U.S. ARMY FORT McCLELLAN
FORT McCLELLAN, ALABAMA
HQ, OSC PROJECT NUMBER USA 99-100

Select Commodity Site Areas

FINAL RADIOLOGICAL STATUS REPORT
Revision 0

Prepared by:

Allied Technology Group Inc.
669 Emory Valley Road
Oak Ridge, TN 37830

October 2000

TABLE OF CONTENTS

TABLE OF CONTENTS

FIGURES

TABLES

TABLE OF CONTENTS

APPENDICES

1.0 EXECUTIVE SUMMARY

This report presents the radiological data gathered by Allied Technology Group (ATG) at the U.S. Army Fort McClellan base in Anniston, AL, during the survey and remediation activities conducted from August 1, 2000, through August 18, 2000. Fort McClellan is under the Army Base Realignment And Closure (BRAC) Act as an installation for closure. ATG has been contracted by the U.S. Army Operations Support Command (OSC) under Modification No. P00004 of Contract No. DAAA09-98-C-0039 [assigned ATG Project No. 10036.03] to perform radiological release surveys of select commodity use areas. These areas have been identified through the mechanism of an Historical Records Search as having radiological issues (the storage and/or routine maintenance of Army radioactive commodities). This report is presented as the technical justification for the release of these areas for unrestricted use.

The subject commodity sites at Fort McClellan consist of nine (9) potentially impacted areas (i.e., six (6) buildings and three (3) site areas). The potentially impacted six (6) buildings are: (1) T-810, (2) T-811, (3) T-812, (4) T-837, (5) 3182, and (6) 3185. The three (3) potentially impacted site areas are: (1) the T-836 area; (2) the original Rattlesnake Gulch area; and (3) the Chemical School Radiological Burial Grounds. These areas were surveyed using the guidance in NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM), as described herein. A records investigation was also conducted to indicate the radiological status of what were determined to be three (3) non-impacted site areas, providing historical justification for release of these areas. These three (3) site areas are: (1) the Radiological Survey Area 1; (2) the Field Hot Cell area; and (3) Range 25.

2.0 HISTORICAL BACKGROUND

Fort McClellan lies adjacent to the city of Anniston, AL and within Calhoun County. During the Spanish American War (1898), units stationed at Camp Shipp in the Blue Mountain Area used the current site area for artillery training. Documented military use began in 1912 when the Alabama National Guard used part of the site as a Field Artillery Range. In 1915, President Woodrow Wilson ordered 1,160 acres in Alabama reserved for military purposes. In 1917, Congress authorized the establishment of Camp McClellan. In 1929, the camp became officially designated as Fort McClellan. Following World War II, the fort was put into an inactive status in June of 1947. The Fort was reactivated in January of 1950. The Department of the Army established the Army Chemical Training Center at Fort McClellan in 1951 and academic instruction began at the US Army Chemical Corps School in September 1952. The Radiological Safety Support Unit, established in 1953, was an organization element of the Army Chemical Training Center at Fort McClellan. The Rad Unit, as it was commonly known, conducted radiological test, research, and development, which aided in the development of training and tactical doctrine. In 1963 the name of the US Army Chemical School changed to the US Army Chemical Center and School.

Fort McClellan is comprised of three (3) areas: the Main Post; the Choccolocco Corridor; and the Pelham Range. The installation occupies 45,679 acres. The Main Post encompasses 19,000 acres and contains the majority of the facilities. The Army leased the Choccolocco Corridor, which occupies approximately 4,500 acres, from the state of Alabama. It connects the Main Post with the Talladega National Forest to the east. The Pelham Range consists of approximately 22,000 acres west of the Main Post.

Radiological training began at Fort McClellan in 1952. The original Radiological Laboratories were located in Post Area No. 8 and consisted of five (5) buildings: T-810, T-811, T-812, T-836, T-837, and a concrete vault for the storage of radioactive materials, primarily Radium (Ra) and Cobalt-60 (^{60}Co).

In 1952, field training in Radiological Surveys was initiated. The first course area was known as Rattlesnake Gulch and used 48 curies of ^{60}Co in sources of two to four Curies (2-4 Ci) each. Approval was also given to use ten (10) sources of ^{60}Co in the Chemical, Biological, Radiological (CBR) Familiarization Course at the Pelham Range.

In 1953, the Rattlesnake Gulch Survey Area was moved closer to the Summerall Gate road and renamed as Radiological Survey Area #1. A radioactive waste burial ground was established at the site of the new survey area and designated as the Chemical School Radioactive Burial Ground. In later years, both the Radiological Survey Area #1 and burial area were referred to as being part of the Rattlesnake Gulch Area. Radioactive waste from the first Rattlesnake Gulch Area was removed and buried in the new burial area. The Radiological Survey Area #1 was used to dispose of radioactive material at the site from 1953 to 1957. A Field Hot Cell was constructed near Radiological Site #1 and was operated until the completion of the Permanent Hot Cell. Some material in this area was moved to the Pelham Range in 1958. Health Physics Division personnel conducted a cleanup of this area in 1971. Remnants of the Field Hot Cell were discovered buried in the Rattlesnake Gulch Area. The results of this cleanup are detailed in the After Action Report (AAR) which refers to the site as Iron Mountain due to its proximity to this area.

In 1957, the US Atomic Energy Commission began issuing Byproduct Material Licenses to the US Army Chemical School at Fort McClellan for activities at the Pelham Range Area and on the Main Post. In 1958, a second Temporary Hot Cell was constructed in the Radiological Laboratory (Bldg. 3185). It was dismantled in 1958, and minutes of the Isotope Committee Meeting in 1958 state that the area was monitored and found to be free of contamination.

The Army Chemical School then established the Radiological Facilities, which included a Hot Cell Facility (Bldg. 3192), a Radiological Laboratory (Bldg. 3182), a Nuclear Accident Training Facility (Alpha Field behind Bldg. 3165), a Vault Radiological Laboratory (Bldg. 3180), a Radiological Training Facility (Bromine Field), a Personnel Decontamination Center (Bldg. 3185), and an Isotope and Scaler Laboratory (Bldg. 3181). The Hot Cell was connected to an underground drainage system leading to two underground storage tanks. A liquid waste disposal pit was also connected. Training at the Hot Cell included the use of ^{60}Co sources.

Training at the Radiological Laboratory Building (Bldg. 3182) included the use of radioactive sources. Radioactive sources were used at the alpha field. These sources were sealed and leak tested. The US Army Chemical Center and School staff stored radioactive material in the vault Radioactive Laboratory Building (Bldg. 3180). Bldg. 3180 was demolished in 1989. Additional radiological storage was done at the radiological storage vault T-8121/2 (Bldg. 8121/2). Training was conducted at the Bromine Field, which included decontamination of vehicles and equipment with the short-lived isotope, ^{82}Br. Bromine tanks, which were used to store the contaminated water containing ^{82}Br, have been removed from the site. The Personnel Decontamination Facility was located in Bldg. 3185. Radiation sources were routinely present and used in the Isotope and Scaler Laboratory, Bldg. 3181.

The US Army Chemical School closed the Radiological Facilities in 1972, and the radioactive sources were removed. The Chemical Corps School was deactivated in 1973.

The US Army Chemical School returned to Fort McClellan in 1979, and the Edwin R. Bradley Radiological Laboratory (Bldg. 2281) became the focus of radiation training where isotope sources were present. The US Army Chemical School also stored radioactive material in Bldg. 4416. The Radiological Calibration Facility was located in Bldg. 228. Sibert Hall (Bldg. 1081) was the last home to the Nuclear, Biological and Chemical (NBC) mission at Fort McClellan. This building was used until the US Army Chemical School closed and transferred to Fort Leonard Wood, MO, in 1999.

3.0 DESCRIPTION OF SPECIFIC AREAS SURVEYED

3.1 Bldg. 3182

Bldg. 3182 is an 11,696 ft^2 facility built in 1954 for use as an Applied Instruction Building, with one (1) wing having been used by the Fort McClellan Radiological Laboratories in conjunction with the Hot Cell facility. The later served as the Military Police Corps museum. The associated Hot Cell facility was decommissioned in 1995, along with the supporting area of Bldg. 3182. The primary contaminants of concern were ^{137}Cs, from the hot cell, as well as ^{3}H and ^{226}Ra associated with lensatic compasses and luminescent dials/gauges of military devices. The facility was surveyed in November of 1999 as a MARSSIM Class III area. Discrete areas of elevated surface activity were found , causing the conservative reclassification as a MARSSIM Class I area. ATG performed a Class I survey of the floor and lower two (2) meters of the interior walls, and a modified Class II survey of the upper walls and ceiling.

3.2 Bldg. T-810

Bldg. T-810 (originally 811) is an 88' x 26' single story frame structure used historically as a temporary laboratory. The primary contaminants of concern were ^{137}Cs, ^{226}Ra, ^{60}Co, and ^{90}Sr. The facility has a large classroom and men's lavatory with several shower stalls on the west end, with an isolated women's area on the east end. The facility interior was surveyed as a MARSSIM Class III area.

3.3 Bldg. T-811

Bldg. T-811 (originally 812) is an 88' x 26' single story frame structure used historically as a temporary laboratory. The primary contaminants of concern were ^{137}Cs, ^{226}Ra, ^{60}Co, and ^{90}Sr. The facility has two (2) large open classrooms on opposite ends, with a single small (~10' x 10') office in between. The facility interior was surveyed as a MARSSIM Class III area.

3.4 Bldg. T-812

Bldg. T-812 (originally 813) is an 88' x 26' single story frame structure used historically as a temporary laboratory. The primary contaminants of concern were ^{137}Cs, ^{226}Ra, ^{60}Co, and ^{90}Sr. The facility has two (2) large open classrooms on opposite ends, with a single small (~10' x 10') office in between. The facility interior was surveyed as a MARSSIM Class III area.

3.5 Bldg. T-836

Bldg. T-836 has been demolished and removed except for the concrete block support pedestals, the chimney, and an associated rubble pile. The historical structure was an 88' x 26' single story frame structure used as a temporary laboratory. The primary contaminants of concern were ^{137}Cs, ^{226}Ra, ^{60}Co, and ^{90}Sr. The footprint plus a 5' buffer on each dimension, for a total area of 98' x 36', was surveyed as a MARSSIM Class III outdoor area without the disturbance of the existing rubble pile.

3.6 Bldg. T-837

Bldg. T-837 (originally 836A) is an 88' x 26' two-story frame structure used historically as a temporary laboratory. The historical record indicated use of the facility to include isotope preparation. The primary contaminants of concern were ^{137}Cs, ^{226}Ra, ^{60}Co, and ^{90}Sr. The facility has several ~ 12' x 12' cubicles/rooms and lavatories on both elevations. The facility interior was surveyed as a MARSSIM Class II area.

3.7 Bldg. 3185

Bldg. 3185 is a 60' x 136' single story structure used historically as a personnel decontamination center for training purposes. Students used this building to change clothes and to practice decontamination procedures. The primary contaminants of concern were ^{137}Cs, ^{226}Ra, ^{60}Co, and ^{90}Sr. Although ^{82}Br may have also been of concern, its 35-hour half-life excluded the prospect of a residual presence. The facility has several ~ 12' x 12' cubicles/rooms and lavatories on both elevations. The facility interior was surveyed as a MARSSIM Class III area.

3.8 The Original Rattlesnake Gulch Area

The Original Rattlesnake Gulch Area is an outdoor area east of the Anniston (Lemlock) Community Center parking area and is mentioned in historical literature attributed to training drills of the Chemical Corp. The assumed area of concern is a wooded ravine located at a present bike trail on the north side, two (2) concrete markers near the east end at the southern turn in the bike trail, and the grassy bank at the tree line on the west (Community Center/parking area) side. The overall area of concern is 200' wide across the ravine by 400' long. The outdoor area was surveyed for gross gamma using the protocol as a MARSSIM Class III area. No samples were collected, but any areas of detected elevated activity were to be temporarily marked by the shallow placement of wire flags and noted on the survey record. No elevated readings were noted.

Additionally, as a result of an area of elevated readings found with a random μR-meter survey by the State and EPA on April 11, 2000, a single point in-situ gamma spectroscopy analysis was required to be performed at the grassy bank located between the parking area and the west end of the subject Original Rattlesnake Gulch Area, where near surface readings in the range of 32 μR/hr gross over a background of ~ 4 μR/hr were found over an area approximately 20' NW of the bike trail sign and 10' inside the grass line.

The In Situ gamma spectroscopy measurement was performed to serve as a rule-out of Fort McClellan contaminants of concern. If the elevated activity was determined to be due to Naturally Occurring Radioactive Material (NORM), then the Original Rattlesnake Gulch Area was to be surveyed for gross gamma, as a MARSSIM Class III area, as planned. If the gamma spectrometry exercise revealed positive identification of above normal background abundances of contaminants of concern (i.e., ^{60}Co and ^{137}Cs), the OSC was to be notified for evaluation of the area survey strategy. The embankment was surface surveyed for γ emitting activity, and the single-point in-situ gamma spectroscopy analysis was performed at the discrete location of highest surface activity. Samples were then taken of the highest point at four (4) different depths, as well as at two (2) nearby reference locations. The presence of only NORM-like radioactive materials was verified through the subject activities.

3.9 Radiological Survey Area #1

Radiological Survey Area #1 was an open land area developed by Fort McClellan as a replacement for the Rattlesnake Gulch. Reportedly, the site placed ^{233}U plates on the ground for survey training purposes. This area is classified as non-impacted based upon the documentation and discussion provided herein. No radiological survey of this area was performed.

3.10 The Field Hot Cell

The Field Hot Cell is part of the Radiological Survey Area #1. This was reportedly a temporary structure made out of cinder blocks and sand bags within the envelope of Radiological Survey Area #1. This area is classified as non-impacted based upon the documentation and discussion provided herein. No field survey of the Field Hot Cell was performed.

3.11 The Chemical School Radiological Burial Grounds

The Chemical School Radiological Burial Grounds is an outdoor wooded area reportedly used by the installation for radiological burials from 1957-1958. This site includes the northeast corner of the Anniston Community Center property. In the 1958-1959 timeframe, the buried radioactive materials were removed. The site conducted a second cleanup in 1971. The observed area covers an assumed area of concern of approximately 400' x 400' and spans both sides of the chain-link fence and the unimproved Perimeter Road, with the majority of the site within the city-side (NW) of the fence line. The area was surveyed for gross gamma as a MARSSIM Class II area, which was revised from the Statement of Work (SOW)-stated Class III, upon the recommendation of the regulators who were providing oversight. No samples were collected, but any areas of detected elevated activity were to be temporarily marked by the shallow placement of wire flags and noted on the survey record. No elevated readings were noted.

3.12 Range 25

Range 25 is an open area of land on the base which was reportedly used for a six-week period to test prototype source actuators. The specific location of concern is between the 300 and 400-yard line of the range. Only ^{60}Co sources were to have been used. This area is classified as non-impacted based upon the documentation and discussion provided herein. No field survey of Range 25 was performed.

4.0 SAMPLING ANALYSIS PLAN

4.1 General Approach

The guidance in NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), was used as the technical basis for planning, performing, interpreting and documenting the radiological survey of the commodity use areas at Fort McClellan. The MARSSIM process, developed collaboratively by the Nuclear Regulatory Commission, Environmental Protection Agency, Department of Energy, and Department of Defense, emphasizes the use of Data Quality Objectives (DQO) and Data Quality Assessment (DQA) processes, along with a sound Quality Assurance (QA)/Quality Control (QC) program.

The objective of MARSSIM is to describe a consistent approach for performance and assessment of building surface and surface soil final status surveys to meet established dose or risk-based release criteria, while at the same time encouraging an effective use of resources. The "graded approach" concept is also used to ensure the greatest survey efforts in those areas where there is the highest probability for residual contamination or the greatest potential for adverse effects from residual contamination.

Some of the site-specific information and methodologies that were used in design and development of the radiological survey plan are described herein.

4.2 Contaminants and Derived Concentration Guideline Levels

The radionuclides of historical concern include α-γ, β, and β-γ emitters. The primary radionuclides vary for each area and include the following: $^{137}Cs(^{137m}Ba)$; ^{226}Ra and progeny; ^{60}Co; $^{90}Sr(^{90}Y)$; and ^{3}H. These radionuclides existed both in: sealed or contained forms, primarily in storage areas, where there is little potential for contamination; and in loose form, for isotope preparation and/or disposal, for which the potential for residual contamination is increased.

As required in the SOW that was prepared by the OSC, a copy of which has been included in Attachment 2 of Appendix A, the "Sampling and Analysis Plan," the Derived Concentration Guideline (DCGL) values were established in accordance with the residual surface contamination limits specified in the Federal Register / Volume 62, Number 222/ Wednesday, November 18, 1998, pages 64132-64134. These values are listed in Table 4-1. In addition to the aforementioned DCGLs, all surfaces surveyed were also required meet the limits of Table 5-2 of Army Regulation (AR) 11-9, a copy of which has been included in Attachment 3 of Appendix A.

TABLE 4-1: $DCGL_w$ FOR FORT McCLELLAN COMMODITY USE AREAS

Release Criteria Based on 25 mrem/year

Nuclide	Release Criteria (dpm/100 cm^2)	Loose Surface Contamination Guidelines (dpm/100 cm^2)
^{3}H	NA	1.23E+07
^{60}Co	7.04E+03	7.04E+02
^{226}Ra	3.13E+02	3.13E+01
^{90}Sr	8.76E+03	8.76E+02
^{137}Cs	2.80E+04	2.80E+03

Each survey unit was considered to meet the unrestricted release criteria if:

- the residual contamination above background was below the $DCGL_W$; and
- the residual removable contamination was below $DCGL_{rem}$.

In areas other than Class I (i.e., Bldg. 3182), there was no provision to perform a test for Elevated Measurement Comparison (EMC). In Bldg. 3182 the MDC_{Scan} was less than the $DCGL_W$ for each of the isotopes of concern [refer to Appendix B for actual MDC_{Scan} information], thereby requiring no additional samples for the EMC. The parameters upon which these MDC_{Scan} values were based (e.g., background, detector and surface efficiency, etc.) were verified during the performance of the survey, and documented in Appendix B. If in an area, specific locations were identified that required such testing, that area, or a portion of that area, was required to be reclassified as Class I, and the OSC was to be notified immediately. No such areas were identified.

4.3 Area Classification

4.3.1 Impacted Areas

Specific MARSSIM survey classifications have been defined by OSC/Fort McClellan for all areas. Six (6) areas have been classified as Class III (i.e., based upon site operating history, these areas were not expected to contain any residual radioactivity, or were expected to contain levels of residual radioactivity at a very small fraction of the $DCGL_W$). Two (2) areas were classified as Class II (i.e., there is some potential for residual radioactivity, but is not expected to exceed the $DCGL_W$), and one (1) area was classified as Class I, based on the positive findings of discrete areas of elevated activity during the earlier screening survey as a Class III area. In each of the nine (9) areas, if discrepancies were identified during the survey that may warrant reclassification of the area, then the OSC was to be notified immediately. No such areas were identified.

4.3.2 Non-Impacted Areas

A records investigation was also conducted to indicate the radiological status of the Radiological Survey Area 1, the Field Hot Cell area, and Range 25, providing historical justification for classification of these areas as non-impacted as described below.

4.3.2.1 Radiological Survey Area #1 and Field Hot Cell

The areas referred to as Radiological Survey Area #1 and Field Hot Cell were included in the survey performed by the Center for Health Promotion and Preventive Medicine (CHPPM), Industrial Radiation Study 27-MH-0987-R2-97, a copy of which is provided in Appendix C. These surveys indicated no elevated activity levels in the subject areas.

4.3.2.2 Range 25

Range 25 was the site of an actuator test from February 19, 1963, to May 14, 1963. Five (5) actuators were tested and each actuator was placed on a concrete base. Each actuator utilized a fifteen Curie (15 Ci) encapsulated ^{60}Co source belonging to the Chemical School. There is no record of leakage from the sources, as described in a letter describing the test results, a copy of which is provided in Appendix D. This is the only time radioactive material was used at Range 25.

4.4 Survey Units

For the Class III areas, MARSSIM does not place a limit on the size of survey units. For class II areas, MARSSIM recommends a maximum survey unit size of 1,000 m^2 for building floor areas and 10,000 m^2 for land areas. For Class I areas, MARSSIM suggests limiting the survey unit for structures to 100 m^2 of floor area.

The indoor survey units included the floor and the lower two meters (2 m) of each wall in the area. Bldg. 3182 was divided into thirteen (13) of these survey units. Each other area represented one (1) survey unit each.

Except in Bldg. 3182, contamination was not suspected on surfaces above two meters (2 m), but some judgmental samples were collected on exposed flat horizontal surfaces located above two meters (2 m). In Bldg. 3182 the surface area above the lower two meters (2 m) of the walls constituted two (2) Class II survey units.

4.5 Background Reference Area

Background (reference) levels of gross α and gross β emitting surface activity for applicable surfaces (e.g., concrete, brick, wood, or vinyl) were determined in a building of similar construction where there is no record of use or storage of radioactive materials.

4.6 Survey Methodology

Field survey activities consisted of:

- surface γ scans;
- surface α and β scans;
- measurements of total α and total β emitting surface activity;
- measurements of removable α and β emitting surface activity; and
- measurements of removable ^{3}H activity in selected areas.

4.6.1 Instrumentation and Sampling Techniques

The instrumentation and sampling protocols are briefly described below. See Attachment 4, "Table of Instrumentation for Radiological Surveys," of Appendix A for instrument parameters and detection sensitivities for each type of instrument and its application.

4.6.1.1 Surface γ Scans

Structures: easily accessible areas of the floor surface in the survey unit as well as the lower two (2) meters of any walls, were scanned for γ emitting activity using a Bicron MicroRem Meter. This instrument was held as close to the surface being scanned as conditions allowed. Scanning was performed by moving the detector from side to side in a serpentine motion while progressing across the surface no faster than 0.5 m/s. The percentage of the area covered by the γ scan is listed in Table 4-2.

Outdoor Areas: Outdoor areas were scanned for γ emitting activity using a Bicron MicroRem Meter. This instrument was held at distance no greater than 36" from the ground. Scanning was performed by moving the detector from side to side in a serpentine motion while progressing across the surface no faster than 0.5 m/s. With an investigation level of four (4) μR/hour above a nominal background of eight (8) μR/hour, this survey method ensured adequate detection sensitivity to detect soil concentrations of: 5.2 ρCi/g of ^{60}Co; and 21.5 ρCi/g of ^{137}Cs. Refer to Attachment 5 of Appendix A for supporting calculations. The percentage of the area covered by the γ scan is listed in Table 4-2.

Table 4-2: Survey Requirements

Activities	Area Classification			
	Class I		Class II	Class III
	Survey Unit #5[1]	Other	Bldg. 3182	All
Surface gamma scans	100%	100%	50%	Judgmental
Total alpha and beta scans	100%	100%	50%	Judgmental
Direct measurements for total α and total β emitting activity	175	15	15	15
Measurements of removable α and β emitting surface activity	175	15	15	15
Measurements of removable ^{3}H activity (LSC)	175	15	15	NA

1 Survey unit containing previously identified affected areas.

4.6.1.2 Surface α and β Scans

Easily accessible areas of the floor were surveyed for α and β emitting activity with a large area floor monitor, consisting of a Ludlum Model 43-37 gas-flow proportional detector coupled to a Ludlum Model 2224 rate-meter/scaler, or its equivalent. The lower two (2) meters of any walls in the area, and floor surfaces that were not assessable with large area floor monitor were surveyed with a Ludlum 43-68 detector, coupled with a Ludlum Model 2224 rate-meter/scaler, or its equivalent. The responses of these detector/meters combinations was checked with a National Institute of Standards and Testing (NIST) referenced source, or equivalent, prior to use.

The percentage of the area covered by the α/β scan is listed in Table 4-2. These instruments were held as close to the surface being scanned as conditions allowed. Scanning progressed across the surface no faster than one (1) detector width per second.

4.6.1.3 Measurements of Total α and Total β Emitting Surface Activity

A sampling grid was established in each area, as described in Section 1.7.4. One (1) minute counts were taken with a Ludlum Model 43-68 100 cm^2 gas proportional detector coupled to a Ludlum Model 2224 rate-meter/scaler, or its equivalent, at each node of the survey grid in the area of interest. The response of this detector/meter combination was checked with a NIST referenced source, or equivalent, prior to use.

Replicate measurements were required as part of the DQOs described herein. Two (2) replicate α/β counts were taken in each area. One (1) was collected at a randomly selected sampling location on the floor, and the other from a randomly selected sampling location on a wall.

4.6.1.4 Measurements of Removable α and β Emitting Surface Activity

Refer to Section 1.7.3.3 for the number of samples taken per survey unit. Where removable α/β emitting activity was to be determined, or ruled-out, course swipe media was applied over a 100 cm^2 area. The swipe samples were maintained individually, and appropriately analyzed on-site on a calibrated low background automated proportional counter. QC analysis of 10% of the samples were provided by ATG Richland on a similar counter. The samples were batch shipped along with the chain-of-custody record to Richland. Calibration and QC records for the laboratory instrumentation are provided in Appendix E.

Replicate measurements were required as part of the DQOs described herein. Two (2) replicate α/β smear samples were collected in each area. One (1) smear sample was collected at a randomly selected sampling location on the floor and the other sample was collected from a randomly selected sampling location on a wall.

4.6.1.5 Measurements of Removable ^3H Activity in Selected Areas

Smear samples were collected and placed immediately in liquid scintillation vials and sealed for analysis for ^3H. These smear samples were collected beside the α/β smear samples collected at every direct measurement location in the Bldg. 3182 where ^3H was listed as a radionuclide of concern.

Comparative analysis (i.e., for QC purposes) were performed on 10% of the samples analyzed by ATG per LSC at a qualified third party laboratory (e.g., Barringer Laboratories, Inc.). Of the approximately 544 LSC samples analyzed by ATG Richland, 54 were forwarded for comparison counting at the qualified third party laboratory (i.e., Barringer Laboratories, Inc. of Golden, CO).

Replicate measurements were required as part of the DQOs described herein. Two (2) replicate ^3H smear samples were collected in each area. One (1) ^3H smear sample was collected at a randomly selected sampling location on the floor and the other sample was collected from a randomly selected sampling location on a wall.

ATG-Richland provided Liquid Scintillation Counting (LSC) vials for placement of associated swipe samples for screening of low energy β emitters, specifically ^{3}H. The samples were batch shipped along with the chain-of-custody record to Richland, for analysis by a liquid scintillation counter. Calibration and QC records for the laboratory instrumentation are presented in Appendix E.

4.6.1.6 Isotopic γ Analyses

Qualitative isotopic γ spectroscopy analyses were performed on the spot where elevated μR/hour readings were noted adjacent to the Community Center parking lot near the Rattle Snake Gulch area. This In Situ analysis was performed using an Oxford Instruments portable NaI detector and Multi-Channel Analyzer (MCA). This instrument was energy calibrated immediately prior to use, using ^{60}Co, with characteristic photo-peaks at 1173 and 1332 keV, and $^{137}Cs(^{137m}Ba)$, with a characteristic photo-peak at 661 keV.

For quantitative isotopic analyses, soil samples were taken in the subject location at four (4) depths (i.e., surface, 3", 6", and 8"). Samples were also taken at two (2) nearby reference locations exhibiting normal background radiation levels. These samples were returned to ATG's Oak Ridge facility for analysis using a Canberra HPGe detector and MCA. This instrument was energy and efficiency calibrated to the sample geometry (i.e., a 500 ml Marinelli beaker) using NIST traceable sources.

The resultant analysis records for both qualitative and quantitative analyses are presented in Appendix F.

4.6.2 Data Quality Indicators

As part of the DQO Process, the data quality indicators for Precision, Accuracy, Representativeness, Completeness, and Comparability (PARCC) were established.

- Precision was determined by comparison of replicate values from field measurements and sample analysis; the objective was a relative percent difference of 30% or less at 50% of the criterion value.
- Accuracy is the degree of agreement with the true or known; the objective for this parameter was +/- 20% at 50% of the criterion value.
- Representativeness and Comparability do not have numeric values. Performance for these indicators was assured through the selection and proper implementation of systematic sampling and measurement techniques.
- Completeness refers to the portion of the data that meets acceptance criteria and is therefore useable for statistical testing. The objective was 90% for this project.

4.6.3 Sampling Density

The number of direct measurements in each survey unit was dependent on several parameters, including the desired confidence of the decision criteria (i.e., decision uncertainty), the presence and variation of background interference, some of which are briefly discussed below.

4.6.3.1 Decision Errors

Among the most important parameters affecting survey design and the number of measurements needed to satisfy the DQOs are the acceptable decision errors. The OSC has established the Type I (α) decision error at 0.05; this provides a confidence level of 95% that the statistical tests would not incorrectly determine that a surveyed area satisfies release criteria when, in fact, it does not. Similarly, the OSC has established the Type II (β) decision error at 0.05; this provides a confidence level of 95% that the statistical tests would not incorrectly determine that a surveyed area does not satisfy release criteria when, in fact, it does. The Type II decision error is more restrictive than is usually recommended for such surveys. This more restrictive value typically has a potential consequence of indicating unnecessary remediation; however, considering the public relations consequences of failing to identify residual contamination, the more restrictive level is considered prudent.

4.6.3.2 Variability (σ)

The survey units in the commodity use areas are mostly Class III areas with a few Class II areas. It was anticipated that the measurement variability in these areas would be similar to that in the background reference areas. Except for Survey Unit Number 5 of Bldg. 3182, it was anticipated that the standard deviation of measurements (σ) would be equal to or less than 75% of average surface activity levels.

The standard deviation of measurements (σ) for Bldg. 3182 Survey Unit Number 5 (i.e., the survey unit containing Rooms 14 and 6) was conservatively bounded at 3.17 $(10)^4$ dpm of ^{137}Cs activity. This was based on the maximum activity noted in the immediate area during the previous survey activities as described in "Commodity Site Survey Final Report," ATG, January 2000. As direct measurements were actually performed, the measurement variability was verified to be within these bounds.

4.6.3.3 Number of Samples Indicated

A Type I error rate (α) of 0.05 and a Type II error rate (β) of 0.05 were assumed. The Lower Bound of the Gray Region (LBGR) was set at half the $DCGL_w$. This resulted in a conservatively bounded Relative Shift (Δ/σ) of:

- 0.4 for Survey Unit Number 5 of Bldg. 3182, Room 14; and
- 1.7 for all other survey units.

The resultant number of data points were found for each using MARSSIM Table 5.3:

- 175 for Survey Unit Number 5 of Bldg. 3182; and
- 15 for all other survey units.

These numbers of data points (N) were applied to direct measurements, as well as smears for determining the amount of removable activity.

4.6.4 Selection of Sampling Locations in Survey Units

MARSSIM recommends a triangular sampling pattern with a random starting point to increase the probability of identifying small areas of elevated activity. Figure 4-1 illustrates a triangular sampling pattern. This type pattern was used for the Commodity Use Areas. The spacing (L) between samples on a triangular pattern was determined by:

$$L = [\text{Survey Unit Area}/(0.866)\ (\text{number of samples})]^{1/2}$$

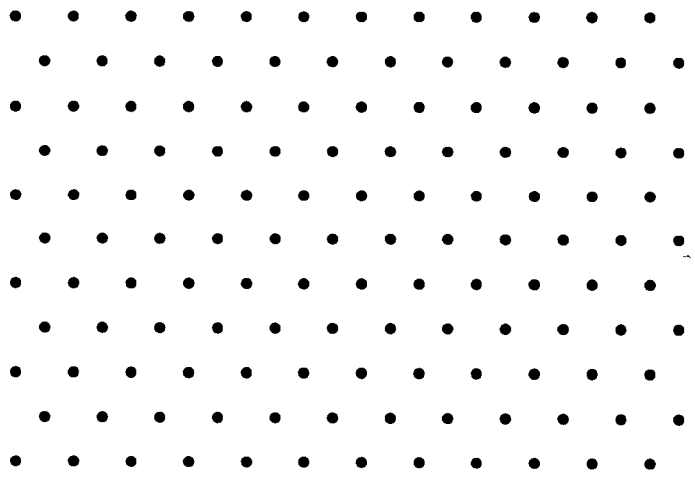

Figure 4-1: Triangular Sampling Pattern

The survey unit breakdown (i.e., room by room) for Bldg. 3182, with the resultant "L" values, is presented in Attachment 1 of Appendix A. All other buildings consisted of a single survey unit with "L" values corresponding to the methodology presented herein.

4.6.5 Reference Background Measurements

No reference background measurements were credited during the performance of the data analysis for the surveys described herein (i.e., gross equals net, with no credit for background).

5.0 FINAL SURVEY AREA RESULTS

5.1 Bldg. 3182

As a Class I impacted indoor area, the lower portion of Bldg. 3182 (i.e., the floor and lower two meters of each wall) was subdivided into thirteen (13) survey units. Each survey unit received a 100 % surface scan, and was sampled on a grid pattern (i.e., established as described in Section 4.6.4) for total and removable α/β emitting and ^{3}H activity. As described in Section 4.6.3.3, each survey unit was sampled at fifteen (15) points, except for Survey Unit 5, for which there were 175 sample points.

The contaminants of concern were ^{137}Cs, ^{3}H, and ^{226}Ra. The maximum activity for each emission type in each survey unit is presented in Table 5-1. The analysis records for the smears taken to measure removable α/β emitting activity are presented in Appendix G. The analysis records for the smears taken to measure removable ^{3}H activity are presented in Appendix H. The actual survey records for the Bldg. 3182, indicating the exact location of grid points, are presented in Appendix I.

Survey Unit 5 also required minor decontamination (decon) efforts. Therefore, both pre-decon and post-decon surveys were performed. The post-decon survey indicated that all residual contamination levels that remained within the structure were less than both the DCGLs and AR 11-9 limits. Since no "as left" contamination measurement exceeded the $DCGL_W$, then further statistical analyses of the results are not required.

5.2 Bldg. T-810

As a Class III impacted indoor area, the lower portion of Bldg. T-810 was considered a single survey unit, which received a 10 % surface scan, and was sampled at fifteen (15) points on a grid pattern for total and removable α/β emitting and ^{3}H activity.

The contaminants of concern were ^{137}Cs, ^{226}Ra, ^{60}Co, and ^{90}Sr. The maximum activity for each emission type in the survey unit is presented in Table 5-2. The actual survey records for Bldg. T-810, indicating the exact location of grid points, are presented in Appendix J. The analysis records for the smears taken to measure removable α/β emitting activity are presented in Appendix G. The analysis records for the smears taken to measure removable ^{3}H activity are presented in Appendix H.

The survey indicated that all residual contamination levels that remained within the structure were less than both the DCGLs and AR 11-9 limits. Since no contamination measurement exceeded the $DCGL_W$ or $DCGL_{Rem}$, as applicable, then further statistical analyses of the results are not required to demonstrate compliance for unconditional release.

Table 5-1: Bldg. 3182 Maximum Activity Results (dpm/100 cm^2)

Survey Unit	α Emitting Activity		β Emitting Activity		^3H Activity
	Total	Removable[1]	Total	Removable[2]	Removable
1	19	<MDA	1,290	<MDA	105
2	23	<MDA	1,196	<MDA	121
3	5	<MDA	1,510	<MDA	62
4	19	<MDA	1,745	<MDA	113
5 (pre-decon)	28	NA	44,861	NA	NA
5 (post-decon)	28	<MDA	3,416	<MDA	667
6	5	<MDA	1,471	<MDA	80
7	28	<MDA	1,584	<MDA	97
8	14	<MDA	1,651	<MDA	128
9	Survey unit numerical designator # 9 was reserved but not used				
10	5	<MDA	945	<MDA	173
11	9	<MDA	1,494	<MDA	64
12	14	<MDA	1,333	<MDA	419
13	9	<MDA	1,247	<MDA	721
14	19	<MDA	1,451	<MDA	339

1 Maximum removable α emitting Minimum Detectable Activity (MDA) of 33.71 dpm

2 Maximum non-^3H removable β emitting MDA of 47.45 dpm

Table 5-2: Activity Results of Buildings other than Bldg. 3182 (dpm/100 cm^2)

Survey Unit	α Emitting Activity		β Emitting Activity		^{3}H Activity
	Total	Removable[1]	Total	Removable[2]	Removable
Bldg. T-810	19	<MDA	1,000	<MDA	48
Bldg. T-811	9	<MDA	753	<MDA	57
Bldg. T-812	19	<MDA	486	<MDA	158
Bldg. T-836	69	NA	1,153	NA	NA
Bldg. T-837	14	<MDA	820	<MDA	62
Bldg. 3185	37	<MDA	2,463	<MDA	101

1 Maximum removable α emitting Minimum Detectable Activity (MDA) of 33.71 dpm

2 Maximum non-^{3}H removable β emitting MDA of 47.45 dpm

5.3 Bldg. T-811

As a Class III impacted indoor area, the lower portion of Bldg. T-811 was considered a single survey unit, which received a 10 % surface scan, and was sampled at fifteen (15) points on a grid pattern for total and removable α/β emitting and ^{3}H activity.

The contaminants of concern were ^{137}Cs, ^{226}Ra, ^{60}Co, and ^{90}Sr. The maximum activity for each emission type in the survey unit is presented in Table 5-2. The actual survey records for Bldg. T-811, indicating the exact location of grid points, are presented in Appendix K. The analysis records for the smears taken to measure removable α/β emitting activity are presented in Appendix G. The analysis records for the smears taken to measure removable ^{3}H activity are presented in Appendix H.

The survey indicated that all residual contamination levels that remained within the structure were less than both the DCGLs and AR 11-9 limits. Since no contamination measurement exceeded the $DCGL_W$ or $DCGL_{Rem}$, as applicable, then further statistical analyses of the results are not required to demonstrate compliance for unconditional release.

5.4 Bldg. T-812

As a Class III impacted indoor area, the lower portion of Bldg. T-812 was considered a single survey unit, which received a 10 % surface scan, and was sampled at fifteen (15) points on a grid pattern for total and removable α/β emitting and ^{3}H activity.

The contaminants of concern were ^{137}Cs, ^{226}Ra, ^{60}Co, and ^{90}Sr. The maximum activity for each emission type in the survey unit is presented in Table 5-2. The actual survey records for Bldg. T-812, indicating the exact location of grid points, are presented in Appendix L. The analysis records for the smears taken to measure removable α/β emitting activity are presented in Appendix G. The analysis records for the smears taken to measure removable ^{3}H activity are presented in Appendix H.

The survey indicated that all residual contamination levels that remained within the structure were less than both the DCGLs and AR 11-9 limits. Since no contamination measurement exceeded the $DCGL_W$ or $DCGL_{Rem}$, as applicable, then further statistical analyses of the results are not required to demonstrate compliance for unconditional release.

5.5 Bldg. T-836

As a Class III impacted outdoor area, the footprint of Bldg. T-836 plus a five foot (5') buffer area was considered a single survey unit. The subject survey unit received a 10 % surface scan and was surveyed at fifteen (15) points on a grid pattern for total surface activity.

The contaminants of concern were ^{137}Cs, ^{226}Ra, ^{60}Co, and ^{90}Sr. The maximum activity for each emission type in the survey unit is presented in Table 5-2. The actual survey record for Bldg. T-836, indicating the exact location of grid points, is presented in Appendix M.

The survey indicated that all residual contamination levels that remained within the structure were less than both the DCGLs and AR 11-9 limits. Since no contamination measurement exceeded the $DCGL_W$ or $DCGL_{Rem}$, as applicable, then further statistical analyses of the results are not required to demonstrate compliance for unconditional release.

5.6 Bldg. T-837

As a Class II impacted indoor area, the lower portion of Bldg. T-837 was considered a single survey unit, which received a 50 % surface scan, and was sampled at fifteen (15) points on a grid pattern for total and removable α/β emitting and ^{3}H activity.

The contaminants of concern were ^{137}Cs, ^{226}Ra, ^{60}Co, and ^{90}Sr. The maximum activity for each emission type in the survey unit is presented in Table 5-2. The actual survey records for Bldg. T-837, indicating the exact location of grid points, are presented in Appendix N. The analysis records for the smears taken to measure removable α/β emitting activity are presented in Appendix G. The analysis records for the smears taken to measure removable ^{3}H activity are presented in Appendix H.

The survey indicated that all residual contamination levels that remained within the structure were less than both the DCGLs and AR 11-9 limits. Since no contamination measurement exceeded the $DCGL_W$ or $DCGL_{Rem}$, as applicable, then further statistical analyses of the results are not required to demonstrate compliance for unconditional release.

5.7 Bldg. 3185

As a Class III impacted indoor area, the lower portion of Bldg. 3185 was considered a single survey unit, which received a 10 % surface scan, and was sampled at fifteen (15) points on a grid pattern for total and removable α/β emitting and ^{3}H activity.

The contaminants of concern were ^{137}Cs, ^{226}Ra, ^{60}Co, and ^{90}Sr. The maximum activity for each emission type in the survey unit is presented in Table 5-2. The actual survey records for Bldg. 3185, indicating the exact location of grid points, are presented in Appendix O. The analysis records for the smears taken to measure removable α/β emitting activity are presented in Appendix G. The analysis records for the smears taken to measure removable ^{3}H activity are presented in Appendix H.

The survey indicated that all residual contamination levels that remained within the structure were less than both the DCGLs and AR 11-9 limits. Since no contamination measurement exceeded the $DCGL_W$ or $DCGL_{Rem}$, as applicable, then further statistical analyses of the results are not required to demonstrate compliance for unconditional release.

5.8 The Original Rattlesnake Gulch Area

As a Class III impacted outdoor area, the Original Rattlesnake Gulch Area was considered a single survey unit, which received a 10 % surface γ scan as described in Section 4.6.1.1. No points of elevated radiation were found except for the single point on the grassy bank between the Rattlesnake Gulch Area and the Community Center parking area, as described in Section 3.8. The actual survey record for the Rattlesnake Gulch Area is presented in Appendix P.

The subject single location was analyzed using an In Situ NaI portable γ spectroscopy system. The resultant spectrum, a copy of which is included in Appendix , indicating the only presence of NORM and NORM progeny isotopes, ruled out the presence of the isotopes of concern (i.e., ^{137}Cs and ^{60}Co), which clearly indicates that the characteristic photo-peaks of the subject isotopes are not present.

Intrusive sampling was performed at the subject spot at four (4) distinct depths (i.e., surface, 3", 6", and 8"), as well as at two (2) nearby reference locations exhibiting normal background radiation levels. The sample analysis results are summarized in Table 5-3, with the analysis records presented in Appendix F.

5.9 Radiological Survey Area #1

Radiological Survey Area #1 was characterized as non-impacted as described in Section 4.3.2. This area is recommended for final release without additional action.

5.10 The Field Hot Cell

The Field Hot Cell was characterized as non-impacted as described in Section 4.3.2. This area is recommended for final release without additional action.

Table 5-3: Activity Results of Elevated NORM Location and Reference Areas (ρCi/g)

Survey Unit	^{226}Ra Activity			^{228}Ra Activity		
	^{226}Ra	^{214}Bi	^{214}Pb	^{228}Ac	^{212}Bi	^{212}Pb
Surface	7.8	2.9	3.7	9.4	12	12
3"	9.2	3.2	3.9	8.6	9.1	11
6"	8.9	3.2	7.6	8.3	12	9.7
8"	9.9	3.1	4.0	9.7	12	12
Reference 1	4.0	1.2	2.7	2.4	<LLD[1]	3.0
Reference 2	<LLD[2]	0.77	2.3	2.6	2.2	2.0

[1] Lower Limit of Detection (LLD) of 3.0 ρCi/g

[2] LLD of 3.1 ρCi/g

5.11 The Chemical School Radiological Burial Grounds

As a Class II impacted outdoor area, the Chemical School Radiological Burial Grounds were considered a single survey unit, which received a 50 % surface γ scan as described in Section 4.6.1.1. No points of elevated radiation were found. The actual survey record for the Chemical School Radiological Burial Grounds is presented in Appendix Q.

5.12 Range 25

Range 25 was characterized as non-impacted as described in Section 4.3.2. This area is recommended for final release without additional action.

6.0 FINAL RECOMMENDATIONS

The final recommendations are that all of the subject commodity site areas be approved for final release, based upon the data provided in this report. This recommendation does not include the area of elevated NORM concentration that was noted adjacent to the Community Center parking lot near the Rattle Snake Gulch area. No recommendation for action is made regarding this specific area.