558	↓
-3				3	5	539	
-4				4	2	617	
-5				5	6	1348	
-6				6	2	582	
-7				7	5	886	
-8				8	5	1212	
				9			
				10			
				11			
				12			
				13			
				14			
				15			
				16			
				17			
				18			
				19			
				20			
				21			
				22			
				23			
				24			
				25			

Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
KP	3/30/2004*	2929	180830	0.33	0.28	4 (5)	965	12/15/04
by Kp	6/25/04*	2360	193675	0.17	0.25	(4)	854	4/29/04
Reviewed By:	**Date:**							
HW Sargent	11/8/04							

Key

Symbol	Meaning	Symbol	Meaning
⬭	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

* Note: smear sample analysis via 2929 were analyzed March 2004
Direct frisk using floor monitor 43-37 probe were taken & analyzed during work in June 2003

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 3 West Wall	RWP#	Survey # 31	Survey Type: Static/Smear

Smear Results DPM/100cm^2 No.	α	β	No.	α	β	AVG Scan Result α (cpm)	AVG Scan Result β (cpm)	1 Min Fixed Result No.	α (cpm)	β (cpm)	Comments
								1			
1			26					2			
2			27					3			
3			28					4			
4			29					5			
5			30					6			
6			31					7			
7			32					8			
8			33					9			
9			34					10			
10			35					11			
11			36					12			
12			37					13			
13			38					14			
14			39					15			
15			40					16			
16			41					17	7	521	
17	-0.6	-11.7	42					18	5	538	
18	0.9	-15.2	43					19	3	508	
19	-0.6	15.2	44					20	3	448	
20	-0.6	-22.4	45					21	6	613	
21	0.9	-13.4	46					22	5	541	
22	-0.6	9.9	47					23	4	527	
23	-0.6	-13.4	48					24	4	542	
24	0.9	-8.1	49					25			
25			50								

Comments

Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
KP	3/30/2004*	→ 2929	180830	0.33	0.28	4	965	12/15/04
by KP	6/25/03*	→ 2360	193675	0.17	0.25	~~4~~ 5	854	4/29/04
Reviewed By:	Date:							
HW Siegrist	11/8/04							

Key			
○	Smear	*-*	Boundary
□	Dose Rate mr/hr	■	A/S Location
*	Direct Reading DPM/100 cm^2		
△	Grab Sample		

*Note: Smear sample analysis via 2929 were analyzed March 2004; direct frisk, using floor monitor, 43-37 probe, were taken & analyzed during work in June 2003

RADIOLOGICAL SURVEY MAP

Location: Wash Rack 3 Ceiling	RWP#	Survey # 32	Survey Type: Static/Smear

Smear Results DPM/100cm^2					
No.	α	β	No.	α	β
1	-0.6	0.9	26		
2	-0.6	-9.9	27		
3	0.9	4.5	28		
4	0.9	11.7	29		
5	-0.6	-31.4	30		
6	-0.6	6.3	31		
7	0.9	-13.4	32		
8	0.9	-9.9	33		
9	-0.6	-8.1	34		
10	-0.6	-22.4	35		
11	0.9	17.0	36		
12	-0.6	20.6	37		
13	-0.6	-8.1	38		
14	-0.6	-9.9	39		
15	0.9	0.9	40		
16	-0.6	8.1	41		
17	-0.6	-4.5	42		
18	0.9	-8.1	43		
19	0.9	4.5	44		
20	-0.6	8.1	45		
21			46		
22			47		
23			48		
24			49		
25			50		

Comments

AVG Scan Result α (cpm)	AVG Scan Result β (cpm)			No.	1 Min Fixed Result α (cpm)	1 Min Fixed Result β (cpm)	Comments
				1	0	108	East Wall
				2	1	115	East Wall
				3	2	98	East Wall
				4	0	88	East Wall
				5	1	92	North Wall
				6	0	96	Ceiling
				7	0	79	Ceiling
				8	2	93	Ceiling
				9	0	87	Ceiling
				10	0	95	South Wall
				11	1	101	North Wall
				12	0	103	Ceiling
				13	2	99	Ceiling
				14	0	86	Ceiling
				15	0	103	Ceiling
				16	1	93	South Wall
				17	0	84	West Wall
				18	0	72	West Wall
				19	0	89	West Wall
				20	2	71	West Wall
				21			
				22			
				23			
				24			
				25			

Surveyed By:	Date:	Instrument	Serial #	α Eff.	β Eff.	α Bkg.	β Bkg	Cal. Due
KP	3/30/2004*	2929	180830	0.33	0.28	4	965	12/15/04
	6/26/03*	2224	162426	0.2	~~0.15~~ 0,20	~~4~~ 0	~~819~~ 0	~~12/27/04~~ 1/15/04
Reviewed By:	Date:							

Key:
- ○ Smear
- □ Dose Rate mr/hr
- * Direct Reading DPM/100 cm^2
- △ Grab Sample
- *-* Boundary
- ■ A/S Location

* Note: Smear sample analysis via 2929 were analyzed in March 2004
direct frisks using 43-93 probe were taken during work in June 2003

No bkg determined use 0 as conservative value.

Appendix H: Survey Unit Worksheets and Data Summaries

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
BARF BUILDING NORTH FLOOR - SMEAR RESULTS

α eff	β eff
0.4060	0.2400

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm^2 α Flag	dpm/100 cm^2 β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts* α	Background Total Counts* β	Sample Total Counts α	Sample Total Counts β	Background (cpm) α	Background (cpm) β	Sample Counts (cpm) α	Sample Counts (cpm) β	Sample (dpm/100 cm^2) α	Sample (dpm/100 cm^2) β	> α flag	> β flag	Tech. Initial
1	BARF NF 1	5/12/2003	7	828	4	98	0.4	41.4	2.00	49	4.1	32			KvH
2	BARF NF 2	5/12/2003	7	828	5	102	0.4	41.4	2.50	51	5.3	40			KvH
3	BARF NF 3	5/12/2003	7	828	4	122	0.4	41.4	2.00	61	4.1	82			KvH
4	BARF NF 4	5/12/2003	7	828	1	93	0.4	41.4	0.50	47	0.4	21			KvH
5	BARF NF 5	5/12/2003	7	828	1	78	0.4	41.4	0.50	39	0.4	-10			KvH
6	BARF NF 6	5/12/2003	7	828	4	85	0.4	41.4	2.00	43	4.1	5			KvH
7	BARF NF 7	5/12/2003	7	828	6	103	0.4	41.4	3.00	52	6.5	42			KvH
8	BARF NF 8	5/12/2003	7	828	1	96	0.4	41.4	0.50	48	0.4	28			KvH
9	BARF NF 9	5/12/2003	7	828	1	105	0.4	41.4	0.50	53	0.4	46			KvH
10	BARF NF 10	5/12/2003	7	828	1	96	0.4	41.4	0.50	48	0.4	28			KvH
11	BARF NF 11	5/12/2003	7	828	2	101	0.4	41.4	1.00	51	1.6	38			KvH
12	BARF NF 12	5/12/2003	7	828	1	106	0.4	41.4	0.50	53	0.4	48			KvH
13	BARF NF 13	5/12/2003	7	828	4	108	0.4	41.4	2.00	54	4.1	53			KvH
14	BARF NF 14	5/12/2003	7	828	2	105	0.4	41.4	1.00	53	1.6	46			KvH
15	BARF NF 15	5/12/2003	7	828	4	80	0.4	41.4	2.00	40	4.1	-6			KvH
16	BARF NF 16	5/12/2003	7	828	0	84	0.4	41.4	0.00	42	-0.9	3			KvH
17	BARF NF 17	5/12/2003	7	828	2	93	0.4	41.4	1.00	47	1.6	21			KvH
18	BARF NF 18	5/12/2003	7	828	1	94	0.4	41.4	0.50	47	0.4	23			KvH
19	BARF NF 19	5/12/2003	7	828	1	93	0.4	41.4	0.50	47	0.4	21			KvH
20	BARF NF 20	5/12/2003	7	828	1	90	0.4	41.4	0.50	45	0.4	15			KvH
21	BARF NF 21	5/12/2003	7	828	0	93	0.4	41.4	0.00	47	-0.9	21			KvH
22	BARF NF 22	5/12/2003	7	828	2	97	0.4	41.4	1.00	49	1.6	30			KvH
23	BARF NF 23	5/12/2003	7	828	4	87	0.4	41.4	2.00	44	4.1	9			KvH
24	BARF NF 24	5/12/2003	7	828	2	80	0.4	41.4	1.00	40	1.6	-6			KvH
25															

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
BARF BUILDING SOUTH FLOOR - SMEAR RESULTS

α eff	β eff
0.4060	0.2400

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm²	
α Flag	β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm²)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	BARF SF 1	5/12/2003	7	828	5	107	0.4	41.4	2.50	54	5.3	50			KvH
2	BARF SF 2	5/12/2003	7	828	0	103	0.4	41.4	0.00	52	-0.9	42			KvH
3	BARF SF 3	5/12/2003	7	828	1	95	0.4	41.4	0.50	48	0.4	25			KvH
4	BARF SF 4	5/12/2003	7	828	2	110	0.4	41.4	1.00	55	1.6	57			KvH
5	BARF SF 5	5/12/2003	7	828	2	96	0.4	41.4	1.00	48	1.6	28			KvH
6	BARF SF 6	5/12/2003	7	828	6	105	0.4	41.4	3.00	53	6.5	46			KvH
7	BARF SF 7	5/12/2003	7	828	1	91	0.4	41.4	0.50	46	0.4	17			KvH
8	BARF SF 8	5/12/2003	7	828	2	95	0.4	41.4	1.00	48	1.6	25			KvH
9	BARF SF 9	5/12/2003	7	828	2	103	0.4	41.4	1.00	52	1.6	42			KvH
10	BARF SF 10	5/12/2003	7	828	4	116	0.4	41.4	2.00	58	4.1	69			KvH
11	BARF SF 11	5/12/2003	7	828	5	117	0.4	41.4	2.50	59	5.3	71			KvH
12	BARF SF 12	5/12/2003	7	828	0	80	0.4	41.4	0.00	40	-0.9	-6			KvH
13	BARF SF 13	5/12/2003	7	828	1	117	0.4	41.4	0.50	59	0.4	71			KvH
14	BARF SF 14	5/12/2003	7	828	2	107	0.4	41.4	1.00	54	1.6	50			KvH
15	BARF SF 15	5/12/2003	7	828	2	90	0.4	41.4	1.00	45	1.6	15			KvH
16	BARF SF 16	5/12/2003	7	828	1	85	0.4	41.4	0.50	43	0.4	5			KvH
17	BARF SF 17	5/12/2003	7	828	0	102	0.4	41.4	0.00	51	-0.9	40			KvH
18	BARF SF 18	5/12/2003	7	828	4	85	0.4	41.4	2.00	43	4.1	5			KvH
19	BARF SF 19	5/12/2003	7	828	2	93	0.4	41.4	1.00	47	1.6	21			KvH
20	BARF SF 20	5/12/2003	7	828	2	83	0.4	41.4	1.00	42	1.6	0			KvH
21	BARF SF 21	5/12/2003	7	828	2	85	0.4	41.4	1.00	43	1.6	5			KvH
22	BARF SF 22	5/12/2003	7	828	1	103	0.4	41.4	0.50	52	0.4	42			KvH
23	BARF SF 23	5/12/2003	7	828	2	96	0.4	41.4	1.00	48	1.6	28			KvH
24	BARF SF 24	5/12/2003	7	828	3	95	0.4	41.4	1.50	48	2.8	25			KvH
25															

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
BARF BUILDING NORTH ROOM LOWER WALLS - SMEAR RESULTS

α eff	β eff
0.4060	0.2400

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm^2	
α Flag	β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	BARF NRNW 1	5/13/2003	6	844	2	87	0.3	42.2	1.00	44	1.7	5			KvH
2	BARF NRNW 2	5/13/2003	6	844	4	102	0.3	42.2	2.00	51	4.2	37			KvH
3	BARF NRNW 3	5/13/2003	6	844	2	97	0.3	42.2	1.00	49	1.7	26			KvH
4	BARF NRNW 4	5/13/2003	6	844	3	84	0.3	42.2	1.50	42	3.0	-1			KvH
5	BARF NRNW 5	5/13/2003	6	844	3	96	0.3	42.2	1.50	48	3.0	24			KvH
6	BARF NRNW 6	5/13/2003	6	844	1	106	0.3	42.2	0.50	53	0.5	45			KvH
7	BARF NREW 7	5/13/2003	6	844	3	99	0.3	42.2	1.50	50	3.0	30			KvH
8	BARF NREW 8	5/13/2003	6	844	1	101	0.3	42.2	0.50	51	0.5	35			KvH
9	BARF NREW 9	5/13/2003	6	844	2	92	0.3	42.2	1.00	46	1.7	16			KvH
10	BARF NREW 10	5/13/2003	6	844	0	86	0.3	42.2	0.00	43	-0.7	3			KvH
11	BARF NRSW 11	5/13/2003	6	844	0	93	0.3	42.2	0.00	47	-0.7	18			KvH
12	BARF NRSW 12	5/13/2003	6	844	4	125	0.3	42.2	2.00	63	4.2	85			KvH
13	BARF NRSW 13	5/13/2003	6	844	0	99	0.3	42.2	0.00	50	-0.7	30			KvH
14	BARF NRSW 14	5/13/2003	6	844	3	114	0.3	42.2	1.50	57	3.0	62			KvH
15	BARF NRSW 15	5/13/2003	6	844	1	103	0.3	42.2	0.50	52	0.5	39			KvH
16	BARF NRSW 16	5/13/2003	6	844	2	101	0.3	42.2	1.00	51	1.7	35			KvH
17	BARF NRWW 17	5/13/2003	6	844	3	89	0.3	42.2	1.50	45	3.0	10			KvH
18	BARF NRWW 18	5/13/2003	6	844	4	108	0.3	42.2	2.00	54	4.2	49			KvH
19	BARF NRWW 19	5/13/2003	6	844	0	89	0.3	42.2	0.00	45	-0.7	10			KvH
20	BARF NRWW 20	5/13/2003	6	844	4	100	0.3	42.2	2.00	50	4.2	33			KvH
21	BARF WWNRB 1	6/2/2003	3	829	5	88	0.2	41.5	2.50	44	5.8	11			AC
22	BARF WWNRB 2	6/2/2003	3	829	0	90	0.2	41.5	0.00	45	-0.4	15			AC
23															

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
BARF BUILDING SOUTH ROOM LOWER WALLS - SMEAR RESULTS

α eff	β eff
0.4060	0.2400

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm^2	
α Flag	β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	BARF SREW 10	5/12/2003	7	828	1	89	0.4	41.4	0.50	45	0.4	13			KvH
2	BARF SREW 9	5/12/2003	7	828	4	104	0.4	41.4	2.00	52	4.1	44			KvH
3	BARF SREW 7	5/12/2003	7	828	2	95	0.4	41.4	1.00	48	1.6	25			KvH
4	BARF SREW 8	5/12/2003	7	828	0	81	0.4	41.4	0.00	41	-0.9	-4			KvH
5	BARF SRWW 18	5/12/2003	7	828	2	103	0.4	41.4	1.00	52	1.6	42			KvH
6	BARF SRWW 17	5/12/2003	7	828	0	90	0.4	41.4	0.00	45	-0.9	15			KvH
7	BARF SRWW 20	5/12/2003	7	828	0	84	0.4	41.4	0.00	42	-0.9	3			KvH
8	BARF SRWW 19	5/12/2003	7	828	2	92	0.4	41.4	1.00	46	1.6	19			KvH
9	BARF SRSW 11	5/12/2003	7	828	2	78	0.4	41.4	1.00	39	1.6	-10			KvH
10	BARF SRSW 12	5/12/2003	7	828	1	99	0.4	41.4	0.50	50	0.4	34			KvH
11	BARF SRSW 13	5/12/2003	7	828	3	97	0.4	41.4	1.50	49	2.8	30			KvH
12	BARF SRSW 14	5/12/2003	7	828	3	93	0.4	41.4	1.50	47	2.8	21			KvH
13	BARF SRSW 15	5/12/2003	7	828	2	79	0.4	41.4	1.00	40	1.6	-8			KvH
14	BARF SRSW 16	5/12/2003	7	828	3	98	0.4	41.4	1.50	49	2.8	32			KvH
15	BARF SRNW 1	5/13/2003	6	844	2	95	0.3	42.2	1.00	48	1.7	22			KvH
16	BARF SRNW 2	5/13/2003	6	844	3	81	0.3	42.2	1.50	41	3.0	-7			KvH
17	BARF SRNW 3	5/13/2003	6	844	1	96	0.3	42.2	0.50	48	0.5	24			KvH
18	BARF SRNW 4	5/13/2003	6	844	1	88	0.3	42.2	0.50	44	0.5	7			KvH
19	BARF SRNW 5	5/13/2003	6	844	0	94	0.3	42.2	0.00	47	-0.7	20			KvH
20	BARF SRNW 6	5/13/2003	6	844	2	83	0.3	42.2	1.00	42	1.7	-3			KvH
21	BARF EWSRB	6/2/2003	3	829	0	85	0.2	41.5	0.00	43	-0.4	4			AC
22	BARF NWSRB	6/2/2003	3	829	3	80	0.2	41.5	1.50	40	3.3	-6			AC
23	BARF WWSRB 1	6/2/2003	3	829	3	111	0.2	41.5	1.50	56	3.3	59			AC
24	BARF WWSRB 2	6/2/2003	3	829	1	97	0.2	41.5	0.50	49	0.9	29			AC
25	BARF WWSRB 3	6/2/2003	3	829	2	89	0.2	41.5	1.00	45	2.1	13			RS
26															

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
BARF BUILDING CEILING AND UPPER WALLS - SMEAR RESULTS

α eff	β eff
0.4060	0.2400

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm²	
α Flag	β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	BARF SRSWU 1	5/14/2003	8	819	0	77	0.4	41.0	0.00	39	-1.0	-10			KvH
2	BARF SRSWU 2	5/14/2003	8	819	1	67	0.4	41.0	0.50	34	0.2	-31			KvH
3	BARF SRSWU 3	5/14/2003	8	819	3	75	0.4	41.0	1.50	38	2.7	-14			KvH
4	BARF SRWWU 8	5/14/2003	8	819	0	62	0.4	41.0	0.00	31	-1.0	-41			KvH
5	BARF SRC 4	5/14/2003	8	819	2	76	0.4	41.0	1.00	38	1.5	-12			KvH
6	BARF SRC 7	5/14/2003	8	819	0	87	0.4	41.0	0.00	44	-1.0	11			KvH
7	BARF SREWU 5	5/14/2003	8	819	1	81	0.4	41.0	0.50	41	0.2	-2			KvH
8	BARF SREWU 6	5/14/2003	8	819	3	83	0.4	41.0	1.50	42	2.7	2			KvH
9	BARF SREWU 9	5/14/2003	8	819	0	75	0.4	41.0	0.00	38	-1.0	-14			KvH
10	BARF SRNWU 10	5/14/2003	8	819	1	75	0.4	41.0	0.50	38	0.2	-14			KvH
11	BARF SRNWU 11	5/14/2003	8	819	1	86	0.4	41.0	0.50	43	0.2	9			KvH
12	BARF SRNWU 12	5/15/2003	6	796	2	88	0.3	39.8	1.00	44	1.7	18			KvH
13	BARF SRNWU 13	5/15/2003	6	796	3	71	0.3	39.8	1.50	36	3.0	-18			KvH
14	BARF SRNWU 14	5/15/2003	6	796	1	105	0.3	39.8	0.50	53	0.5	53			KvH
15	BARF SRNWU 15	5/15/2003	6	796	3	93	0.3	39.8	1.50	47	3.0	28			KvH
16	BARF SRNWU 19	5/15/2003	6	796	0	75	0.3	39.8	0.00	38	-0.7	-10			KvH
17	BARF SRNWU 20	5/15/2003	6	796	4	90	0.3	39.8	2.00	45	4.2	22			KvH
18	BARF SRNWU 18	5/15/2003	6	796	1	83	0.3	39.8	0.50	42	0.5	7			KvH
19	BARF NRCU 16	5/15/2003	6	796	0	84	0.3	39.8	0.00	42	-0.7	9			KvH
20	BARF NRCU 17	5/15/2003	6	796	3	81	0.3	39.8	1.50	41	3.0	3			KvH
21	BARF CB 1	6/2/2003	3	829	3	101	0.2	41.5	1.50	51	3.3	38			KvH
22	BARF CB 2	6/2/2003	3	829	2	88	0.2	41.5	1.00	44	2.1	11			KvH
23	BARF CB 3	6/2/2003	3	829	1	96	0.2	41.5	0.50	48	0.9	27			KvH
24															KvH
25															

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
BARF NORTH FLOOR - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)
582

α eff	β eff
0.1700	0.2500

Static Count Time (min)
1.0

Daily Background Count Time (min)
20.0

dpm/100 cm^2	
α Flag	β Flag
100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	NF1	5/12/2003	4	478	10	648	0.2	23.9	10.00	648	9.9	429			KP
2	NF2	5/12/2003	4	478	12	661	0.2	23.9	12.00	661	11.9	438			KP
3	NF3	5/12/2003	4	478	7	847	0.2	23.9	7.00	847	6.9	566			KP
4	NF4	5/12/2003	4	478	11	878	0.2	23.9	11.00	878	10.9	587			KP
5	NF5	5/12/2003	4	478	30	800	0.2	23.9	30.00	800	30.1	533			KP
6	NF6	5/12/2003	4	478	4	675	0.2	23.9	4.00	675	3.8	447			KP
7	NF7	5/12/2003	4	478	17	992	0.2	23.9	17.00	992	17.0	665			KP
8	NF8	5/12/2003	4	478	12	689	0.2	23.9	12.00	689	11.9	457			KP
9	NF9	5/12/2003	4	478	6	670	0.2	23.9	6.00	670	5.9	444			KP
10	NF10	5/12/2003	4	478	12	944	0.2	23.9	12.00	944	11.9	632			KP
11	NF11	5/12/2003	4	478	13	828	0.2	23.9	13.00	828	12.9	553			KP
12	NF12	5/12/2003	4	478	10	673	0.2	23.9	10.00	673	9.9	446			KP
13	NF13	5/12/2003	4	478	7	815	0.2	23.9	7.00	815	6.9	544			KP
14	NF14	5/12/2003	4	478	4	719	0.2	23.9	4.00	719	3.8	478			KP
15	NF15	5/12/2003	4	478	7	755	0.2	23.9	7.00	755	6.9	502			KP
16	NF16	5/12/2003	4	478	3	842	0.2	23.9	3.00	842	2.8	562			KP
17	NF17	5/12/2003	4	478	10	926	0.2	23.9	10.00	926	9.9	620			KP
18	NF18	5/12/2003	4	478	17	721	0.2	23.9	17.00	721	17.0	479			KP
19	NF19	5/12/2003	4	478	10	1131	0.2	23.9	10.00	1131	9.9	761			KP
20	NF20	5/12/2003	4	478	6	808	0.2	23.9	6.00	808	5.9	539			KP
21	NF21	5/12/2003	4	478	4	758	0.2	23.9	4.00	758	3.8	505			KP
22	NF22	5/12/2003	4	478	9	722	0.2	23.9	9.00	722	8.9	480			KP
23	NF23	5/12/2003	4	478	8	699	0.2	23.9	8.00	699	7.9	464			KP
24	NF24	5/12/2003	4	478	6	606	0.2	23.9	6.00	606	5.9	400			KP

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
BARF SOUTH FLOOR - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)
582

α eff	β eff
0.1700	0.2500

Static Count Time (min)
1.0

Daily Background Count Time (min)
20.0

dpm/100 cm^2 α Flag	dpm/100 cm^2 β Flag
100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts* α	Background Total Counts* β	Sample Total Counts α	Sample Total Counts β	Background (cpm) α	Background (cpm) β	Sample Counts (cpm) α	Sample Counts (cpm) β	Sample (dpm/100 cm^2) α	Sample (dpm/100 cm^2) β	> α flag	> β flag	Tech. Initial
1	SF1	5/12/2003	4	478	4	791	0.2	23.9	4.00	791	3.8	527			KP
2	SF2	5/12/2003	4	478	20	779	0.2	23.9	20.00	779	20.0	519			KP
3	SF3	5/12/2003	4	478	9	700	0.2	23.9	9.00	700	8.9	465			KP
4	SF4	5/12/2003	4	478	18	665	0.2	23.9	18.00	665	18.0	441			KP
5	SF5	5/12/2003	4	478	10	681	0.2	23.9	10.00	681	9.9	452			KP
6	SF6	5/12/2003	4	478	16	675	0.2	23.9	16.00	675	16.0	447			KP
7	SF7	5/12/2003	4	478	9	660	0.2	23.9	9.00	660	8.9	437			KP
8	SF8	5/12/2003	4	478	10	734	0.2	23.9	10.00	734	9.9	488			KP
9	SF9	5/12/2003	4	478	8	819	0.2	23.9	8.00	819	7.9	546			KP
10	SF10	5/12/2003	4	478	9	864	0.2	23.9	9.00	864	8.9	577			KP
11	SF11	5/12/2003	4	478	11	922	0.2	23.9	11.00	922	10.9	617			KP
12	SF12	5/12/2003	4	478	6	686	0.2	23.9	6.00	686	5.9	455			KP
13	SF13	5/12/2003	4	478	10	687	0.2	23.9	10.00	687	9.9	456			KP
14	SF14	5/12/2003	4	478	4	696	0.2	23.9	4.00	696	3.8	462			KP
15	SF15	5/12/2003	4	478	9	783	0.2	23.9	9.00	783	8.9	522			KP
16	SF16	5/12/2003	4	478	6	846	0.2	23.9	6.00	846	5.9	565			KP
17	SF17	5/12/2003	4	478	11	730	0.2	23.9	11.00	730	10.9	485			KP
18	SF18	5/12/2003	4	478	7	713	0.2	23.9	7.00	713	6.9	474			KP
19	SF19	5/12/2003	4	478	11	633	0.2	23.9	11.00	633	10.9	419			KP
20	SF20	5/12/2003	4	478	10	720	0.2	23.9	10.00	720	9.9	478			KP
21	SF21	5/12/2003	4	478	10	1029	0.2	23.9	10.00	1029	9.9	691			KP
22	SF22	5/12/2003	4	478	5	853	0.2	23.9	5.00	853	4.9	570			KP
23	SF23	5/12/2003	4	478	9	761	0.2	23.9	9.00	761	8.9	507			KP
24	SF24	5/12/2003	4	478	7	734	0.2	23.9	7.00	734	6.9	488			KP

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
BARF NORTH ROOM LOWER WALLS - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)	α eff	β eff	Static Count Time (min)	Daily Background Count Time (min)	dpm/100 cm^2 α Flag	dpm/100 cm^2 β Flag
582	0.1700	0.2500	1.0	20.0	100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	NRNW1	5/13/2003	3	560	12	697	0.2	28.0	12.00	697	12.0	460			KP
2	NRNW2	5/13/2003	3	560	4	663	0.2	28.0	4.00	663	3.9	436			KP
3	NRNW3	5/13/2003	3	560	4	624	0.2	28.0	4.00	624	3.9	410			KP
4	NRNW4	5/13/2003	3	560	2	635	0.2	28.0	2.00	635	1.9	417			KP
5	NRNW5	5/13/2003	3	560	1	591	0.2	28.0	1.00	591	0.9	387			KP
6	NRNW6	5/13/2003	3	560	3	560	0.2	28.0	3.00	560	2.9	366			KP
7	D-NRNW1	5/13/2003	3	560	10	619	0.2	28.0	10.00	619	10.0	406			KP
8	NREW7	5/13/2003	3	560	2	711	0.2	28.0	2.00	711	1.9	469			KP
9	NREW8	5/13/2003	3	560	5	676	0.2	28.0	5.00	676	4.9	445			KP
10	NREW9	5/13/2003	3	560	6	673	0.2	28.0	6.00	673	5.9	443			KP
11	NREW10	5/13/2003	3	560	7	691	0.2	28.0	7.00	691	6.9	456			KP
12	D-NREW10	5/13/2003	3	560	4	594	0.2	28.0	4.00	594	3.9	389			KP
13	NRSW11	5/13/2003	3	560	4	678	0.2	28.0	4.00	678	3.9	447			KP
14	NRSW12	5/13/2003	3	560	9	639	0.2	28.0	9.00	639	8.9	420			KP
15	NRSW13	5/13/2003	3	560	5	632	0.2	28.0	5.00	632	4.9	415			KP
16	NRSW14	5/13/2003	3	560	3	583	0.2	28.0	3.00	583	2.9	381			KP
17	NRSW15	5/13/2003	3	560	4	589	0.2	28.0	4.00	589	3.9	386			KP
18	NRSW16	5/13/2003	3	560	5	659	0.2	28.0	5.00	659	4.9	434			KP
19	D-NRSW12	5/13/2003	3	560	10	677	0.2	28.0	10.00	677	10.0	446			KP
20	NRWW17	5/13/2003	3	560	7	699	0.2	28.0	7.00	699	6.9	461			KP
21	NRWW18	5/13/2003	3	560	5	709	0.2	28.0	5.00	709	4.9	468			KP
22	NRWW19	5/13/2003	3	560	7	644	0.2	28.0	7.00	644	6.9	423			KP
23	NRWW20	5/13/2003	3	560	4	547	0.2	28.0	4.00	547	3.9	357			KP
24	D-NRWW17	5/13/2003	3	560	4	699	0.2	28.0	4.00	699	3.9	461			KP

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
BARF SOUTH ROOM LOWER WALLS - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)	α eff	β eff	Static Count Time (min)	Daily Background Count Time (min)	α Flag (dpm/100 cm^2)	β Flag (dpm/100 cm^2)
582	0.1700	0.2500	1.0	20.0	100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts* α	Background Total Counts* β	Sample Total Counts α	Sample Total Counts β	Background (cpm) α	Background (cpm) β	Sample Counts (cpm) α	Sample Counts (cpm) β	Sample (dpm/100 cm^2) α	Sample (dpm/100 cm^2) β	> α flag	> β flag	Tech. Initial
1	SRNW1	5/13/2003	3	560	7	642	0.2	28.0	7.00	642	6.9	422			KP
2	SRNW2	5/13/2003	3	560	4	616	0.2	28.0	4.00	616	3.9	404			KP
3	SRNW3	5/13/2003	3	560	4	586	0.2	28.0	4.00	586	3.9	384			KP
4	SRNW4	5/13/2003	3	560	5	641	0.2	28.0	5.00	641	4.9	421			KP
5	SRNW5	5/13/2003	3	560	4	620	0.2	28.0	4.00	620	3.9	407			KP
6	SRNW6	5/13/2003	3	560	3	604	0.2	28.0	3.00	604	2.9	396			KP
7	D-SRNW1	5/13/2003	3	560	5	655	0.2	28.0	5.00	655	4.9	431			KP
8	SREW7	5/12/2003	3	560	1	649	0.2	28.0	1.00	649	0.9	427			KP
9	SREW8	5/12/2003	3	560	0	691	0.2	28.0	0.00	691	-0.2	456			KP
10	SREW9	5/12/2003	3	560	3	700	0.2	28.0	3.00	700	2.9	462			KP
11	SREW10	5/12/2003	3	560	7	675	0.2	28.0	7.00	675	6.9	445			KP
12	D - SREW10	5/12/2003	3	560	6	674	0.2	28.0	6.00	674	5.9	444			KP
13	SRSW11	5/12/2003	3	560	2	609	0.2	28.0	2.00	609	1.9	399			KP
14	SRSW12	5/12/2003	3	560	3	686	0.2	28.0	3.00	686	2.9	452			KP
15	SRSW13	5/12/2003	3	560	3	599	0.2	28.0	3.00	599	2.9	392			KP
16	SRSW14	5/12/2003	3	560	1	606	0.2	28.0	1.00	606	0.9	397			KP
17	SRSW15	5/12/2003	3	560	3	626	0.2	28.0	3.00	626	2.9	411			KP
18	SRSW16	5/12/2003	3	560	2	596	0.2	28.0	2.00	596	1.9	390			KP
19	D-SRSW12	5/12/2003	3	560	10	731	0.2	28.0	10.00	731	10.0	483			KP
20	SRWW17	5/12/2003	3	560	1	750	0.2	28.0	1.00	750	0.9	496			KP
21	SRWW18	5/12/2003	3	560	3	681	0.2	28.0	3.00	681	2.9	449			KP
22	SRWW19	5/12/2003	3	560	7	647	0.2	28.0	7.00	647	6.9	425			KP
23	SRWW20	5/12/2003	3	560	2	702	0.2	28.0	2.00	702	1.9	463			KP
24	D-SRWW19	5/12/2003	3	560	8	566	0.2	28.0	8.00	566	7.9	370			KP

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
BARF CEILING AND UPPER WALLS - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)
100

α eff	β eff
0.2000	0.2000

Static Count Time (min)
1.0

Daily Background Count Time (min)
20.0

dpm/100 cm^2	
α Flag	β Flag
100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	NRCU16	5/15/2003	1	99	0	85	0.1	5.0	0.00	85	-0.3	400			AC
2	NRCU17	5/15/2003	1	99	0	112	0.1	5.0	0.00	112	-0.3	535			AC
3	SRC4	5/14/2003	1	99	0	105	0.1	5.0	0.00	105	-0.3	500			AC
4	SRC7	5/14/2003	1	99	1	100	0.1	5.0	1.00	100	4.8	475			AC
5	NRNWU19	5/13/2003	3	560	2	89	0.2	28.0	2.00	89	9.3	305			KP
6	NRNWU20	5/13/2003	3	560	2	97	0.2	28.0	2.00	97	9.3	345			KP
7	NREWU18	5/13/2003	3	560	2	94	0.2	28.0	2.00	94	9.3	330			KP
8	NRSWU12	5/13/2003	3	560	1	94	0.2	28.0	1.00	94	4.3	330			KP
9	NRSWU13	5/13/2003	3	560	1	86	0.2	28.0	1.00	86	4.3	290			KP
10	NRSWU14	5/13/2003	3	560	2	84	0.2	28.0	2.00	84	9.3	280			KP
11	NRSWU15	5/13/2003	3	560	1	91	0.2	28.0	1.00	91	4.3	315			KP
12	SRNWU9	5/13/2003	3	560	0	70	0.2	28.0	0.00	70	-0.8	210			KP
13	SRNWU10	5/13/2003	3	560	3	87	0.2	28.0	3.00	87	14.3	295			KP
14	SRNWU11	5/13/2003	3	560	0	77	0.2	28.0	0.00	77	-0.8	245			KP
15	D-SRNWU11	5/13/2003	3	560	1	89	0.2	28.0	1.00	89	4.3	305			KP
16	SREWU5	5/12/2003	3	560	0	94	0.2	28.0	0.00	94	-0.8	330			KP
17	SREWU6	5/12/2003	3	560	1	104	0.2	28.0	1.00	104	4.3	380			KP
18	SRSWU1	5/12/2003	3	560	2	88	0.2	28.0	2.00	88	9.3	300			KP
19	SRSWU2	5/12/2003	3	560	2	97	0.2	28.0	2.00	97	9.3	345			KP
20	SRSWU3	5/12/2003	3	560	1	92	0.2	28.0	1.00	92	4.3	320			KP
21	SRWWU8	5/12/2003	3	560	0	80	0.2	28.0	0.00	80	-0.8	260			KP

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
BARF BIAS LOCATIONS - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)	α eff	β eff	Static Count Time (min)	Daily Background Count Time (min)	dpm/100 cm^2 α Flag	dpm/100 cm^2 β Flag
582	0.1700	0.2500	1.0	20.0	100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	CB1	6/2/2003	5	560	3	547	0.3	28.0	3.00	547	2.8	357			AC
2	CB2	6/2/2003	5	560	7	728	0.3	28.0	7.00	728	6.8	481			AC
3	CB3	6/2/2003	5	560	4	589	0.3	28.0	4.00	589	3.8	386			AC
4	BB1	6/2/2003	5	560	8	593	0.3	28.0	8.00	593	7.8	388			AC
5	BB2	6/2/2003	5	560	7	574	0.3	28.0	7.00	574	6.8	375			AC
6	DB	6/2/2003	5	560	4	590	0.3	28.0	4.00	590	3.8	386			AC
7	EWSRB	6/2/2003	5	560	1	488	0.3	28.0	1.00	488	0.8	316			AC
8	NWSRB	6/2/2003	5	560	6	466	0.3	28.0	6.00	466	5.8	301			AC
9	WWNRB1	6/2/2003	5	560	8	626	0.3	28.0	8.00	626	7.8	411			AC
10	WWNRB2	6/2/2003	5	560	5	538	0.3	28.0	5.00	538	4.8	351			AC
11	WWSRB1	6/2/2003	5	560	4	484	0.3	28.0	4.00	484	3.8	313			AC
12	WWSRB2	6/2/2003	5	560	7	530	0.3	28.0	7.00	530	6.8	345			AC
13	WWSRB3	6/2/2003	5	560	7	527	0.3	28.0	7.00	527	6.8	343			AC

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
CONCRETE PAD #1 (SU09) NORTH - SMEAR RESULTS

α eff	β eff
0.3850	0.2650

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm²	
α Flag	β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm²)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	6550	6/10/2004	8	1456	1	143	0.4	72.8	0.50	72	0.3	-5			JAC
2	6551	6/10/2004	8	1456	1	150	0.4	72.8	0.50	75	0.3	8			JAC
3	6552	6/10/2004	8	1456	0	165	0.4	72.8	0.00	83	-1.0	37			JAC
4	6553	6/10/2004	8	1456	0	140	0.4	72.8	0.00	70	-1.0	-11			JAC
5	6554	6/10/2004	8	1456	0	129	0.4	72.8	0.00	65	-1.0	-31			JAC
6	6555	6/10/2004	8	1456	4	141	0.4	72.8	2.00	71	4.2	-9			JAC
7	6556	6/10/2004	8	1456	1	132	0.4	72.8	0.50	66	0.3	-26			JAC
8	6557	6/10/2004	8	1456	2	136	0.4	72.8	1.00	68	1.6	-18			JAC
9	6558	6/10/2004	8	1456	1	138	0.4	72.8	0.50	69	0.3	-14			JAC
10	6559	6/10/2004	8	1456	0	112	0.4	72.8	0.00	56	-1.0	-63			JAC
11	6560	6/10/2004	8	1456	1	135	0.4	72.8	0.50	68	0.3	-20			JAC
12	6561	6/10/2004	8	1456	1	129	0.4	72.8	0.50	65	0.3	-31			JAC
13	6562	6/10/2004	8	1456	0	149	0.4	72.8	0.00	75	-1.0	6			JAC
14	6563	6/10/2004	8	1456	1	141	0.4	72.8	0.50	71	0.3	-9			JAC
15	6564	6/10/2004	8	1456	0	133	0.4	72.8	0.00	67	-1.0	-24			JAC
16	6565	6/10/2004	8	1456	1	136	0.4	72.8	0.50	68	0.3	-18			JAC
17	6566	6/10/2004	8	1456	1	152	0.4	72.8	0.50	76	0.3	12			JAC
18	6567	6/10/2004	8	1456	0	157	0.4	72.8	0.00	79	-1.0	22			JAC
19	6568	6/10/2004	8	1456	0	133	0.4	72.8	0.00	67	-1.0	-24			JAC
20	6569	6/10/2004	8	1456	0	155	0.4	72.8	0.00	78	-1.0	18			JAC
21															

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
CONCRETE PAD #1 (SU09) SOUTH - SMEAR RESULTS

α eff	β eff
0.3850	0.2650

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm²	
α Flag	β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm²)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	6530	6/10/2004	8	1456	0	139	0.4	72.8	0.00	70	-1.0	-12			JAC
2	6531	6/10/2004	8	1456	1	141	0.4	72.8	0.50	71	0.3	-9			JAV
3	6532	6/10/2004	8	1456	1	124	0.4	72.8	0.50	62	0.3	-41			JAV
4	6533	6/10/2004	8	1456	0	129	0.4	72.8	0.00	65	-1.0	-31			JAV
5	6534	6/10/2004	8	1456	0	130	0.4	72.8	0.00	65	-1.0	-29			JAV
6	6535	6/10/2004	8	1456	1	150	0.4	72.8	0.50	75	0.3	8			JAV
7	6536	6/10/2004	8	1456	0	139	0.4	72.8	0.00	70	-1.0	-12			JAV
8	6537	6/10/2004	8	1456	0	126	0.4	72.8	0.00	63	-1.0	-37			JAV
9	6538	6/10/2004	8	1456	2	134	0.4	72.8	1.00	67	1.6	-22			JAV
10	6539	6/10/2004	8	1456	0	141	0.4	72.8	0.00	71	-1.0	-9			JAV
11	6540	6/10/2004	8	1456	0	160	0.4	72.8	0.00	80	-1.0	27			JAV
12	6541	6/10/2004	8	1456	2	130	0.4	72.8	1.00	65	1.6	-29			JAV
13	6542	6/10/2004	8	1456	1	132	0.4	72.8	0.50	66	0.3	-26			JAC
14	6543	6/10/2004	8	1456	2	157	0.4	72.8	1.00	79	1.6	22			JAC
15	6544	6/10/2004	8	1456	0	122	0.4	72.8	0.00	61	-1.0	-45			JAC
16	6545	6/10/2004	8	1456	0	137	0.4	72.8	0.00	69	-1.0	-16			JAC
17	6546	6/10/2004	8	1456	0	159	0.4	72.8	0.00	80	-1.0	25			JAC
18	6547	6/10/2004	8	1456	0	141	0.4	72.8	0.00	71	-1.0	-9			JAC
19	6548	6/10/2004	8	1456	1	133	0.4	72.8	0.50	67	0.3	-24			JAC
20	6549	6/10/2004	8	1456	0	136	0.4	72.8	0.00	68	-1.0	-18			JAC
21															

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
CONCRETE PAD #1 (SU09) SOUTH - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)	α eff	β eff	Static Count Time (min)	Daily Background Count Time (min)	dpm/100 cm^2 α Flag	dpm/100 cm^2 β Flag
126	0.1879	0.3200	1.0	20.0	100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts* α	Background Total Counts* β	Sample Total Counts α	Sample Total Counts β	Background (cpm) α	Background (cpm) β	Sample Counts (cpm) α	Sample Counts (cpm) β	Sample (dpm/100 cm^2) α	Sample (dpm/100 cm^2) β	> α flag	> β flag	Tech. Initial
1	6530	6/10/2004	3	200	3	200	0.2	10.0	3.00	200	12.0	471			JAC
2	6531	6/10/2004	3	200	0	404	0.2	10.0	0.00	404	-0.6	977			JAC
3	6532	6/10/2004	3	200	2	196	0.2	10.0	2.00	196	7.8	461			JAC
4	6533	6/10/2004	3	200	2	226	0.2	10.0	2.00	226	7.8	536			JAC
5	6534	6/10/2004	3	200	2	200	0.2	10.0	2.00	200	7.8	471			JAC
6	6535	6/10/2004	3	200	4	383	0.2	10.0	4.00	383	16.3	925			JAC
7	6536	6/10/2004	3	200	0	178	0.2	10.0	0.00	178	-0.6	417			JAC
8	6537	6/10/2004	3	200	2	168	0.2	10.0	2.00	168	7.8	392			JAC
9	6538	6/10/2004	3	200	2	155	0.2	10.0	2.00	155	7.8	360			JAC
10	6539	6/10/2004	3	200	3	151	0.2	10.0	3.00	151	12.0	350			JAC
11	6540	6/10/2004	3	200	2	143	0.2	10.0	2.00	143	7.8	330			JAC
12	6541	6/10/2004	3	200	2	208	0.2	10.0	2.00	208	7.8	491			JAC
13	6542	6/10/2004	3	200	2	214	0.2	10.0	2.00	214	7.8	506			JAC
14	6543	6/10/2004	3	200	0	229	0.2	10.0	0.00	229	-0.6	543			JAC
15	6544	6/10/2004	3	200	0	198	0.2	10.0	0.00	198	-0.6	466			JAC
16	6545	6/10/2004	3	200	0	184	0.2	10.0	0.00	184	-0.6	432			JAC
17	6546	6/10/2004	3	200	0	172	0.2	10.0	0.00	172	-0.6	402			JAC
18	6547	6/10/2004	3	200	0	150	0.2	10.0	0.00	150	-0.6	347			JAC
19	6548	6/10/2004	3	200	3	201	0.2	10.0	3.00	201	12.0	474			JAC
20	6549	6/10/2004	3	200	1	146	0.2	10.0	1.00	146	3.6	337			JAC
21															
22															

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
CONCRETE PAD #1 (SU09) NORTH - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm²)	α eff	β eff	Static Count Time (min)	Daily Background Count Time (min)	dpm/100 cm² α Flag	dpm/100 cm² β Flag
126	0.1879	0.3200	1.0	20.0	100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts* α	Background Total Counts* β	Sample Total Counts α	Sample Total Counts β	Background (cpm) α	Background (cpm) β	Sample Counts (cpm) α	Sample Counts (cpm) β	Sample (dpm/100 cm²) α	Sample (dpm/100 cm²) β	> α flag	> β flag	Tech. Initial
1	6550	6/10/2004	3	200	2	293	0.2	10.0	2.00	293	7.8	702			JAC
2	6551	6/10/2004	3	200	3	364	0.2	10.0	3.00	364	12.0	878			JAC
3	6552	6/10/2004	3	200	8	723	0.2	10.0	8.00	723	33.2	1768			JAC
4	6553	6/10/2004	3	200	3	220	0.2	10.0	3.00	220	12.0	521			JAC
5	6554	6/10/2004	3	200	4	300	0.2	10.0	4.00	300	16.3	719			JAC
6	6555	6/10/2004	3	200	4	318	0.2	10.0	4.00	318	16.3	764			JAC
7	6556	6/10/2004	3	200	0	153	0.2	10.0	0.00	153	-0.6	355			JAC
8	6557	6/10/2004	3	200	4	151	0.2	10.0	4.00	151	16.3	350			JAC
9	6558	6/10/2004	3	200	2	213	0.2	10.0	2.00	213	7.8	503			JAC
10	6559	6/10/2004	3	200	2	187	0.2	10.0	2.00	187	7.8	439			JAC
11	6560	6/10/2004	3	200	0	136	0.2	10.0	0.00	136	-0.6	313			JAC
12	6561	6/10/2004	3	200	1	169	0.2	10.0	1.00	169	3.6	394			JAC
13	6562	6/10/2004	3	200	1	149	0.2	10.0	1.00	149	3.6	345			JAC
14	6563	6/10/2004	3	200	0	160	0.2	10.0	0.00	160	-0.6	372			JAC
15	6564	6/10/2004	3	200	1	169	0.2	10.0	1.00	169	3.6	394			JAC
16	6565	6/10/2004	3	200	1	198	0.2	10.0	1.00	198	3.6	466			JAC
17	6566	6/10/2004	3	200	0	179	0.2	10.0	0.00	179	-0.6	419			JAC
18	6567	6/10/2004	3	200	3	229	0.2	10.0	3.00	229	12.0	543			JAC
19	6568	6/10/2004	3	200	3	165	0.2	10.0	3.00	165	12.0	384			JAC
20	6569	6/10/2004	3	200	1	205	0.2	10.0	1.00	205	3.6	484			JAC
21															
22															
23															

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
CONCRETE PAD #2 (SU16) NORTH - SMEAR RESULTS

α eff	β eff
0.3850	0.2650

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm² α Flag	dpm/100 cm² β Flag
100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	6510	6/10/2004	8	1456	1	154	0.4	72.8	0.50	77	0.3	16			JAC
2	6511	6/10/2004	8	1456	1	154	0.4	72.8	0.50	77	0.3	16			JAV
3	6512	6/10/2004	8	1456	1	159	0.4	72.8	0.50	80	0.3	25			JAV
4	6513	6/10/2004	8	1456	0	149	0.4	72.8	0.00	75	-1.0	6			JAV
5	6514	6/10/2004	8	1456	0	144	0.4	72.8	0.00	72	-1.0	-3			JAV
6	6515	6/10/2004	8	1456	0	137	0.4	72.8	0.00	69	-1.0	-16			JAV
7	6516	6/10/2004	8	1456	0	106	0.4	72.8	0.00	53	-1.0	-75			JAV
8	6517	6/10/2004	8	1456	2	149	0.4	72.8	1.00	75	1.6	6			JAC
9	6518	6/10/2004	8	1456	0	146	0.4	72.8	0.00	73	-1.0	1			JAC
10	6519	6/10/2004	8	1456	1	133	0.4	72.8	0.50	67	0.3	-24			JAC
11	6520	6/10/2004	8	1456	1	117	0.4	72.8	0.50	59	0.3	-54			JAC
12	6521	6/10/2004	8	1456	1	150	0.4	72.8	0.50	75	0.3	8			JAC
13	6522	6/10/2004	8	1456	1	144	0.4	72.8	0.50	72	0.3	-3			JAC
14	6523	6/10/2004	8	1456	3	155	0.4	72.8	1.50	78	2.9	18			JAC
15	6524	6/10/2004	8	1456	0	146	0.4	72.8	0.00	73	-1.0	1			JAC
16	6525	6/10/2004	8	1456	0	165	0.4	72.8	0.00	83	-1.0	37			JAC
17	6526	6/10/2004	8	1456	1	130	0.4	72.8	0.50	65	0.3	-29			JAC
18	6527	6/10/2004	8	1456	0	145	0.4	72.8	0.00	73	-1.0	-1			JAC
19	6528	6/10/2004	8	1456	0	138	0.4	72.8	0.00	69	-1.0	-14			JAC
20	6529	6/10/2004	8	1456	1	131	0.4	72.8	0.50	66	0.3	-28			JAC
21															

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
CONCRETE PAD #2 (SU16) SOUTH - SMEAR RESULTS

α eff	β eff
0.3850	0.2650

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm^2 α Flag	dpm/100 cm^2 β Flag
100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts* α	Background Total Counts* β	Sample Total Counts α	Sample Total Counts β	Background (cpm) α	Background (cpm) β	Sample Counts (cpm) α	Sample Counts (cpm) β	Sample (dpm/100 cm^2) α	Sample (dpm/100 cm^2) β	> α flag	> β flag	Tech. Initial
1	6490	6/10/2004	8	1456	2	151	0.4	72.8	1.00	76	1.6	10			JAC
2	6491	6/10/2004	8	1456	1	140	0.4	72.8	0.50	70	0.3	-11			JAC
3	6492	6/10/2004	8	1456	0	132	0.4	72.8	0.00	66	-1.0	-26			JAC
4	6493	6/10/2004	8	1456	0	145	0.4	72.8	0.00	73	-1.0	-1			JAC
5	6494	6/10/2004	8	1456	1	163	0.4	72.8	0.50	82	0.3	33			JAC
6	6495	6/10/2004	8	1456	1	125	0.4	72.8	0.50	63	0.3	-39			JAC
7	6496	6/10/2004	8	1456	1	138	0.4	72.8	0.50	69	0.3	-14			JAC
8	6497	6/10/2004	8	1456	0	150	0.4	72.8	0.00	75	-1.0	8			JAC
9	6498	6/10/2004	8	1456	0	124	0.4	72.8	0.00	62	-1.0	-41			JAC
10	6499	6/10/2004	8	1456	1	136	0.4	72.8	0.50	68	0.3	-18			JAC
11	6500	6/10/2004	8	1456	1	112	0.4	72.8	0.50	56	0.3	-63			JAC
12	6501	6/10/2004	8	1456	1	129	0.4	72.8	0.50	65	0.3	-31			JAC
13	6502	6/10/2004	8	1456	2	143	0.4	72.8	1.00	72	1.6	-5			JAC
14	6503	6/10/2004	8	1456	2	137	0.4	72.8	1.00	69	1.6	-16			JAC
15	6504	6/10/2004	8	1456	0	159	0.4	72.8	0.00	80	-1.0	25			JAC
16	6505	6/10/2004	8	1456	2	158	0.4	72.8	1.00	79	1.6	23			JAC
17	6506	6/10/2004	8	1456	1	118	0.4	72.8	0.50	59	0.3	-52			JAC
18	6507	6/10/2004	8	1456	1	142	0.4	72.8	0.50	71	0.3	-7			JAC
19	6508	6/10/2004	8	1456	0	159	0.4	72.8	0.00	80	-1.0	25			JAC
20	6509	6/10/2004	8	1456	0	146	0.4	72.8	0.00	73	-1.0	1			JAC
21															

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
CONCRETE PAD #2 (SU16) SOUTH - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)	α eff	β eff	Static Count Time (min)	Daily Background Count Time (min)	dpm/100 cm^2 α Flag	dpm/100 cm^2 β Flag
126	0.1700	0.2500	1.0	20.0	100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	6490	6/10/2004	3	200	1	168	0.2	10.0	1.00	168	4.0	502			JAC
2	6491	6/10/2004	3	200	1	182	0.2	10.0	1.00	182	4.0	546			JAC
3	6492	6/10/2004	3	200	2	121	0.2	10.0	2.00	121	8.6	352			JAC
4	6493	6/10/2004	3	200	1	114	0.2	10.0	1.00	114	4.0	330			JAC
5	6494	6/10/2004	3	200	3	107	0.2	10.0	3.00	107	13.3	308			JAC
6	6495	6/10/2004	3	200	1	121	0.2	10.0	1.00	121	4.0	352			JAC
7	6496	6/10/2004	3	200	2	119	0.2	10.0	2.00	119	8.6	346			JAC
8	6497	6/10/2004	3	200	2	129	0.2	10.0	2.00	129	8.6	378			JAC
9	6498	6/10/2004	3	200	1	129	0.2	10.0	1.00	129	4.0	378			JAC
10	6499	6/10/2004	3	200	3	137	0.2	10.0	3.00	137	13.3	403			JAC
11	6500	6/10/2004	3	200	1	139	0.2	10.0	1.00	139	4.0	410			JAC
12	6501	6/10/2004	3	200	3	129	0.2	10.0	3.00	129	13.3	378			JAC
13	6502	6/10/2004	3	200	1	112	0.2	10.0	1.00	112	4.0	324			JAC
14	6503	6/10/2004	3	200	1	142	0.2	10.0	1.00	142	4.0	419			JAC
15	6504	6/10/2004	3	200	1	341	0.2	10.0	1.00	341	4.0	1051			JAC
16	6505	6/10/2004	3	200	2	306	0.2	10.0	2.00	306	8.6	940			JAC
17	6506	6/10/2004	3	200	4	229	0.2	10.0	4.00	229	18.0	695			JAC
18	6507	6/10/2004	3	200	3	158	0.2	10.0	3.00	158	13.3	470			JAC
19	6508	6/10/2004	3	200	1	109	0.2	10.0	1.00	109	4.0	314			JAC
20	6509	6/10/2004	3	200	1	103	0.2	10.0	1.00	103	4.0	295			JAC

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
CONCRETE PAD #2 (SU16) NORTH - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)
126

α eff	β eff
0.1700	0.2500

Static Count Time (min)
1.0

Daily Background Count Time (min)
20.0

dpm/100 cm^2	
α Flag	β Flag
100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	6510	6/10/2004	4	800	4	289	0.2	40.0	4.00	289	17.7	790			JAC
2	6511	6/10/2004	4	800	3	336	0.2	40.0	3.00	336	13.1	940			JAC
3	6512	6/10/2004	4	800	4	306	0.2	40.0	4.00	306	17.7	844			JAC
4	6513	6/10/2004	4	800	1	291	0.2	40.0	1.00	291	3.7	797			JAC
5	6514	6/10/2004	4	800	3	144	0.2	40.0	3.00	144	13.1	330			JAC
6	6515	6/10/2004	4	800	2	116	0.2	40.0	2.00	116	8.4	241			JAC
7	6516	6/10/2004	4	800	6	230	0.2	40.0	6.00	230	27.1	603			JAC
8	6517	6/10/2004	4	800	3	128	0.2	40.0	3.00	128	13.1	279			JAC
9	6518	6/10/2004	4	800	2	135	0.2	40.0	2.00	135	8.4	302			JAC
10	6519	6/10/2004	4	800	2	143	0.2	40.0	2.00	143	8.4	327			JAC
11	6520	6/10/2004	4	800	4	137	0.2	40.0	4.00	137	17.7	308			JAC
12	6521	6/10/2004	4	800	0	116	0.2	40.0	0.00	116	-0.9	241			JAC
13	6522	6/10/2004	4	800	4	176	0.2	40.0	4.00	176	17.7	432			JAC
14	6523	6/10/2004	4	800	5	156	0.2	40.0	5.00	156	22.4	368			JAC
15	6524	6/10/2004	4	800	0	156	0.2	40.0	0.00	156	-0.9	368			JAC
16	6525	6/10/2004	4	800	0	90	0.2	40.0	0.00	90	-0.9	159			JAC
17	6526	6/10/2004	4	800	1	163	0.2	40.0	1.00	163	3.7	390			JAC
18	6527	6/10/2004	4	800	5	158	0.2	40.0	5.00	158	22.4	375			JAC
19	6528	6/10/2004	4	800	0	147	0.2	40.0	0.00	147	-0.9	340			JAC
20	6529	6/10/2004	4	800	3	160	0.2	40.0	3.00	160	13.1	381			JAC

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
WASH RACK #2 NORTH FLOOR - SMEAR RESULTS

α eff	β eff
0.3300	0.2800

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm²	
α Flag	β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm²)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	WR2-NF-1	3/31/2004	2	994	0	106	0.1	49.7	0.00	53	-0.3	12			KP
2	WR2-NF-2	3/31/2004	2	994	1	99	0.1	49.7	0.50	50	1.2	-1			KP
3	WR2-NF-3	3/31/2004	2	994	2	94	0.1	49.7	1.00	47	2.7	-10			KP
4	WR2-NF-4	3/31/2004	2	994	0	97	0.1	49.7	0.00	49	-0.3	-4			KP
5	WR2-NF-5	3/31/2004	2	994	0	103	0.1	49.7	0.00	52	-0.3	6			KP
6	WR2-NF-6	3/31/2004	2	994	0	99	0.1	49.7	0.00	50	-0.3	-1			KP
7	WR2-NF-7	3/31/2004	2	994	1	93	0.1	49.7	0.50	47	1.2	-11			KP
8	WR2-NF-8	3/31/2004	2	994	0	94	0.1	49.7	0.00	47	-0.3	-10			KP
9	WR2-NF-9	3/31/2004	2	994	1	108	0.1	49.7	0.50	54	1.2	15			KP
10	WR2-NF-10	3/31/2004	2	994	1	92	0.1	49.7	0.50	46	1.2	-13			KP
11	WR2-NF-11	3/31/2004	2	994	2	97	0.1	49.7	1.00	49	2.7	-4			KP
12	WR2-NF-12	3/31/2004	2	994	0	91	0.1	49.7	0.00	46	-0.3	-15			KP
13	WR2-NF-13	3/31/2004	2	994	1	110	0.1	49.7	0.50	55	1.2	19			KP
14	WR2-NF-14	3/31/2004	2	994	0	103	0.1	49.7	0.00	52	-0.3	6			KP
15	WR2-NF-15	3/31/2004	2	994	0	93	0.1	49.7	0.00	47	-0.3	-11			KP
16	WR2-NF-16	3/31/2004	2	994	0	108	0.1	49.7	0.00	54	-0.3	15			KP
17	WR2-NF-17	3/31/2004	2	994	1	93	0.1	49.7	0.50	47	1.2	-11			KP
18	WR2-NF-18	3/31/2004	2	994	0	91	0.1	49.7	0.00	46	-0.3	-15			KP
19	WR2-NF-19	3/31/2004	2	994	0	96	0.1	49.7	0.00	48	-0.3	-6			KP
20	WR2-NF-20	3/31/2004	2	994	0	92	0.1	49.7	0.00	46	-0.3	-13			KP

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
WASH RACK #2 SOUTH FLOOR - SMEAR RESULTS

α eff	β eff
0.3300	0.2800

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm^2 α Flag	dpm/100 cm^2 β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts* α	Background Total Counts* β	Sample Total Counts α	Sample Total Counts β	Background (cpm) α	Background (cpm) β	Sample Counts (cpm) α	Sample Counts (cpm) β	Sample (dpm/100 cm^2) α	Sample (dpm/100 cm^2) β	> α flag	> β flag	Tech. Initial
1	WR2-SF-1	3/31/2004	2	994	0	96	0.1	49.7	0.00	48	-0.3	-6			KP
2	WR2-SF-2	3/31/2004	2	994	0	102	0.1	49.7	0.00	51	-0.3	5			KP
3	WR2-SF-3	3/31/2004	2	994	0	95	0.1	49.7	0.00	48	-0.3	-8			KP
4	WR2-SF-4	3/31/2004	2	994	1	93	0.1	49.7	0.50	47	1.2	-11			KP
5	WR2-SF-5	3/31/2004	2	994	2	82	0.1	49.7	1.00	41	2.7	-31			KP
6	WR2-SF-6	3/31/2004	2	994	0	98	0.1	49.7	0.00	49	-0.3	-3			KP
7	WR2-SF-7	3/31/2004	2	994	0	94	0.1	49.7	0.00	47	-0.3	-10			KP
8	WR2-SF-8	3/31/2004	2	994	0	92	0.1	49.7	0.00	46	-0.3	-13			KP
9	WR2-SF-9	3/31/2004	2	994	0	106	0.1	49.7	0.00	53	-0.3	12			KP
10	WR2-SF-10	3/31/2004	2	994	0	99	0.1	49.7	0.00	50	-0.3	-1			KP
11	WR2-SF-11	3/31/2004	2	994	0	84	0.1	49.7	0.00	42	-0.3	-28			KP
12	WR2-SF-12	3/31/2004	2	994	0	97	0.1	49.7	0.00	49	-0.3	-4			KP
13	WR2-SF-13	3/31/2004	2	994	0	99	0.1	49.7	0.00	50	-0.3	-1			KP
14	WR2-SF-14	3/31/2004	2	994	2	104	0.1	49.7	1.00	52	2.7	8			KP
15	WR2-SF-15	3/31/2004	2	994	2	95	0.1	49.7	1.00	48	2.7	-8			KP
16	WR2-SF-16	3/31/2004	2	994	0	93	0.1	49.7	0.00	47	-0.3	-11			KP
17	WR2-SF-17	3/31/2004	2	994	0	97	0.1	49.7	0.00	49	-0.3	-4			KP
18	WR2-SF-18	3/31/2004	2	994	0	94	0.1	49.7	0.00	47	-0.3	-10			KP
19	WR2-SF-19	3/31/2004	2	994	1	91	0.1	49.7	0.50	46	1.2	-15			KP
20	WR2-SF-20	3/31/2004	2	994	1	86	0.1	49.7	0.50	43	1.2	-24			KP

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
WASH RACK #2 CEILING AND UPPER WALLS - SMEAR RESULTS

α eff	β eff
0.3300	0.2800

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm^2	
α Flag	β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	WR2-C-1	3/31/2004	2	994	0	90	0.1	49.7	0.00	45	-0.3	-17			KP
2	WR2-C-2	3/31/2004	2	994	1	89	0.1	49.7	0.50	45	1.2	-19			KP
3	WR2-C-3	3/31/2004	2	994	0	91	0.1	49.7	0.00	46	-0.3	-15			KP
4	WR2-C-4	3/31/2004	2	994	0	90	0.1	49.7	0.00	45	-0.3	-17			KP
5	WR2-C-5	3/31/2004	2	994	2	83	0.1	49.7	1.00	42	2.7	-29			KP
6	WR2-C-6	3/31/2004	2	994	0	89	0.1	49.7	0.00	45	-0.3	-19			KP
7	WR2-C-7	3/31/2004	2	994	1	104	0.1	49.7	0.50	52	1.2	8			KP
8	WR2-C-8	3/31/2004	2	994	0	108	0.1	49.7	0.00	54	-0.3	15			KP
9	WR2-C-9	3/31/2004	2	994	0	96	0.1	49.7	0.00	48	-0.3	-6			KP
10	WR2-C-10	3/31/2004	2	994	1	98	0.1	49.7	0.50	49	1.2	-3			KP
11	WR2-C-11	3/31/2004	2	994	1	90	0.1	49.7	0.50	45	1.2	-17			KP
12	WR2-C-12	3/31/2004	2	994	0	99	0.1	49.7	0.00	50	-0.3	-1			KP
13	WR2-C-13	3/31/2004	2	994	0	93	0.1	49.7	0.00	47	-0.3	-11			KP
14	WR2-C-14	3/31/2004	2	994	0	84	0.1	49.7	0.00	42	-0.3	-28			KP
15	WR2-C-15	3/31/2004	2	994	0	77	0.1	49.7	0.00	39	-0.3	-40			KP
16	WR2-C-16	3/31/2004	2	994	1	78	0.1	49.7	0.50	39	1.2	-38			KP
17	WR2-C-17	3/31/2004	2	994	0	89	0.1	49.7	0.00	45	-0.3	-19			KP
18	WR2-C-18	3/31/2004	2	994	1	94	0.1	49.7	0.50	47	1.2	-10			KP
19	WR2-C-19	3/31/2004	2	994	0	95	0.1	49.7	0.00	48	-0.3	-8			KP
20	WR2-C-20	3/31/2004	2	994	0	96	0.1	49.7	0.00	48	-0.3	-6			KP

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
WASH RACK #2 LOWER WALLS - SMEAR RESULTS

α eff	β eff
0.3300	0.2800

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm²	
α Flag	β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	WR2-NW-1	3/31/2004	2	994	0	114	0.1	49.7	0.00	57	-0.3	26			KP
2	WR2-NW-2	3/31/2004	2	994	1	93	0.1	49.7	0.50	47	1.2	-11			KP
3	WR2-NW-3	3/31/2004	2	994	0	84	0.1	49.7	0.00	42	-0.3	-28			KP
4	WR2-NW-4	3/31/2004	2	994	0	98	0.1	49.7	0.00	49	-0.3	-3			KP
5	WR2-SW-1	3/31/2004	2	994	0	79	0.1	49.7	0.00	40	-0.3	-36			KP
6	WR2-SW-2	3/31/2004	2	994	0	94	0.1	49.7	0.00	47	-0.3	-10			KP
7	WR2-SW-3	3/31/2004	2	994	1	97	0.1	49.7	0.50	49	1.2	-4			KP
8	WR2-SW-4	3/31/2004	2	994	1	92	0.1	49.7	0.50	46	1.2	-13			KP
9	WR2-EW-1	3/31/2004	2	994	1	103	0.1	49.7	0.50	52	1.2	6			KP
10	WR2-EW-2	3/31/2004	2	994	1	83	0.1	49.7	0.50	42	1.2	-29			KP
11	WR2-EW-3	3/31/2004	2	994	0	99	0.1	49.7	0.00	50	-0.3	-1			KP
12	WR2-EW-4	3/31/2004	2	994	0	95	0.1	49.7	0.00	48	-0.3	-8			KP
13	WR2-EW-5	3/31/2004	2	994	2	91	0.1	49.7	1.00	46	2.7	-15			KP
14	WR2-EW-6	3/31/2004	2	994	1	96	0.1	49.7	0.50	48	1.2	-6			KP
15	WR2-EW-7	3/31/2004	2	994	1	93	0.1	49.7	0.50	47	1.2	-11			KP
16	WR2-EW-8	3/31/2004	2	994	0	94	0.1	49.7	0.00	47	-0.3	-10			KP
17	WR2-WW-1	3/31/2004	2	994	0	99	0.1	49.7	0.00	50	-0.3	-1			KP
18	WR2-WW-2	3/31/2004	2	994	0	98	0.1	49.7	0.00	49	-0.3	-3			KP
19	WR2-WW-3	3/31/2004	2	994	0	93	0.1	49.7	0.00	47	-0.3	-11			KP
20	WR2-WW-4	3/31/2004	2	994	1	97	0.1	49.7	0.50	49	1.2	-4			KP
21	WR2-WW-5	3/31/2004	2	994	0	105	0.1	49.7	0.00	53	-0.3	10			KP
22	WR2-WW-6	3/31/2004	2	994	1	95	0.1	49.7	0.50	48	1.2	-8			KP
23	WR2-WW-7	3/31/2004	2	994	0	93	0.1	49.7	0.00	47	-0.3	-11			KP
24	WR2-WW-8	3/31/2004	2	994	1	96	0.1	49.7	0.50	48	1.2	-6			KP

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
WASH RACK #2 NORTH FLOOR - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)
582

α eff	β eff
0.1700	0.2500

Static Count Time (min)
1.0

Daily Background Count Time (min)
20.0

dpm/100 cm^2	
α Flag	β Flag
100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	WR2-NF-1	6/27/2003	4	819	8	829	0.2	41.0	8.00	829	7.9	542			KP
2	WR2-NF-2	6/27/2003	4	819	7	1121	0.2	41.0	7.00	1121	6.9	742			KP
3	WR2-NF-3	6/27/2003	4	819	10	1345	0.2	41.0	10.00	1345	9.9	896			KP
4	WR2-NF-4	6/27/2003	4	819	9	1500	0.2	41.0	9.00	1500	8.9	1003			KP
5	WR2-NF-5	6/27/2003	4	819	5	729	0.2	41.0	5.00	729	4.9	473			KP
6	WR2-NF-6	6/27/2003	4	819	7	659	0.2	41.0	7.00	659	6.9	425			KP
7	WR2-NF-7	6/27/2003	4	819	5	580	0.2	41.0	5.00	580	4.9	370			KP
8	WR2-NF-8	6/27/2003	4	819	12	857	0.2	41.0	12.00	857	11.9	561			KP
9	WR2-NF-9	6/27/2003	4	819	5	871	0.2	41.0	5.00	871	4.9	570			KP
10	WR2-NF-10	6/27/2003	4	819	6	917	0.2	41.0	6.00	917	5.9	602			KP
11	WR2-NF-11	6/27/2003	4	819	4	593	0.2	41.0	4.00	593	3.8	379			KP
12	WR2-NF-12	6/27/2003	4	819	5	556	0.2	41.0	5.00	556	4.9	354			KP
13	WR2-NF-13	6/27/2003	4	819	4	696	0.2	41.0	4.00	696	3.8	450			KP
14	WR2-NF-14	6/27/2003	4	819	9	686	0.2	41.0	9.00	686	8.9	443			KP
15	WR2-NF-15	6/27/2003	4	819	15	778	0.2	41.0	15.00	778	15.0	507			KP
16	WR2-NF-16	6/27/2003	4	819	11	689	0.2	41.0	11.00	689	10.9	445			KP
17	WR2-NF-17	6/27/2003	4	819	7	627	0.2	41.0	7.00	627	6.9	403			KP
18	WR2-NF-18	6/27/2003	4	819	6	698	0.2	41.0	6.00	698	5.9	452			KP
19	WR2-NF-19	6/27/2003	4	819	12	612	0.2	41.0	12.00	612	11.9	392			KP
20	WR2-NF-20	6/27/2003	4	819	5	713	0.2	41.0	5.00	713	4.9	462			KP

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
WASH RACK #2 SOUTH FLOOR - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)	α eff	β eff	Static Count Time (min)	Daily Background Count Time (min)	dpm/100 cm^2 α Flag	dpm/100 cm^2 β Flag
582	0.1700	0.2500	1.0	20.0	100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts* α	Background Total Counts* β	Sample Total Counts α	Sample Total Counts β	Background (cpm) α	Background (cpm) β	Sample Counts (cpm) α	Sample Counts (cpm) β	Sample (dpm/100 cm^2) α	Sample (dpm/100 cm^2) β	> α flag	> β flag	Tech. Initial
1	WR2-SF-1	6/27/2003	4	819	5	594	0.2	41.0	5.00	594	4.9	380			KP
2	WR2-SF-2	6/27/2003	4	819	7	703	0.2	41.0	7.00	703	6.9	455			KP
3	WR2-SF-3	6/27/2003	4	819	4	687	0.2	41.0	4.00	687	3.8	444			KP
4	WR2-SF-4	6/27/2003	4	819	10	673	0.2	41.0	10.00	673	9.9	434			KP
5	WR2-SF-5	6/27/2003	4	819	9	692	0.2	41.0	9.00	692	8.9	447			KP
6	WR2-SF-6	6/27/2003	4	819	7	694	0.2	41.0	7.00	694	6.9	449			KP
7	WR2-SF-7	6/27/2003	4	819	7	741	0.2	41.0	7.00	741	6.9	481			KP
8	WR2-SF-8	6/27/2003	4	819	12	1272	0.2	41.0	12.00	1272	11.9	846			KP
9	WR2-SF-9	6/27/2003	4	819	7	1147	0.2	41.0	7.00	1147	6.9	760			KP
10	WR2-SF-10	6/27/2003	4	819	5	921	0.2	41.0	5.00	921	4.9	605			KP
11	WR2-SF-11	6/27/2003	4	819	8	827	0.2	41.0	8.00	827	7.9	540			KP
12	WR2-SF-12	6/27/2003	4	819	3	712	0.2	41.0	3.00	712	2.8	461			KP
13	WR2-SF-13	6/27/2003	4	819	9	802	0.2	41.0	9.00	802	8.9	523			KP
14	WR2-SF-14	6/27/2003	4	819	6	753	0.2	41.0	6.00	753	5.9	489			KP
15	WR2-SF-15	6/27/2003	4	819	11	769	0.2	41.0	11.00	769	10.9	500			KP
16	WR2-SF-16	6/27/2003	4	819	10	652	0.2	41.0	10.00	652	9.9	420			KP
17	WR2-SF-17	6/27/2003	4	819	5	696	0.2	41.0	5.00	696	4.9	450			KP
18	WR2-SF-18	6/27/2003	4	819	6	723	0.2	41.0	6.00	723	5.9	469			KP
19	WR2-SF-19	6/27/2003	4	819	4	649	0.2	41.0	4.00	649	3.8	418			KP
20	WR2-SF-20	6/27/2003	4	819	8	698	0.2	41.0	8.00	698	7.9	452			KP

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
WASH RACK #2 CEILING AND UPPER WALLS - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)	α eff	β eff	Static Count Time (min)	Daily Background Count Time (min)	dpm/100 cm^2 α Flag	dpm/100 cm^2 β Flag
100	0.2000	0.2000	1.0	20.0	100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts* α	Background Total Counts* β	Sample Total Counts α	Sample Total Counts β	Background (cpm) α	Background (cpm) β	Sample Counts (cpm) α	Sample Counts (cpm) β	Sample (dpm/100 cm^2) α	Sample (dpm/100 cm^2) β	> α flag	> β flag	Tech. Initial
1	East Wall	6/26/2003	0	0	0	79	0.0	0.0	0.00	79	0.0	395			KP
2	East Wall	6/26/2003	0	0	0	104	0.0	0.0	0.00	104	0.0	520			KP
3	East Wall	6/26/2003	0	0	2	86	0.0	0.0	2.00	86	10.0	430			KP
4	East Wall	6/26/2003	0	0	1	78	0.0	0.0	1.00	78	5.0	390			KP
5	North Wall	6/26/2003	0	0	1	100	0.0	0.0	1.00	100	5.0	500			KP
6	Ceiling	6/26/2003	0	0	2	77	0.0	0.0	2.00	77	10.0	385			KP
7	Ceiling	6/26/2003	0	0	0	84	0.0	0.0	0.00	84	0.0	420			KP
8	Ceiling	6/26/2003	0	0	0	93	0.0	0.0	0.00	93	0.0	465			KP
9	Ceiling	6/26/2003	0	0	0	96	0.0	0.0	0.00	96	0.0	480			KP
10	South Wall	6/26/2003	0	0	1	82	0.0	0.0	1.00	82	5.0	410			KP
11	North Wall	6/26/2003	0	0	0	85	0.0	0.0	0.00	85	0.0	425			KP
12	Ceiling	6/26/2003	0	0	0	91	0.0	0.0	0.00	91	0.0	455			KP
13	Ceiling	6/26/2003	0	0	1	92	0.0	0.0	1.00	92	5.0	460			KP
14	Ceiling	6/26/2003	0	0	1	98	0.0	0.0	1.00	98	5.0	490			KP
15	Ceiling	6/26/2003	0	0	2	97	0.0	0.0	2.00	97	10.0	485			KP
16	South Wall	6/26/2003	0	0	0	92	0.0	0.0	0.00	92	0.0	460			KP
17	West Wall	6/26/2003	0	0	0	91	0.0	0.0	0.00	91	0.0	455			KP
18	West Wall	6/26/2003	0	0	2	105	0.0	0.0	2.00	105	10.0	525			KP
19	West Wall	6/26/2003	0	0	0	98	0.0	0.0	0.00	98	0.0	490			KP
20	West Wall	6/26/2003	0	0	1	72	0.0	0.0	1.00	72	5.0	360			KP

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
WASH RACK #2 LOWER WALLS - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)
582

α eff	β eff
0.1700	0.2500

Static Count Time (min)
1.0

Daily Background Count Time (min)
20.0

dpm/100 cm^2	
α Flag	β Flag
100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	North Wall	6/25/2003	5	854	14	543	0.3	42.7	14.00	543	13.9	344			KP
2	North Wall	6/25/2003	5	854	9	523	0.3	42.7	9.00	523	8.8	330			KP
3	North Wall	6/25/2003	5	854	8	530	0.3	42.7	8.00	530	7.8	335			KP
4	North Wall	6/25/2003	5	854	7	517	0.3	42.7	7.00	517	6.8	326			KP
5	East Wall	6/25/2003	5	854	11	561	0.3	42.7	11.00	561	10.9	356			KP
6	East Wall	6/25/2003	5	854	9	602	0.3	42.7	9.00	602	8.8	384			KP
7	East Wall	6/25/2003	5	854	14	581	0.3	42.7	14.00	581	13.9	370			KP
8	East Wall	6/25/2003	5	854	9	574	0.3	42.7	9.00	574	8.8	365			KP
9	East Wall	6/25/2003	5	854	6	550	0.3	42.7	6.00	550	5.8	349			KP
10	East Wall	6/25/2003	5	854	7	568	0.3	42.7	7.00	568	6.8	361			KP
11	East Wall	6/25/2003	5	854	8	578	0.3	42.7	8.00	578	7.8	368			KP
12	East Wall	6/25/2003	5	854	5	583	0.3	42.7	5.00	583	4.8	371			KP
13	South Wall	6/25/2003	5	854	6	545	0.3	42.7	6.00	545	5.8	345			KP
14	South Wall	6/25/2003	5	854	5	525	0.3	42.7	5.00	525	4.8	331			KP
15	South Wall	6/25/2003	5	854	9	499	0.3	42.7	9.00	499	8.8	314			KP
16	South Wall	6/25/2003	5	854	11	573	0.3	42.7	11.00	573	10.9	364			KP
17	West Wall	6/25/2003	5	854	8	581	0.3	42.7	8.00	581	7.8	370			KP
18	West Wall	6/25/2003	5	854	12	589	0.3	42.7	12.00	589	11.9	375			KP
19	West Wall	6/25/2003	5	854	10	545	0.3	42.7	10.00	545	9.9	345			KP
20	West Wall	6/25/2003	5	854	11	503	0.3	42.7	11.00	503	10.9	316			KP
21	West Wall	6/25/2003	5	854	5	574	0.3	42.7	5.00	574	4.8	365			KP
22	West Wall	6/25/2003	5	854	10	560	0.3	42.7	10.00	560	9.9	356			KP
23	West Wall	6/25/2003	5	854	8	582	0.3	42.7	8.00	582	7.8	371			KP
24	West Wall	6/25/2003	5	854	8	555	0.3	42.7	8.00	555	7.8	352			KP

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
WASH RACK #3 NORTH FLOOR - SMEAR RESULTS

α eff	β eff
0.3300	0.2800

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm²	
α Flag	β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm²)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	WR3-NF-1	3/30/2004	4	965	1	92	0.2	48.3	0.50	46	0.9	-8			KP
2	WR3-NF-2	3/30/2004	4	965	0	97	0.2	48.3	0.00	49	-0.6	1			KP
3	WR3-NF-3	3/30/2004	4	965	0	101	0.2	48.3	0.00	51	-0.6	8			KP
4	WR3-NF-4	3/30/2004	4	965	0	90	0.2	48.3	0.00	45	-0.6	-12			KP
5	WR3-NF-5	3/30/2004	4	965	1	89	0.2	48.3	0.50	45	0.9	-13			KP
6	WR3-NF-6	3/30/2004	4	965	0	96	0.2	48.3	0.00	48	-0.6	-1			KP
7	WR3-NF-7	3/30/2004	4	965	0	97	0.2	48.3	0.00	49	-0.6	1			KP
8	WR3-NF-8	3/30/2004	4	965	0	102	0.2	48.3	0.00	51	-0.6	10			KP
9	WR3-NF-9	3/30/2004	4	965	0	101	0.2	48.3	0.00	51	-0.6	8			KP
10	WR3-NF-10	3/30/2004	4	965	0	91	0.2	48.3	0.00	46	-0.6	-10			KP
11	WR3-NF-11	3/30/2004	4	965	1	89	0.2	48.3	0.50	45	0.9	-13			KP
12	WR3-NF-12	3/30/2004	4	965	0	94	0.2	48.3	0.00	47	-0.6	-4			KP
13	WR3-NF-13	3/30/2004	4	965	1	108	0.2	48.3	0.50	54	0.9	21			KP
14	WR3-NF-14	3/30/2004	4	965	1	93	0.2	48.3	0.50	47	0.9	-6			KP
15	WR3-NF-15	3/30/2004	4	965	0	88	0.2	48.3	0.00	44	-0.6	-15			KP
16	WR3-NF-16	3/30/2004	4	965	1	76	0.2	48.3	0.50	38	0.9	-37			KP
17	WR3-NF-17	3/30/2004	4	965	0	90	0.2	48.3	0.00	45	-0.6	-12			KP
18	WR3-NF-18	3/30/2004	4	965	0	94	0.2	48.3	0.00	47	-0.6	-4			KP
19	WR3-NF-19	3/30/2004	4	965	1	89	0.2	48.3	0.50	45	0.9	-13			KP
20	WR3-NF-20	3/30/2004	4	965	0	95	0.2	48.3	0.00	48	-0.6	-3			KP

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
WASH RACK #3 SOUTH FLOOR - SMEAR RESULTS

α eff	β eff
0.3300	0.2800

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm² α Flag	dpm/100 cm² β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	WR3-SF-1	3/30/2004	4	965	0	102	0.2	48.3	0.00	51	-0.6	10			KP
2	WR3-SF-2	3/30/2004	4	965	0	97	0.2	48.3	0.00	49	-0.6	1			KP
3	WR3-SF-3	3/30/2004	4	965	0	100	0.2	48.3	0.00	50	-0.6	6			KP
4	WR3-SF-4	3/30/2004	4	965	0	76	0.2	48.3	0.00	38	-0.6	-37			KP
5	WR3-SF-5	3/30/2004	4	965	0	82	0.2	48.3	0.00	41	-0.6	-26			KP
6	WR3-SF-6	3/30/2004	4	965	0	93	0.2	48.3	0.00	47	-0.6	-6			KP
7	WR3-SF-7	3/30/2004	4	965	0	73	0.2	48.3	0.00	37	-0.6	-42			KP
8	WR3-SF-8	3/30/2004	4	965	0	80	0.2	48.3	0.00	40	-0.6	-29			KP
9	WR3-SF-9	3/30/2004	4	965	0	110	0.2	48.3	0.00	55	-0.6	24			KP
10	WR3-SF-10	3/30/2004	4	965	0	96	0.2	48.3	0.00	48	-0.6	-1			KP
11	WR3-SF-11	3/30/2004	4	965	0	101	0.2	48.3	0.00	51	-0.6	8			KP
12	WR3-SF-12	3/30/2004	4	965	0	99	0.2	48.3	0.00	50	-0.6	4			KP
13	WR3-SF-13	3/30/2004	4	965	0	86	0.2	48.3	0.00	43	-0.6	-19			KP
14	WR3-SF-14	3/30/2004	4	965	0	79	0.2	48.3	0.00	40	-0.6	-31			KP
15	WR3-SF-15	3/30/2004	4	965	0	103	0.2	48.3	0.00	52	-0.6	12			KP
16	WR3-SF-16	3/30/2004	4	965	0	78	0.2	48.3	0.00	39	-0.6	-33			KP
17	WR3-SF-17	3/30/2004	4	965	0	92	0.2	48.3	0.00	46	-0.6	-8			KP
18	WR3-SF-18	3/30/2004	4	965	0	102	0.2	48.3	0.00	51	-0.6	10			KP
19	WR3-SF-19	3/30/2004	4	965	0	96	0.2	48.3	0.00	48	-0.6	-1			KP
20	WR3-SF-20	3/30/2004	4	965	0	94	0.2	48.3	0.00	47	-0.6	-4			KP
21															

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
WASH RACK #3 CEILING AND UPPER WALLS - SMEAR RESULTS

α eff	β eff
0.3328	0.2789

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm²	
α Flag	β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm²)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	WR3-C-1	3/30/2004	4	965	0	97	0.2	48.3	0.00	49	-0.6	1			KP
2	WR3-C-2	3/30/2004	4	965	0	91	0.2	48.3	0.00	46	-0.6	-10			KP
3	WR3-C-3	3/30/2004	4	965	1	99	0.2	48.3	0.50	50	0.9	4			KP
4	WR3-C-4	3/30/2004	4	965	1	103	0.2	48.3	0.50	52	0.9	12			KP
5	WR3-C-5	3/30/2004	4	965	0	79	0.2	48.3	0.00	40	-0.6	-31			KP
6	WR3-C-6	3/30/2004	4	965	0	100	0.2	48.3	0.00	50	-0.6	6			KP
7	WR3-C-7	3/30/2004	4	965	1	89	0.2	48.3	0.50	45	0.9	-13			KP
8	WR3-C-8	3/30/2004	4	965	1	91	0.2	48.3	0.50	46	0.9	-10			KP
9	WR3-C-9	3/30/2004	4	965	0	92	0.2	48.3	0.00	46	-0.6	-8			KP
10	WR3-C-10	3/30/2004	4	965	0	84	0.2	48.3	0.00	42	-0.6	-22			KP
11	WR3-C-11	3/30/2004	4	965	1	106	0.2	48.3	0.50	53	0.9	17			KP
12	WR3-C-12	3/30/2004	4	965	0	108	0.2	48.3	0.00	54	-0.6	21			KP
13	WR3-C-13	3/30/2004	4	965	0	92	0.2	48.3	0.00	46	-0.6	-8			KP
14	WR3-C-14	3/30/2004	4	965	0	91	0.2	48.3	0.00	46	-0.6	-10			KP
15	WR3-C-15	3/30/2004	4	965	1	97	0.2	48.3	0.50	49	0.9	1			KP
16	WR3-C-16	3/30/2004	4	965	0	101	0.2	48.3	0.00	51	-0.6	8			KP
17	WR3-C-17	3/30/2004	4	965	0	94	0.2	48.3	0.00	47	-0.6	-4			KP
18	WR3-C-18	3/30/2004	4	965	1	92	0.2	48.3	0.50	46	0.9	-8			KP
19	WR3-C-19	3/30/2004	4	965	1	99	0.2	48.3	0.50	50	0.9	4			KP
20	WR3-C-20	3/30/2004	4	965	0	101	0.2	48.3	0.00	51	-0.6	8			KP
21															

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
WASH RACK #3 LOWER WALLS - SMEAR RESULTS

α eff	β eff
0.3300	0.2800

Sample Count Time (min)	Daily Background Count Time (min)
2.0	20.0

dpm/100 cm^2	
α Flag	β Flag
10	500

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	WR3-NW-1	3/30/2004	4	965	0	5	0.2	48.3	0.00	3	-0.6	-163			KP
2	WR3-NW-2	3/30/2004	4	965	0	82	0.2	48.3	0.00	41	-0.6	-26			KP
3	WR3-NW-3	3/30/2004	4	965	2	85	0.2	48.3	1.00	43	2.4	-21			KP
4	WR3-NW-4	3/30/2004	4	965	0	98	0.2	48.3	0.00	49	-0.6	3			KP
5	WR3-EW-1	3/30/2004	4	965	0	118	0.2	48.3	0.00	59	-0.6	38			KP
6	WR3-EW-2	3/30/2004	4	965	1	99	0.2	48.3	0.50	50	0.9	4			KP
7	WR3-EW-3	3/30/2004	4	965	2	87	0.2	48.3	1.00	44	2.4	-17			KP
8	WR3-EW-4	3/30/2004	4	965	0	101	0.2	48.3	0.00	51	-0.6	8			KP
9	WR3-EW-5	3/30/2004	4	965	0	92	0.2	48.3	0.00	46	-0.6	-8			KP
10	WR3-EW-6	3/30/2004	4	965	1	106	0.2	48.3	0.50	53	0.9	17			KP
11	WR3-EW-7	3/30/2004	4	965	0	93	0.2	48.3	0.00	47	-0.6	-6			KP
12	WR3-EW-8	3/30/2004	4	965	0	89	0.2	48.3	0.00	45	-0.6	-13			KP
13	WR3-SW-1	3/30/2004	4	965	0	94	0.2	48.3	0.00	47	-0.6	-4			KP
14	WR3-SW-2	3/30/2004	4	965	0	92	0.2	48.3	0.00	46	-0.6	-8			KP
15	WR3-SW-3	3/30/2004	4	965	2	95	0.2	48.3	1.00	48	2.4	-3			KP
16	WR3-SW-4	3/30/2004	4	965	1	81	0.2	48.3	0.50	41	0.9	-28			KP
17	WR3-WW-1	3/30/2004	4	965	0	90	0.2	48.3	0.00	45	-0.6	-12			KP
18	WR3-WW-2	3/30/2004	4	965	1	88	0.2	48.3	0.50	44	0.9	-15			KP
19	WR3-WW-3	3/30/2004	4	965	0	105	0.2	48.3	0.00	53	-0.6	15			KP
20	WR3-WW-4	3/30/2004	4	965	0	84	0.2	48.3	0.00	42	-0.6	-22			KP
21	WR3-WW-5	3/30/2004	4	965	1	89	0.2	48.3	0.50	45	0.9	-13			KP
22	WR3-WW-6	3/30/2004	4	965	0	102	0.2	48.3	0.00	51	-0.6	10			KP
23	WR3-WW-7	3/30/2004	4	965	0	89	0.2	48.3	0.00	45	-0.6	-13			KP
24	WR3-WW-8	3/30/2004	4	965	1	92	0.2	48.3	0.50	46	0.9	-8			KP
25															

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
WASH RACK #3 NORTH FLOOR - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)	α eff	β eff	Static Count Time (min)	Daily Background Count Time (min)	α Flag (dpm/100 cm^2)	β Flag (dpm/100 cm^2)
582	0.1700	0.2500	1.0	20.0	100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts*		Sample Total Counts		Background (cpm)		Sample Counts (cpm)		Sample (dpm/100 cm^2)		> α flag	> β flag	Tech. Initial
			α	β	α	β	α	β	α	β	α	β			
1	WR3-NF-1	6/25/2003	5	854	3	525	0.3	42.7	3.00	525	2.8	331			KP
2	WR3-NF-2	6/25/2003	5	854	1	605	0.3	42.7	1.00	605	0.8	386			KP
3	WR3-NF-3	6/25/2003	5	854	2	548	0.3	42.7	2.00	548	1.8	347			KP
4	WR3-NF-4	6/25/2003	5	854	4	606	0.3	42.7	4.00	606	3.8	387			KP
5	WR3-NF-5	6/25/2003	5	854	3	613	0.3	42.7	3.00	613	2.8	392			KP
6	WR3-NF-6	6/25/2003	5	854	8	637	0.3	42.7	8.00	637	7.8	408			KP
7	WR3-NF-7	6/25/2003	5	854	10	634	0.3	42.7	10.00	634	9.9	406			KP
8	WR3-NF-8	6/25/2003	5	854	8	588	0.3	42.7	8.00	588	7.8	375			KP
9	WR3-NF-9	6/25/2003	5	854	6	589	0.3	42.7	6.00	589	5.8	375			KP
10	WR3-NF-10	6/25/2003	5	854	11	640	0.3	42.7	11.00	640	10.9	411			KP
11	WR3-NF-11	6/25/2003	5	854	8	621	0.3	42.7	8.00	621	7.8	397			KP
12	WR3-NF-12	6/25/2003	5	854	7	602	0.3	42.7	7.00	602	6.8	384			KP
13	WR3-NF-13	6/25/2003	5	854	6	617	0.3	42.7	6.00	617	5.8	395			KP
14	WR3-NF-14	6/25/2003	5	854	5	740	0.3	42.7	5.00	740	4.8	479			KP
15	WR3-NF-15	6/25/2003	5	854	5	569	0.3	42.7	5.00	569	4.8	362			KP
16	WR3-NF-16	6/25/2003	5	854	8	552	0.3	42.7	8.00	552	7.8	350			KP
17	WR3-NF-17	6/25/2003	5	854	12	558	0.3	42.7	12.00	558	11.9	354			KP
18	WR3-NF-18	6/25/2003	5	854	10	781	0.3	42.7	10.00	781	9.9	507			KP
19	WR3-NF-19	6/25/2003	5	854	8	601	0.3	42.7	8.00	601	7.8	384			KP
20	WR3-NF-20	6/25/2003	5	854	15	639	0.3	42.7	15.00	639	14.9	410			KP

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
WASH RACK #3 SOUTH FLOOR - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)
582

α eff	β eff
0.1700	0.2500

Static Count Time (min)
1.0

Daily Background Count Time (min)
20.0

dpm/100 cm^2 α Flag	dpm/100 cm^2 β Flag
100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts* α	Background Total Counts* β	Sample Total Counts α	Sample Total Counts β	Background (cpm) α	Background (cpm) β	Sample Counts (cpm) α	Sample Counts (cpm) β	Sample (dpm/100 cm^2) α	Sample (dpm/100 cm^2) β	> α flag	> β flag	Tech. Initial
1	WR3-SF-1	6/23/2003	5	866	5	808	0.3	43.3	5.00	808	4.8	526			KP
2	WR3-SF-2	6/23/2003	5	866	3	758	0.3	43.3	3.00	758	2.8	491			KP
3	WR3-SF-3	6/23/2003	5	866	6	561	0.3	43.3	6.00	561	5.8	356			KP
4	WR3-SF-4	6/23/2003	5	866	7	1005	0.3	43.3	7.00	1005	6.8	661			KP
5	WR3-SF-5	6/23/2003	5	866	2	258	0.3	43.3	2.00	258	1.8	148			KP
6	WR3-SF-6	6/23/2003	5	866	2	647	0.3	43.3	2.00	647	1.8	415			KP
7	WR3-SF-7	6/23/2003	5	866	3	665	0.3	43.3	3.00	665	2.8	427			KP
8	WR3-SF-8	6/23/2003	5	866	1	569	0.3	43.3	1.00	569	0.8	361			KP
9	WR3-SF-9	6/23/2003	5	866	6	880	0.3	43.3	6.00	880	5.8	575			KP
10	WR3-SF-10	6/23/2003	5	866	4	940	0.3	43.3	4.00	940	3.8	616			KP
11	WR3-SF-11	6/23/2003	5	866	2	558	0.3	43.3	2.00	558	1.8	354			KP
12	WR3-SF-12	6/23/2003	5	866	3	551	0.3	43.3	3.00	551	2.8	349			KP
13	WR3-SF-13	6/23/2003	5	866	2	434	0.3	43.3	2.00	434	1.8	269			KP
14	WR3-SF-14	6/23/2003	5	866	4	1283	0.3	43.3	4.00	1283	3.8	852			KP
15	WR3-SF-15	6/23/2003	5	866	7	1076	0.3	43.3	7.00	1076	6.8	710			KP
16	WR3-SF-16	6/23/2003	5	866	4	572	0.3	43.3	4.00	572	3.8	363			KP
17	WR3-SF-17	6/23/2003	5	866	4	620	0.3	43.3	4.00	620	3.8	396			KP
18	WR3-SF-18	6/23/2003	5	866	4	576	0.3	43.3	4.00	576	3.8	366			KP
19	WR3-SF-19	6/23/2003	5	866	7	683	0.3	43.3	7.00	683	6.8	440			KP
20	WR3-SF-20	6/23/2003	5	866	4	664	0.3	43.3	4.00	664	3.8	427			KP

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
WASH RACK #3 CEILING AND UPPER WALLS - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)	α eff	β eff	Static Count Time (min)	Daily Background Count Time (min)	α Flag (dpm/100 cm^2)	β Flag (dpm/100 cm^2)
100	0.2000	0.2000	1.0	20.0	100	5000

* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts* α	Background Total Counts* β	Sample Total Counts α	Sample Total Counts β	Background (cpm) α	Background (cpm) β	Sample Counts (cpm) α	Sample Counts (cpm) β	Sample (dpm/100 cm^2) α	Sample (dpm/100 cm^2) β	> α flag	> β flag	Tech. Initial
1	East Wall	6/26/2003	0	0	0	108	0.0	0.0	0.00	108	0.0	540			KP
2	East Wall	6/26/2003	0	0	1	115	0.0	0.0	1.00	115	5.0	575			KP
3	East Wall	6/26/2003	0	0	2	98	0.0	0.0	2.00	98	10.0	490			KP
4	East Wall	6/26/2003	0	0	0	88	0.0	0.0	0.00	88	0.0	440			KP
5	North Wall	6/26/2003	0	0	1	92	0.0	0.0	1.00	92	5.0	460			KP
6	Ceiling	6/26/2003	0	0	0	96	0.0	0.0	0.00	96	0.0	480			KP
7	Ceiling	6/26/2003	0	0	0	79	0.0	0.0	0.00	79	0.0	395			KP
8	Ceiling	6/26/2003	0	0	2	93	0.0	0.0	2.00	93	10.0	465			KP
9	Ceiling	6/26/2003	0	0	0	87	0.0	0.0	0.00	87	0.0	435			KP
10	South Wall	6/26/2003	0	0	0	95	0.0	0.0	0.00	95	0.0	475			KP
11	North Wall	6/26/2003	0	0	1	101	0.0	0.0	1.00	101	5.0	505			KP
12	Ceiling	6/26/2003	0	0	0	103	0.0	0.0	0.00	103	0.0	515			KP
13	Ceiling	6/26/2003	0	0	2	99	0.0	0.0	2.00	99	10.0	495			KP
14	Ceiling	6/26/2003	0	0	0	86	0.0	0.0	0.00	86	0.0	430			KP
15	Ceiling	6/26/2003	0	0	0	103	0.0	0.0	0.00	103	0.0	515			KP
16	South Wall	6/26/2003	0	0	1	93	0.0	0.0	1.00	93	5.0	465			KP
17	West Wall	6/26/2003	0	0	0	84	0.0	0.0	0.00	84	0.0	420			KP
18	West Wall	6/26/2003	0	0	0	72	0.0	0.0	0.00	72	0.0	360			KP
19	West Wall	6/26/2003	0	0	0	89	0.0	0.0	0.00	89	0.0	445			KP
20	West Wall	6/26/2003	0	0	2	71	0.0	0.0	2.00	71	10.0	355			KP

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
WASH RACK #3 LOWER WALLS - INTEGRATED DIRECT MEASUREMENTS

Detector Active Area (cm^2)	α eff	β eff	Static Count Time (min)	Daily Background Count Time (min)	dpm/100 cm^2 α Flag	dpm/100 cm^2 β Flag
582	0.1700	0.2500	1.0	20.0	100	5000

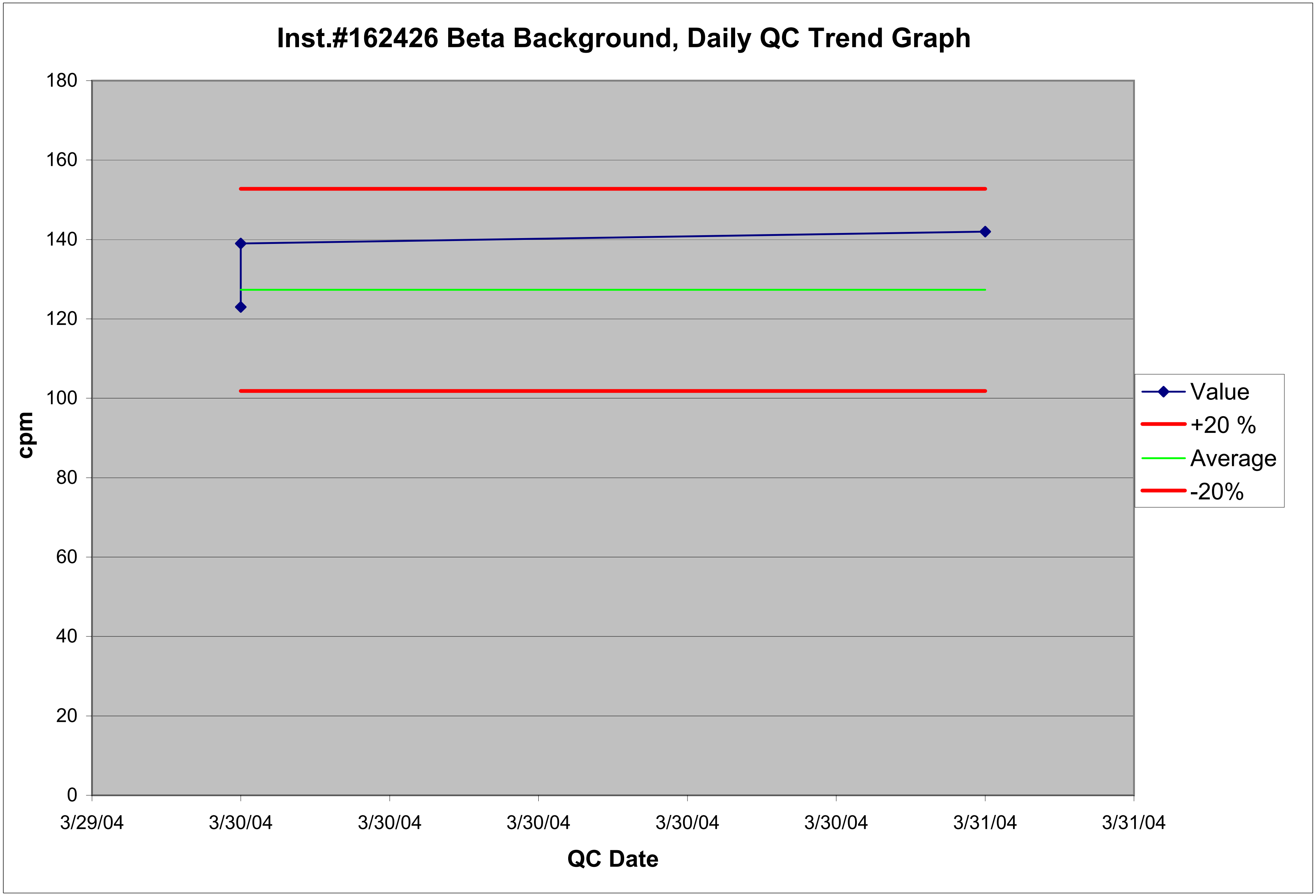
* Morning Daily Count

seq. #	Sample ID# and Description	Date	Background Total Counts* α	Background Total Counts* β	Sample Total Counts α	Sample Total Counts β	Background (cpm) α	Background (cpm) β	Sample Counts (cpm) α	Sample Counts (cpm) β	Sample (dpm/100 cm^2) α	Sample (dpm/100 cm^2) β	> α flag	> β flag	Tech. Initial
1	North Wall	6/25/2003	5	854	4	757	0.3	42.7	4.00	757	3.8	491			KP
2	North Wall	6/25/2003	5	854	5	781	0.3	42.7	5.00	781	4.8	507			KP
3	North Wall	6/25/2003	5	854	9	988	0.3	42.7	9.00	988	8.8	650			KP
4	North Wall	6/25/2003	5	854	6	794	0.3	42.7	6.00	794	5.8	516			KP
5	East Wall	6/25/2003	5	854	7	516	0.3	42.7	7.00	516	6.8	325			KP
6	East Wall	6/25/2003	5	854	5	558	0.3	42.7	5.00	558	4.8	354			KP
7	East Wall	6/25/2003	5	854	5	539	0.3	42.7	5.00	539	4.8	341			KP
8	East Wall	6/25/2003	5	854	2	617	0.3	42.7	2.00	617	1.8	395			KP
9	East Wall	6/25/2003	5	854	6	1348	0.3	42.7	6.00	1348	5.8	897			KP
10	East Wall	6/25/2003	5	854	2	582	0.3	42.7	2.00	582	1.8	371			KP
11	East Wall	6/25/2003	5	854	5	886	0.3	42.7	5.00	886	4.8	580			KP
12	East Wall	6/25/2003	5	854	5	1212	0.3	42.7	5.00	1212	4.8	804			KP
13	South Wall	6/25/2003	5	854	5	861	0.3	42.7	5.00	861	4.8	562			KP
14	South Wall	6/25/2003	5	854	9	1206	0.3	42.7	9.00	1206	8.8	800			KP
15	South Wall	6/25/2003	5	854	4	1102	0.3	42.7	4.00	1102	3.8	728			KP
16	South Wall	6/25/2003	5	854	5	974	0.3	42.7	5.00	974	4.8	640			KP
17	West Wall	6/25/2003	5	854	7	521	0.3	42.7	7.00	521	6.8	329			KP
18	West Wall	6/25/2003	5	854	5	538	0.3	42.7	5.00	538	4.8	340			KP
19	West Wall	6/25/2003	5	854	3	508	0.3	42.7	3.00	508	2.8	320			KP
20	West Wall	6/25/2003	5	854	3	448	0.3	42.7	3.00	448	2.8	279			KP
21	West Wall	6/25/2003	5	854	6	613	0.3	42.7	6.00	613	5.8	392			KP
22	West Wall	6/25/2003	5	854	5	541	0.3	42.7	5.00	541	4.8	342			KP
23	West Wall	6/25/2003	5	854	4	527	0.3	42.7	4.00	527	3.8	333			KP
24	West Wall	6/25/2003	5	854	4	542	0.3	42.7	4.00	542	3.8	343			KP

Appendix I: Survey Instrument Quality Control and Calibration Certificates

Inst.#162426 Beta Background		
QC Daily Source		
Date	Result (cpm)	P/F
3/30/2004	123	Pass
3/30/2004	139	Pass
3/31/2004	142	Pass

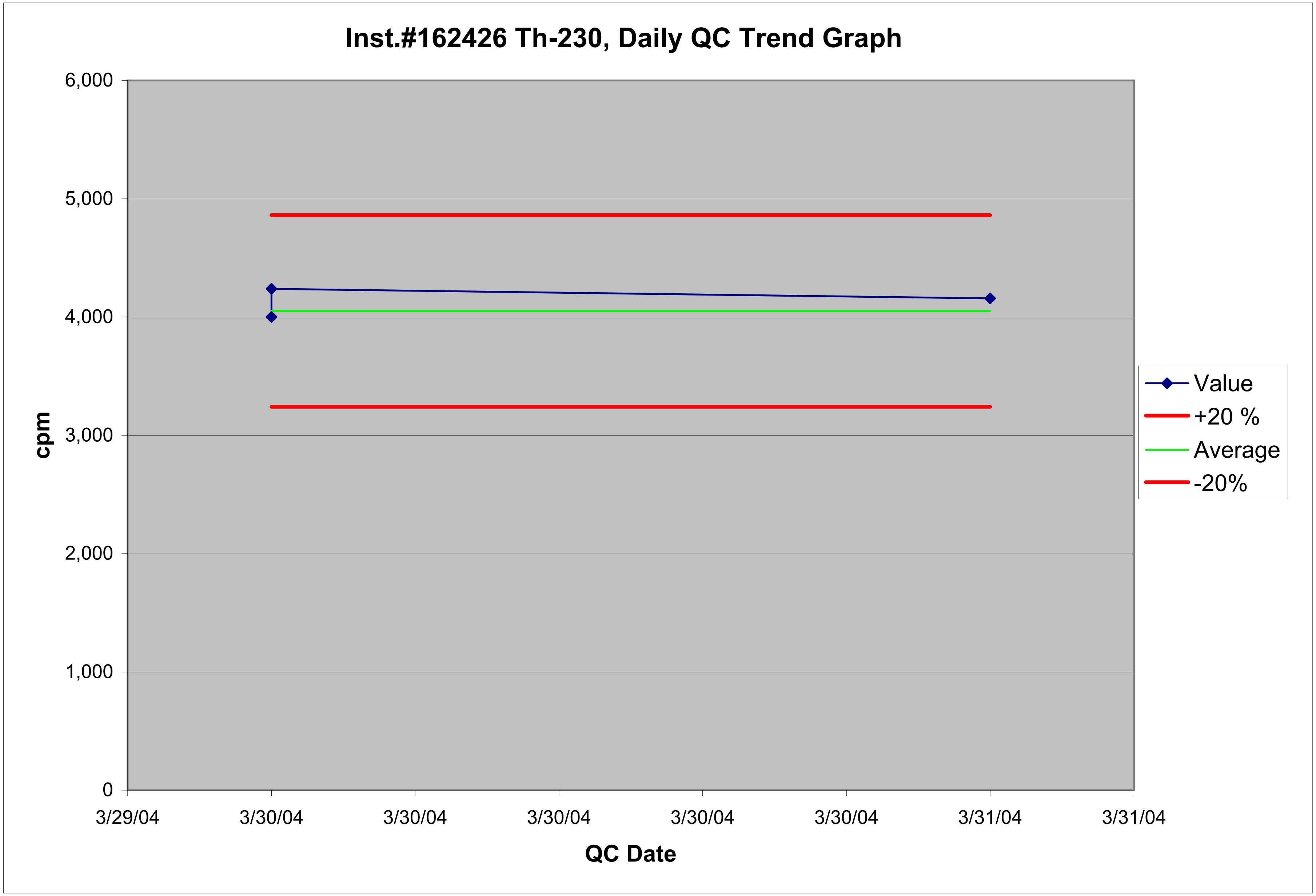
Inst.#162426 Beta Background		Source Ser. #	BKG
Initial Source Readings		Nuclide	
Date	Result (cpm)		
3/29/2004	124		
3/29/2004	113		
3/29/2004	119		
3/29/2004	117		
3/29/2004	152		
3/29/2004	139		
3/29/2004	122		
3/29/2004	131		
3/29/2004	138		
3/29/2004	118		
	Average		
	127		



Inst.#162426 Beta Background, Daily QC Trend Graph
cpm
180
160
140
120
100
80
60
40
20
0
3/29/04
3/30/04
3/30/04
3/30/04
3/30/04
3/30/04
3/31/04
3/31/04
QC Date
Value
+20 %
Average
-20%

Inst.#162426 Th-230		
QC Daily Source		
Date	Result (cpm)	P/F
3/30/2004	4,000	Pass
3/30/2004	4,237	Pass
3/31/2004	4,158	Pass

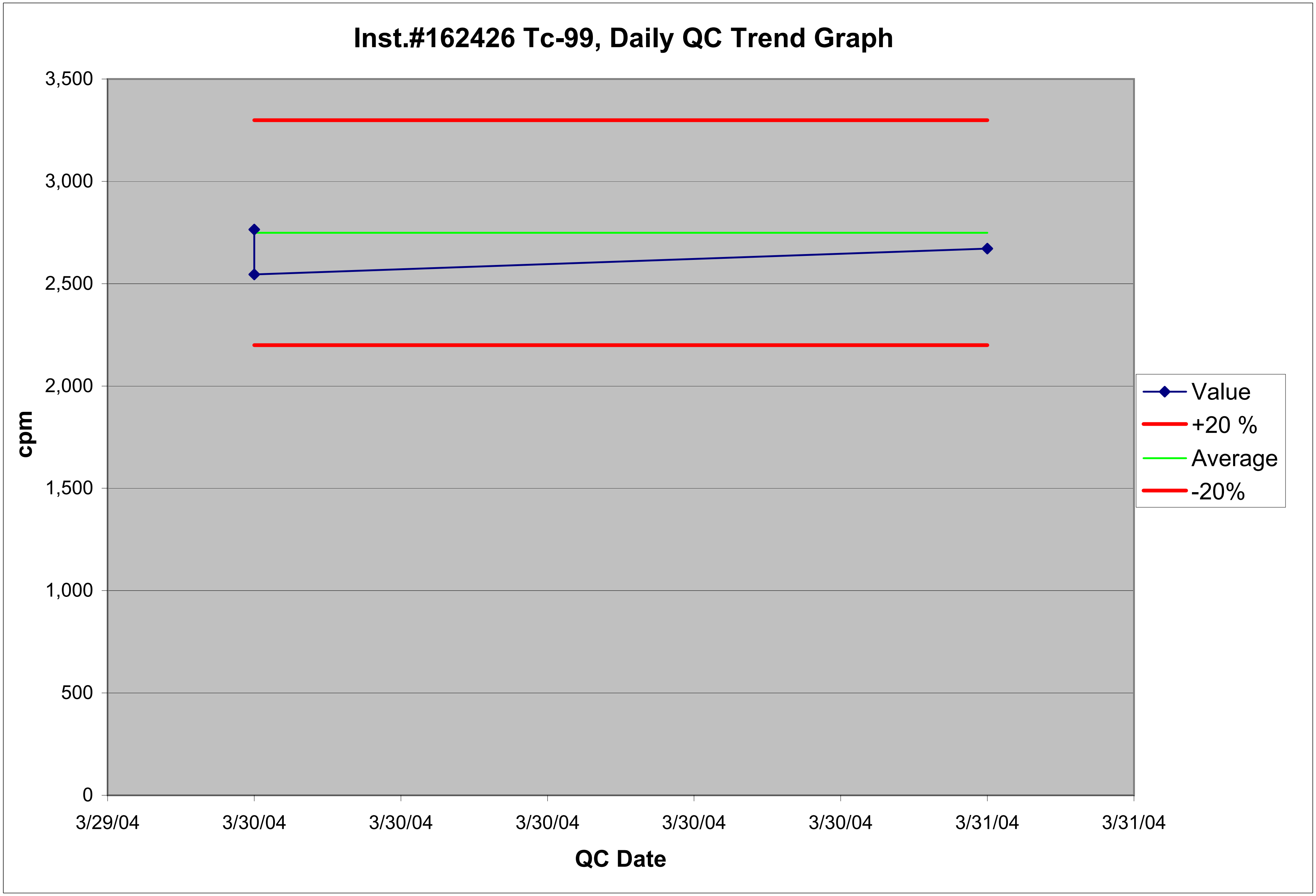
Inst.#162426 Th-230		Source Ser. #	2888-01
Initial Source Readings		Nuclide	Th-230
Date	Result (cpm)		
3/29/2004	3,948		
3/29/2004	4,080		
3/29/2004	4,151		
3/29/2004	4,062		
3/29/2004	4,067		
3/29/2004	4,021		
3/29/2004	3,996		
3/29/2004	4,060		
3/29/2004	4,155		
3/29/2004	3,972		
	Average		
	4051		



Inst.#162426 Th-230, Daily QC Trend Graph
6,000
5,000
4,000
3,000
2,000
1,000
0
cpm
3/29/04
3/30/04
3/30/04
3/30/04
3/30/04
3/30/04
3/31/04
3/31/04
QC Date
Value
+20 %
Average
-20%

Inst.#162426 Tc-99		
QC Daily Source		
Date	Result (cpm)	P/F
3/30/2004	2,764	Pass
3/30/2004	2,545	Pass
3/31/2004	2,671	Pass

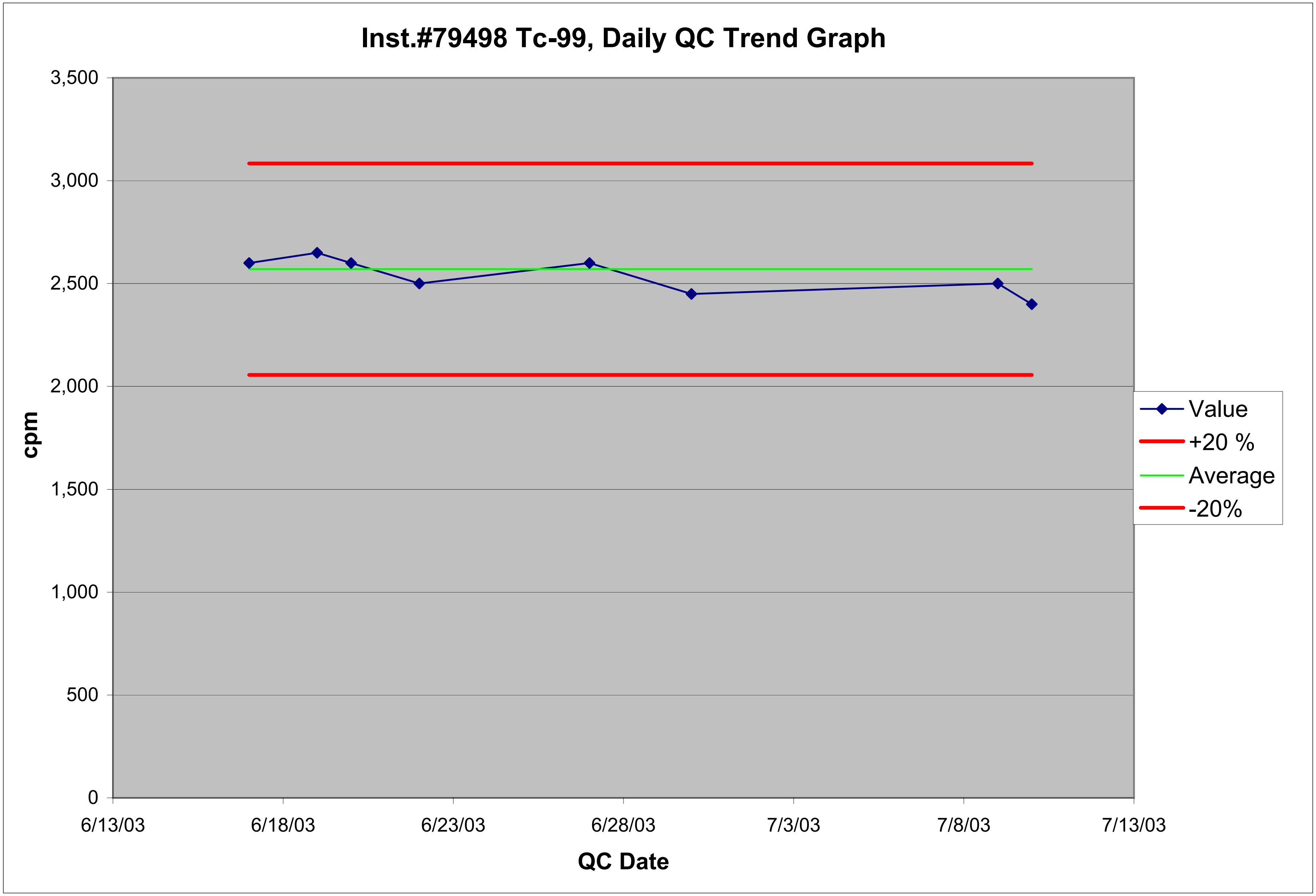
Inst.#162426 Tc-99		Source Ser. #	2889-01
Initial Source Readings		Nuclide	Tc-99
Date	Result (cpm)		
3/29/2004	2,664		
3/29/2004	2,684		
3/29/2004	2,859		
3/29/2004	2,704		
3/29/2004	2,718		
3/29/2004	2,807		
3/29/2004	2,788		
3/29/2004	2,745		
3/29/2004	2,724		
3/29/2004	2,796		
	Average		
	2749		



Inst.#162426 Tc-99, Daily QC Trend Graph
3,500
3,000
2,500
2,000
1,500
1,000
500
0
cpm
3/29/04
3/30/04
3/30/04
3/30/04
3/30/04
3/30/04
3/31/04
3/31/04
QC Date
Value
+20 %
Average
-20%

Inst.#79498 Tc-99		
QC Daily Source		
Date	Result (cpm)	P/F
6/17/2003	2,600	Pass
6/19/2003	2,650	Pass
6/20/2003	2,600	Pass
6/22/2003	2,500	Pass
6/27/2003	2,600	Pass
6/30/2003	2,450	Pass
7/9/2003	2,500	Pass
7/10/2003	2,400	Pass

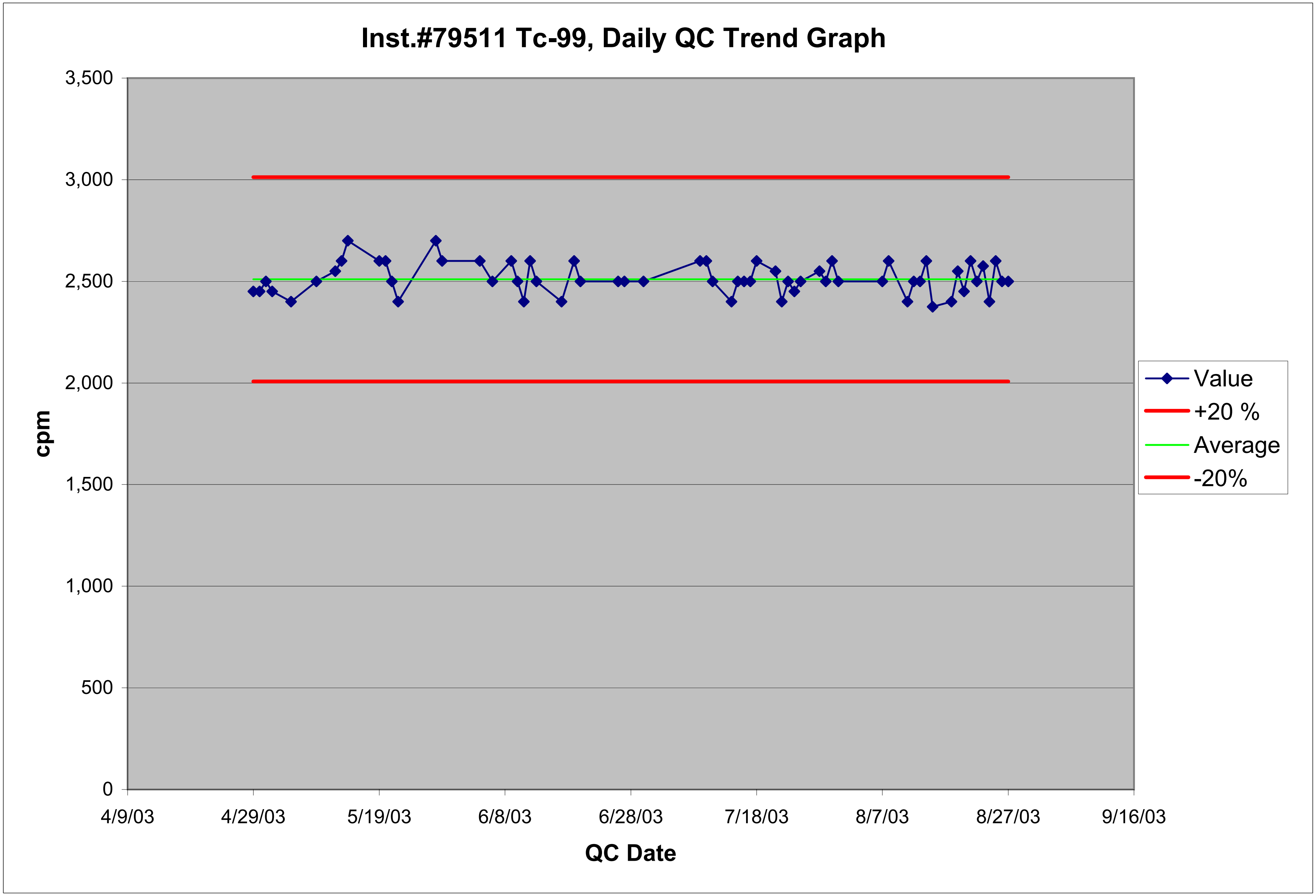
Inst.#79498 Tc-99		Source Ser. #	3974-02
Initial Source Readings		Nuclide	Tc-99
Date	Result (cpm)		
6/16/2003	2,600		
6/16/2003	2,700		
6/16/2003	2,550		
6/16/2003	2,500		
6/16/2003	2,600		
6/16/2003	2,650		
6/16/2003	2,700		
6/16/2003	2,600		
6/16/2003	2,500		
6/16/2003	2,300		
	Average		
	2570		



Inst.#79498 Tc-99, Daily QC Trend Graph
3,500
3,000
2,500
2,000
1,500
1,000
500
0
cpm
6/13/03
6/18/03
6/23/03
6/28/03
7/3/03
7/8/03
7/13/03
QC Date
Value
+20 %
Average
-20%

Inst.#79511 Tc-99		
QC Daily Source		
Date	**Result (cpm)**	**P/F**
4/29/2003	2,450	Pass
4/30/2003	2,450	Pass
5/1/2003	2,500	Pass
5/2/2003	2,450	Pass
5/5/2003	2,400	Pass
5/9/2003	2,500	Pass
5/12/2003	2,550	Pass
5/13/2003	2,600	Pass
5/14/2003	2,700	Pass
5/19/2003	2,600	Pass
5/20/2003	2,600	Pass
5/21/2003	2,500	Pass
5/22/2003	2,400	Pass
5/28/2003	2,700	Pass
5/29/2003	2,600	Pass
6/4/2003	2,600	Pass
6/6/2003	2,500	Pass
6/9/2003	2,600	Pass
6/10/2003	2,500	Pass
6/11/2003	2,400	Pass
6/12/2003	2,600	Pass
6/13/2003	2,500	Pass
6/17/2003	2,400	Pass
6/19/2003	2,600	Pass
6/20/2003	2,500	Pass
6/26/2003	2,500	Pass
6/27/2003	2,500	Pass
6/30/2003	2,500	Pass
7/9/2003	2,600	Pass
7/10/2003	2,600	Pass
7/11/2003	2,500	Pass
7/14/2003	2,400	Pass
7/15/2003	2,500	Pass
7/16/2003	2,500	Pass
7/17/2003	2,500	Pass
7/18/2003	2,600	Pass
7/21/2003	2,550	Pass
7/22/2003	2,400	Pass
7/23/2003	2,500	Pass
7/24/2003	2,450	Pass
7/25/2003	2,500	Pass
7/28/2003	2,550	Pass
7/29/2003	2,500	Pass
7/30/2003	2,600	Pass
7/31/2003	2,500	Pass
8/7/2003	2,500	Pass
8/8/2003	2,600	Pass
8/11/2003	2,400	Pass
8/12/2003	2,500	Pass
8/13/2003	2,500	Pass
8/14/2003	2,600	Pass
8/15/2003	2,375	Pass
8/18/2003	2,400	Pass
8/19/2003	2,550	Pass
8/20/2003	2,450	Pass
8/21/2003	2,600	Pass
8/22/2003	2,500	Pass
8/23/2003	2,575	Pass
8/24/2003	2,400	Pass
8/25/2003	2,600	Pass
8/26/2003	2,500	Pass
8/27/2003	2,500	Pass

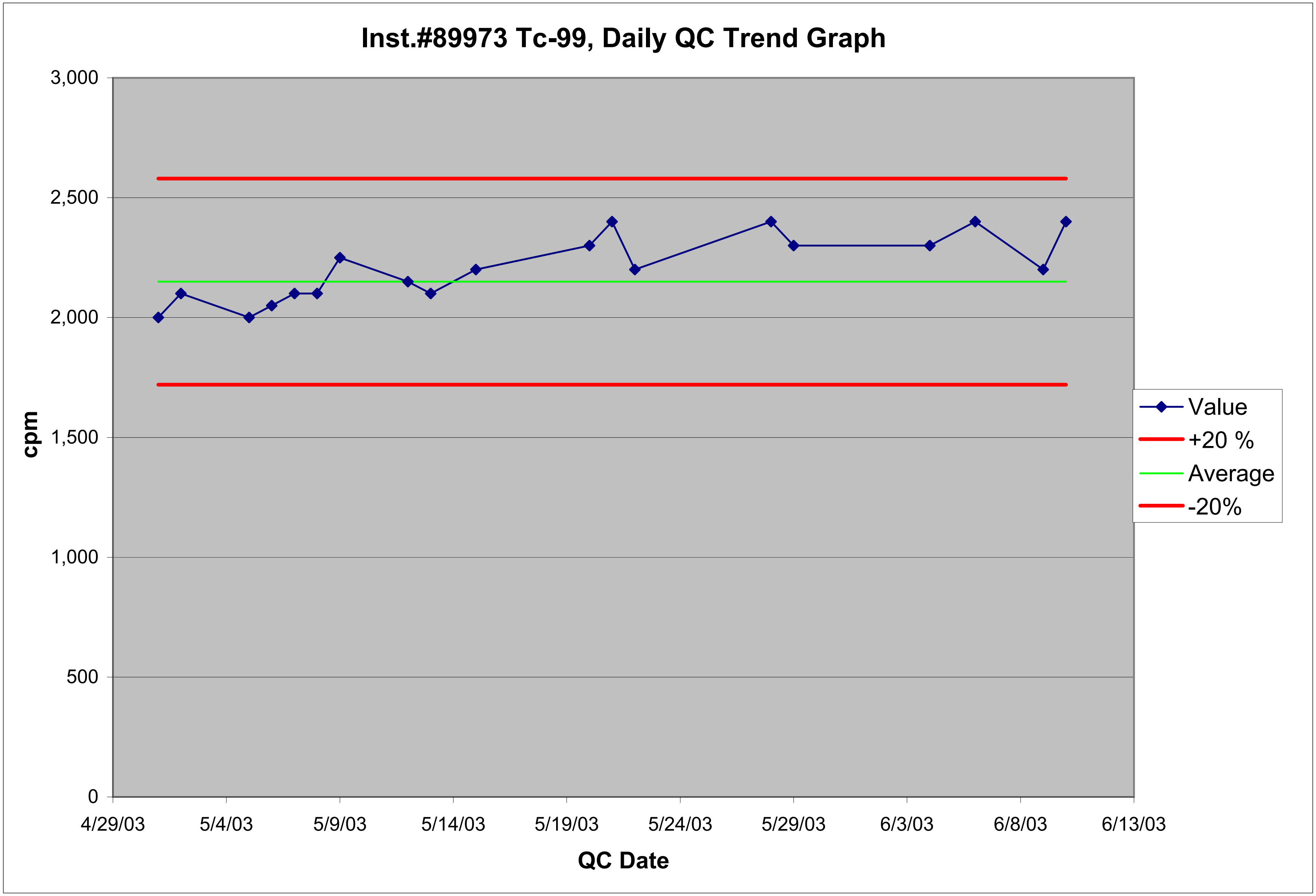
Inst.#79511 Tc-99		Source Ser. #	3974-02
Initial Source Readings		Nuclide	Tc-99
Date	**Result (cpm)**		
4/28/2003	2,500		
4/28/2003	2,650		
4/28/2003	2,450		
4/28/2003	2,500		
4/28/2003	2,500		
4/28/2003	2,450		
4/28/2003	2,550		
4/28/2003	2,500		
4/28/2003	2,550		
4/28/2003	2,450		
	Average		
	2510		



Inst.#79511 Tc-99, Daily QC Trend Graph
3,500
3,000
2,500
2,000
1,500
1,000
500
0
cpm
4/9/03
4/29/03
5/19/03
6/8/03
6/28/03
7/18/03
8/7/03
8/27/03
9/16/03
QC Date
Value
+20 %
Average
-20%

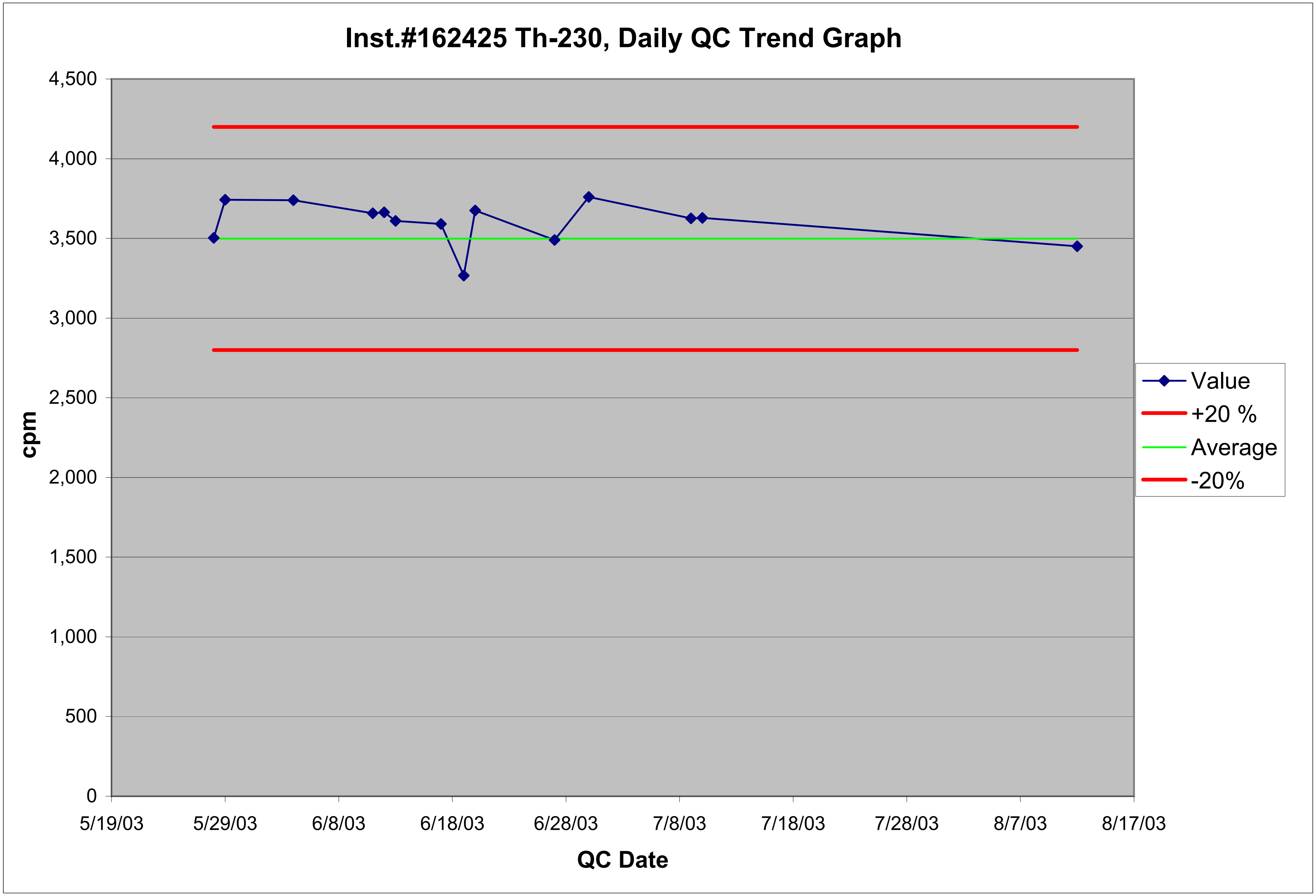
Inst.#89973 Tc-99		
QC Daily Source		
Date	Result (cpm)	P/F
5/1/2003	2,000	Pass
5/2/2003	2,100	Pass
5/5/2003	2,000	Pass
5/6/2003	2,050	Pass
5/7/2003	2,100	Pass
5/8/2003	2,100	Pass
5/9/2003	2,250	Pass
5/12/2003	2,150	Pass
5/13/2003	2,100	Pass
5/15/2003	2,200	Pass
5/20/2003	2,300	Pass
5/21/2003	2,400	Pass
5/22/2003	2,200	Pass
5/28/2003	2,400	Pass
5/29/2003	2,300	Pass
6/4/2003	2,300	Pass
6/6/2003	2,400	Pass
6/9/2003	2,200	Pass
6/10/2003	2,400	Pass

Inst.#89973 Tc-99		Source Ser. #	3974-02
Initial Source Readings		Nuclide	Tc-99
Date	Result (cpm)		
5/1/2003	2,200		
5/1/2003	2,200		
5/1/2003	2,000		
5/1/2003	2,200		
5/1/2003	2,200		
5/1/2003	2,000		
5/1/2003	2,200		
5/1/2003	2,200		
5/1/2003	2,100		
5/1/2003	2,200		
	Average		
	2150		


Inst.#89973 Tc-99, Daily QC Trend Graph
3,000
2,500
2,000
1,500
1,000
500
0
cpm
4/29/03
5/4/03
5/9/03
5/14/03
5/19/03
5/24/03
5/29/03
6/3/03
6/8/03
6/13/03
QC Date
Value
+20 %
Average
-20%

Inst.#162425 Th-230		
QC Daily Source		
Date	Result (cpm)	P/F
5/28/2003	3,503	Pass
5/29/2003	3,742	Pass
6/4/2003	3,740	Pass
6/11/2003	3,658	Pass
6/12/2003	3,664	Pass
6/13/2003	3,610	Pass
6/17/2003	3,591	Pass
6/19/2003	3,266	Pass
6/20/2003	3,676	Pass
6/27/2003	3,490	Pass
6/30/2003	3,760	Pass
7/9/2003	3,626	Pass
7/10/2003	3,628	Pass
8/12/2003	3,450	Pass

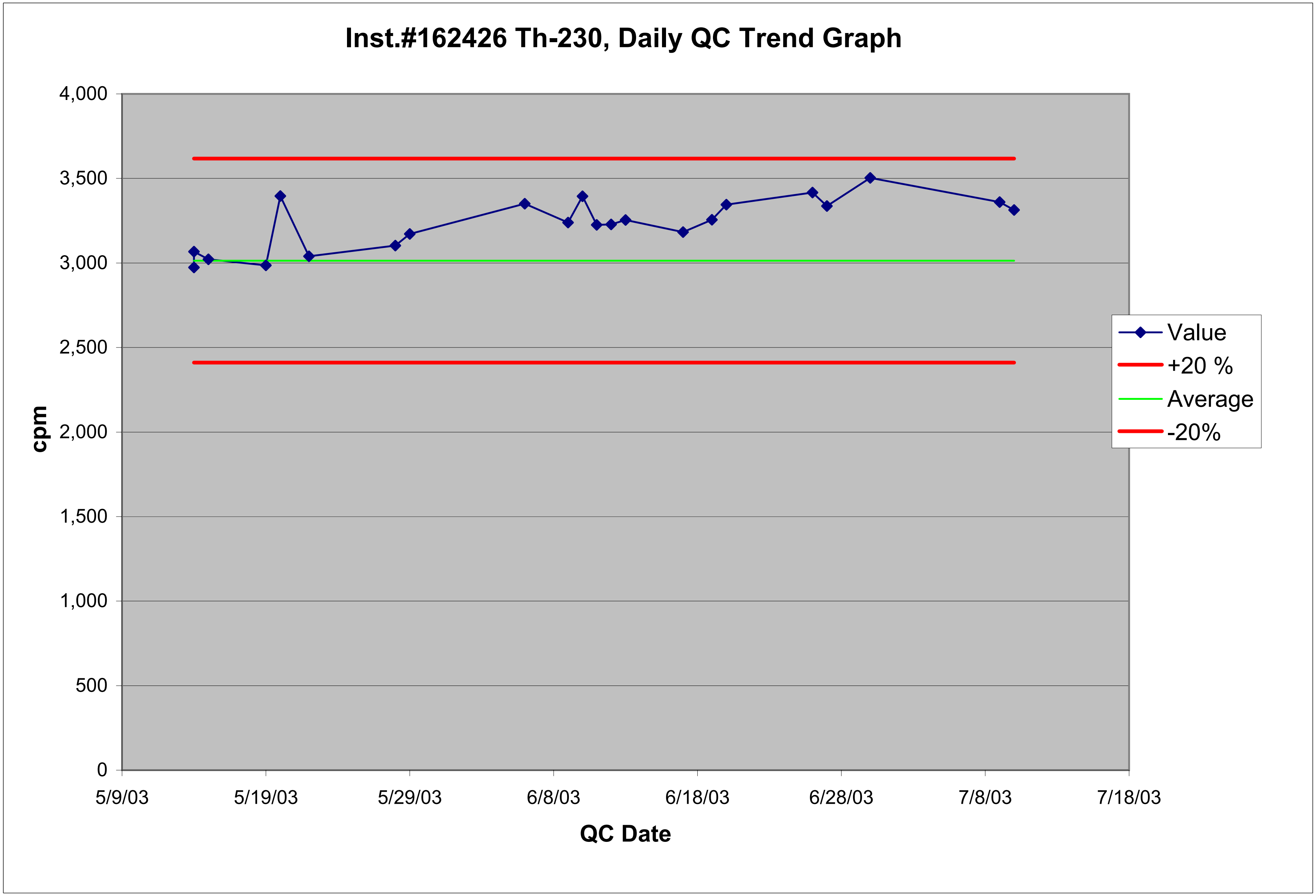
Inst.#162425 Th-230		Source Ser. #	3972-02
Initial Source Readings		Nuclide	Th-230
Date	Result (cpm)		
5/28/2003	3,443		
5/28/2003	3,459		
5/28/2003	3,557		
5/28/2003	3,446		
5/28/2003	3,570		
5/28/2003	3,493		
5/28/2003	3,531		
5/28/2003	3,459		
5/28/2003	3,532		
5/28/2003	3,503		
	Average		
	3499		



Inst.#162425 Th-230, Daily QC Trend Graph
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
cpm
5/19/03
5/29/03
6/8/03
6/18/03
6/28/03
7/8/03
7/18/03
7/28/03
8/7/03
8/17/03
QC Date
Value
+20 %
Average
-20%

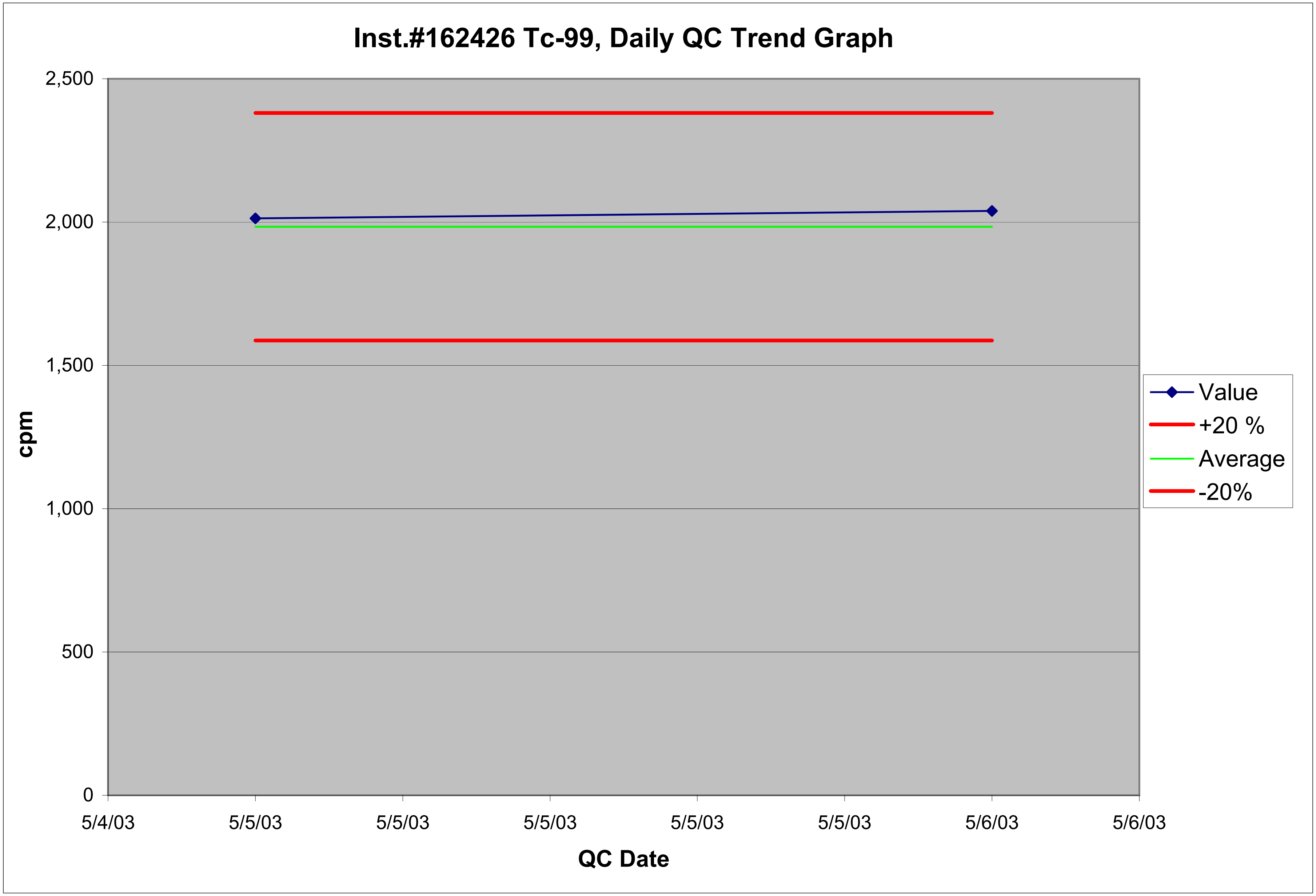
Inst.#162426 Th-230		
QC Daily Source		
Date	Result (cpm)	P/F
5/14/2003	2,974	Pass
5/14/2003	3,067	Pass
5/15/2003	3,021	Pass
5/19/2003	2,986	Pass
5/20/2003	3,396	Pass
5/22/2003	3,039	Pass
5/28/2003	3,103	Pass
5/29/2003	3,171	Pass
6/6/2003	3,351	Pass
6/9/2003	3,239	Pass
6/10/2003	3,394	Pass
6/11/2003	3,225	Pass
6/12/2003	3,228	Pass
6/13/2003	3,254	Pass
6/17/2003	3,183	Pass
6/19/2003	3,256	Pass
6/20/2003	3,345	Pass
6/26/2003	3,417	Pass
6/27/2003	3,337	Pass
6/30/2003	3,503	Pass
7/9/2003	3,360	Pass
7/10/2003	3,314	Pass

Inst.#162426 Th-230		Source Ser. #	3972-02
Initial Source Readings		Nuclide	Th-230
Date	Result (cpm)		
5/13/2003	2,975		
5/13/2003	3,062		
5/13/2003	2,968		
5/13/2003	2,989		
5/13/2003	3,000		
5/13/2003	2,934		
5/13/2003	3,040		
5/13/2003	3,043		
5/13/2003	3,034		
5/13/2003	3,095		
	Average		
	3014		


Inst.#162426 Th-230, Daily QC Trend Graph
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
cpm
5/9/03
5/19/03
5/29/03
6/8/03
6/18/03
6/28/03
7/8/03
7/18/03
QC Date
Value
+20 %
Average
-20%

Inst.#162426 Tc-99		
QC Daily Source		
Date	Result (cpm)	P/F
5/5/2003	2,013	Pass
5/6/2003	2,039	Pass

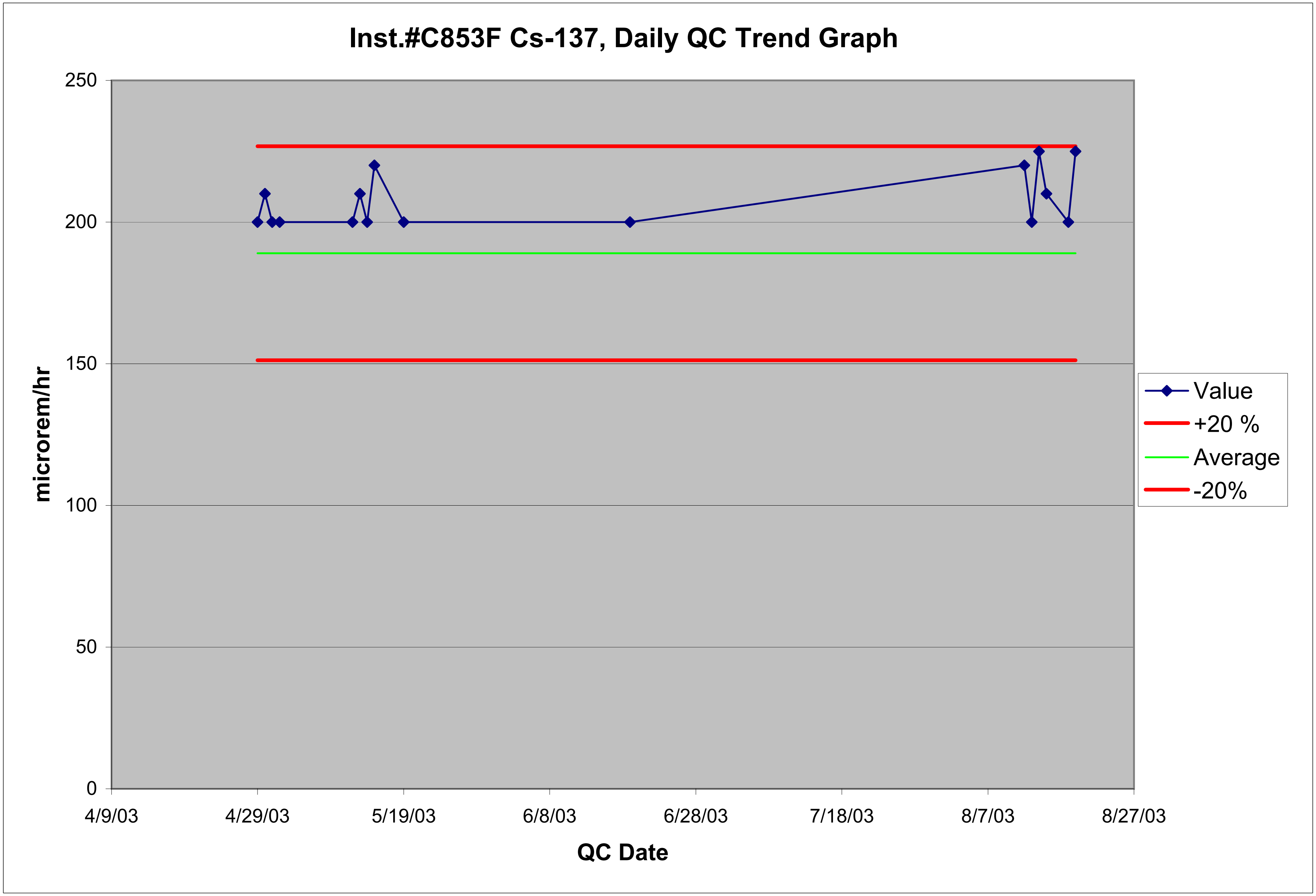
Inst.#162426 Tc-99		Source Ser. #	3974-02
Initial Source Readings		Nuclide	Tc-99
Date	Result (cpm)		
5/1/2003	1,959		
5/1/2003	1,969		
5/1/2003	1,934		
5/1/2003	1,981		
5/1/2003	1,964		
5/1/2003	1,997		
5/1/2003	1,987		
5/1/2003	2,052		
5/1/2003	2,042		
5/1/2003	1,951		
	Average		
	1984		



Inst.#162426 Tc-99, Daily QC Trend Graph
2,500
2,000
1,500
1,000
500
0
cpm
5/4/03
5/5/03
5/5/03
5/5/03
5/5/03
5/5/03
5/6/03
5/6/03
QC Date
Value
+20 %
Average
-20%

Inst.#C853F Cs-137		
QC Daily Source		
Date	**Result (μrem/hr)**	**P/F**
4/29/2003	200	Pass
4/30/2003	210	Pass
5/1/2003	200	Pass
5/2/2003	200	Pass
5/12/2003	200	Pass
5/13/2003	210	Pass
5/14/2003	200	Pass
5/15/2003	220	Pass
5/19/2003	200	Pass
6/19/2003	200	Pass
8/12/2003	220	Pass
8/13/2003	200	Pass
8/14/2003	225	Pass
8/15/2003	210	Pass
8/18/2003	200	Pass
8/19/2003	225	Pass

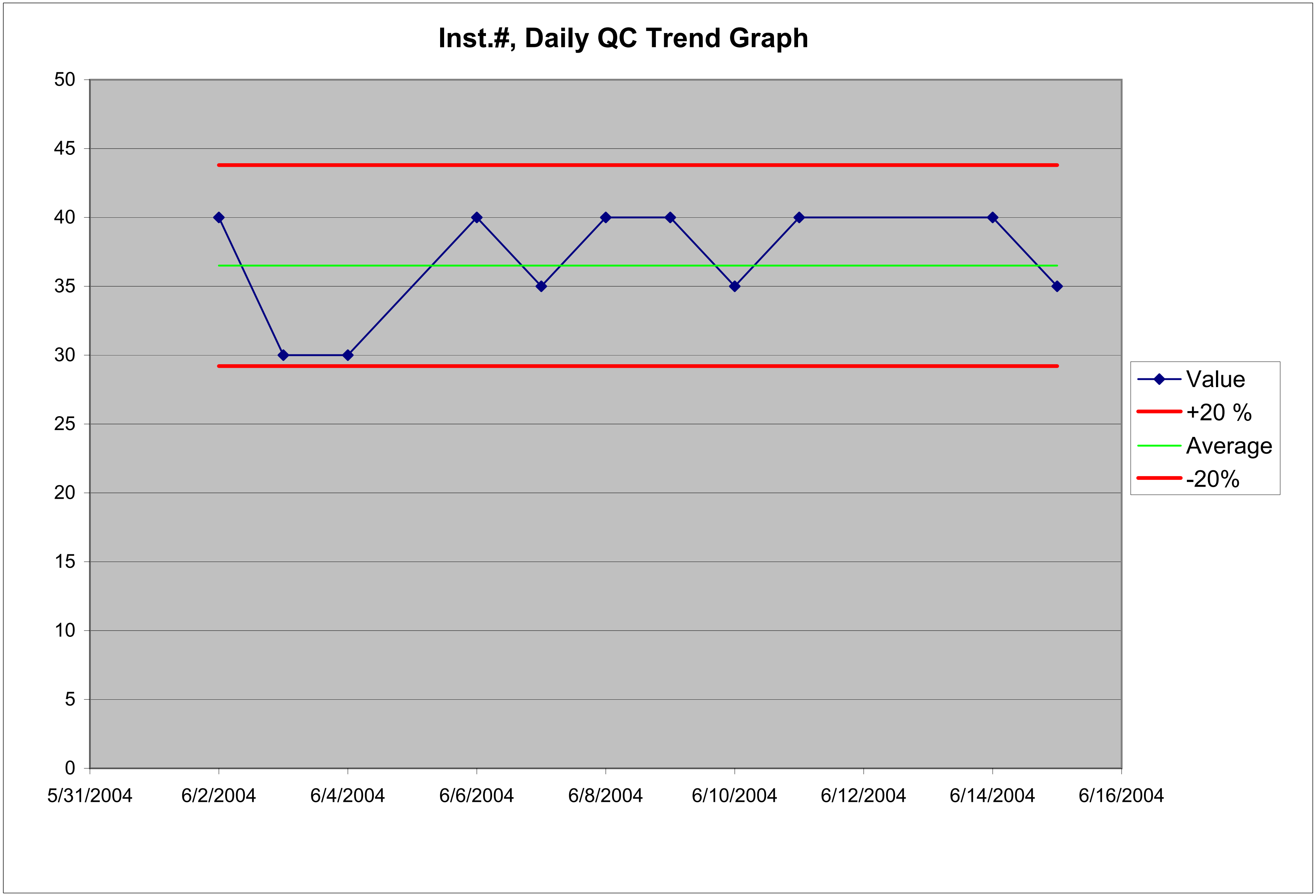
Inst.#C853F Cs-137		Source Ser. #	1127
Initial Source Readings		Nuclide	Cs-137
Date	**Result (μrem/hr)**		
4/28/2003	190		
4/28/2003	210		
4/28/2003	190		
4/28/2003	180		
4/28/2003	190		
4/28/2003	180		
4/28/2003	190		
4/28/2003	180		
4/28/2003	190		
4/28/2003	190		
	Average		
	189		



Inst.#C853F Cs-137, Daily QC Trend Graph
250
200
150
100
50
0
microrem/hr
4/9/03
4/29/03
5/19/03
6/8/03
6/28/03
7/18/03
8/7/03
8/27/03
QC Date
Value
+20 %
Average
-20%

Inst.#79498 Background		
QC Daily Source		
Date	Result (cpm)	P/F
6/2/2004	40	Pass
6/3/2004	30	Pass
6/4/2004	30	Pass
6/6/2004	40	Pass
6/7/2004	35	Pass
6/8/2004	40	Pass
6/9/2004	40	Pass
6/10/2004	35	Pass
6/11/2004	40	Pass
6/14/2004	40	Pass
6/15/2004	35	Pass

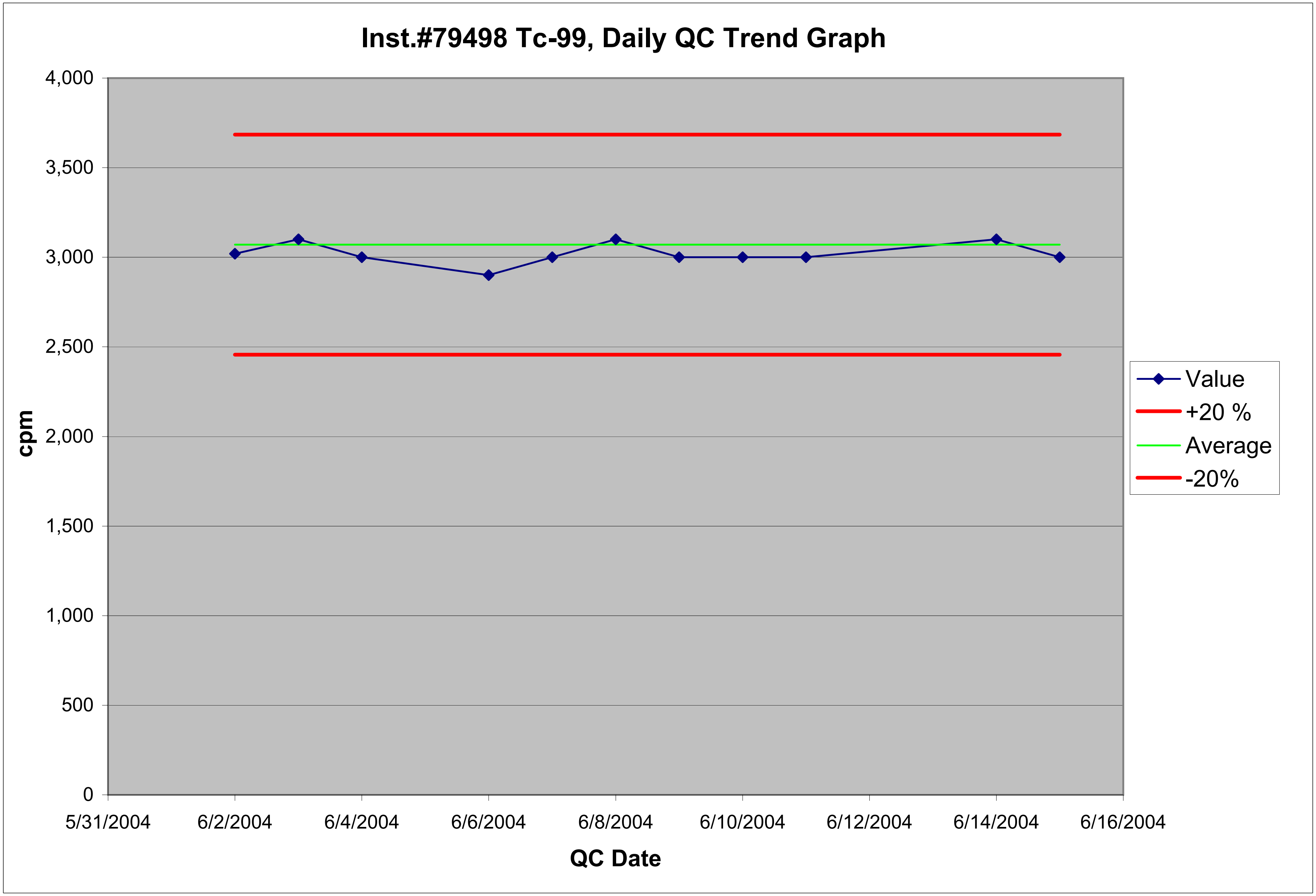
Inst.#79498 Background		Source Ser. #	BKG
Initial Source Readings		Nuclide	
Date	Result (cpm)		
6/2/2004	50		
6/2/2004	40		
6/2/2004	50		
6/2/2004	30		
6/2/2004	25		
6/2/2004	30		
6/2/2004	40		
6/2/2004	20		
6/2/2004	60		
6/2/2004	20		
	Average		
	37		



Inst.#, Daily QC Trend Graph
50
45
40
35
30
25
20
15
10
5
0
5/31/2004
6/2/2004
6/4/2004
6/6/2004
6/8/2004
6/10/2004
6/12/2004
6/14/2004
6/16/2004
Value
+20 %
Average
-20%

Inst.#79498 Tc-99		
QC Daily Source		
Date	Result (cpm)	P/F
6/2/2004	3,020	Pass
6/3/2004	3,100	Pass
6/4/2004	3,000	Pass
6/6/2004	2,900	Pass
6/7/2004	3,000	Pass
6/8/2004	3,100	Pass
6/9/2004	3,000	Pass
6/10/2004	3,000	Pass
6/11/2004	3,000	Pass
6/14/2004	3,100	Pass
6/15/2004	3,000	Pass

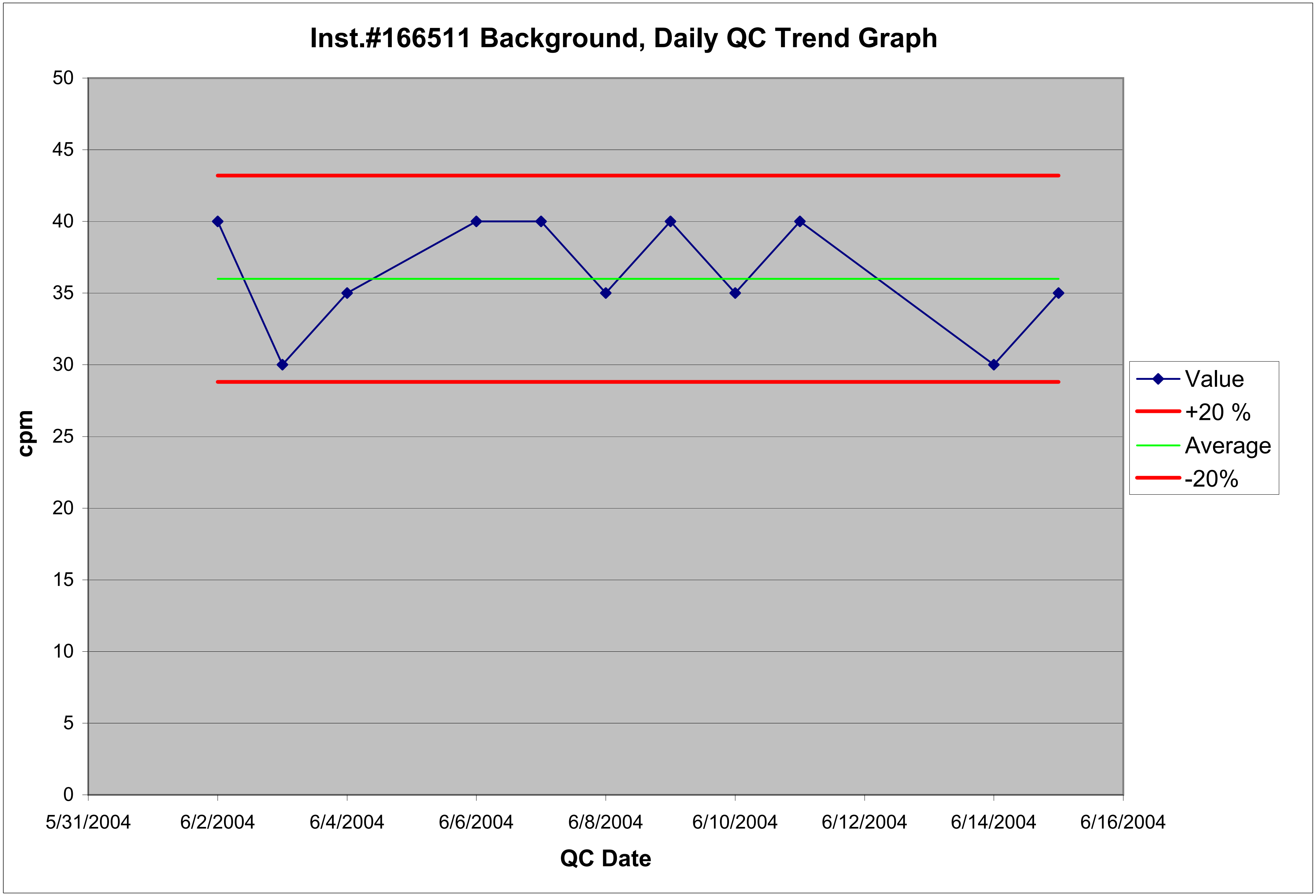
Inst.#79498 Tc-99		Source Ser. #	2889-01
Initial Source Readings		Nuclide	Tc-99
Date	Result (cpm)		
6/2/2004	2,900		
6/2/2004	3,100		
6/2/2004	2,800		
6/2/2004	3,000		
6/2/2004	3,200		
6/2/2004	3,300		
6/2/2004	3,100		
6/2/2004	3,300		
6/2/2004	3,100		
6/2/2004	2,900		
	Average		
	3070		



Inst.#79498 Tc-99, Daily QC Trend Graph
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
cpm
5/31/2004
6/2/2004
6/4/2004
6/6/2004
6/8/2004
6/10/2004
6/12/2004
6/14/2004
6/16/2004
QC Date
Value
+20 %
Average
-20%

Inst.#166511 Background		
QC Daily Source		
Date	Result (cpm)	P/F
6/2/2004	40	Pass
6/3/2004	30	Pass
6/4/2004	35	Pass
6/6/2004	40	Pass
6/7/2004	40	Pass
6/8/2004	35	Pass
6/9/2004	40	Pass
6/10/2004	35	Pass
6/11/2004	40	Pass
6/14/2004	30	Pass
6/15/2004	35	Pass

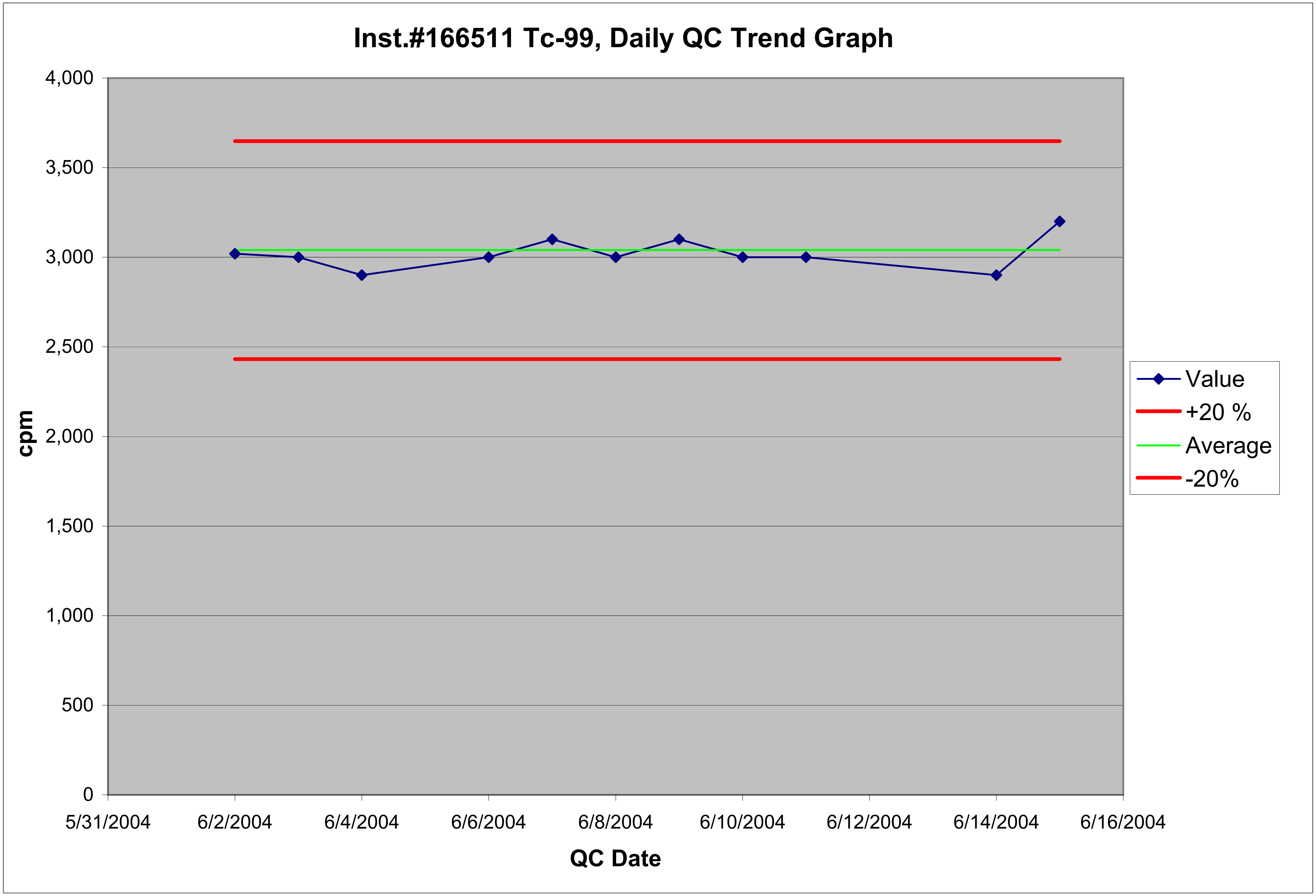
Inst.#166511 Background		Source Ser. #	BKG
Initial Source Readings		Nuclide	
Date	Result (cpm)		
6/2/2004	20		
6/2/2004	50		
6/2/2004	60		
6/2/2004	30		
6/2/2004	35		
6/2/2004	25		
6/2/2004	50		
6/2/2004	40		
6/2/2004	30		
6/2/2004	20		
	Average		
	36		



Inst.#166511 Background, Daily QC Trend Graph
cpm
50
45
40
35
30
25
20
15
10
5
0
5/31/2004
6/2/2004
6/4/2004
6/6/2004
6/8/2004
6/10/2004
6/12/2004
6/14/2004
6/16/2004
QC Date
Value
+20 %
Average
-20%

Inst.#166511 Tc-99		
QC Daily Source		
Date	Result (cpm)	P/F
6/2/2004	3,020	Pass
6/3/2004	3,000	Pass
6/4/2004	2,900	Pass
6/6/2004	3,000	Pass
6/7/2004	3,100	Pass
6/8/2004	3,000	Pass
6/9/2004	3,100	Pass
6/10/2004	3,000	Pass
6/11/2004	3,000	Pass
6/14/2004	2,900	Pass
6/15/2004	3,200	Pass

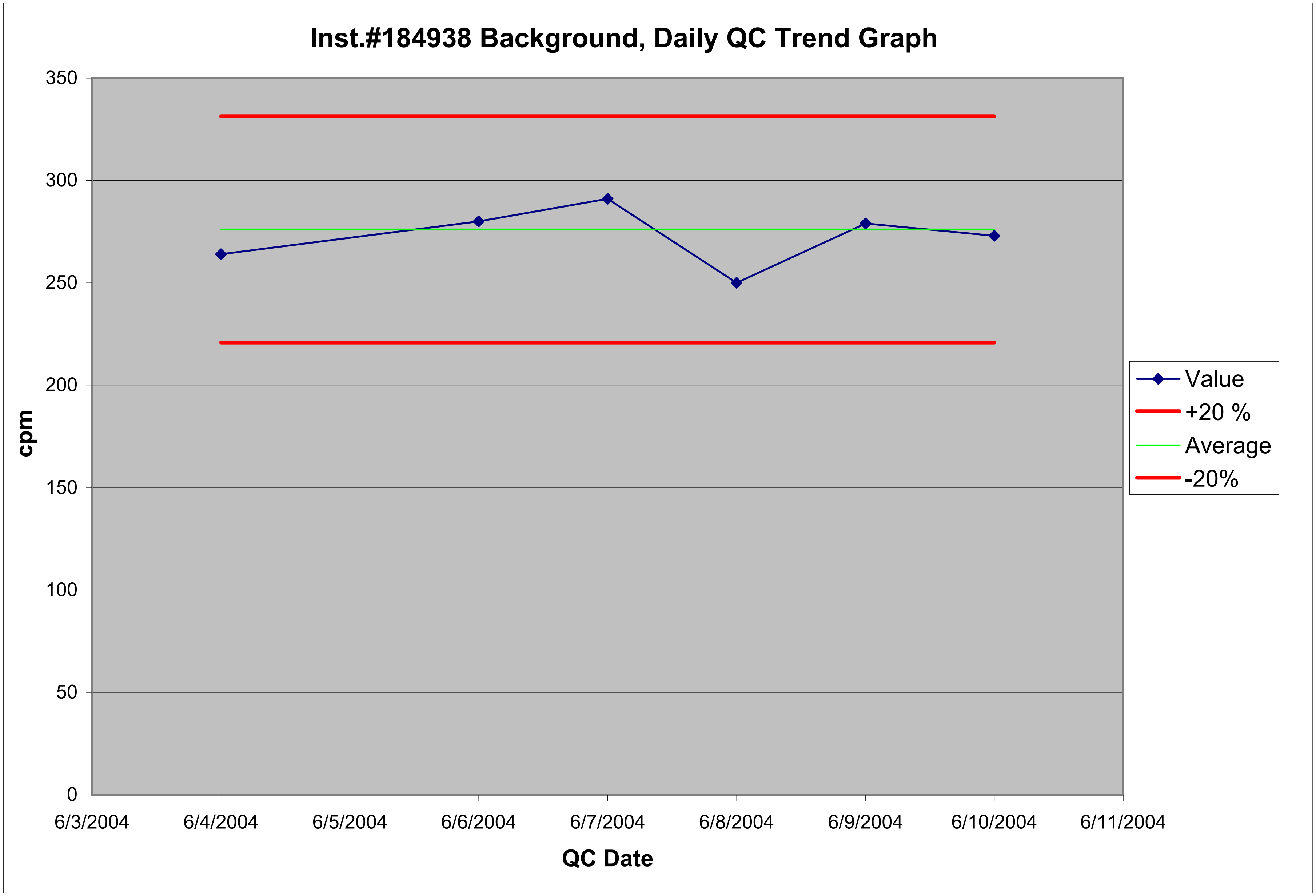
Inst.#166511 Tc-99		Source Ser. #	2889-01
Initial Source Readings		Nuclide	Tc-99
Date	Result (cpm)		
6/2/2004	3,100		
6/2/2004	3,000		
6/2/2004	2,900		
6/2/2004	3,000		
6/2/2004	3,200		
6/2/2004	2,800		
6/2/2004	3,100		
6/2/2004	3,300		
6/2/2004	3,100		
6/2/2004	2,900		
	Average		
	3040		



Inst.#166511 Tc-99, Daily QC Trend Graph
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
cpm
5/31/2004
6/2/2004
6/4/2004
6/6/2004
6/8/2004
6/10/2004
6/12/2004
6/14/2004
6/16/2004
QC Date
Value
+20 %
Average
-20%

Inst.#184938 Background		
QC Daily Source		
Date	Result (cpm)	P/F
6/4/2004	264	Pass
6/6/2004	280	Pass
6/7/2004	291	Pass
6/8/2004	250	Pass
6/9/2004	279	Pass
6/10/2004	273	Pass

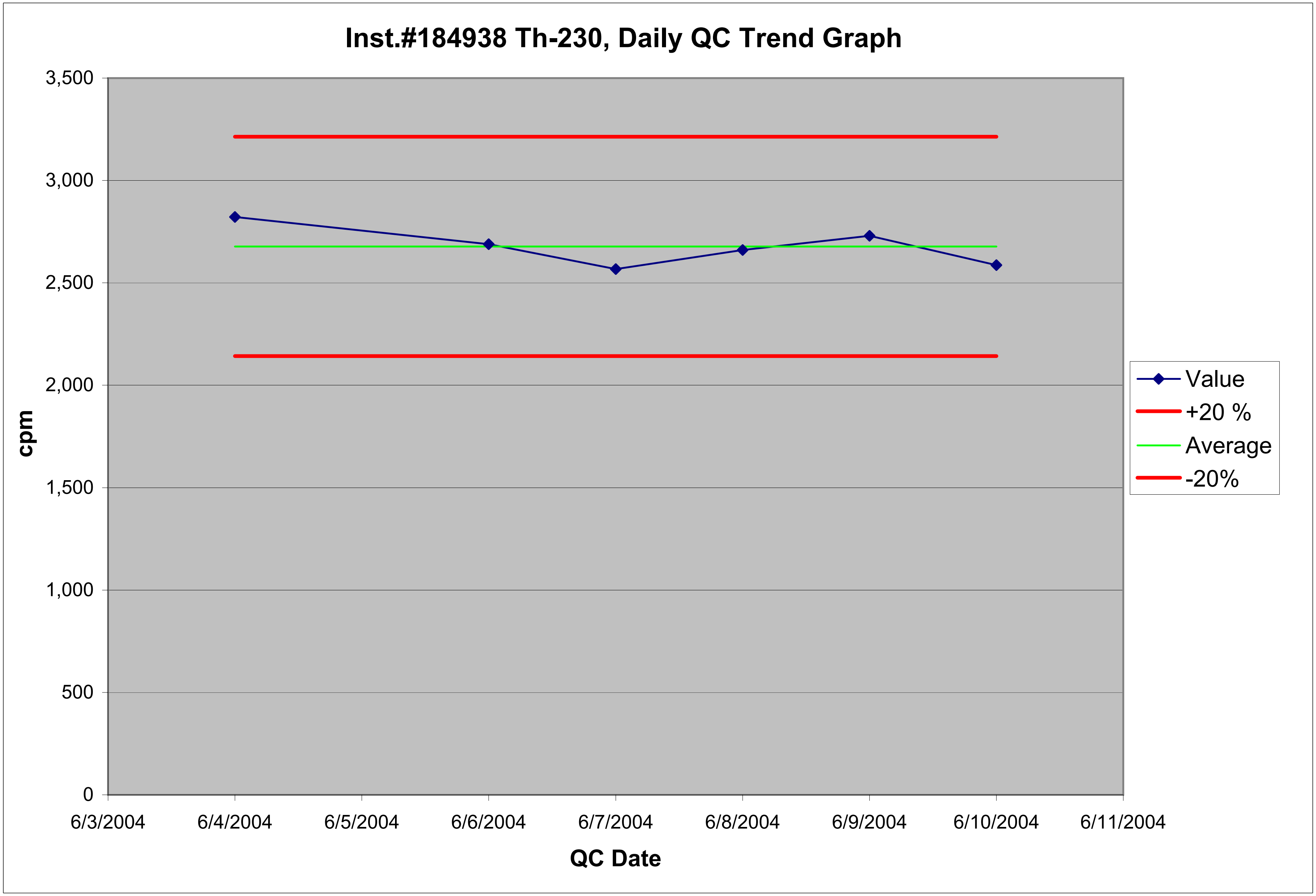
Inst.#184938 Background		Source Ser. #	BKG
Initial Source Readings		Nuclide	
Date	Result (cpm)		
6/4/2004	263		
6/4/2004	286		
6/4/2004	287		
6/4/2004	279		
6/4/2004	256		
6/4/2004	285		
6/4/2004	280		
6/4/2004	290		
6/4/2004	265		
6/4/2004	269		
	Average		
	276		



Inst.#184938 Background, Daily QC Trend Graph
350
300
250
200
150
100
50
0
cpm
6/3/2004
6/4/2004
6/5/2004
6/6/2004
6/7/2004
6/8/2004
6/9/2004
6/10/2004
6/11/2004
QC Date
Value
+20 %
Average
-20%

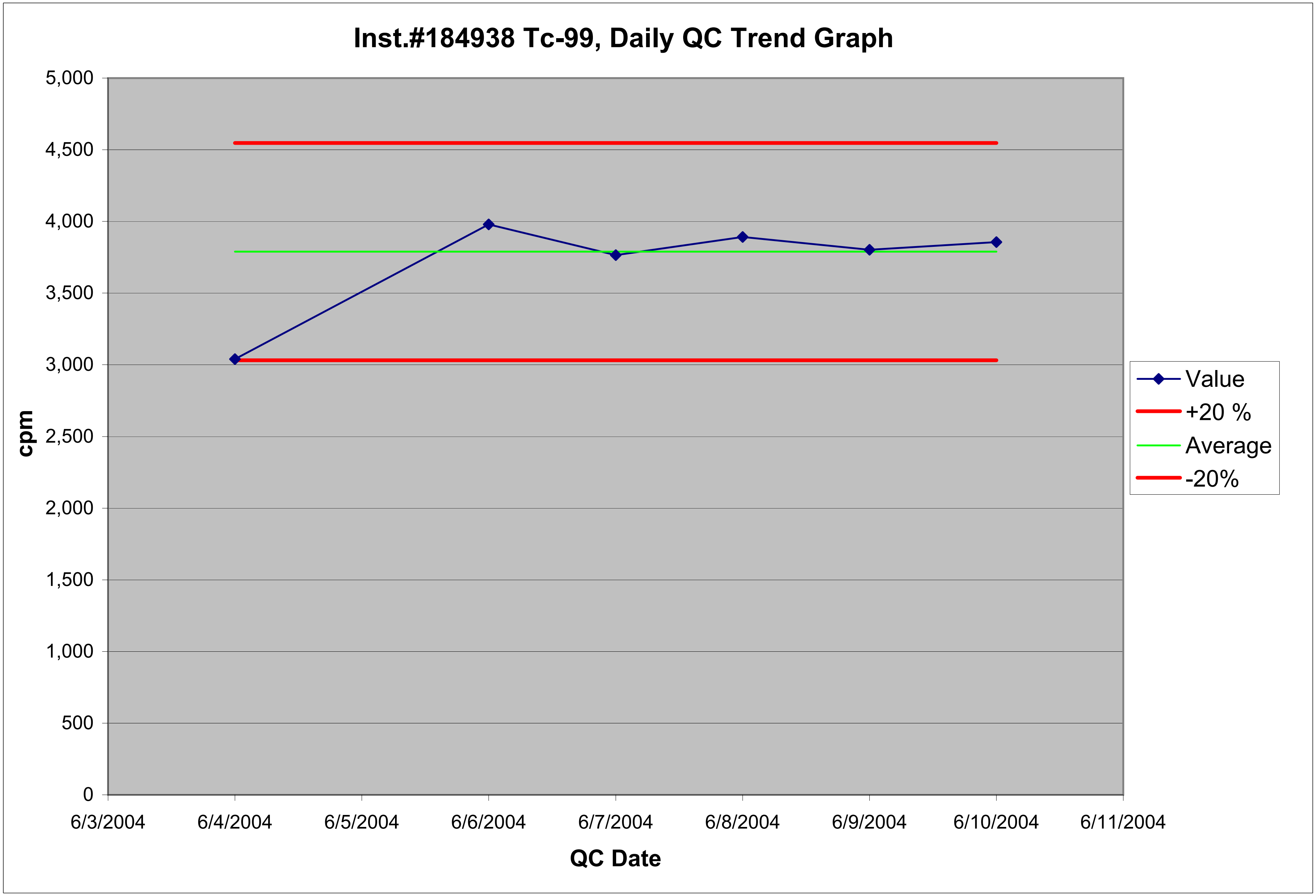
Inst.#184938 Th-230		
QC Daily Source		
Date	Result (cpm)	P/F
6/4/2004	2,822	Pass
6/6/2004	2,689	Pass
6/7/2004	2,567	Pass
6/8/2004	2,661	Pass
6/9/2004	2,730	Pass
6/10/2004	2,587	Pass

Inst.#184938 Th-230		Source Ser. #	2897-01
Initial Source Readings		Nuclide	Th-230
Date	Result (cpm)		
6/4/2004	2,811		
6/4/2004	2,709		
6/4/2004	2,722		
6/4/2004	2,730		
6/4/2004	2,556		
6/4/2004	2,649		
6/4/2004	2,585		
6/4/2004	2,657		
6/4/2004	2,638		
6/4/2004	2,722		
	Average		
	2678		


Inst.#184938 Th-230, Daily QC Trend Graph
3,500
3,000
2,500
2,000
1,500
1,000
500
0
cpm
6/3/2004
6/4/2004
6/5/2004
6/6/2004
6/7/2004
6/8/2004
6/9/2004
6/10/2004
6/11/2004
QC Date
Value
+20 %
Average
-20%

Inst.#184938 Tc-99		
QC Daily Source		
Date	Result (cpm)	P/F
6/4/2004	3,039	Pass
6/6/2004	3,980	Pass
6/7/2004	3,765	Pass
6/8/2004	3,891	Pass
6/9/2004	3,802	Pass
6/10/2004	3,856	Pass

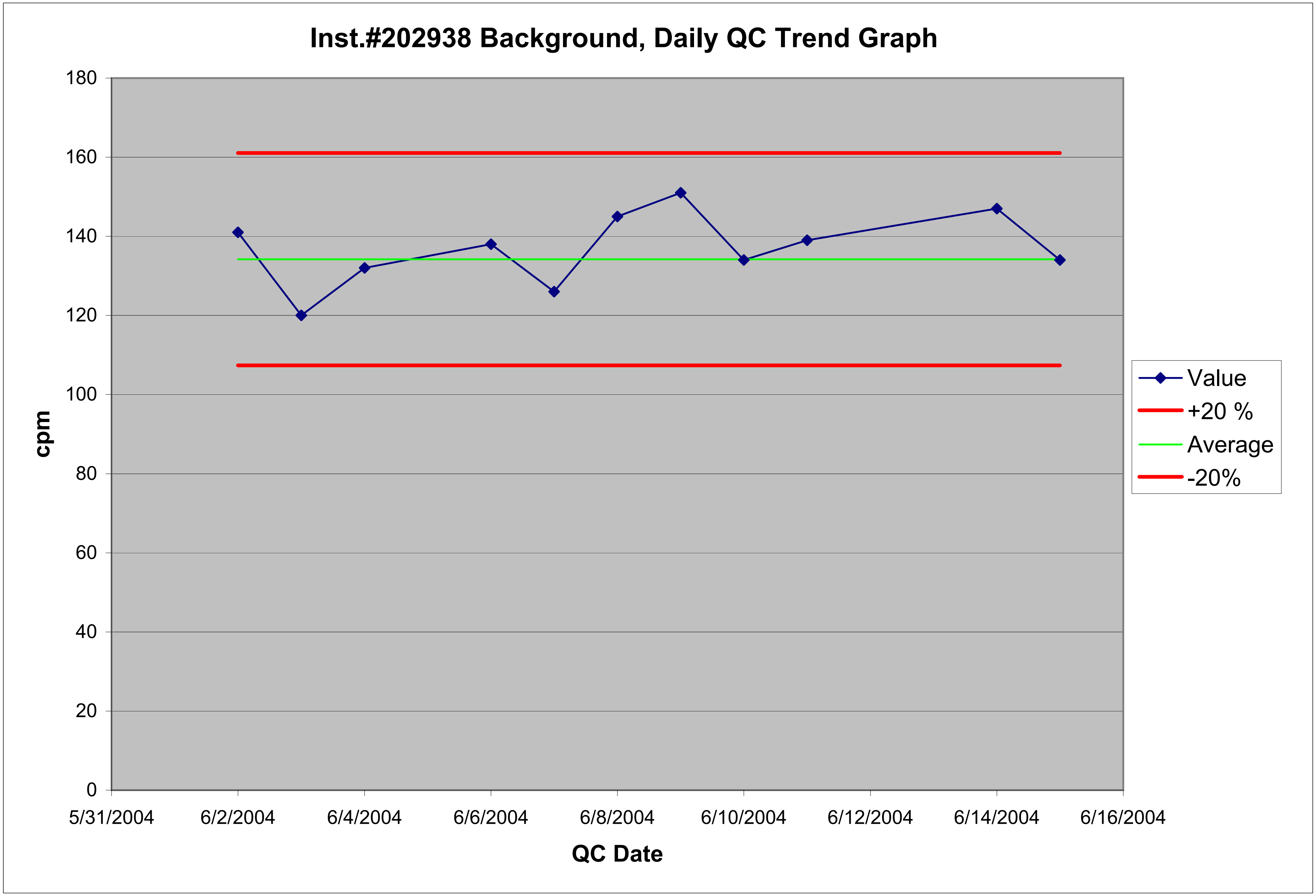
Inst.#184938 Tc-99		Source Ser. #	2889-01
Initial Source Readings		Nuclide	Tc-99
Date	Result (cpm)		
6/4/2004	3,671		
6/4/2004	3,787		
6/4/2004	3,730		
6/4/2004	3,797		
6/4/2004	3,799		
6/4/2004	3,939		
6/4/2004	3,776		
6/4/2004	3,820		
6/4/2004	3,789		
6/4/2004	3,782		
	Average		
	3789		



Inst.#184938 Tc-99, Daily QC Trend Graph
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
cpm
6/3/2004
6/4/2004
6/5/2004
6/6/2004
6/7/2004
6/8/2004
6/9/2004
6/10/2004
6/11/2004
QC Date
Value
+20 %
Average
-20%

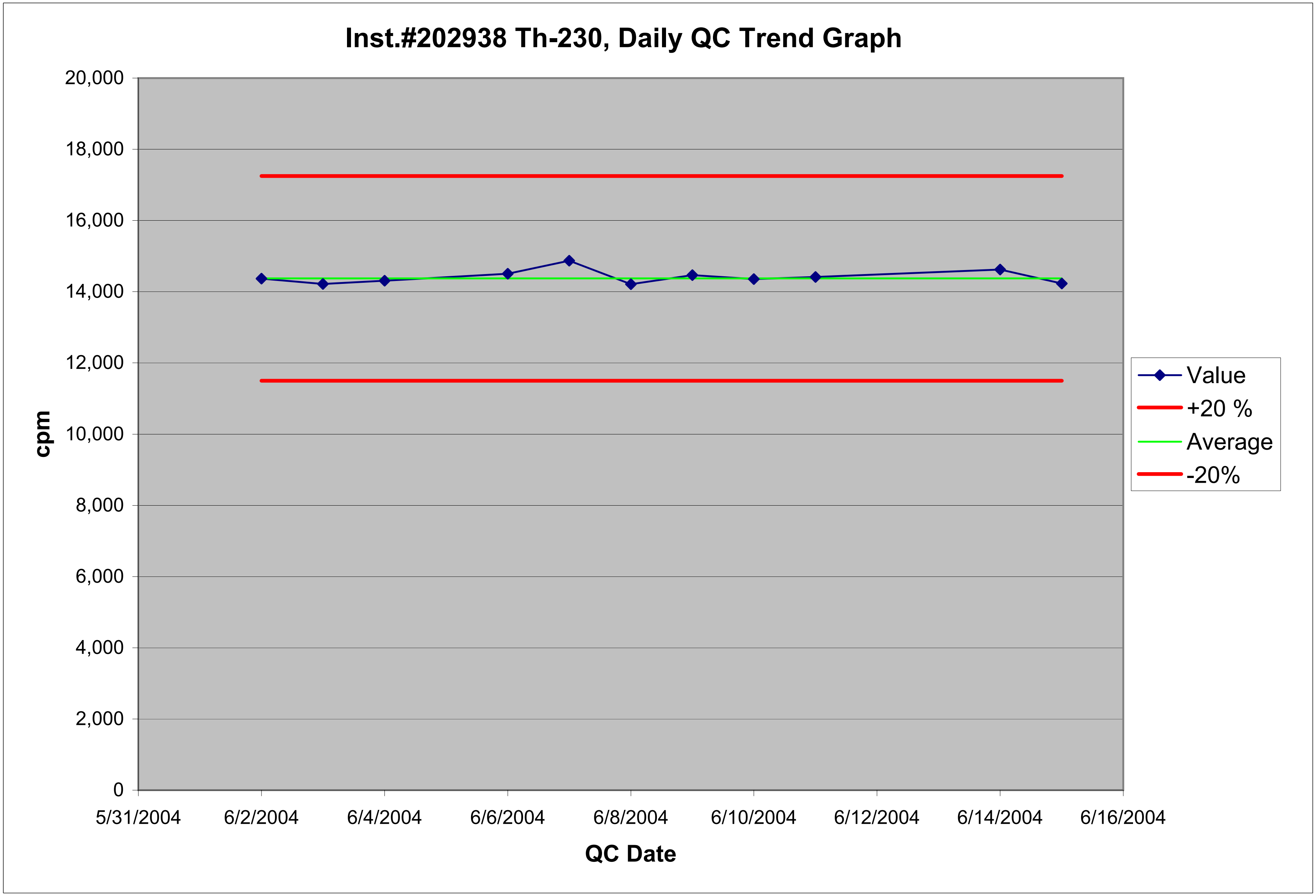
Inst.#202938 Background		
QC Daily Source		
Date	Result (cpm)	P/F
6/2/2004	141	Pass
6/3/2004	120	Pass
6/4/2004	132	Pass
6/6/2004	138	Pass
6/7/2004	126	Pass
6/8/2004	145	Pass
6/9/2004	151	Pass
6/10/2004	134	Pass
6/11/2004	139	Pass
6/14/2004	147	Pass
6/15/2004	134	Pass

Inst.#202938 Background		Source Ser. #	BKG
Initial Source Readings		Nuclide	
Date	Result (cpm)		
6/2/2004	135		
6/2/2004	145		
6/2/2004	156		
6/2/2004	123		
6/2/2004	137		
6/2/2004	123		
6/2/2004	133		
6/2/2004	138		
6/2/2004	146		
6/2/2004	106		
	Average		
	134		


Inst.#202938 Background, Daily QC Trend Graph
180
160
140
120
100
80
60
40
20
0
cpm
5/31/2004
6/2/2004
6/4/2004
6/6/2004
6/8/2004
6/10/2004
6/12/2004
6/14/2004
6/16/2004
QC Date
Value
+20 %
Average
-20%

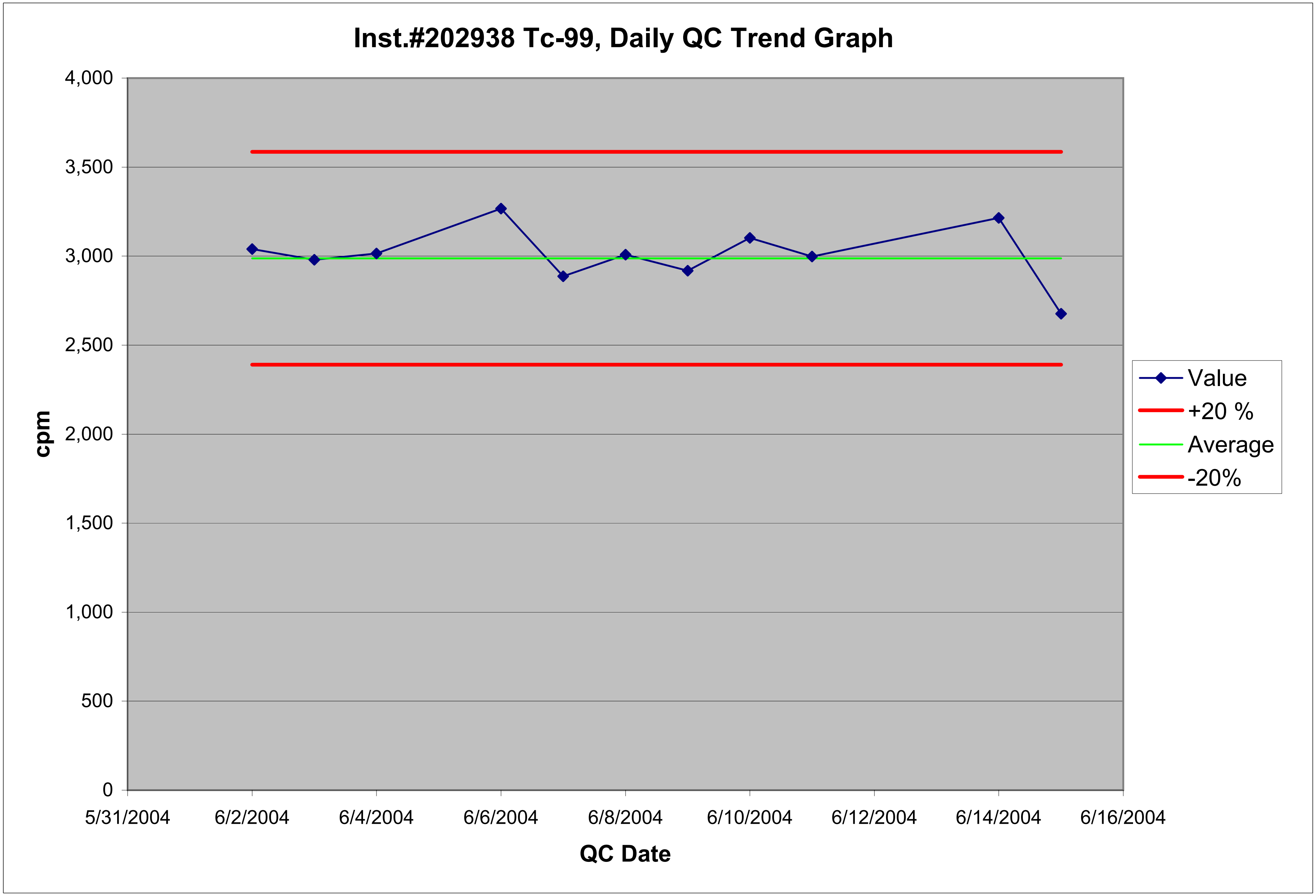
Inst.#202938 Th-230		
QC Daily Source		
Date	Result (cpm)	P/F
6/2/2004	14,370	Pass
6/3/2004	14,218	Pass
6/4/2004	14,310	Pass
6/6/2004	14,507	Pass
6/7/2004	14,870	Pass
6/8/2004	14,213	Pass
6/9/2004	14,467	Pass
6/10/2004	14,354	Pass
6/11/2004	14,412	Pass
6/14/2004	14,621	Pass
6/15/2004	14,231	Pass

Inst.#202938 Th-230		Source Ser. #	2897-01
Initial Source Readings		Nuclide	Th-230
Date	Result (cpm)		
6/2/2004	14,463		
6/2/2004	14,390		
6/2/2004	14,504		
6/2/2004	14,211		
6/2/2004	14,433		
6/2/2004	14,315		
6/2/2004	14,183		
6/2/2004	14,452		
6/2/2004	14,421		
6/2/2004	14,356		
	Average		
	14373		


Inst.#202938 Th-230, Daily QC Trend Graph
20,000
18,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
cpm
5/31/2004
6/2/2004
6/4/2004
6/6/2004
6/8/2004
6/10/2004
6/12/2004
6/14/2004
6/16/2004
QC Date
Value
+20 %
Average
-20%

Inst.#202938 Tc-99		
QC Daily Source		
Date	Result (cpm)	P/F
6/2/2004	3,039	Pass
6/3/2004	2,980	Pass
6/4/2004	3,015	Pass
6/6/2004	3,267	Pass
6/7/2004	2,887	Pass
6/8/2004	3,008	Pass
6/9/2004	2,918	Pass
6/10/2004	3,102	Pass
6/11/2004	2,998	Pass
6/14/2004	3,214	Pass
6/15/2004	2,676	Pass

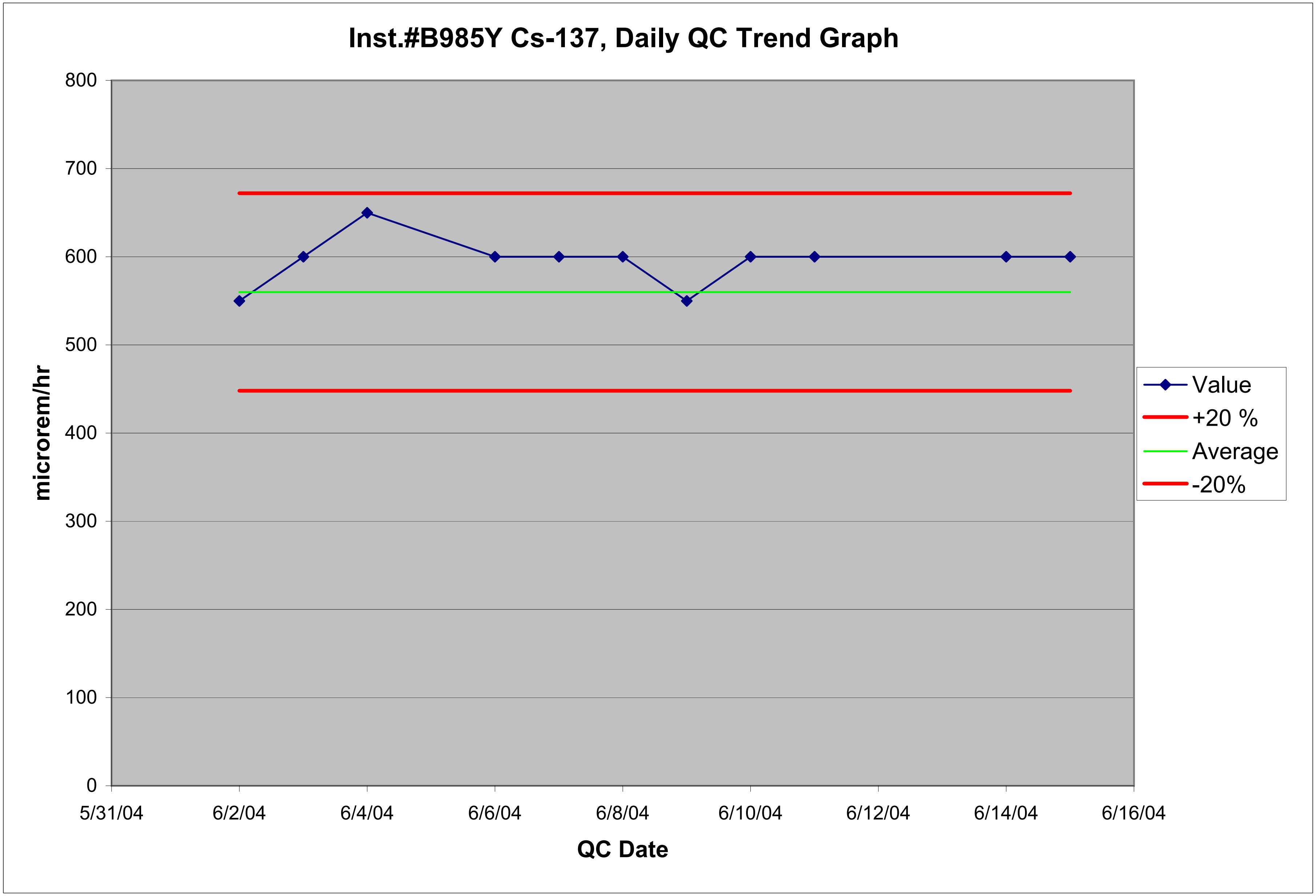
Inst.#202938 Tc-99		Source Ser. #	2889-01
Initial Source Readings		Nuclide	Tc-99
Date	Result (cpm)		
6/2/2004	3,168		
6/2/2004	3,000		
6/2/2004	2,932		
6/2/2004	3,027		
6/2/2004	3,127		
6/2/2004	2,901		
6/2/2004	3,046		
6/2/2004	2,872		
6/2/2004	2,840		
6/2/2004	2,965		
	Average		
	2988		



Inst.#202938 Tc-99, Daily QC Trend Graph
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
cpm
5/31/2004
6/2/2004
6/4/2004
6/6/2004
6/8/2004
6/10/2004
6/12/2004
6/14/2004
6/16/2004
QC Date
Value
+20 %
Average
-20%

Inst.#B985Y Cs-137		
QC Daily Source		
Date	Result (μrem/hr)	P/F
6/2/2004	550	Pass
6/3/2004	600	Pass
6/4/2004	650	Pass
6/6/2004	600	Pass
6/7/2004	600	Pass
6/8/2004	600	Pass
6/9/2004	550	Pass
6/10/2004	600	Pass
6/11/2004	600	Pass
6/14/2004	600	Pass
6/15/2004	600	Pass

Inst.#B985Y Cs-137		Source Ser. #	1134
Initial Source Readings		Nuclide	Cs-137
Date	Result (μrem/hr)		
6/2/2004	550		
6/2/2004	600		
6/2/2004	550		
6/2/2004	550		
6/2/2004	500		
6/2/2004	600		
6/2/2004	550		
6/2/2004	550		
6/2/2004	600		
6/2/2004	550		
	Average		
	560		


Inst.#B985Y Cs-137, Daily QC Trend Graph
800
700
600
500
400
300
200
100
0
microrem/hr
5/31/04
6/2/04
6/4/04
6/6/04
6/8/04
6/10/04
6/12/04
6/14/04
6/16/04
QC Date
Value
+20 %
Average
-20%

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
STATIC INSTRUMENT QC

Counting Instrument:	Ludlum 2360	Detector:	43-37	Cal. Date:	4/29/2004
Serial #:	193675	Serial #:	PR161687	Cal. Due Date OK?	WARNING
Detector Active Area or Area Covered by Smear (cm^2):	582				

	Efficiency (fraction)	Source Nuclide	Source Number	Original Source Activity (DPM)	Source Creation Date	$T_{1/2}$ (yr)	Source Decayed Activity	Required MDA (DPM)	Control Chart & Daily Bkg Count Time	Control Chart & Daily Source Count Time	Control Chart bkg Average α/β cpm	Control Chart bkg 1 sigma, cpm	Control Chart Source-bkg Average α/β cpm	Control Chart source 1 sigma, cpm
Alpha	0.1206	Th-230	3973-02	17,500	4/29/2002	7.70E+04	17,500	100	1	1	4.40	1.51	2107.6	49.72
Beta	0.2685	Tc-99	3975-02	17,700	4/29/2002	2.13E+05	17,700	1000	1	1	505.30	24.15	4247.1	83.68

Date	Daily Bkg Counts		Daily Check Source Counts		Daily Bkg Rate (cpm)		Net Daily Source Rate (cpm)		Bkg QC Pass/Fail		Source QC Pass/Fail				α MDA	β MDA	H.P.	Technician
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	MDA α (dpm)	MDA β (dpm)	OK?	OK?	Technician	Initials
5/8/2003	8	797	2,419	4,229	8.0	797.0	2411.0	3432.0	*QUESTION*	**FAIL**	**FAIL**	**FAIL**	23.02	86	Yes	Yes		
5/9/2003	7	722	2,451	4,328	7.0	722.0	2444.0	3606.0	PASS	**FAIL**	**FAIL**	**FAIL**	21.81	82	Yes	Yes		
5/12/2003	5	457	2,156	4,750	5.0	457.0	2151.0	4293.0	PASS	PASS	PASS	PASS	19.10	66	Yes	Yes		
5/12/2003	4	478	2,162	4,645	4.0	478.0	2158.0	4167.0	PASS	PASS	PASS	PASS	17.53	67	Yes	Yes		
5/13/2003	4	492	2,096	4,675	4.0	492.0	2092.0	4183.0	PASS	PASS	PASS	PASS	17.53	68	Yes	Yes		
5/13/2003	3	560	2,100	4,846	3.0	560.0	2097.0	4286.0	PASS	*QUESTION*	PASS	PASS	15.76	72	Yes	Yes		
5/13/2003	3	528	2,100	4,846	3.0	528.0	2097.0	4318.0	PASS	PASS	PASS	PASS	15.76	70	Yes	Yes		
5/14/2003	4	459	2,052	4,560	4.0	459.0	2048.0	4101.0	PASS	PASS	PASS	PASS	17.53	66	Yes	Yes		
5/14/2003	4	529	2,085	4,751	4.0	529.0	2081.0	4222.0	PASS	PASS	PASS	PASS	17.53	70	Yes	Yes		
5/15/2003	6	463	2,049	4,582	6.0	463.0	2043.0	4119.0	PASS	PASS	PASS	PASS	20.51	66	Yes	Yes		
6/2/2003	5	482	2,056	4,699	5.0	482.0	2051.0	4217.0	PASS	PASS	PASS	PASS	19.10	67	Yes	Yes		
6/2/2003	4	510	2,078	4,755	4.0	510.0	2074.0	4245.0	PASS	PASS	PASS	PASS	17.53	69	Yes	Yes		

Initial Background and Source Counts for Control Chart

#	Initial bkg counts				Initial source plus bkg counts			
	Alpha	**cpm**	**Beta**	**cpm**	**Alpha**	**cpm**	**Beta**	**cpm**
1	5	5	511	511	2,197	2197	4,657	4657
2	2	2	519	519	2,172	2172	4,786	4786
3	4	4	550	550	2,042	2042	4,743	4743
4	5	5	479	479	2,072	2072	4,891	4891
5	6	6	492	492	2,143	2143	4,651	4651
6	5	5	508	508	2,121	2121	4,684	4684
7	3	3	520	520	2,057	2057	4,798	4798
8	7	7	518	518	2,101	2101	4,739	4739
9	4	4	490	490	2,089	2089	4,804	4804
10	3	3	466	466	2,126	2126	4,771	4771
Mean		4.40		505.3		2112.0		4752.4
$S_{(n-1)}$		1.51		24.15		49.71		74.35
-3 sigma		-0.12		432.84		1962.88		4529.34
+3 sigma		8.92		577.76		2261.12		4975.46
-2 sigma		1.39		456.99		2012.58		4603.69
+2 sigma		7.41		553.61		2211.42		4901.11
					Mean-bkg	2107.6		4247.1
					$S_{(n-1)}$	49.72		83.68
				Mean-bkg	-3 sigma	1958.43		3996.07
				Mean-bkg	+3 sigma	2256.77		4498.13
				Mean-bkg	-2 sigma	2008.16		4079.75
				Mean-bkg	+2 sigma	2207.04		4414.45
						2192		4146
						2170		4267
						2038		4193
						2067		4412
						2137		4159
						2116		4176
						2054		4278
						2094		4221
						2085		4314
						2123		4305

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
STATIC INSTRUMENT QC

Counting Instrument:	Ludlum 2360	Detector:	43-37
Serial #:	193675	Serial #:	PR161687
Cal. Date:	4/29/2004	Cal. Due Date OK?	WARNING
Detector Active Area or Area Covered by Smear (cm^2):	582		

	Efficiency (fraction)	Source Nuclide	Source Number	Original Source Activity (DPM)	Source Creation Date	$T_{1/2}$ (yr)	Source Decayed Activity	Required MDA (DPM)	Control Chart & Daily Bkg Count Time	Control Chart & Daily Source Count Time	Control Chart bkg Average α/β cpm	Control Chart bkg 1 sigma, cpm	Control Chart Source-bkg Average α/β cpm	Control Chart source 1 sigma, cpm
Alpha	0.1115	Th-230	3973-02	17,500	4/29/2002	7.70E+04	17,500	100	1	1	4.50	0.53	1946.3	39.22
Beta	0.2563	Tc-99	3975-02	17,700	4/29/2002	2.13E+05	17,700	1000	1	1	822.70	37.06	3713.6	115.87

Date	Daily Bkg Counts		Daily Check Source Counts		Daily Bkg Rate (cpm)		Net Daily Source Rate (cpm)		Bkg QC Pass/Fail		Source QC Pass/Fail		MDA α (dpm)	MDA β (dpm)	α MDA OK?	β MDA OK?	H.P. Technician	Technician Initials
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta						
6/5/2003	4	842	2,020	4,588	4.0	842.0	2016.0	3746.0	PASS	PASS	PASS	PASS	18.96	93	Yes	Yes		
6/5/2003	4	855	2,004	4,576	4.0	855.0	2000.0	3721.0	PASS	PASS	PASS	PASS	18.96	93	Yes	Yes		
6/6/2003	2	740	2,008	4,591	2.0	740.0	2006.0	3851.0	FAIL	QUESTION	PASS	PASS	14.76	87	Yes	Yes		
6/6/2003	5	768	2,008	4,591	5.0	768.0	2003.0	3823.0	PASS	PASS	PASS	PASS	20.66	88	Yes	Yes		
6/6/2003	4	786	2,020	4,513	4.0	786.0	2016.0	3727.0	PASS	PASS	PASS	PASS	18.96	89	Yes	Yes		
6/9/2003	5	874	2,024	4,629	5.0	874.0	2019.0	3755.0	PASS	PASS	PASS	PASS	20.66	94	Yes	Yes		
6/9/2003	5	759	2,029	4,559	5.0	759.0	2024.0	3800.0	PASS	PASS	PASS	PASS	20.66	88	Yes	Yes		
6/11/2003	5	758	1,876	4,646	5.0	758.0	1871.0	3888.0	PASS	PASS	PASS	PASS	20.66	88	Yes	Yes		
6/11/2003	4	764	2,041	4,533	4.0	764.0	2037.0	3769.0	PASS	PASS	QUESTION	PASS	18.96	88	Yes	Yes		
6/12/2003	5	801	1,878	4,665	5.0	801.0	1873.0	3864.0	PASS	PASS	PASS	PASS	20.66	90	Yes	Yes		
6/12/2003	5	812	1,986	4,697	5.0	812.0	1981.0	3885.0	PASS	PASS	PASS	PASS	20.66	91	Yes	Yes		
6/16/2003	5	787	2,029	4,701	5.0	787.0	2024.0	3914.0	PASS	PASS	PASS	PASS	20.66	90	Yes	Yes		
6/16/2003	4	778	1,923	4,607	4.0	778.0	1919.0	3829.0	PASS	PASS	PASS	PASS	18.96	89	Yes	Yes		
6/19/2003	5	816	1,969	4,584	5.0	816.0	1964.0	3768.0	PASS	PASS	PASS	PASS	20.66	91	Yes	Yes		
6/20/2003	4	848	1,987	4,592	4.0	848.0	1983.0	3744.0	PASS	PASS	PASS	PASS	18.96	93	Yes	Yes		
6/23/2003	5	866	1,950	4,809	5.0	866.0	1945.0	3943.0	PASS	PASS	PASS	PASS	20.66	94	Yes	Yes		
6/24/2003	4	756	1,906	4,428	4.0	756.0	1902.0	3672.0	PASS	PASS	PASS	PASS	18.96	88	Yes	Yes		
6/25/2003	5	854	1,920	4,792	5.0	854.0	1915.0	3938.0	PASS	PASS	PASS	PASS	20.66	93	Yes	Yes		
6/25/2003	4	819	2,027	4,646	4.0	819.0	2023.0	3827.0	PASS	PASS	PASS	PASS	18.96	91	Yes	Yes		

Initial Background and Source Counts for Control Chart

#	Initial bkg counts				Initial source plus bkg counts			
	Alpha	**cpm**	**Beta**	**cpm**	**Alpha**	**cpm**	**Beta**	**cpm**
1	4	4	827	827	1,972	1972	4,650	4650
2	4	4	888	888	2,021	2021	4,563	4563
3	4	4	774	774	1,936	1936	4,676	4676
4	4	4	840	840	1,964	1964	4,402	4402
5	5	5	833	833	1,947	1947	4,507	4507
6	4	4	854	854	1,951	1951	4,436	4436
7	5	5	759	759	1,988	1988	4,442	4442
8	5	5	808	808	1,927	1927	4,677	4677
9	5	5	827	827	1,879	1879	4,549	4549
10	5	5	817	817	1,923	1923	4,461	4461
Mean		4.50		822.7		1950.8		4536.3
$S_{(n-1)}$		0.53		37.06		38.96		103.62
-3 sigma		2.92		711.51		1833.91		4225.44
+3 sigma		6.08		933.89		2067.69		4847.16
-2 sigma		3.45		748.57		1872.87		4329.06
+2 sigma		5.55		896.83		2028.73		4743.54
					Mean-bkg	1946.3		3713.6
					$S_{(n-1)}$	39.22		115.87
				Mean-bkg	-3 sigma	1828.63		3366.00
				Mean-bkg	+3 sigma	2063.97		4061.20
				Mean-bkg	-2 sigma	1867.85		3481.87
				Mean-bkg	+2 sigma	2024.75		3945.33
						1968		3823
						2017		3675
						1932		3902
						1960		3562
						1942		3674
						1947		3582
						1983		3683
						1922		3869
						1874		3722
						1918		3644

CABRERA STATIC COUNTING WORKSHEET (Rev 5)
STATIC INSTRUMENT QC

Counting Instrument:	Ludlum 2360	Detector:	43-37	Cal. Date:	4/29/2004		
Serial #:	193675	Serial #:	PR161687	Cal. Due Date OK?	WARNING		
Detector Active Area or Area Covered by Smear (cm^2):	582						

	Efficiency (fraction)	Source Nuclide	Source Number	Original Source Activity (DPM)	Source Creation Date	$T_{1/2}$ (yr)	Source Decayed Activity	Required MDA (DPM)	Control Chart & Daily Bkg Count Time	Control Chart & Daily Source Count Time	Control Chart bkg Average α/β cpm	Control Chart bkg 1 sigma, cpm	Control Chart Source-bkg Average α/β cpm	Control Chart source 1 sigma, cpm
Alpha	0.1115	Th-230	3973-02	17,500	4/29/2002	7.70E+04	17,500	100	1	1	5.30	2.45	2468.5	47.44
Beta	0.2563	Tc-99	3975-02	17,700	4/29/2002	2.13E+05	17,700	1000	1	1	730.70	25.96	3863.1	76.52

Date	Daily Bkg Counts		Daily Check Source Counts		Daily Bkg Rate (cpm)		Net Daily Source Rate (cpm)		Bkg QC Pass/Fail		Source QC Pass/Fail		MDA α (dpm)	MDA β (dpm)	α MDA OK?	β MDA OK?	H.P. Technician	Technician Initials
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta						
3/30/2004	10	714	2,450	4,475	10.0	714.0	2440.0	3761.0	PASS	PASS	PASS	PASS	27.30	85	Yes	Yes		
3/30/2004	6	755	2,467	4,532	6.0	755.0	2461.0	3777.0	PASS	PASS	PASS	PASS	22.19	88	Yes	Yes		
3/31/2004	8	769	2,237	4,447	8.0	769.0	2229.0	3678.0	PASS	PASS	**FAIL**	*QUESTION*	24.90	89	Yes	Yes		
3/31/2004	6				6.0				PASS									

Initial Background and Source Counts for Control Chart

#	Initial bkg counts				Initial source plus bkg counts			
	Alpha	**cpm**	**Beta**	**cpm**	**Alpha**	**cpm**	**Beta**	**cpm**
1	7	7	712	712	2,461	2461	4,565	4565
2	4	4	724	724	2,486	2486	4,600	4600
3	2	2	725	725	2,549	2549	4,479	4479
4	3	3	697	697	2,460	2460	4,521	4521
5	5	5	758	758	2,409	2409	4,582	4582
6	7	7	773	773	2,428	2428	4,599	4599
7	3	3	704	704	2,501	2501	4,742	4742
8	7	7	724	724	2,508	2508	4,560	4560
9	10	10	765	765	2,521	2521	4,633	4633
10	5	5	725	725	2,415	2415	4,657	4657
Mean		5.30		730.7		2473.8		4593.8
$S_{(n-1)}$		2.45		25.96		47.20		73.14
-3 sigma		-2.06		652.83		2332.20		4374.37
+3 sigma		12.66		808.57		2615.40		4813.23
-2 sigma		0.40		678.79		2379.40		4447.51
+2 sigma		10.20		782.61		2568.20		4740.09
					Mean-bkg	2468.5		3863.1
					$S_{(n-1)}$	47.44		76.52
				Mean-bkg	-3 sigma	2326.17		3633.53
				Mean-bkg	+3 sigma	2610.83		4092.67
				Mean-bkg	-2 sigma	2373.61		3710.06
				Mean-bkg	+2 sigma	2563.39		4016.14
						2454		3853
						2482		3876
						2547		3754
						2457		3824
						2404		3824
						2421		3826
						2498		4038
						2501		3836
						2511		3868
						2410		3932

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
SMEAR INSTRUMENT QC

Counting Instrument:	Ludlum 2929	Detector:	43-10-1	Calibration Date:	1/21/2004
Serial #:	163827	Serial #:	PR171322	12 month calibration:	OK
Detector Active Area or Area Covered by Smear (cm^2):	100			NRC 6 Mo Cal. Due Date?	OK

	Efficiency (fraction)	Source Nuclide	Source Number	Original Source Activity (DPM)	Source Creation Date	$T_{1/2}$ (yr)	Source Decayed Activity	Required MDA ($DPM/100cm^2$)	Control Chart & Daily Bkg Count Time	Control Chart & Daily Source-Sample Count Time	Control Chart bkg Average α/β cpm	Control Chart bkg 1 sigma, cpm	Control Chart Source-bkg Average α/β cpm	Control Chart source 1 sigma, cpm
Alpha	0.4060	Th-230	3972-02	15,700	4/29/2002	2.13E+05	15,700	10	20	2	0.12	0.08	5576.2	56.96
Beta	0.2400	Tc-99	3974-02	16,600	4/29/2002	7.70E+04	16,600	500	20	2	36.66	1.22	3294.2	51.92

Date	Daily Bkg Counts		Daily Check Source Counts		Daily Bkg Rate (cpm)		Net Daily Source Rate (cpm)		Bkg QC Pass/Fail		Source QC Pass/Fail				α MDA OK?	β MDA OK?	H.P. Technician	Technician Initials
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	MDA α (dpm)	MDA β (dpm)				
5/3/2003	3	732	11,184	6,477	0.2	36.6	5591.9	3201.9	PASS	PASS	PASS	PASS	6.02	68	Yes	Yes		
5/5/2003	2	738	11,280	6,709	0.1	36.9	5639.9	3317.6	PASS	PASS	PASS	PASS	5.60	68	Yes	Yes		

Initial Background and Source Counts for Control Chart

#	Initial bkg counts				Initial source plus bkg counts			
	Alpha	**cpm**	**Beta**	**cpm**	**Alpha**	**cpm**	**Beta**	**cpm**
1	2	0.1	714	35.7	11,083	5541.5	6,622	3311
2	2	0.1	709	35.45	11,120	5560	6,644	3322
3	3	0.15	737	36.85	10,886	5443	6,809	3404.5
4	4	0.2	713	35.65	11,179	5589.5	6,796	3398
5	1	0.05	727	36.35	11,276	5638	6,737	3368.5
6	6	0.3	727	36.35	11,175	5587.5	6,621	3310.5
7	2	0.1	714	35.7	11,135	5567.5	6,663	3331.5
8	2	0.1	740	37	11,159	5579.5	6,696	3348
9	0	0	777	38.85	11,281	5640.5	6,494	3247
10	2	0.1	773	38.65	11,233	5616.5	6,535	3267.5
Mean		0.12		36.7		5576.4		3330.9
$S_{(n-1)}$		0.08		1.22		56.94		51.18
-3 sigma		-0.13		32.99		5405.54		3177.31
+3 sigma		0.37		40.32		5747.16		3484.39
-2 sigma		-0.04		34.21		5462.47		3228.49
+2 sigma		0.28		39.10		5690.23		3433.21
					Mean-bkg	5576.2		3294.2
					$S_{(n-1)}$	56.96		51.92
				Mean-bkg	-3 sigma	5405.34		3138.45
				Mean-bkg	+3 sigma	5747.12		3449.94
				Mean-bkg	-2 sigma	5462.30		3190.36
				Mean-bkg	+2 sigma	5690.16		3398.03
						5541.4		3275.3
						5559.9		3286.55
						5442.85		3367.65
						5589.3		3362.35
						5637.95		3332.15
						5587.2		3274.15
						5567.4		3295.8
						5579.4		3311
						5640.5		3208.15
						5616.4		3228.85

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
SMEAR INSTRUMENT QC

Counting Instrument:	Ludlum 2929	Detector:	43-10-1	Calibration Date:	1/21/2004
Serial #:	163827	Serial #:	PR171322	12 month calibration:	OK
Detector Active Area or Area Covered by Smear (cm^2):	100			NRC 6 Mo Cal. Due Date?	OK

	Efficiency (fraction)	Source Nuclide	Source Number	Original Source Activity (DPM)	Source Creation Date	$T_{1/2}$ (yr)	Source Decayed Activity	Required MDA ($DPM/100cm^2$)	Control Chart & Daily Bkg Count Time	Control Chart & Daily Source-Sample Count Time	Control Chart bkg Average α/β cpm	Control Chart bkg 1 sigma, cpm	Control Chart Source-bkg Average α/β cpm	Control Chart source 1 sigma, cpm
Alpha	0.4060	Th-230	3972-02	15,700	4/29/2002	7.70E+04	15,700	10	20	2	0.38	0.14	5576.0	56.97
Beta	0.2400	Tc-99	3974-02	16,600	4/29/2002	2.13E+05	16,600	500	20	2	39.96	1.30	3290.9	51.05

Date	Daily Bkg Counts		Daily Check Source Counts		Daily Bkg Rate (cpm)		Net Daily Source Rate (cpm)		Bkg QC Pass/Fail		Source QC Pass/Fail				α MDA OK?	β MDA OK?	H.P. Technician	Technician Initials
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	MDA α (dpm)	MDA β (dpm)				
5/8/2003	3	850	11,147	6,590	0.2	42.5	5573.4	3252.5	PASS	PASS	PASS	PASS	6.02	73	Yes	Yes		
5/9/2003	8	812	11,153	6,682	0.4	40.6	5576.1	3300.4	PASS	PASS	PASS	PASS	7.50	71	Yes	Yes		
5/12/2003	7	828	11,336	6,724	0.4	41.4	5667.7	3320.6	PASS	PASS	PASS	PASS	7.25	72	Yes	Yes		
5/12/2003	7	828	11,106	6,730	0.4	41.4	5552.7	3323.6	PASS	PASS	PASS	PASS	7.25	72	Yes	Yes		
5/13/2003	6	844	11,184	6,694	0.3	42.2	5591.7	3304.8	PASS	PASS	PASS	PASS	6.99	72	Yes	Yes		
5/13/2003	6	844	11,294	6,485	0.3	42.2	5646.7	3200.3	PASS	PASS	PASS	PASS	6.99	72	Yes	Yes		
5/14/2003	8	819	11,118	6,584	0.4	41.0	5558.6	3251.1	PASS	PASS	PASS	PASS	7.50	71	Yes	Yes		
5/14/2003	8	819	11,015	6,604	0.4	41.0	5507.1	3261.1	PASS	PASS	PASS	PASS	7.50	71	Yes	Yes		
5/15/2003	6	796	11,094	6,632	0.3	39.8	5546.7	3276.2	PASS	PASS	PASS	PASS	6.99	70	Yes	Yes		
5/19/2003	7	845	11,162	6,635	0.4	42.3	5580.7	3275.3	PASS	PASS	PASS	PASS	7.25	72	Yes	Yes		
5/21/2003	6	892	11,050	6,690	0.3	44.6	5524.7	3300.4	PASS	**FAIL**	PASS	PASS	6.99	74	Yes	Yes		
5/21/2003	6	847	11,050	6,690	0.3	42.4	5524.7	3302.7	PASS	PASS	PASS	PASS	6.99	72	Yes	Yes		
5/22/2003	10	850	11,080	6,547	0.5	42.5	5539.5	3231.0	PASS	PASS	PASS	PASS	7.94	73	Yes	Yes		
5/29/2003	6	818	11,097	6,717	0.3	40.9	5548.2	3317.6	PASS	PASS	PASS	PASS	6.99	71	Yes	Yes		
5/29/2003	5	875	11,167	6,739	0.3	43.8	5583.3	3325.8	PASS	*QUESTION*	PASS	PASS	6.70	73	Yes	Yes		
5/29/2003	3	918	11,167	6,739	0.2	45.9	5583.4	3323.6	PASS	**FAIL**	PASS	PASS	6.02	75	Yes	Yes		
5/30/2003	7	898	11,177	6,671	0.4	44.9	5588.2	3290.6	PASS	**FAIL**	PASS	PASS	7.25	74	Yes	Yes		
5/30/2003	6	840	11,177	6,671	0.3	42.0	5588.2	3293.5	PASS	PASS	PASS	PASS	6.99	72	Yes	Yes		
6/2/2003	3	829	11,014	6,637	0.2	41.5	5506.9	3277.1	PASS	PASS	PASS	PASS	6.02	72	Yes	Yes		
6/2/2003	6	860	11,243	6,597	0.3	43.0	5621.2	3255.5	PASS	*QUESTION*	PASS	PASS	6.99	73	Yes	Yes		
6/2/2003	4	850	11,243	6,597	0.2	42.5	5621.3	3256.0	PASS	PASS	PASS	PASS	6.38	73	Yes	Yes		
6/3/2003	9	868	11,163	6,458	0.5	43.4	5581.1	3185.6	PASS	*QUESTION*	PASS	*QUESTION*	7.73	73	Yes	Yes		
6/3/2003	7	848	11,163	6,593	0.4	42.4	5581.2	3254.1	PASS	PASS	PASS	PASS	7.25	72	Yes	Yes		
6/3/2003	8	848	11,056	6,578	0.4	42.4	5527.6	3246.6	PASS	PASS	PASS	PASS	7.50	72	Yes	Yes		
6/4/2003	6	834	11,274	6,690	0.3	41.7	5636.7	3303.3	PASS	PASS	PASS	PASS	6.99	72	Yes	Yes		
6/6/2003	2	863	10,898	6,748	0.1	43.2	5448.9	3330.9	PASS	*QUESTION*	*QUESTION*	PASS	5.60	73	Yes	Yes		
6/9/2003	5	799	11,344	6,594	0.3	40.0	5671.8	3257.1	PASS	PASS	PASS	PASS	6.70	71	Yes	Yes		
6/10/2003	4	834	11,292	6,704	0.2	41.7	5645.8	3310.3	PASS	PASS	PASS	PASS	6.38	72	Yes	Yes		
6/11/2003	6	843	11,234	6,651	0.3	42.2	5616.7	3283.4	PASS	PASS	PASS	PASS	6.99	72	Yes	Yes		
6/12/2003	13	836	11,120	6,729	0.7	41.8	5559.4	3322.7	PASS	PASS	PASS	PASS	8.54	72	Yes	Yes		
6/16/2003	6	847	11,321	6,614	0.3	42.4	5660.2	3264.7	PASS	PASS	PASS	PASS	6.99	72	Yes	Yes		
6/26/2003	12	847	11,228	6,673	0.6	42.4	5613.4	3294.2	PASS	PASS	PASS	PASS	8.35	72	Yes	Yes		
6/26/2003	2	851	11,336	6,585	0.1	42.6	5667.9	3250.0	PASS	*QUESTION*	PASS	PASS	5.60	73	Yes	Yes		
6/27/2003	2	849	11,233	6,733	0.1	42.5	5616.4	3324.1	PASS	PASS	PASS	PASS	5.60	72	Yes	Yes		
6/27/2003	6	771	11,271	6,575	0.3	38.6	5635.2	3249.0	PASS	PASS	PASS	PASS	6.99	69	Yes	Yes		
6/30/2003	9	752	11,290	6,581	0.5	37.6	5644.6	3252.9	PASS	PASS	PASS	PASS	7.73	69	Yes	Yes		
6/30/2003	4	753	10,981	6,623	0.2	37.7	5490.3	3273.9	PASS	PASS	PASS	PASS	6.38	69	Yes	Yes		
7/1/2003	7	765	11,133	6,641	0.4	38.3	5566.2	3282.3	PASS	PASS	PASS	PASS	7.25	69	Yes	Yes		
7/1/2003	7	801	11,114	6,537	0.4	40.1	5556.7	3228.5	PASS	PASS	PASS	PASS	7.25	71	Yes	Yes		
7/2/2003	6	748	11,046	6,477	0.3	37.4	5522.7	3201.1	PASS	PASS	PASS	PASS	6.99	68	Yes	Yes		
7/2/2003	3	791	10,942	6,518	0.2	39.6	5470.9	3219.5	PASS	PASS	PASS	PASS	6.02	70	Yes	Yes		
7/8/2003	8	766	11,105	6,507	0.4	38.3	5552.1	3215.2	PASS	PASS	PASS	PASS	7.50	69	Yes	Yes		
7/8/2003	3	786	11,255	6,581	0.2	39.3	5627.4	3251.2	PASS	PASS	PASS	PASS	6.02	70	Yes	Yes		
7/9/2003	2	764	11,039	6,492	0.1	38.2	5519.4	3207.8	PASS	PASS	PASS	PASS	5.60	69	Yes	Yes		
7/10/2003	4	756	11,110	6,467	0.2	37.8	5554.8	3195.7	PASS	PASS	PASS	PASS	6.38	69	Yes	Yes		
8/26/2003	4	786	11,107	6,572	0.2	39.3	5553.3	3246.7	PASS	PASS	PASS	PASS	6.38	70	Yes	Yes		
8/26/2003	5	797	10,946	6,631	0.3	39.9	5472.8	3275.7	PASS	PASS	PASS	PASS	6.70	70	Yes	Yes		

Initial Background and Source Counts for Control Chart

#	Initial bkg counts				Initial source plus bkg counts			
	Alpha	**cpm**	**Beta**	**cpm**	**Alpha**	**cpm**	**Beta**	**cpm**
1	8	0.4	797	39.85	11,083	5541.5	6,622	3311
2	7	0.35	812	40.6	11,120	5560	6,644	3322
3	11	0.55	795	39.75	10,886	5443	6,809	3404.5
4	8	0.4	784	39.2	11,179	5589.5	6,796	3398
5	8	0.4	791	39.55	11,276	5638	6,737	3368.5
6	4	0.2	768	38.4	11,175	5587.5	6,621	3310.5
7	9	0.45	798	39.9	11,135	5567.5	6,663	3331.5
8	3	0.15	861	43.05	11,159	5579.5	6,696	3348
9	12	0.6	774	38.7	11,281	5640.5	6,494	3247
10	5	0.25	811	40.55	11,233	5616.5	6,535	3267.5
Mean		0.38		40.0		5576.4		3330.9
$S_{(n-1)}$		0.14		1.30		56.94		51.18
-3 sigma		-0.06		36.06		5405.54		3177.31
+3 sigma		0.81		43.85		5747.16		3484.39
-2 sigma		0.09		37.36		5462.47		3228.49
+2 sigma		0.66		42.55		5690.23		3433.21
					Mean-bkg	5576.0		3290.9
					$S_{(n-1)}$	56.97		51.05
				Mean-bkg	-3 sigma	5405.07		3137.74
				Mean-bkg	+3 sigma	5746.88		3444.05
				Mean-bkg	-2 sigma	5462.04		3188.79
				Mean-bkg	+2 sigma	5689.91		3393.00
						5541.1		3271.15
						5559.65		3281.4
						5442.45		3364.75
						5589.1		3358.8
						5637.6		3328.95
						5587.3		3272.1
						5567.05		3291.6
						5579.35		3304.95
						5639.9		3208.3
						5616.25		3226.95

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
SMEAR INSTRUMENT QC

Counting Instrument:	Ludlum 2929	Detector:	43-10-1	Calibration Date:	12/15/2004
Serial #:	180830	Serial #:	PR 207849	12 month calibration:	OK
Detector Active Area or Area Covered by Smear (cm^2):			100	NRC 6 Mo Cal. Due Date?	OK

	Efficiency (fraction)	Source Nuclide	Source Number	Original Source Activity (DPM)	Source Creation Date	$T_{1/2}$ (yr)	Source Decayed Activity	Required MDA ($DPM/100cm^2$)	Control Chart & Daily Bkg Count Time	Control Chart & Daily Source-Sample Count Time	Control Chart bkg Average α/β cpm	Control Chart bkg 1 sigma, cpm	Control Chart Source-bkg Average α/β cpm	Control Chart source 1 sigma, cpm
Alpha	0.3328	Th 230	2888-01	20,200	5/1/2001	7.70E+04	20,199	10	20	2	0.11	0.08	7113.1	41.91
Beta	0.2789	Tc 99	2889-01	21,400	5/1/2001	2.13E+05	21,400	500	20	2	50.99	1.48	5634.7	61.44

Date	Daily Bkg Counts		Daily Check Source Counts		Daily Bkg Rate (cpm)		Net Daily Source Rate (cpm)		Bkg QC Pass/Fail		Source QC Pass/Fail		MDA α (dpm)	MDA β (dpm)	α MDA OK?	β MDA OK?	H.P. Technician	Technician Initials
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta						
2/11/2004	2	1,012	14,215	11,313	0.1	50.6	7107.4	5605.9	PASS	PASS	PASS	PASS	6.83	68	Yes	Yes		
2/16/2004	3	1,063	14,109	11,428	0.2	53.2	7054.4	5660.9	PASS	PASS	PASS	PASS	7.35	69	Yes	Yes		
2/17/2004	2	1,020	14,174	11,490	0.1	51.0	7086.9	5694.0	PASS	PASS	PASS	PASS	6.83	68	Yes	Yes		
2/18/2004	3	1,048	14,275	11,525	0.2	52.4	7137.4	5710.1	PASS	PASS	PASS	PASS	7.35	69	Yes	Yes		
2/19/2004	4	1,068	14,239	11,463	0.2	53.4	7119.3	5678.1	PASS	PASS	PASS	PASS	7.79	69	Yes	Yes		
2/20/2004	5	1,045	14,187	11,405	0.3	52.3	7093.3	5650.3	PASS	PASS	PASS	PASS	8.17	69	Yes	Yes		
2/23/2004	2	1,050	14,334	11,311	0.1	52.5	7166.9	5603.0	PASS	PASS	PASS	PASS	6.83	69	Yes	Yes		
2/24/2004	5	1,017	14,240	11,400	0.3	50.9	7119.8	5649.2	PASS	PASS	PASS	PASS	8.17	68	Yes	Yes		
2/25/2004	3	1,063	14,368	11,314	0.2	53.2	7183.9	5603.9	PASS	PASS	PASS	PASS	7.35	69	Yes	Yes		
2/26/2004	5	1,004	14,357	11,281	0.3	50.2	7178.3	5590.3	PASS	PASS	PASS	PASS	8.17	67	Yes	Yes		
2/27/2004	5	997	14,322	11,447	0.3	49.9	7160.8	5673.7	PASS	PASS	PASS	PASS	8.17	67	Yes	Yes		
3/1/2004	5	1,038	14,114	11,246	0.3	51.9	7056.8	5571.1	PASS	PASS	PASS	PASS	8.17	68	Yes	Yes		
3/2/2004	4	1,033	14,181	11,234	0.2	51.7	7090.3	5565.4	PASS	PASS	PASS	PASS	7.79	68	Yes	Yes		
3/3/2004	5	1,068	14,359	11,527	0.3	53.4	7179.3	5710.1	PASS	PASS	PASS	PASS	8.17	69	Yes	Yes		
3/4/2004	2	1,059	14,136	11,444	0.1	53.0	7067.9	5669.1	PASS	PASS	PASS	PASS	6.83	69	Yes	Yes		
3/30/2004	4	965	14,190	11,287	0.2	48.3	7094.8	5595.3	PASS	PASS	PASS	PASS	7.79	66	Yes	Yes		
3/30/2004	5	987	14,099	11,130	0.3	49.4	7049.3	5515.7	PASS	PASS	PASS	PASS	8.17	67	Yes	Yes		
3/31/2004	2	994	14,150	11,137	0.1	49.7	7074.9	5518.8	PASS	PASS	PASS	PASS	6.83	67	Yes	Yes		

Initial Background and Source Counts for Control Chart

#	Initial bkg counts				Initial source plus bkg counts			
	Alpha	**cpm**	**Beta**	**cpm**	**Alpha**	**cpm**	**Beta**	**cpm**
1	2	0.1	1,033	51.65	14,166	7083	11,208	5604
2	5	0.25	1,048	52.4	14,105	7052.5	11,558	5779
3	0	0	1,036	51.8	14,198	7099	11,281	5640.5
4	4	0.2	1,001	50.05	14,164	7082	11,391	5695.5
5	3	0.15	1,016	50.8	14,235	7117.5	11,319	5659.5
6	1	0.05	984	49.2	14,191	7095.5	11,452	5726
7	1	0.05	1,055	52.75	14,263	7131.5	11,571	5785.5
8	2	0.1	974	48.7	14,255	7127.5	11,326	5663
9	1	0.05	997	49.85	14,411	7205.5	11,360	5680
10	2	0.1	1,054	52.7	14,276	7138	11,248	5624
Mean		0.11		51.0		7113.2		5685.7
$S_{(n-1)}$		0.08		1.48		41.87		61.59
-3 sigma		-0.12		46.54		6987.59		5500.92
+3 sigma		0.33		55.44		7238.81		5870.48
-2 sigma		-0.05		48.03		7029.46		5562.51
+2 sigma		0.26		53.95		7196.94		5808.89
					Mean-bkg	7113.1		5634.7
					$S_{(n-1)}$	41.91		61.44
				Mean-bkg	-3 sigma	6987.37		5450.38
				Mean-bkg	+3 sigma	7238.82		5819.04
				Mean-bkg	-2 sigma	7029.28		5511.82
				Mean-bkg	+2 sigma	7196.91		5757.60
						7082.9		5552.35
						7052.25		5726.6
						7099		5588.7
						7081.8		5645.45
						7117.35		5608.7
						7095.45		5676.8
						7131.45		5732.75
						7127.4		5614.3
						7205.45		5630.15
						7137.9		5571.3

CABRERA SMEAR COUNTING WORKSHEET (Rev 4)
SMEAR INSTRUMENT QC

Counting Instrument:	Ludlum 2929	Detector:	43-10-1	Calibration Date:	11/19/2003
Serial #:	171590	Serial #:	PR 174813	12 month calibration:	OK
Detector Active Area or Area Covered by Smear (cm^2):	100			NRC 6 Mo Cal. Due Date?	WARNING

	Efficiency (fraction)	Source Nuclide	Source Number	Original Source Activity (DPM)	Source Creation Date	$T_{1/2}$ (yr)	Source Decayed Activity	Required MDA ($DPM/100cm^2$)	Control Chart & Daily Bkg Count Time	Control Chart & Daily Source-Sample Count Time	Control Chart bkg Average α/β cpm	Control Chart bkg 1 sigma, cpm	Control Chart Source-bkg Average α/β cpm	Control Chart source 1 sigma, cpm
Alpha	0.3850	Th-230	2897-01	22,800	6/11/2001	7.70E+04	22,799	10	20	2	0.33	0.12	7983.1	81.27
Beta	0.2650	Tc-99	2889-01	21,400	5/1/2001	2.13E+05	21,400	500	20	2	70.26	2.26	5007.0	39.53

Date	Daily Bkg Counts		Daily Check Source Counts		Daily Bkg Rate (cpm)		Net Daily Source Rate (cpm)		Bkg QC Pass/Fail		Source QC Pass/Fail				α MDA OK?	β MDA OK?	H.P. Technician	Technician Initials
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	MDA α (dpm)	MDA β (dpm)				
6/10/2004	8	1,456	15,704	10,123	0.4	72.8	7851.6	4988.7	PASS	PASS	PASS	PASS	7.90	84	Yes	Yes	Cote	JAC

Initial Background and Source Counts for Control Chart

#	Initial bkg counts				Initial source plus bkg counts			
	Alpha	**cpm**	**Beta**	**cpm**	**Alpha**	**cpm**	**Beta**	**cpm**
1	11	0.55	1,412	70.6	16,251	8125.5	10,241	5120.5
2	8	0.4	1,345	67.25	15,875	7937.5	10,112	5056
3	9	0.45	1,441	72.05	15,946	7973	10,113	5056.5
4	3	0.15	1,425	71.25	15,894	7947	10,268	5134
5	4	0.2	1,352	67.6	15,933	7966.5	10,058	5029
6	7	0.35	1,410	70.5	15,865	7932.5	10,094	5047
7	7	0.35	1,466	73.3	16,035	8017.5	10,153	5076.5
8	5	0.25	1,438	71.9	15,710	7855	10,235	5117.5
9	7	0.35	1,335	66.75	15,947	7973.5	10,216	5108
10	5	0.25	1,427	71.35	16,213	8106.5	10,055	5027.5
Mean		0.33		70.3		7983.5		5077.3
$S_{(n-1)}$		0.12		2.26		81.32		39.80
-3 sigma		-0.03		63.48		7739.50		4957.84
+3 sigma		0.69		77.03		8227.40		5196.66
-2 sigma		0.09		65.74		7820.82		4997.65
+2 sigma		0.57		74.77		8146.08		5156.85
					Mean-bkg	7983.1		5007.0
					$S_{(n-1)}$	81.27		39.53
				Mean-bkg	-3 sigma	7739.32		4888.41
				Mean-bkg	+3 sigma	8226.92		5125.58
				Mean-bkg	-2 sigma	7820.59		4927.94
				Mean-bkg	+2 sigma	8145.65		5086.05
						8124.95		5049.9
						7937.1		4988.75
						7972.55		4984.45
						7946.85		5062.75
						7966.3		4961.4
						7932.15		4976.5
						8017.15		5003.2
						7854.75		5045.6
						7973.15		5041.25
						8106.25		4956.15

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER CABRERA SERVICES ORDER NO. 295451 / 271487

Mfg. Ludlum Measurements, Inc. Model 2224-1 Serial No. 162425

Mfg. Ludlum Measurements, Inc. Model 43-93 Serial No. PR 182403

Cal. Date 15-Apr-03 Cal Due Date 15-Apr-04 Cal. Interval 1 Year Meterface 202-848

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 78 °F RH 38 % Alt 700.8 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 02/07/97.

Instrument Volt Set 900 V Input Sens. Comment mV Det. Oper. 900 V at Comment mV Threshold Dial Ratio ____ = ____ mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. ~~1X8~~ 1500 / 1490 V

COMMENTS:

AT: 120mv
BT: 3.5mv
BW: 30mv
OL set to simulated light leak
Firmware: 390094
Calibrated with 6ft cable

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	800
X1000	200kcpm	200	200
X100	80kcpm	800	800
X100	20kcpm	200	200
X10	8kcpm	800	800
X10	2kcpm	200	200
X1	800cpm	800	800
X1	200cpm	200	200

*Uncertainty within ± 10% C.F. within ± 20% ALL **Range(s) Calibrated Electronically**

Digital Readout

REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
800kcpm	798621	798621
80kcpm	79863	79863
8kcpm	7987	7987
800cpm	799	799
80cpm	80	80

Log Scale

REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*

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-304

☑ Alpha S/N Pu-239 2928-01 ☑ Beta S/N Sr-90/Y-90 vols, Tc-99 Ni-EV ☐ Other

☑ m 500 S/N 134709 ☐ Oscilloscope S/N ☑ Multimeter S/N 57390613

Calibrated By: Conrad Galindo Date 15 Apr 03

Reviewed By: Rhonda Harris Date 16 Apr 03

FORM C22A 04/09/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 43-93 Serial No. PR182403 Order #. 295451 / 271487

Customer CABRERA SERVICES

Alpha Input Sensitivity 120 mV

Counter 2224-1 Serial No. 162425 Beta Input Sensitivity 35 mV

Count Time 1 Minute Beta Window 30 mV

Other Distance Source to Detector Surface

High Voltage	Background Alpha	Background Beta	Isotope Pu-239, Size 12600 cpm Alpha	Beta	Isotope Sr-90 Y-90, Size 44710 Alpha	Beta	Isotope Tc-99, Size 14100 cpm Alpha	Beta
850	0	110	5802	385	2	13110	1	4062
875	0	161	6006	421	0	16757	0	4786
900	0	214	6152	604	3	20357	0	5339
925	0	260	6082	849	5	22934	3	6078
950	3	290	6313	1255	3	23862	1	6520

☐ 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 Conrad Galindo Date 15Apr03

FORM C4B 04/09/2003

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. 289386/268534

Mfg. Ludlum Measurements, Inc. Model 2224-1 Serial No. 162426

Mfg. Ludlum Measurements, Inc. Model 43-93 Serial No. Pr 193921

Cal. Date 15-Jan-03 Cal Due Date 15-Jan-04 Cal. Interval 1 Year Meterface 202-848

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 72 °F RH 20 % Alt 709.8 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 02/07/97.

Instrument Volt Set 800 V Input Sens. Comm. mV Det. Oper. 800 V at Comm. mV Threshold Dial Ratio ____ = ____ mV

☑ HV Readout (2 points) Ref./Inst. 505 / 500 V Ref./Inst. 1513 / 1500 V

COMMENTS:

Alpha Thshld: 120 mv
Beta Thshld: 3.6 mv
Beta Win: 30 mv
Firmware No. 390096

Cal'd using 5' c/c Cable.
OL Set to simulate light leak.
efficiency for Th^{230} 5390 dpm is 19% 4π.
(1024 cpm) Th^{230} S/N 1619

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	800
X1000	200kcpm	200	200
X100	80kcpm	800	800
X100	20kcpm	200	200
X10	8kcpm	800	800
X10	2kcpm	200	200
X1	800cpm	800	800
X1	200cpm	200	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	801320 kcpm	801320 kcpm			
80kcpm	80129 "	80129 "			
8kcpm	8013 "	8013 "			
800cpm	801 cpm	801 cpm			
80cpm	80 "	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-304

☐ Alpha S/N ______ ☐ Beta S/N ______ ☐ Other ______

☑ m 500 S/N 54680 ☐ Oscilloscope S/N ______ ☑ Multimeter S/N 69101832

Calibrated By: [signature] Date 15-Jan-03

Reviewed By: Rhonda Harris Date 16 Jan 03

FORM C22A 10/31/2001

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: ______

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.

Bench Test Data For Detector

Detector 43-93 Serial No. PR 193921

Customer CABRERA SERVICES

Counter 2224-1 Serial No. 162426

Count Time 1 Minute

Other

Order #. 289386/268534

Alpha Input Sensitivity 120 mV

Beta Input Sensitivity 3.6 mV

Beta Window 30 mV

Distance Source to Detector Surface

High Voltage	Background Alpha	Background Beta	Isotope Pu 239, Size 12,600 cpm Alpha	Isotope Pu 239, Size 12,600 cpm Beta	Isotope Tc 99, Size 14,300 cpm Alpha	Isotope Tc 99, Size 14,300 cpm Beta	Isotope Sr90Y90, Size 44979 cpm Alpha	Isotope Sr90Y90, Size 44979 cpm Beta
750	0	97	4720	347	7	2532	0	11770
775	0	141	5110	370	6	3590	0	15651
– 800	1	197	5472	425	10	4408	3	19451
825	0	269	5673	469	11	5052	2	21624
850	1	322	5744	652	11	5698	2	22583

☐ 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 [signature]

Date 15-Jan-03

FORM C4B 12/09/97

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

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.

CUSTOMER CABRERA SERVICES ORDER NO. 212582/279960

Mfg. Ludlum Measurements, Inc. Model 2224-1 Serial No. 162426

Mfg. Ludlum Measurements, Inc. Model 43-93 Serial No. PR193921

Cal. Date 11-Mar-04 Cal Due Date 11-Mar-05 Cal. Interval 1 Year Meterface 202-848

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 20 % Alt 706.8 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 02/07/97.

Instrument Volt Set 825 V Input Sens. Comments mV Det. Oper. 825 V at comments mV Threshold Dial Ratio ____ = ____ mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 1500 / 1500 V

COMMENTS:
Alpha threshold = 120 mV
Beta threshold = 3.5 mV
Beta window = 30 mV
Firmware: 390096
OL set to simulated light leak.
Cal'd with 6' cable.

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	800
x1000	200kcpm	200	200
x100	80kcpm	800	800
x100	20kcpm	200	200
x10	8kcpm	800	800
x10	2kcpm	200	200
x1	800cpm	800	800
x1	200cpm	200	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	801124	801124				
	80kcpm	80112	80112				
	8kcpm	8011	8011				
	800cpm	801	801				
	80cpm	80	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-304

☑ Alpha S/N Th-230-5020-03 ☑ Beta S/N Tc-99-NI-EV, Sr-Y-90-4016 ☐ Other

☑ m 500 S/N 132899 ☐ Oscilloscope S/N ☑ Multimeter S/N 82080087

Calibrated By: Josh Boston Date 11 Mar 04

Reviewed By: [signature] Date 15 MAR 04

This certificate shall not be reproduced except in full, without the written approval of Ludlum Measurements, Inc.
FORM C22A 10/31/2001

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed

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.

Bench Test Data For Detector

Detector 43-93 Serial No. PR193921

Order #. 212582/279960

Customer CABRERA SERVICES

Alpha Input Sensitivity 120 mV

Counter 2224-1 Serial No. 162426

Beta Input Sensitivity 3.5 mV

Count Time 1 Minute

Beta Window 30 mV

Other

Distance Source to Detector Surface

High Voltage	Background Alpha	Background Beta	Isotope Th-230 Size 2910 cpm Alpha	Isotope Th-230 Size 2910 cpm Beta	Isotope Tc-99 Size 14100 cpm Alpha	Isotope Tc-99 Size 14100 cpm Beta	Isotope SrY-90 Size 43732 cpm Alpha	Isotope SrY-90 Size 43732 cpm Beta
800	1	101	1110	235	2	3547	4	16680
825	0	196	1196	244	7	4656	2	19525
850	0	458	1197	361	2	5473	2	20755

☐ 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 Josh Boston

Date 11 Mar 04

FORM C48 12/09/97

• *Serving The Nuclear Industry Since 1962* •

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

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.

CUSTOMER CABRERA SERVICES ORDER NO. 282597

Mfg. Ludlum Measurements, Inc. Model 2224 Serial No. 183048

Mfg. Ludlum Measurements, Inc. Model 43-68 Serial No. PR 161781

Cal. Date 15-Jul-02 Cal Due Date 15-Jul-03 Cal. Interval 1 Year Meterface 202-783

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 36 % 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 02/07/97.

Instrument Volt Set 1575 V Input Sens. Comment mV Det. Oper. 1575 V at Comment mV Threshold Dial Ratio ____ = ____ mV

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 1512 / 1500 V

COMMENTS:

```
Alpha sensitivity=120mV
 Beta sensitivity=3.5mV
     Beta window= 35mV
Overload not set.
Count time set to 60 sec.
High Voltage set with detector connected.
Firmware #390063
Plateau'd using 5 ft. cable.

Pu 239 s/n 4337       ; 30,900 dpm is ≈   21.2% 4pi
Tc 99  s/n 635/83     ; 22,900 dpm is ≈  29.59% 4pi
Ni 63  s/n 91N13100909; 258,890dpm is ≈   6.33% 4pi
C 14   s/n I-659      ; 311,649dpm is ≈  7.69% 4pi
  All efficiencies are NET efficiencies.(without background)
  All readings for efficiencies were taken with
  source placed at the surface and centered against the
  protective screen of the 43-68 probe.
```

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	400kcpm		400
x1000	100kcpm		100
x100	40kcpm		400
x100	10kcpm		100
x10	4kcpm		400
x10	1kcpm		100
x1	400cpm		400
x1	100cpm		100

*Uncertainty within ± 10% C.F. within ± 20% ALL **Range(s) Calibrated Electronically**

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm		40030 (0)	Log Scale			
	40kcpm		4006 (0)				
	4kcpm		400 (0)				
	400cpm		40 (0)				
	40cpm		4 (0)				

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-304

☑ Alpha S/N 4337,Pu239 ☑ Beta S/N 635/83,Tc99*5030,Sr90y90 ☐ Other

☑ m 500 S/N 94940 ☐ Oscilloscope S/N ☑ Multimeter S/N 50100581

Calibrated By: Cresencia Alvarado Date 15 Jul 02

Reviewed By: [signature] Date 17 Jul 02

FORM C22A 10/31/2001

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

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.

Bench Test Data For Detector

Detector 43-68 Serial No. PR161781 Order #. 282597

Customer CABRERA SERVICES

Alpha Input Sensitivity 120 mV

Counter 2224 Serial No. 183048

Beta Input Sensitivity 3.5 mV

Count Time 1Minute

Beta Window 35 mV

Other Plateau'd using 5ft. cable.

Distance Source to Detector surface

High Voltage	Background		Isotope Pu 239 Size 15,700cpm		Isotope Tc 99 Size 14,300cpm		Isotope Sr90Y90 Size 6850 cpm	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
1525	0	133	5813	715	7	7291	1	3127
1550	0	146	6205	762	4	7184	0	3859
1575	2	205	6555	782	6	6982	2	3949
1600	3	274	6777	782	31	6263	17	4125
1625	0	255	7017	709	209	5270	51	3821

☐ 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 Cresencia Alvarado

Date 15 Jul 02

FORM C4B 12/09/97

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER CSTE-DTC-AT-CS-SO ORDER NO. 295475

Mfg. Ludlum Measurements, Inc. Model 2360 Serial No. 193675

Mfg. Ludlum Measurements, Inc. Model 43-37 Serial No. PR161687

Cal. Date 29-Apr-03 Cal Due Date 29-Apr-04 Cal. Interval 1 Year Meterface 202-855

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 37 % Alt 699.8 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 02/07/97.

Instrument Volt Set 1700 V

☑ HV Readout (2 points) Ref./Inst. 500 / 503 V Ref./Inst. 2000 / 2008 V

Firmware Version: 39010N25
Alpha Threshold: 100 mV.
Beta Threshold: 4 mV.
Beta Window: 40 mV
Overload checked but not set.
Instrument calibrated with a 6 ft. cable.
High voltage set with detector connected

(EEPROM Settings)
User Time: 1.0 min
Alpha Alarm: 050000
Beta Alarm: 050000
A/B Alarm: 050000
Model 2360 Date: 04/29/2003
Calibration Date Due: 04/29/2004

COMMENTS:

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	400kcpm		400
x1000	100kcpm		100
x100	40kcpm		400
x100	10kcpm		100
x10	4kcpm		400
x10	1kcpm		100
x1	400cpm		400
x1	100cpm		100

*Uncertainty within ± 10% C.F. within ± 20% ALL **Range(s) Calibrated Electronically**

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm		399989	Log Scale			
	40kcpm		40001				
	4kcpm		4001				
	400cpm		400				
	40cpm		40				

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-304

☑ Alpha S/N 4337.Pu 239 ☑ Beta S/N 635/83,Tc99*#918,Sr90y90 ☐ Other

☑ m 500 S/N 94940 ☐ Oscilloscope S/N ☑ Multimeter S/N 65240152

Calibrated By: [signature] Date 29-APR-03

Reviewed By: [signature] Date 29 Apr 03

FORM C22S 04/09/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 43-37 Serial No. PR161687

Customer CSTE-DTC-AT-CS-SO

Counter 2360 Serial No. 193675

Count Time 1 Minute

Other

Order #. 295475

Alpha Input Sensitivity 100 mV

Beta Input Sensitivity 4 mV

Beta Window 40 mV

Distance Source to Detector Surface

High Voltage	Background		Isotope Pu239 Size 15,700cpm		Isotope Sr90Y90 Size 79,881cpm		Isotope Tc99 Size 14,300cpm	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
1625	5	434	6322	931	3	21733	13	6515
1650	4	574	6522	1068	4	26826	9	7230
1675	3	740	6802	1211	7	30741	11	8085
– 1700	5	860	7035	1421	29	34888	18	8246
1725	11	929	7311	1550	203	37371	52	7949

☐ 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 Elvir Chanley

Date 29 APR 03

FORM C4B 04/09/2003

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER CABRERA SERVICES ORDER NO. 213520/280435

Mfg. Ludlum Measurements, Inc. Model 2360 Serial No. 184938

Mfg. Ludlum Measurements, Inc. Model 43-37 Serial No. PR178371

Cal. Date 1-Apr-04 Cal Due Date 1-Apr-05 Cal. Interval 1 Year Meterface 202-855

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 73 °F RH 20 % Alt 710.8 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 02/07/97.

Instrument Volt Set 1675 V

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 2000 V

Firmware Version: 39010-010-25
Alpha Threshold: 100mV
Beta Threshold: 4mV
Beta Window: 40 mV
Overload checked but not set.
Instrument calibrated with a 39" cable.
High voltage set with detector not connected.

(EEPROM Settings)
User Time: 1.0
Alpha Alarm: 50000
Beta Alarm: 50000
A/B Alarm: 50000
Model 2360 Date: 04/01/2004
Calibration Date Due: 04/01/2005

COMMENTS:

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	400 kcpm	400	400
x1000	100 kcpm	100	100
x100	40 kcpm	400	400
x100	10 kcpm	100	100
x10	4 kcpm	400	400
x10	1 kcpm	100	100
x1	400 cpm	400	400
x1	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*
400 kcpm	40053(0)	40053(0)
40 kcpm	4009	4009
4 kcpm	401	401
400 cpm	40	40
40 cpm	4	4

Log Scale

REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*

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 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☑ Alpha S/N Pu-239-2928-01 ☑ Beta S/N Tc-99 NI-EV, Sr90-4016 ☐ Other

☑ m 500 S/N 132899 ☐ Oscilloscope S/N ☑ Multimeter S/N 82080087

Calibrated By: Josh Boston Date 1 Apr 04

Reviewed By: [signature] Date 1 APR 04

FORM C22S 11/26/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 43-37 Serial No. PR178371 Order #. 213520/280435

Customer CABRERA SERVICES Alpha Input Sensitivity 100 mV

Counter 2360 Serial No. 184938 Beta Input Sensitivity 4 mV

Count Time 1Minute Beta Window 40 mV

Other Distance Source to Detector Surface

High Voltage	Background Alpha	Background Beta	Isotope Pu-239, Size 12600cpm Alpha	Isotope Pu-239, Size 12600cpm Beta	Isotope Tc-99, Size 14100cpm Alpha	Isotope Tc-99, Size 14100cpm Beta	Isotope SrY-90, Size 43670cpm Alpha	Isotope SrY-90, Size 43670cpm Beta
1625	4	382	4904	705	1	7092	7	14641
1650	2	515	5022	934	2	7478	6	17734
→ 1675	2	672	5243	962	6	7698	16	18478
1700	5	895	5361	1145	34	7459	73	19837
1725	12	947	5455	1244	194	6452	431	19941

☐ 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 Josh Boston Date 1 Apr 04

FORM C4B 04/09/2003

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A. 216674

CERTIFICATE OF CALIBRATION

CUSTOMER CABRERA SERVICES ORDER NO. 216718/281992

Mfg. Ludlum Measurements, Inc. Model 2360 Serial No. 202398

Mfg. Ludlum Measurements, Inc. Model 43-93 Serial No. PR211706

Cal. Date 26-May-04 Cal Due Date 26-May-05 Cal. Interval 1 Year Meterface 202-855

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 72 °F RH 56 % Alt 696.0 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 02/07/97.

Instrument Volt Set 725 V

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 1500 / 1500 V

Firmware Version: 39010-010-25
Alpha Threshold: 120 mV
Beta Threshold: 3.5 mV
Beta Window: 30 mV
Overload set to simulated light leak.
Instrument calibrated with a 5' cable.
High voltage set with detector not connected.

(EEPROM Settings)
User Time: 1.0
Alpha Alarm: 50000
Beta Alarm: 50000
A/B Alarm: 50000
Model 2360 Date: 05/26/2004
Calibration Date Due: 05/26/2005

COMMENTS:
4 pi efficiencies (Refer to plateau sheet at set voltage for details):
Th-230 = 19.48%, Tc-99 = 20.82%, SrY-90 = 30.97%, Ni-63 = 0.13%.

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	400kcpm		400
x1000	100kcpm		100
x100	40kcpm		400
x100	10kcpm		100
x10	4kcpm		400
x10	1kcpm		100
x1	400cpm		400
x1	100cpm		100

*Uncertainty within ± 10% C.F. within ± 20% ALL Range(s) Calibrated Electronically

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout	400kcpm	(0) JB	40151 (0)	Log Scale			
	40kcpm		4015				
	4kcpm		400				
	400cpm		40				
	40cpm		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 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☑ Alpha S/N Th-230-5020-03 ☑ Beta S/N Tc-99-NI-EV, SrY-90-4016, Ni-63-4017 ☐ Other

☑ m 500 S/N 132899 ☐ Oscilloscope S/N ☑ Multimeter S/N 82080087

Calibrated By: Josh Boston Date 26 May 04

Reviewed By: [signature] Date 27 May 04

FORM C22S 11/26/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

216674

Detector 43-93 Serial No. PR211706
Order #. 216718/281992
Customer CABRERA SERVICES
Alpha Input Sensitivity 120 mV
Counter 2360 Serial No. 202398
Beta Input Sensitivity 3.5 mV
Count Time 1Minute
Beta Window 30 mV
Other
Distance Source to Detector Surface

High Voltage	Background Alpha	Background Beta	Isotope Th-230, Size 5730dpm Alpha	Isotope Th-230, Size 5730dpm Beta	Isotope Tc-99, Size 22600dpm Alpha	Isotope Tc-99, Size 22600dpm Beta	Isotope SrY-90, Size 62157dpm Alpha	Isotope SrY-90, Size 62157dpm Beta
675	0	70	1009	140	1	2560	2	13265
700	1	119	1129	191	2	3849	2	16078
→ 725	0	170	1116	255	2	4876	3	19422
750	1	204	1155	397	0	5773	5	20319

☐ 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 Josh Boston
Date 26 May 04

FORM C4B 04/09/2003

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

216674

Detector 43-93 Serial No. PR211706

Order #. 216718/281992

Customer CABRERA SERVICES

Alpha Input Sensitivity 120 mV

Counter 2360 Serial No. 202398

Beta Input Sensitivity 3.5 mV

Count Time 1Minute

Beta Window 30 mV

Other

Distance Source to Detector Surface

High Voltage	Background		Isotope Ni-63 Size 294126dpm		Isotope Size		Isotope Size	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
675	0	70	1	75				
700	1	119	0	193				
→ 725	0	170	0	551				
750	1	204	0	1581				

☐ 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 Josh Boston

Date 26 May 04

FORM C4B 04/09/2003

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. 291453/269534

Mfg. Ludlum Measurements, Inc. Model 2929 Serial No. 163827
Mfg. Ludlum Measurements, Inc. Model 43-10-1 Serial No. PR171322

Cal. Date 21-Jan-03 Cal Due Date 21-Jan-04 Cal. Interval 1 Year Meterface 202-014

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 76 °F RH 20 % Alt 700.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ 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 02/07/97.

Instrument Volt Set 825 V = 3.28 on High Voltage dial. High Voltage set with detector connected.

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2010 / 2000 V

COMMENTS:

```
Th230   #2748
Current Activity:   6130dpm
Source count minus background:  2772cpm
Eff:  45 %(4pi)
```

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	39994 (0)	39994 (0)
	40K cpm	4002	4002
	4K cpm	400	400
	400 cpm	40	40
	40 cpm	4	4

Beta/Gamma Channel Digital Readout	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
	400K cpm	40012 (0)	40012 (0)
	40K cpm	4001	4001
	4K cpm	400	400
	400 cpm	40	40
	40 cpm	4	4

*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 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-304

☑ Alpha S/N Th230 #2748 ☑ Beta S/N Tc99 NI-EV, C14 GV471 ☐ Other

☑ m 500 S/N 57885 ☐ Oscilloscope S/N ☑ Multimeter S/N 71300353

Calibrated By: [signature] Date 21-Jan-03

Reviewed By: Rhoda Harris Date 22 Jan 03

AC Inst. Only ☑ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

FORM C25 10/31/2001

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.

Bench Test Data For Detector

Detector 43-10-1 Serial No. PR 171322 Order #. 291453/269534

Customer CABRERA SERVICES

Alpha Input Sensitivity 175 mV

Counter 2929 Serial No. 163827 Beta Input Sensitivity 4 mV

Count Time 1 Minute Beta Window 50 mV

Other

Distance Source to Detector Tray

High Voltage	Background		Isotope Th 230 Size 6130 dpm		Isotope C 14 Size 240 kdpm		Isotope Tc 99 Size 22.6 dpm	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
775	0	37	2214	196	0	9278	0	5098
800	1	49	2588	187	1	13647	0	6268
→ 825	0	58	2772	232	1	19991	2	7028
850	0	69	2738	281	4	24368	2	7567

☐ 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 Jeremy [signature]

Date 21-Jan-03

FORM C4B 12/09/97

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER CABRERA SERVICES ORDER NO. 206689 / 277045

Mfg. Ludlum Measurements, Inc. Model 2929 Serial No. 171590

Mfg. Ludlum Measurements, Inc. Model 43-10-1 Serial No. PR 174813

Cal. Date 19-Nov-03 Cal Due Date 19-Nov-04 Cal. Interval 1 Year Meterface 202-014

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 73 °F RH 33 % Alt 708.8 mm Hg

☐ New Instrument Instrument Received ☑ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ 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 02/07/97.

Instrument Volt Set 875 V = 3.59 on High Voltage dial. High Voltage set with detector connected.

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 2025 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	399989	399989
	40K cpm	40009	40009
	4K cpm	4008	4008
	400 cpm	400	400
	40 cpm	40	40

Beta/Gamma Channel Digital Readout	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
	400K cpm	399987	399987
	40K cpm	40009	40009
	4K cpm	4007	4007
	400 cpm	400	400
	40 cpm	40	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 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-304

☑ Alpha S/N Pu 239 12.6Kcpm ☑ Beta S/N Tc99 161.3Kcpm C14 91.8Kcpm ☐ Other

☑ m 500 S/N 102799 ☐ Oscilloscope S/N ☑ Multimeter S/N 68260348

Calibrated By: V. Lee Alvarado Date 19Nov03

Reviewed By: [signature] Date 19NOV03

AC Inst. Only ☑ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

FORM C25 04/09/2003

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 43-10-1 Serial No. PR 174813 Order #. 206689 / 277045

Customer CABRERA SERVICES Alpha Input Sensitivity 175 mV

Counter 2929 Serial No. 171590 Beta Input Sensitivity 4 mV

Count Time 1Minute Beta Window 50 mV

Other H.V. set with detector connected Distance Source to Detector Tray

High Voltage	Background Alpha	Background Beta	Isotope Pu 239, Size 12.6Kcpm Alpha	Isotope Pu 239, Size 12.6Kcpm Beta	Isotope Tc 99, Size 14.3Kcpm Alpha	Isotope Tc 99, Size 14.3Kcpm Beta	Isotope C14, Size 91.8Kcpm Alpha	Isotope C14, Size 91.8Kcpm Beta
825	0	44	9654	414	12	6427	1	13281
850	0	43	9890	391	14	6964	1	17268
875	0	51	9692	325	12	7633	3	22561
900	0	69	9860	280	24	7994	0	26432
925	0	61	9859	343	11	8724	1	32163

☐ 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 V. [signature] Date 19Nov03

FORM C4B 04/09/2003

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER CABRERA SERVICES ORDER NO. 208017

Mfg. Ludlum Measurements, Inc. Model 2929 Serial No. 180830

Mfg. Ludlum Measurements, Inc. Model 43-10-1 Serial No. PR 207849

Cal. Date 15-Dec-03 Cal Due Date 15-Dec-04 Cal. Interval 1 Year Meterface 202-014

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 72 °F RH 25 % Alt 694.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ 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 02/07/97.

Instrument Volt Set 675 V = 2.81 on High Voltage dial. High Voltage set with detector connected.

☑ HV Readout (2 points) Ref./Inst. 500 / 500 V Ref./Inst. 2000 / 1996 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		400340
	40K cpm		39992
	4K cpm		3999
	400 cpm		400
	40 cpm		40

Beta/Gamma Channel Digital Readout	REFERENCE CAL POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
	400K cpm		400063
	40K cpm		40021
	4K cpm		4004
	400 cpm		400
	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 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 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☑ Alpha S/N 4337 Pu239 15.7kcpm ☑ Beta S/N 1659 C14, 635/83 Tc99 ☐ Other

☑ m 500 S/N 141244 ☐ Oscilloscope S/N ☑ Multimeter S/N 68160950

Calibrated By: [signature] Date 15-Dec-03

Reviewed By: [signature] Date 16 Dec 03

FORM C25 11/26/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 43-10-1 Serial No. PR 207849 Order #. 208017

Customer CABRERA SERVICES

Alpha Input Sensitivity 175 mV

Counter 2929 Serial No. 180830

Beta Input Sensitivity 4 mV

Count Time 1Minute

Beta Window 50 mV

Other

Distance Source to Detector Tray

High Voltage	Background		Isotope C14, Size 155,824 cpm		Isotope Pu239, Size 15,700 cpm		Isotope Tc99, Size 14,300 cpm	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
625	0	54	0	20785	12380	357	7	8080
650	0	56	0	26072	12305	430	11	8841
→ 675	0	57	0	29842	12405	607	14	9261
700	0	49	0	33312	12534	1015	12	9034
725	0	66	0	36433	12377	1960	15	8389
750	0	81	0	40094	12441	8888	9	7890

☐ 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 Joyce Althof

Date 15-Dec-03

FORM C4B 04/09/2003

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER CABRERA SERVICES ORDER NO. 297060/272290

Mfg. Ludlum Measurements, Inc. Model 3 Serial No. 79498

Mfg. Ludlum Measurements, Inc. Model 44-9 Serial No. PR073106

Cal. Date 9-May-03 Cal Due Date 9-May-04 Cal. Interval 1 Year Meterface 202-002

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 73 °F RH 28 % Alt 697.8 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 02/07/97.

Instrument Volt Set 900 V Input Sens. 28 mV Det. Oper. 900 V at 28 mV Threshold Dial Ratio ______ = ______ mV

☐ HV Readout (2 points) Ref./Inst. ______ / ______ V Ref./Inst. ______ / ______ V

COMMENTS:
Efficiency for Tc-99: Background count = 50cpm, source count = 4800 cpm, dpm value of source = 22600 dpm, 4π efficiency = 21.02%, SN of Tc-99 source = NI-EY.

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 100	400kcpm	4K	4K
X 100	100kcpm	1K	1K
X 10	40kcpm	4K	4K
X 10	10kcpm	1K	1K
X 1	4kcpm	4K	4K
X 1	1kcpm	1K	1K
X 0.1	400cpm	4K	4K
X 0.1	100cpm	1K	1K

*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*

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-304

☐ Alpha S/N ______ ☐ Beta S/N ______ ☐ Other ______

☑ m 500 S/N 57881 ☐ Oscilloscope S/N ______ ☑ Multimeter S/N 82080087

Calibrated By: Josh Boston Date 9 May 03

Reviewed By: Rhonda Harris Date 14 May 03

FORM C22A 04/09/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: ______

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CONVERSION CHART

Customer CABRERA SERVICES Date 9-May-03 Order #. 297060/272290

Model 3 Serial No. 79498 Detector Model 44-9 Serial No. PR073106

Source Cs-137 194.6 mCi Cs-137 20 mCi High Voltage 900 V

Input Sensitivity 28 mV

Reference Point	"As Found" Readings (CPM): Meter Reading	Range/Scale	After Adjustment Readings (CPM): Meter Reading	Range/Scale
150 mR/hr	NA	NA	2.2K	X100
50 mR/hr	↓	↓	1.15K	X100
15 mR/hr	↓	↓	4.0K	X10
5 mR/hr	↓	↓	1.45K	X10
1.5 mR/hr	↓	↓	4.5K	X1
1.0 mR/hr	↓	↓	3.1K	X1

Signature: Josh Boston Date 9 May 03

FORM C17-1A 04/09/2003

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER CABRERA SERVICES ORDER NO. 216307/281793

Mfg. Ludlum Measurements, Inc. Model 3 Serial No. 79498

Mfg. Ludlum Measurements, Inc. Model 44-9 Serial No. PR073106

Cal. Date 19-May-04 Cal Due Date 19-May-05 Cal. Interval 1 Year Meterface 202-002

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 75 °F RH 45 % Alt 698.8 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 02/07/97.

Instrument Volt Set 900 V Input Sens. 29 mV Det. Oper. 900 V at 29 mV Threshold Dial Ratio ______ = ______ mV

☐ HV Readout (2 points) Ref./Inst. ______ / ______ V Ref./Inst. ______ / ______ V

COMMENTS:
4 pi efficiency for Tc-99 as follows: source count = 5000cpm, background count = 39cpm, dpm value of source = 22600dpm, SN of source = NI-EV, 4 pi efficiency = 21.95%.
Cal'd with 6' Cable.

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 100	400kcpm	4K	4K
X 100	100kcpm	1K	1K
X 10	40kcpm	4K	4K
X 10	10kcpm	1K	1K
X 1	4kcpm	4K	4K
X 1	1kcpm	1K	1K
X 0.1	400cpm	4K	4K
X 0.1	100cpm	1K	1K

*Uncertainty within ± 10% C.F. within ± 20% ALL **Range(s) Calibrated Electronically**

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout				Log Scale			

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 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ______ ☐ Beta S/N ______ ☐ Other ______

☑ m 500 S/N 132899 ☐ Oscilloscope S/N ______ ☑ Multimeter S/N 82080087

Calibrated By: Josh Boston Date 19 May 04

Reviewed By: [signature] Date 20 may 04

FORM C22A 11/26/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: ______

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CONVERSION CHART

Customer CABRERA SERVICES Date 19-May-04 Order #. 216307/281793

Model 3 Serial No. 79498 Detector Model 44-9 Serial No. PR073106

Source Cs-137 194.6 mCi Cs-137 20 mCi

High Voltage 900 V

Input Sensitivity 29 mV

Reference Point	"As Found" Readings (CPM): Meter Reading	Range/Scale	After Adjustment Readings (CPM): Meter Reading	Range/Scale
150 mR/hr	2.05K	X100	2.05K	X100
50 mR/hr	1.1K	X100	1.1K	X100
15 mR/hr	4.1K	X10	4.1K	X10
5 mR/hr	1.5K	X10	1.5K	X10
1.5 mR/hr	4.6K	X1	4.6K	X1
1.0 mR/hr	3.2K	X1	3.2K	X1

Signature: Josh Boston Date 19 May 04

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

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.

CUSTOMER CABRERA SERVICES ORDER NO. 289386/268534

Mfg. Ludlum Measurements, Inc. Model 3 Serial No. 79511

Mfg. Ludlum Measurements, Inc. Model 44-9 Serial No. PR 137499

Cal. Date 3-Dec-02 Cal Due Date 3-Dec-03 Cal. Interval 1 Year Meterface 202-002

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 72 °F RH 28 % Alt 701.8 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 02/07/97.

Instrument Volt Set 900 V Input Sens. 28 mV Det. Oper. 900 V at 28 mV Threshold Dial Ratio ______ = ______ mV

☐ HV Readout (2 points) Ref./Inst. ______ / ______ V Ref./Inst. ______ / ______ V

COMMENTS: efficiency for Tc 99 22.9 Kdpm Value is 26 % 4π
(6000 cpm - 50 cpm BG: 5950 cpm)

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 100	400 Kcpm	4K	4K
X 100	100 Kcpm	1K	1K
X 10	40 Kcpm	4K	4K
X 10	10 Kcpm	1K	1K
X 1	4 Kcpm	4K	4K
X 1	1 Kcpm	1K	1K
X 0.1	400 cpm	4K	4K
X 0.1	100 cpm	1K	1K

*Uncertainty within ± 10% C.F. within ± 20% ______ **Range(s) Calibrated Electronically**

Digital Readout: REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	Log Scale: REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*

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-304

☐ Alpha S/N ______ ☐ Beta S/N ______ ☐ Other ______

☑ m 500 S/N 54680 ☐ Oscilloscope S/N ______ ☑ Multimeter S/N 69101832

Calibrated By: [signature] Date 3-Dec-02

Reviewed By: Rhonda Harris Date 5 Dec 02

FORM C22A 10/31/2001

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: ______

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.

CONVERSION CHART

Customer CABRERA SERVICES Date 3-Dec-02 Order #. 289386/268534

Model 3 Serial No. 79511 Detector Model 44-9 Serial No. PR 137499

Source Cs-137 194.6 mCi Cs-137 20 mCi High Voltage 900 V

Input Sensitivity 28 mV

Reference Point	"As Found" Readings (CPM): Meter Reading	Range/Scale	After Adjustment Readings (CPM): Meter Reading	Range/Scale
150 mR/hr	N/A		1.7 K	X100
50 mR/hr			1.1 K	"
15 mR/hr			4.2 K	X10
5 mR/hr			1.6 K	"
1.5 mR/hr			4.5 K	X1
1.0 mR/hr			3.3 K	"

Signature: [signature] Date 3-Dec-02

FORM C17-1A 05/20/98

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. 294734/271134

Mfg. Ludlum Measurements, Inc. Model 3 Serial No. 89973

Mfg. Ludlum Measurements, Inc. Model 44-9 Serial No. PR084781

Cal. Date 27-Mar-03 Cal Due Date 27-Mar-04 Cal. Interval 1 Year Meterface 202-560

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 78 °F RH 20 % Alt 690.8 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 02/07/97.

Instrument Volt Set 900 V Input Sens. 27 mV Det. Oper. 900 V at 27 mV Threshold Dial Ratio ______ = ______ mV

☐ HV Readout (2 points) Ref./Inst. ______ / ______ V Ref./Inst. ______ / ______ V

COMMENTS: eff for Tc-99: 20.6% (4π) source size: 22,600 dpm source count: 4,700 cpm background: 50 cpm S/n: NI-EV

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 100	150 mR/hr	1.5	1.5
X 100	50 mR/hr	0.5	0.5
X 10	15 mR/hr	1.48	1.48
X 10	5 mR/hr	0.53	0.53
X 1	1.5 mR/hr = 5160 cpm	1.6	1.5
X 1	1.0 mR/hr	1.1	1.0
X 0.1	516 cpm	1.6	1.5
X 0.1	172 cpm	0.55	0.5

*Uncertainty within ± 10% C.F. within ± 20% X 0.1 **Range(s) Calibrated Electronically**

Digital Readout: REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	Log Scale: REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*

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-304

☐ Alpha S/N ______ ☐ Beta S/N ______ ☐ Other ______

☑ m 500 S/N 81084 ☐ Oscilloscope S/N ______ ☑ Multimeter S/N 80040300

Calibrated By: Michael J Thomas Date 27-Mar-03

Reviewed By: Rhonda Harris Date 30 Mar 03

FORM C22A 03/07/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: ______

LM

of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER CABRERA SERVICES ORDER NO. 298393/272921

Mfg. Ludlum Measurements, Inc. Model 3 Serial No. 135696

Mfg. Ludlum Measurements, Inc. Model 44-9 Serial No. PR145224

Cal. Date 6-Jun-03 Cal Due Date 6-Jun-04 Cal. Interval 1 Year Meterface 202-002

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 73 °F RH 59 % Alt 701.8 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 02/07/97.

Instrument Volt Set 900 V Input Sens. 38 mV Det. Oper. 900 V at 38 mV Threshold Dial Ratio ____ = ____ mV

☐ HV Readout (2 points) Ref./Inst. ____ / ____ V Ref./Inst. ____ / ____ V

COMMENTS:
EFF: for TC-99#NI-EV act.22,600dpm 5000cpm - Bg 50 4950cpm 22% 4pi
Cal. with a 6 Ft. cable

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 100	400 K cpm	4K	4K
X 100	100 K cpm	1K	1K
X 10	40 K cpm	4K	4K
X 10	10 K cpm	1K	1K
X 1	4 K cpm	4K	4K
X 1	1 K cpm	1K	1K
X 0.1	400 cpm	4K	4K
X 0.1	100 cpm	1K	1K

*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*

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-304

☐ Alpha S/N ____ ☐ Beta S/N ____ ☐ Other ____

☑ m 500 S/N 54683 ☐ Oscilloscope S/N ____ ☑ Multimeter S/N 70602489

Calibrated By: Duaine Jackson Date 6-Jun-03

Reviewed By: [signature] Date 6 Jun 03

FORM C22A 04/09/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed:

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CONVERSION CHART

Customer CABRERA SERVICES Date 6-Jun-03 Order #. 298393/272921

Model 3 Serial No. 135696 Detector Model 44-9 Serial No. PR145224

Source Cs-137 194.6 mCi Cs-137 20 mCi High Voltage 900 V

Input Sensitivity 38 mV

Reference Point	"As Found" Readings (CPM): Meter Reading	Range/Scale	After Adjustment Readings (CPM): Meter Reading	Range/Scale
150 mR/hr	3.5K	X100	3.5K	X100
50 mR/hr	1.65K	X100	1.65K	X 100
15 mR/hr	0.55K	X100	0.55K	X 100
5 mR/hr	1.85K	X10	1.85K	X 10
1.5 mR/hr	0.55K	X 10	0.55K	X 10
1.0 mR/hr	3.2K	X1	3.2K	X 1

Signature: Duane Jackson Date 6-Jun-03

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER CABRERA SERVICES ORDER NO. 207741/277558

Mfg. Ludlum Measurements, Inc. Model 3 Serial No. 166511

Mfg. Ludlum Measurements, Inc. Model 44-9 Serial No. PR073107

Cal. Date 16-Dec-03 Cal Due Date 16-Dec-04 Cal. Interval 1 Year Meterface 202-002

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 74 °F RH 20 % Alt 710.8 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 02/07/97.

Instrument Volt Set 900 V Input Sens. 35 mV Det. Oper. 900 V at 35 mV Threshold Dial Ratio ______ = ______ mV

☐ HV Readout (2 points) Ref./Inst. ______ / ______ V Ref./Inst. ______ / ______ V

COMMENTS:

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 100	400kcpm	4K	4K
X 100	100kcpm	1K	1K
X 10	40kcpm	4K	4K
X 10	10kcpm	1K	1K
X 1	4kcpm	4K	4K
X 1	1kcpm	1K	1K
X 0.1	400cpm	4K	4K
X 0.1	100cpm	1K	1K

*Uncertainty within ± 10% C.F. within ± 20% ALL **Range(s) Calibrated Electronically**

	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*		REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
Digital Readout				Log Scale			

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 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ______ ☐ Beta S/N ______ ☐ Other ______

☑ m 500 S/N 132899 ☐ Oscilloscope S/N ______ ☑ Multimeter S/N 82080087

Calibrated By: Josh Boston Date 16 Dec 03

Reviewed By: [signature] Date 17 Dec 03

FORM C22A 11/26/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: ______

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CONVERSION CHART

Customer CABRERA SERVICES Date 16-Dec-03 Order #. 207741/277558

Model 3 Serial No. 166511 Detector Model 44-9 Serial No. PR073107

Source Cs-137 194.6 mCi Cs-137 20 mCi High Voltage 900 V

Input Sensitivity 35 mV

Reference Point	"As Found" Readings (CPM): Meter Reading	Range/Scale	After Adjustment Readings (CPM): Meter Reading	Range/Scale
150 mR/hr	3.8K	X100	3.8K	X100
50 mR/hr	1.8K	X100	1.8K	X100
15 mR/hr	0.5K	X100	0.5K	X100
5 mR/hr	1.9K	X10	1.9K	X10
1.5 mR/hr	4.8K	X1	4.8K	X1
1.0 mR/hr	3.3K	X1	3.3K	X1

Signature: Josh Boston Date 16 Dec 03

FORM C17-1A 04/09/2003

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

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.

CUSTOMER CABRERA SERVICES ORDER NO. 291453/269534

Mfg. Bicron Model MICRO REM Serial No. C853F

Mfg. ______ Model ______ Serial No. ______

Cal. Date 20-Jan-03 Cal Due Date 20-Jan-04 Cal. Interval 1 Year Meterface 0-200μrem

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 76 °F RH 20 % Alt 700.8 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) ______VDC

☐ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☑ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set ______ V Input Sens. ______ mV Det. Oper. ______ V at ______ mV Threshold Dial Ratio ______ = ______ mV

☐ HV Readout (2 points) Ref./Inst. ______ / ______ V Ref./Inst. ______ / ______ V

COMMENTS:

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	150mR/hr	155	150
X1000	50mR/hr	50	50
X100	15mR/hr	155	150
X100	5mR/hr	50	50
X10	1.5mR/hr	145	150
X10	500μR/hr	50	50
X1	150μR/hr	145	~~5H 50~~ 150
X1	100μR/hr	95	100
X0.1	15μR/hr	140	150
X0.1			

*Uncertainty within ± 10% C.F. within ± 20%

______ **Range(s) Calibrated Electronically**

Digital Readout: REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	Log Scale: REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*

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-304

☐ Alpha S/N ______ ☐ Beta S/N ______ ☑ Other Cs 137 201μCi

☐ m 500 S/N ______ ☐ Oscilloscope S/N ______ ☐ Multimeter S/N ______

Calibrated By: [signature] Date 20-Jan-03

Reviewed By: [signature] Date 22 Jan 03

FORM C22A 10/31/2001

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: ______

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER CABRERA SERVICES ORDER NO. 298393/272921

Mfg. Bicron Model MICRO REM Serial No. B837Y

Mfg. ______ Model ______ Serial No. ______

Cal. Date 6-Jun-03 Cal Due Date 6-Jun-04 Cal. Interval 1 Year Meterface 0-200µrem/

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 73 °F RH 59 % Alt 701.8 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) ______VDC

☐ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☐ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set ______ V Input Sens. ______ mV Det. Oper. ______ V at ______ mV Threshold Dial Ratio ______ = ______ mV

☐ HV Readout (2 points) Ref./Inst. ______ / ______ V Ref./Inst. ______ / ______ V

COMMENTS:

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	150 mR/hr	155	150
x 1000	50 mR/hr	55	50
x 100	15 mR/hr	150	150
x 100	5 mR/hr	51	51
x 10	1500 µR/hr	140	150
x 10	500 µR/hr	48	50
x 1	150 µR/hr	135	150
x 1	100 µR/hr	90	100
x0.1	15 µR/hr	150	150
x0.1			

*Uncertainty within ± 10% C.F. within ± 20% ______ **Range(s) Calibrated Electronically**

Digital Readout	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	Log Scale	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*

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-304

☐ Alpha S/N ______ ☐ Beta S/N ______ ☐ Other CS-137 20 µci

☐ m 500 S/N ______ ☐ Oscilloscope S/N ______ ☐ Multimeter S/N ______

Calibrated By: Duane Jackson Date 6-Jun-03

Reviewed By: [signature] Date 6 June 03

FORM C22A 04/09/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: ______

Designer and Manufacturer of Scientific and Industrial Instruments

CERTIFICATE OF CALIBRATION

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 325-235-5494
501 OAK STREET FAX NO. 325-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CUSTOMER CABRERA SERVICES ORDER NO. 208949 / 278168

Mfg. Bicron Model MICRO REM Serial No. B985Y

Mfg. ___ Model ___ Serial No. ___

Cal. Date 13-Jan-04 Cal Due Date 13-Jan-05 Cal. Interval 1 Year Meterface 0-200μrem/

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 76 °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) ___ VDC

☐ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☑ Calibrated in accordance with LMI SOP 14.9 rev 02/07/97.

Instrument Volt Set ___ V Input Sens. ___ mV Det. Oper. ___ V at ___ mV Threshold Dial Ratio ___ = ___ mV

☐ HV Readout (2 points) Ref./Inst. ___ / ___ V Ref./Inst. ___ / ___ V

COMMENTS:

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	150 mR/hr	140	150
x 1000	50 mR/hr	50	50
x 100	15 mR/hr	145	150
x 100	5 mR/hr	50	50
x 10	1500 μR/hr	150	150
x 10	500 μR/hr	50	50
x 1	150 μR/hr	150	150
x 1	100 μR/hr	100	100
x0.1	15 μR/hr	150	150
x0.1			

*Uncertainty within ± 10% C.F. within ± 20% **Range(s) Calibrated Electronically**

Digital Readout: REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	Log Scale: REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*

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 ☐ 720 ☐ 734 ☐ 1616 ☐ Neutron Am-241 Be S/N T-304

☐ Alpha S/N ___ ☐ Beta S/N ___ ☐ Other ___

☐ m 500 S/N ___ ☐ Oscilloscope S/N ___ ☐ Multimeter S/N ___

Calibrated By: Aaron Jolley Date 13·JAN·04

Reviewed By: W Robin Date 13 Jan 04

FORM C22A 11/26/2003

AC Inst. Only ☐ Passed Dielectric (Hi-Pot) and Continuity Test ☐ Failed: ___

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Alpha Standard

S.O.# 3740
P.O.# 01-267

Description of Standard:

Model No. DNS-11 Serial No. 2888-01 Isotope Th-230

Electroplated on polished Ni disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi alpha emission rate was measured using an internal gas flow proportional chamber. Absolute counting of alpha particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated alpha source S/N 2393/91.

Measurement Result:

The observed alpha particles emitted from the surface of the disc per minute (cpm) on the calibration date was:

10,100 ± 403

The total disintegration rate (dpm) assuming no backscatter of alpha particles from the surface of the disc, was:

20,200 ± 807 (0.00909 μCi)

The uncertainty of the measurement is 4 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by: [signature]

Calibration Technician: [signature] Q.A. Representative: [signature]

Calibration Date: 5-01-2001 Reviewed Date: 05/02/01

Analytical Services
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 345-3461 Fax (505) 761-5416
Toll Free (866) RAD-LABS (723-5227)
www.eberlineservices.com

EBERLINE
SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Beta Standard

S.O.# 3740
P.O.# 01-267

Description of Standard:

Model No. DNS-12 Serial No. 2889-01 Isotope Tc-99

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi beta emission rate was measured using an internal gas flow proportional chamber. Absolute counting of beta particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated beta source S/N 2148/90.

Measurement Result:

The observed beta count rate from the surface of the disc per minute (cpm) on the calibration date was:

13,400 ± 402

The total disintegration rate (dpm) assuming 25 % backscatter of beta particles from the surface of the disc, was:

21,400 ± 643 (0.00966 μCi)

The uncertainty of the measurement is 3 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by: [signature]

Calibration Technician: [signature] Q.A. Representative: [signature]

Calibration Date: 5-01-2001 Reviewed Date: 05/02/01

Analytical Services
7021 Pan American Freeway NE
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www.eberlineservices.com

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Alpha Standard

S.O.# 3759
P.O.# 01-325

Description of Standard:

Model No. DNS-11 Serial No. 2897-01 Isotope Th-230

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi alpha emission rate was measured using an internal gas flow proportional chamber. Absolute counting of alpha particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated alpha source S/N 2393/91.

Measurement Result:

The observed alpha particles emitted from the surface of the disc per minute (cpm) on the calibration date was:

11,400 ± 343

The total disintegration rate (dpm) assuming no backscatter of alpha particles from the surface of the disc, was:

22,800 ± 685 (0.0103 μCi)

The uncertainty of the measurement is 3 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by: Barbara M. Fu[illegible]

Calibration Technician: Art Reust Q.A. Representative: [signature]

Calibration Date: 6-11-2001 Reviewed Date: 6/11/01

Analytical Services
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
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www.eberlineservices.com

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Alpha Standard

S.O.# 3863
P.O.# 02-055

Description of Standard:

Model No. DNS-11 Serial No. 3972-02 Isotope Th-230

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi alpha emission rate was measured using an internal gas flow proportional chamber. Absolute counting of alpha particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated alpha source S/N 2393/91.

Measurement Result:

The observed alpha particles emitted from the surface of the disc per minute (cpm) on the calibration date was:

7,970 $\pm$ 398

The total disintegration rate (dpm) assuming 1.5% backscatter of alpha particles from the surface of the disc, was:

15,700 $\pm$ 785 (0.00708 μCi)

The uncertainty of the measurement is 5 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by:

Calibration Technician: Q.A. Representative:

Calibration Date: 4-29-2002 Reviewed Date: 4-29-02

Analytical Services
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
(505) 345-3461 Fax (505) 761-5416
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www.eberlineservices.com

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Alpha Standard

S.O.# 3863
P.O.# 02-055

Description of Standard:

Model No. DNS-11 Serial No. 3973-02 Isotope Th-230

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi alpha emission rate was measured using an internal gas flow proportional chamber. Absolute counting of alpha particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated alpha source S/N 2393/91 .

Measurement Result:

The observed alpha particles emitted from the surface of the disc per minute (cpm) on the calibration date was:

8,860 ± 265

The total disintegration rate (dpm) assuming 1.5% backscatter of alpha particles from the surface of the disc, was:

17,500 ± 523 (0.00786 µCi)

The uncertainty of the measurement is 3 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by: [signature]

Calibration Technician: [signature] Q.A. Representative: [signature]

Calibration Date: 4-29-2002 Reviewed Date: 4-29-02

Analytical Services
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
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www.eberlineservices.com

EBERLINE SERVICES

CERTIFICATE OF CALIBRATION

Electroplated Beta Standard

S.O.# 3863
P.O.# 02-055

Description of Standard:

Model No. DNS-12 Serial No. 3974-02 Isotope Tc-99

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi beta emission rate was measured using an internal gas flow proportional chamber. Absolute counting of beta particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated beta source S/N 2148/90.

Measurement Result:

The observed beta count rate from the surface of the disc per minute (cpm) on the calibration date was:

10,400 ± 414

The total disintegration rate (dpm) assuming 25 % backscatter of beta particles from the surface of the disc, was:

16,600 ± 663 (0.00747 μCi)

The uncertainty of the measurement is 4 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by: [signature]

Calibration Technician: [signature] Q.A. Representative: [signature]

Calibration Date: 4-25-2002 Reviewed Date: 4-29-02

Analytical Services
7021 Pan American Freeway NE
Albuquerque, New Mexico 87109-4238
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www.eberlineservices.com

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CERTIFICATE OF CALIBRATION

Electroplated Beta Standard

S.O.# 3863
P.O.# 02-055

Description of Standard:

Model No. DNS-12 Serial No. 3975-02 Isotope Tc-99

Electroplated on polished SS disc, 0.79 mm thick.

Total diameter of 4.77 cm and an active diameter of 4.45 cm.

The radioactive material is permanently fixed to the disc by heat treatment without any covering over the active surface.

Measurement Method:

The 2pi beta emission rate was measured using an internal gas flow proportional chamber. Absolute counting of beta particles emitted in the hemisphere above the active surface was verified by counting above, below, and at the operative voltage. The calibration is traceable to NIST by reference to an NIST calibrated beta source S/N 2148/90.

Measurement Result:

The observed beta count rate from the surface of the disc per minute (cpm) on the calibration date was:

11,000 ± 441

The total disintegration rate (dpm) assuming 25 % backscatter of beta particles from the surface of the disc, was:

17,700 ± 706 (0.00796 µCi)

The uncertainty of the measurement is 4 %, which is the sum of random counting error at the 99% confidence level, and the estimated upper limit of systematic error in this measurement.

Calibrated by: ART REUST Reviewed by: [signature]

Calibration Technician: [signature] Q.A. Representative: [signature]

Calibration Date: 4-25-2002 Reviewed Date: 4-29-02

Analytical Services
7021 Pan American Freeway NE
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Toll Free (866) RAD-LABS (723-5227)
www.eberlineservices.com

Isotope Products Laboratories
An Eckert & Ziegler Company

24937 Avenue Tibbitts
Valencia, California 91355

Tel 661•309•1010
Fax 661•257•8303

CERTIFICATE OF CALIBRATION
GAMMA STANDARD SOURCE

Radionuclide:	Eu-152	**Customer:**	CABRERA SERVICES, INC.			
Half-life:	4933 ± 11 days	**P.O. No.:**	01-414			
Catalog No.:	GF-152	**Reference Date:**	15-Oct-01	12:00	PST	
Source No.:	812-99-2	**Contained Radioactivity:**	0.9640	**μCi**	35.67	**kBq**

Physical description:

A. Capsule type:	D
B. Nature of active deposit:	Evaporated metallic salt
C. Active Diameter:	5 mm
D. Backing:	Epoxy
E. Cover:	Acrylic

Radioimpurities:

Gd-153 = 2.25%; Eu-154 = 1.30% on 15 Oct 01

Method of Calibration:

This source was prepared from a weighed aliquot of solution whose activity in μCi/g was determined using gamma ray spectrometry.

Peak energy used for integration:	344.3 keV
Branching ratio used:	0.266 gammas per decay

Uncertainty of Measurement:

A. Type A (random) uncertainty:	± 0.7 %
B. Type B (systematic) uncertainty:	± 3.0 %
C. Uncertainty in aliquot weighing:	± 0.6 %
D. Total uncertainty at the 99% confidence level:	± 3.1 %

Notes:

- See reverse side for leak test(s) performed on this source.
- IPL participates in a NIST measurement assurance program to establish and maintain implicit traceability for a number of nuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).
- Nuclear data was taken from IAEA-TECDOC-619, 1991.
- This source has a working life of 5 years.

[signature]
Quality Control

26-Sep-01
Date Signed

IPL Ref. No.: 812-99