Decomm.

DEPARTMENT OF THE ARMY
UNITED STATES ARMY TACOM LIFE CYCLE MANAGEMENT COMMAND
6501 EAST 11 MILE ROAD
WARREN, MICHIGAN 48397-5000

30 March 2012

Mr. Michael Lafranzo
U.S. Nuclear Regulatory Commission Region III
2442 Warrenville Rd. Suite 210
Lisle, IL 60532-4352

Dear Mr. Lafranzo,

The US Army TACOM LCMC (licensee) requests to have Fort Monroe, VA removed from NRC BML license no. 21-32838-01. This notification is in accordance with 10 CFR Part 30.36(d) for decommissioning for a site specific location. The licensee considers the Fort Monroe site (bldg. 261 storage) to fall under Decommissioning Group I. The licensee will reutilize the storage site for unrestrictive use. The attached Radiological Historical Site Assessment and Survey of Fort Monroe, VA Report (February 2012) will show the subject storage area can be released for unrestricted use. Due to mission requirements at Fort Monroe, the licensee requests expeditious response for this decommissioning request. The Army cannot release building 261 for unrestrictive use without NRC approval.

The POC for further information is Mr. Thomas Gizicki, TACOM LCMC Senior Health Physicist/NRC license Radiation Safety Officer, commercial 586-282-0891, email; thomas.g.gizicki.civ@mail.mil or the undersigned at 586-282-6194.

Patrick J. Kelley
PATRICK J. KELLEY
TACOM LCMC Safety Director

RECEIVED APR 19 2012

Encl
cf: HQ US Army Material Command, AMCPE-SG, LTC Schley, Bldg. 4400, Redstone Arsenal, 35898

RADIOLOGICAL HISTORICAL SITE ASSESSMENT AND SURVEYS OF FORT MONROE, VIRGINIA

Final

Prepared for:

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1. INTRODUCTION

Fort Monroe, located in Hampton, Virginia, is undergoing closure pursuant to action by the 2005 Base Realignment and Closure (BRAC) Committee. BRAC closure of the installation and transfer from U.S. Department of Defense (DOD) control necessitates that a comprehensive review be performed to identify and evaluate potential environmental impacts. This report investigates the historical storage and use of radioactive materials on Fort Monroe consistent with Section 3.1 of the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (DOD 2000). MARSSIM notes that radiological site evaluations start with the Historical Site Assessment (HSA), which is "an investigation to collect existing information describing the site's complete history from the start of site activities to the present time." The HSA:

- Identifies potential, likely, or known sources of radioactive material and radioactive contamination based on existing or derived information
- Identifies sites that need further action as opposed to those posing no threat to human health
- Provides an assessment for the likelihood of contaminant migration
- Provides information useful to scoping and characterization surveys
- Provides initial classification of the site or survey unit (SU) as impacted or nonimpacted.

There are three possible recommendations that result from an HSA:

- An action is needed to reduce the risk to human health and the environment
- A decision that the site or area is impacted and that further investigation is needed before a final decision can be made regarding need for action/final disposition
- The site or area is nonimpacted (i.e., there is no or an extremely low probability of residual radioactive material being present at the site, such that the site or area can be released without further action).

1.1 BACKGROUND

Fort Monroe is a military installation located in Hampton Roads, Virginia on Old Point Comfort where the Hampton Roads Harbor meets the Chesapeake Bay. It dates to the early 1600s and was initially called Algernourne Fort. The area known as Old Point Comfort has served as the location for at least four fortifications. Fort Monroe initially served as an element of coastal defenses following the War of 1812. It was constructed between 1819 and 1834, received its first official U.S. Army garrison on July 25, 1823, and has been an active installation since that time. Fort Monroe was instrumental during the Civil War as it was the only Federal military installation in the Upper South to remain under United States control throughout the Civil War. After the Civil War, 12 separate concrete artillery batteries were constructed at Fort Monroe between 1891 and 1899 pursuant to the introduction of new wartime munitions. Since that time, the installation has continually undergone change and growth to meet its diverse missions. These missions have recently included serving as home base for a number of commands and activities, including Headquarters, U.S. Army Training and Doctrine Command; Installation Management Command's Northeast Region; and the Navy's Naval Surface Warfare Center Detachment Norfolk. The missions of each of the former military organizations have been relocated pursuant to closure of the installation.

1.2 PURPOSE AND SCOPE

The scope of work for this effort consists of the collection and evaluation of information pertaining to radioactive material storage and use at Fort Monroe, Virginia. Fort Monroe is located at the southeastern tip of the Virginia Lower Peninsula between Hampton Roads harbor to the southwest, the Chesapeake Bay to the east, and Mill Creek to the west. The Fort Monroe property covers approximately 568 acres plus accreted lands (approximately 77 acres). Although the Big Bethel Water Treatment Plan and Reservoir were previously part of Fort Monroe, these facilities were transferred to Air Force control in 2006 and are beyond the geographic scope of this HSA. The scope specifically includes evaluation of potential, likely, or known sources of radioactive material and radioactive contamination at Fort Monroe; determination as to whether portions of the facility needed further action; providing information useful to site characterization; and providing an initial classification of the site or individual SUs as impacted or nonimpacted. Areas identified as impacted were to be subjected to radiological surveys of sufficient quantity and quality to be carried forward as MARSSIM final status surveys. Preliminary screening-level derived concentration guideline levels (DCGLs) for impacted areas of structures or surface soils consisted of U.S. Nuclear Regulatory Commission (NRC) screening levels prescribed in Nuclear Regulation (NUREG) 1757, Volume 2, Revision 1 (NRC 2006) and "screening levels for clearance" cited in Table 5-2, Department of the Army Pamphlet 385-24. The most restrictive DCGLs for alpha- and beta-emitting radionuclides are used for activity of unknown origin pending fractionation of isotopic activity and the application of isotope-specific values. Further, given that screening level criteria do not exist for volumetric contamination, the upper bounds of the two standard deviations range for reference area background is used as initial screening criteria pending development of site-specific volumetric DCGLs if required.

2. RADIOLOGICAL HISTORICAL SITE ASSESSMENT

The radiological HSA of Fort Monroe consisted of a review of available records and consultation with personnel who had knowledge of the prior use of radioactive materials and devices on Fort Monroe. The following sections provide information relative to the HSA.

2.1 RECORDS REVIEW

Records reviewed included but were not limited to:

- ***Headquarters, U.S. Army Material Command "Guidance" Document***—This document dated February 2004 Subject: Radiological Surveys of Areas Where NRC-Licensed Commodities or Radium Containing Commodities Were Present, provides recommendations on the radiological clearance of Army property.
- ***U.S. Army Environmental Records***—U.S. Army BRAC 2005, Environmental Condition of Property Report, Fort Monroe – Hampton, Virginia, November 2006. Section 5.1.7 (NRC Licenses) of the Final ECP Report (U.S. Army 2006) notes that "Fort Monroe holds no NRC license (USAEC & Fort Monroe 2005)." In addition, Section 5.8 entitled "Radioactive Material" states that "Available evidence suggests that radioactive materials were never used, stored, or disposed of on Fort Monroe with the exception of low-level, sealed source radiological materials used in the medical and dental clinics for X-ray purposes (USACE 2003)." The "(Environmental Condition of Property) ECP Personnel Interview Questionnaire" prepared by Mr. Chuck Ketchem, the installation Industrial Hygienist, dated August 24, 2006 also notes that no radioactive materials were on the installation at that time, had been there previously, or had been stored on the property or on any adjoining property (Ketchem 2006). In addition, as indicated in Sections 4.3.4 and 5.2.2 of the ECP (U.S. Army 2006), it is noteworthy that range operations at Fort Monroe generally preceded the use of radioluminous tritium night sights, minimizing the potential for such items to serve as a contaminant.
- ***U.S. Nuclear Regulatory Commission Records***—The NRC Agency-wide Documents Access and Management System (ADAMS) database system is the official recordkeeping system through which NRC provides access to publicly available documents. A search of ADAMS for information relative to the possession or use of licensed materials indicated that the only record of the use of radioactive material was contained in Amendment 3 to NRC Materials License 19-30563-01, which permitted the use of Fort Monroe as a storage location for sources consisting of americium-241 (Am-241) contained in M43A1 Chemical Agent Detectors, nickel-63 (Ni-63) sources contained in Model GID-3 Chemical Agent Alarms, and Ni-63 contained in chemical agent monitors (CAMs) and in improved CAMs.

  U.S. Army Soldier and Biological Chemical Command (SBCCOM) NRC License 19-30563-01 was terminated in December 2003 and transferred to Tank-Automotive and Armaments Command (TACOM) Life Cycle Management Command (LCMC), Rock Island License 12-00722-06 in January 2004. Due to changes mandated by BRAC 2005, NRC issued a new NRC license (21-32838-01) to the U.S Army TACOM LCMC, Warren, Michigan in November 2011 and terminated TACOM LCMC, Rock Island License 12-00722-06.

  With respect to the potential for residual radioactivity, license requirements mandated leak testing and the retention of leak test results for a minimum period of 3 years and prohibited maintenance operations that included or involved any repair or contact with Ni-63 or Am-241 plated sources. Given leak testing that confirmed the absence of leakage, the potential for residual radioactivity is judged to be sufficiently low as to negate designation of the storage area as "impacted" as defined in the MARSSIM.

- ***U.S. Army Public Health Command and Predecessor Organizations***—Extensive radiological survey reports and related documents published by the U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM), Aberdeen Providing Ground, Maryland (now the U.S. Army Public Health Command) and the U.S. Army Environmental Hygiene Agency (USAEHA), Aberdeen Providing Ground, Maryland, the CHPPM predecessor organization. These documents, which dated to the mid-1950s, indicated that the use of radioactive materials and radiation producing devices at Fort Monroe was limited to diagnostic medical X-ray machines contained in the Health, Dental, and Veterinary Clinics and "use of radioactive material for in-vitro testing which was authorized by NRC Form 483, Registration Certificate, In-Vitro Testing with Byproduct Material Under General License, Registration No. 4486, issued 18 May 1978 with no expiration date." Subsequent investigation revealed that these radioactive materials were associated with the BACTEC™ System and that operations actually took place at McDonald Army Hospital, Fort Eustis, VA, rather than at Fort Monroe and are, therefore, beyond the scope of this HSA.

Other documents include:

- U.S. Army Communications-electronics Command Directorate for Safety tracking data bases used for accountability of serialized commodities. Search of this data base did not indicate that serialized commodities were used or stored at Fort Monroe.
- Fort Monroe Human Health Risk Assessment Technical Memorandum, November 2010, which was prepared by Science Applications International Corporation (SAIC) under contract to the U.S. Army Corps of Engineers (USACE) Louisville District to evaluate residual site risks. No indication was contained in this document relative to radiological risk.
- In 2009, NRC issued a Demand for Information relative to possession and control of self-luminous tritium exit signs. The Army response to this letter supports the conclusion that tritium exit signs were not present on Fort Monroe (ASO 2009).

2.2 PERSONNEL CONSULTED/INTERVIEWED

Personnel consulted/ interviewed relative to the possession and use of radioactive materials on Fort Monroe, Virginia, included:

- Mr. Wayne Deason, Health Physicist and Radiation Safety Officer (RSO), U.S. Army Aviation and Missile Life Cycle Management Command (AM-LCMC), Huntsville, Alabama from 2010 to present indicated that available aviation and missile command records did not reflect the presence of licensed materials at Fort Monroe nor was Fort Monroe among the list of installations at which NRC-licensed aircraft engine maintenance was performed on military rotary wing aircraft (Deason 2011). (This information is reinforced by personal knowledge on the part of Dennis Chambers, SAIC Senior Health Physicist, who had served as Health Physicist/RSO for AM-LCMC predecessor commands from 1982 until 1998.) Mr. Keith Rose, AMCOM Health Physicist/RSO between Messrs. Chambers and Deason, also was consulted and concurred that no known storage, use, or maintenance of AMCOM radioactive commodities was known to have occurred at Fort Monroe, Virginia.
- Mr. Thomas G. Gizicki, Senior Health Physicist/NRC License RSO, TACOM LCMC, Warren, Michigan, previously from TACOM LCMC, Rock Island, Illinois. Mr. Gizicki confirmed (Gizicki 2011) that automatic chemical agent detector alarms (NSN 6665-01-438-3673) and improved CAMs (6665-01-357-8502) were stored at Fort Monroe pursuant to a Memorandum of Agreement (MOA) between Joint Task Force Civil Support and TACOM LCMC, Warren, Michigan from 2007 until January 2011 when the MOA was officially terminated. This MOA notes that "These detectors and monitors contain the radioactive isotopes of americium-241

(Am-241) and nickel-63 (Ni-63) that require the establishment of a radiation protection program for their use and control." Mr. Gizicki also indicated that no maintenance was believed to have been performed on these systems at Fort Monroe. Primary and Alternate Radiation Safety Officers for these items were listed as being Damage Controlman First Class (SW) Nathan A. Bjorn and Damage Controlman First Class (SW) Tony R. Ellis, respectively. Attempts to contact these individuals were not successful, although one Navy service member was specifically noted as being at sea.

- Mr. Craig Goldberg, Chief, Radiation Analysis and Compliance Division, U.S. Army Communications-Electronics Command, Aberdeen Proving Ground, Maryland (formerly located at Fort Monmouth, New Jersey) confirmed that the "CECOM Directorate for Safety searched data bases used for accountability of serialized commodities, ran searches of their electronic document storage system, and interviewed the most senior HP regarding the possible use of CECOM commodities at Fort Monroe" and could find nothing to substantiate that radioactive material under their licenses had been in use at Fort Monroe (Goldberg 2011).
- Mr. Earl J. (Joe) Hart, Health Physicist and Project Manager for Radiological Projects for the U.S. Army Joint Munitions Command, Rock Island, Illinois, initiated searches of the DOD Executive Agency for Radioactive Waste's Waste Information System. This system, which dates back to the mid-1960s, has no record of the disposal of any radioactive waste from Fort Monroe, Virginia. Mr. Hart also provided information suggesting that the Navy may have performed operations involving radioactive materials on Fort Monroe in the recent past (Hart 2011). Additional investigations subsequently confirmed radiological operations in the August to September 2010 timeframe. (See comments below from Kush et al. 2011.)
- Messrs. Gregory R. Komp, Certified Health Physicist (CHP), U.S. Army Radiation Safety Officer, Headquarters, Department of the Army, and Timothy Mikulski, CHP, Senior Health Physicist, Headquarters, Department of the Army, provided guidance with respect to the desired content and level of detail in the radiological HSA for Fort Monroe.
- Mr. John Manfre, Safety Director, U. S. Army Materiel Command (AMC) Redstone Arsenal, Alabama, and formerly AMC Health Physicist and Radiation Safety Officer, Alexandria, Virginia, from the mid-1980s until the late 1990s (Manfre 2011). Mr. Manfre advised that the only radioactive materials of which he had personal knowledge at Fort Monroe consisted of those table of distribution and allowances (TDA) items (e.g., compasses and watches containing tritium) that would generally be encountered at each Army facility.
- Mr. Robert S. Reali, PE, Certified Hazardous Materials Manager (CHMM), Fort Monroe Caretaker Team, BRAC Environmental Coordinator, Fort Monroe, Virginia. Mr. Reali provided electronic access to documents for review, including information indicating that no radioactive materials had been known to the Directorate of Public Works (DPW) as having been used at Fort Monroe. Materials considered in this evaluation of potential contaminants included Black Beauty sand blasting media; military vehicles subject to the presence of dials and gauges with radium-sulfate radioluminescent paint; museum exhibits containing radioluminous dials and gauges; serialized commodities; and radioluminous exit signs containing tritium. It was noted that the Army Safety Office had investigated the control of tritium exit signs pursuant to a January 16, 2009 NRC Demand for Information and associated March 11, 2009 response (ASO 2009). With respect to Fort Monroe, this investigation concluded that tritium exit signs were not present on the installation. Mr. Reali also noted that the absence of radium paint on museum exhibits had been confirmed by long-time employees and by the museum curator. Mr. Reali also noted that the Army RSO requested an inventory of smoke detectors in response to which he estimated that there were approximately 820 smoke detectors contained in family housing units on Fort Monroe (Reali 2011b and 2011c).

- Messrs. Thomas A. Kush (Waterfront Operations, Naval Surface Warfare Center, Carderock Division, Detachment Norfolk, Virginia), Patrick J. Winters (Radiation Technology Group, C/6301, Naval Surface Warfare Center, Carderock Division, West Bethesda, Maryland), and Charles J. (Joe) Olenik (Radiation Safety Officer, Naval Surface Warfare Center, Carderock Division, West Bethesda, Maryland) confirmed that they used a number of sources for imaging investigations, which were conducted during the August to September 2010 timeframe and provided relevant details. These investigations were accomplished as an integral part of Chemical, Biological, Radiological, Nuclear and High Yield Explosive (CBRNE) missions. They involved multiple radiation sources consisting of four National Institute of Standards and Technology (NIST) sealed sources, two U.S. Department of Energy (DOE) sources, and a commercial neutron generating system. The NIST sources contained 85 megabecquerels (MBq) (2.3 millicuries [mCi]) of cobalt-60; 185 MBq (5 mCi) of cesium-137; and two each californium-252 sources with neutron emission rates of 1.96×10^4 and 5.32×10^5 neutrons per second, respectively. DOE sources possessed for the investigations included a Pacific Northwest National Laboratory sealed source containing about 110 grams of weapons grade plutonium metal; an Oak Ridge National Laboratory (ORNL) highly enriched uranium source with a total activity of about 2.9 mCi; and an SAIC-manufactured 14 million electron volt Pulsed Elemental Analysis with Neutrons (PELAN) Model IV. The project was completed such that each of the sources was transferred back to its owning organization on September 17, 2010 (Kush 2010).

  Sources were used to test neutron imaging capabilities by placing the camera on the pier and moving past the pier in a boat with the source(s). Sources were placed in secure storage in Building 204 when not in use. The imaging investigations lasted approximately 10 days with all sources being returned to their respective owners on September 17, 2010 when testing was completed. Given that radioactive materials were limited to sealed sources and that all such sources were subjected to leak testing as appropriate to confirm the integrity of each source, the potential for residual radioactivity is limited to the possible presence of neutron activation products. In addition, it is notable that although radiological surveys were performed by the project RSO, Mr. Charles J. (Joe) Olenick, available survey information required augmentation pursuant to evaluation of construction materials potentially impacted by neutron sources.

2.3 RADIOLOGICAL HISTORICAL SITE ASSESSMENT SUMMARY

Historical information relative to use of radioactive materials at Fort Monroe, Virginia indicates that such use was generally limited to military troop items such as radioluminous watches and compasses, which all Army organizations possess. Two exceptions have been identified by investigations performed pursuant to development of this HSA. These exceptions involve the storage of chemical agent detection devices in Building 261 from 2007 until early 2011 and the storage and use of neutron sources for a comparatively short duration in August and September 2010. The "Source Path" was specifically used for movement of the sources from the storage room in Building 204 along the pier to area in which they were loaded onto boats pursuant to testing. It is notable that each of the exceptions occurred subsequent to issuance of the BRAC 2005 ECP Report, in November 2006 (U.S. Army 2006); thus, information relative to prior use was consistent with the additional information obtained.

With respect to radionuclides of concern for the two noted operations, although the primary isotope of interest with respect to storage of chemical agent detection equipment was Ni-63, some detectors contained Am-241. In addition, although several sealed sources were utilized in Navy testing adjacent to Buildings 204 and 205, these sources were subjected to confirmatory leak testing such that neutron activation is the limiting concern with respect to the potential for residual radioactivity. As such, the isotopes of interest for radiological surveys consist of Ni-63 and Am-241 in Building 261 and neutron activation products in and around Building 204 impacted storage and test areas.

3. SURVEY DESIGN

The methodology described in this document has been applied to all accessible areas within the project scope.

3.1 THE DECISION

The decision for each individual area with alpha, beta, or gamma count rates that are elevated with respect to background is whether the area has radiological contaminants present at concentrations that exceed applicable screening-level DCGLs.

3.2 INPUTS TO THE DECISION

Inputs to the decision as to whether the area in question is contaminated is based on data to include scan and fixed-point measurements of gross alpha, gross beta, and gamma radioactivity. Levels of surficial gamma activity generally serving as a qualitative indicator with quantitative measurements of gross alpha, gross beta, and total low energy beta by liquid scintillation counting proving the basis for evaluation of each SU. The information contained in the remainder of this section provides the technical basis for determination as to whether a given area is suitable for release without radiological restrictions.

NUREG-1507 (NRC 1998) and NUREG-1575 (DOD 2000) provide methodology for the calculation of minimum detectable concentrations (MDCs). The MDC is the minimum concentration of the contaminant that can be measured with certainty. The MDC of a scan survey "depends on the intrinsic characteristics of the detector (efficiency, physical probe area, etc.), the nature (type and energy of emissions) and relative distribution of the potential contamination (point versus distributed source and depth of contamination), scan rate, and other characteristics of the surveyor" (DOD 2000). The assumptions used to calculate walkover survey MDCs in NRC's NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, are appropriate for this survey. Using 2- by 2-inch (2" × 2") sodium iodide (NaI) detectors, the following assumptions apply:

- 2" × 2" NaI background count-rate of 10,700 counts per minute (cpm) on concrete
- 2" × 2" NaI detector count-rate versus. exposure rate values in NUREG-1507, Table 6.3
- An observation interval of 1 second (based on a scan rate of 1.6 feet (ft) per second (0.5 meters [m] per second)
- A level of performance to yield an index of sensitivity (d') of 1.38.

3.2.1 Data Review

Limited radiological data were available for Navy operations performed in the August to September 2010 timeframe. This information was reviewed prior to development of survey protocols.

3.2.2 Background Reference Areas

To account for background conditions and the associated variability, multiple reference areas were identified consistent with MARSSIM, Section 4.5 and subjected to radiological measurements. Reference areas were established in nonimpacted portions of Buildings 204 and 205 and in areas along a nonimpacted pier to establish background conditions. Twenty general area measurements (10 per instrument) were collected from each reference area to establish background conditions. These background measurements were compared to survey data obtained from impacted buildings/structures to determine the levels of radioactivity for each area. Given that background count rates vary significantly based on the composition of construction materials, site background count rates were collected for a range of different materials. Reference area survey results are provided in Appendix A, Table A-1.

3.3 RADIOLOGICAL SURVEYS

Radiological surveys are performed for a variety of reasons: to obtain information to evaluate whether existing concentrations of site contaminants exceed DCGLs (and as part of the final status survey [FSS] process); to identify the lateral and vertical extent of identified constituents of potential concern (COPCs) exceeding DCGLs and, thus, to enable the scope of remedial actions to be defined; and to evaluate the effectiveness of decontamination. The surveys performed within the impacted buildings at Fort Monroe address each of these objectives.

Radiological surveys/investigations were conducted on January 9 and 10, 2012 to investigate the presence of radiological contaminants exceeding background concentrations in the impacted buildings on Fort Monroe. Radiological investigations included qualitative gamma walkover surveys to identify potentially elevated areas for further investigation; alpha and beta scan and fixed point measurements for direct comparison to screening-level DCGLs, removable contamination measurements to confirm the percentage of total activity that is removable; and collection of swipes for total activity screening by liquid scintillation counting (LSC) to quantify the removable activity present as a result of the presence of low-energy beta emitting radionuclides. Project equipment also was monitored to ensure that contamination, if encountered, was properly controlled.

Detailed survey information for each area surveyed at Fort Monroe is provided in Appendix A.

3.3.1 Study Boundaries

As discussed in Section 2.3 and determined by the HSA, portions of two buildings and the associated pier at Fort Monroe required classification as "impacted" by radioactive materials as defined by MARSSIM with all other buildings being classified as "nonimpacted." "Nonimpacted areas—identified through knowledge of site history or previous survey information—are those areas where there is no reasonable possibility for residual radioactive contamination" (DOD 2000). The areas characterized as impacted are listed in Table 3-1.

Table 3-1. Fort Monroe Impacted Areas
Fort Monroe, Hampton, Virginia

Building Number	Current Function/Description
204	Calibration Room
261	NBC Storage and Maintenance Rooms
204 "Source Path"	Building 204 Pier and Floating Dock

3.3.2 Gamma Walkthrough

Both impacted buildings were qualitatively evaluated by performing walkthrough surveys with gamma detectors to identify and investigate areas that exhibit gamma emissions that are potentially elevated with respect to background. Gamma walkthrough surveys were performed using 2" × 2" NaI gamma scintillation detectors. The surveyor advanced at a speed of approximately 1.6 feet/second (0.5 m/second) while passing the detector in a serpentine pattern approximately 10 centimeters (cm) (4 inches) above the ground floor surface. Audible response of the instrument was monitored by the surveyor and locations of elevated audible response, if located, were investigated. Elevated areas are those in which the count rate exceeds the applicable background count rate for the media of interest (e.g., concrete, asphalt) by 2,000 cpm. Appropriate scan coverage was achieved for all areas within the scope of this investigation. No areas of elevated gamma activity were detected.

3.3.3 *Alpha-Beta Scan Surveys*

Surficial DCGLs are defined in terms of radionuclide-specific activity per unit area (e.g., disintegrations per minute per 100 square centimeters [dpm/100 cm^2]) for alpha and beta activity. Surveys were performed to assess whether alpha or beta emissions exceeded applicable DCGLs. Both Building 204 and 261 were subjected to scan surveys of the appropriate percentage of the floors, walls etc. based on the applicable MARSSIM classification of the area involved. (See Section 3.10 and Table 3.6, ["MARSSIM Suggested Survey Units"]) (DOD 2000). Scan MDCs are included in Appendix B for the instruments used for the surveys addressed in this report.

3.3.4 *Fixed-Point Surveys and Removable Contamination Evaluations*

The fixed-point measurements result in units of cpm but have been converted to the units of the surficial release criteria of dpm/100 cm^2 with the following equation:

$$Surficial\ Activity\ \left(\frac{dpm}{100\ cm^2}\right) = \frac{R_g - R_b}{(\varepsilon_i)(\varepsilon_s)\frac{Probe\ Area}{100}}$$

Where

R_g is the static data point gross count rate (cpm)

R_b is the instrument field background count rate (cpm)

ε_i is the instrument 2 π efficiency (cpm/dpm)

ε_s is the source efficiency

Probe Area is the open area of the detector face (cm^2).

For Example, using Sample #4, Galvanized Metal from Building 204 (Table A-2):

Where

R_g = 278 cpm

R_b = 200 cpm (Metal background from Building 205)

ε_i = 0.283 cpm/dpm

ε_s = 0.5

Probe Area = 125 cm^2

$$Surficial\ Activity\ \left(\frac{dpm}{100\ cm^2}\right) = \frac{278\ \text{cpm} - 200\ \text{cpm}}{(0.283\frac{cpm}{dpm})(0.5)\frac{125\ cm^2}{100}} = 440\ \frac{dpm}{100\ cm^2}$$

MARSSIM notes on page 25, that "A source efficiency of 0.5 is recommended for beta emitters with maximum energies above 0.4 million electron-Volt (MeV). Alpha emitters and beta emitters with maximum beta energies between 0.15 and 0.4 MeV have a recommended source efficiency of 0.25" (DOD 2000). Based on these recommendations, source efficiencies of 0.25 and 0.5 are used for alpha and beta, respectively.

Determination of the percentage of total activity that is removable is generally required to verify that site conditions with regard to the removable fraction are consistent with assumptions integral to the development of DCGLs. This is accomplished by determining the gross alpha and gross beta removable activity by swiping an area of approximately 100 cm^2 with filter paper and then measuring the alpha and beta activity on the swipe. Limited elevated radioactivity was detected on impacted structures at Fort Monroe. These measurements confirmed that the beta removable fraction did not exceed 10 percent of the total activity and was, therefore, consistent with assumptions inherent in development of screening-level DCGLs.

Given that evaluation of low-energy beta emitting radionuclides cannot generally be directly measured by scan or routine fixed point survey measurements using field instrumentation, the activity of such radionuclides was evaluated by total activity screen by LSC. This is accomplished by swiping an area of approximately 100 cm^2 with filter paper and evaluating the amount of activity present on the swipe. (Although tritium analysis commonly includes the use of swipes dampened with demineralized or "dead" water, evaluation of the activity of other low-energy beta emitting radionuclides [e.g., Ni-63] does not commonly require wetting agents for collection. Nonetheless, swipes collected in this survey effort were dampened.) Radioanalytical laboratory results are contained in Appendix C.

4. INSTRUMENT USE AND QUALITY ASSURANCE

Survey instruments used for radiological measurements were:

- Selected based on the survey instrument's detection capability for the COPCs present at Fort Monroe
- Calibrated in accordance with manufacturers' recommendations and American National Standards Institute (ANSI) N323A, *Radiation Protection Instrumentation Test and Calibration – Portable Survey Instruments* (ANSI 1997)
- Calibrated with a NIST traceable source to obtain a quantitative measurement
- Operated and maintained by qualified personnel, in accordance with SAIC Health Physics Program procedures (e.g., physical inspection, background checks, response/operational checks). (Calibration and instrument quality assurance [QA]/quality control [QC] records are in Appendix D.)

Radiological field instrumentation used for this survey had been calibrated in accordance with ANSI-N323A within the past 12 months. (Instrumentation is calibrated in accordance with manufacturer's recommendations at an interval not to exceed 12 months.) QC checks were performed at the beginning and end of each day consistent with SAIC Health Physics Procedures. Radiological instruments operated as designed with no quality problems being experienced. All radiation survey data obtained during these efforts used radiation measurement instrumentation that achieved all performance requirements.

The instruments selected for this site included those to be used for the gamma walkthrough surveys as well as instrumentation to ensure compliance with contamination limits applicable to project equipment and analytical samples. Field instrumentation used is presented in Table 4-1.

Table 4-1. Survey Instrumentation Used
Fort Monroe, Hampton, Virginia

Measurement Type	Detector Type	Detector Area	Instrument Model	Detector Model
Alpha/Beta Scan/Static	Zinc sulfide (ZnS) scintillator	125 cm^2	Ludlum 2360	Ludlum 43-89
Gamma Scan/Static	2"x 2" NaI gamma scintillator	*2 in (5.1 cm diameter)	Ludlum 2221	Ludlum 44-10

* Gamma detectors were generally used for qualitative surveys to identify areas that were potentially elevated with respect to background; thus, detector area is provided for completeness only.

4.1 PRE-OPERATIONAL CHECKS

Pre-operational checks were performed prior to each use and whenever instrument response became questionable. Pre-operational steps included:

- Verifying instrument calibration was current
- Visually inspecting instrument for physical damage that may affect operation
- Performing satisfactory battery check, (manufacturer's operating instructions defined satisfactory battery check)
- Checking cable connection and cable integrity.

4.2 OVERVIEW OF ROUTINE INSTRUMENT QUALITY EVALUATIONS

The following provisions were implemented to ensure appropriate survey quality:

- Site-specific instrument background was established upon arrival at a site by determining the mean value of 10 each 2-minute background counts for the Ludlum 43-89 zinc sulfide (ZnS) alpha/beta plastic scintillator, and 10 each 1-minute source counts for the Ludlum 44-10, 2" × 2" NaI gamma scintillation detector.
- Background and source checks were performed at the same location in a reproducible geometry at the beginning and end of each survey day. There were no occasions during which instrument response appeared questionable; therefore, additional background and source checks were not required.
- Radiological field instruments used for collecting fixed point and scan measurements were performance checked at the beginning and end of each survey day to confirm acceptability and usability of data collected. No deviations from standards were experienced.
- The Ludlum Model 2360 ratemeter/scaler coupled with a Ludlum Model 43-89 ZnS plastic scintillator hand-held probe was checked with thorium-230 and strontium-yttrium-90 sources.
- The Ludlum Model 2221 scaler coupled with a 44-10, 2" × 2" NaI Gamma Scintillation Detector was checked with a cesium-137 source.
- The acceptance criterion for background was a background count rate within two standard deviations of the mean instrument background. Similarly, the instrument efficiency is maintained within two standard deviations of the mean.

Sources were stored and handled as specified in SAIC Health Physics Procedures and were shipped in accordance with U.S. Department of Transportation (DOT) regulations.

4.3 STATIC AND SCAN MINIMUM DETECTABLE CONCENTRATIONS

The MDC is an activity level that a specific instrument and measurement technique will detect 95 percent of the time. Site-specific detection sensitivities (static [i.e., fixed point] and scan MDCs) for Fort Monroe have been calculated in accordance with the approach detailed in NUREG-1507. These calculations are provided in Appendix B and are listed in Table 4-2.

Table 4-2. Evaluation of Quantitative Instruments Used
Fort Monroe, Hampton, Virginia

Detector Model	Radiation of Interest	Background Count Time (minutes)	Background (cpm)	Sample Count Time (minutes)	Total Efficiency (cpm/dpm)	Scan MDC[1] (dpm/ 100 cm^2)	Static MDC[1] (dpm/ 100 cm^2)
Ludlum 43-89 Instrument B	Alpha/Beta	2	256 (beta) 1.6 (alpha)	2	0.283 (beta) 0.364 (alpha)	687 (beta) 85 (alpha)	306 (beta) 50 (alpha)
Ludlum 43-89 Instrument F	Alpha/Beta	2	214 (beta) 0.9 (alpha)	2	0.349 (beta) 0.230 (alpha)	767 (beta) 65 (alpha)	345 (beta) 42 (alpha)

[1]The derivation of site-specific MDCs are presented in Appendix B.

Sample counting times may be adjusted in order to obtain desired minimum detectable activity (MDA) or MDC values. The longer a sample is counted, the lower the MDA/MDC value. Sample count times are long enough to yield the required sensitivity as a function of the applicable DCGL. As discussed in Section 4.5, the most restrictive screening-level DCGL values used for the initial evaluation of surficial activity at Fort Monroe is 400 dpm/100 cm^2 for alpha. (The only beta emitting radionuclide of potential concern was Ni-63 thus no DCGL was applicable to standard beta emissions.)

Swipes were collected for total activity screening by LSC and submitted to a U.S. Army radioanalytical laboratory. The laboratory analytical reports and LSC results are contained in Appendix C. The applicable MDC for LSC analysis was 22 dpm/100 cm^2.

4.4 RADIOLOGICAL CONSTITUENTS OF POTENTIAL CONCERN

The radiological COPCs at Fort Monroe include Ni-63, Am-241, and a variety of potential radionuclides associated with neutron activation of construction materials such as wood and painted and galvanized steel.

4.5 DERIVED CONCENTRATION GUIDELINE LEVELS

The first step in the process of releasing a given room, building, or site is to determine what release criteria apply. In June 1974, the Atomic Energy Commission (AEC) issued Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors* (AEC 1974), which provided guidance with respect to surface contamination limits. (Historically, this NRC document is commonly referred to as "NRC Reg Guide 1.86" although NRC did not exist at the time that the document was initially produced.) Limits contained in Reg Guide 1.86 were derived based on detectability rather than being dose- or risk-based with removable contamination limits equating to 20 percent of the respective total contamination limits.

In 1997, NRC published Title 10, Code of Federal Regulations (CFR), Part 20, Subpart E, "Radiological Criteria for License Termination," in the Federal Register (FR) (62 FR 39058). These regulations included dose-based cleanup levels, also referred to as DCGLs, for releases both with and without radiological restrictions. Section 20.1402 of Subpart E notes that, "A site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem (0.25 mSv) per year, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA). Determination of the levels which are ALARA must take into account consideration of any detriments, such as deaths from transportation accidents, expected to potentially result from decontamination and waste disposal."

In addition to issuance of radiological criteria for license termination, NRC also performed "generic modeling" that "addresses residual radioactive contamination inside buildings and in soils." NUREG-5512 screening-level DCGLs for structure surfaces were developed based on "building renovation and normal building occupancy" scenarios. The building occupancy scenario accounts for exposure to fixed and removable residual radioactivity on the walls, floor, and ceiling of a decommissioned facility. It assumes that the building will be used for commercial or light industrial activities (e.g., an office building or warehouse) and includes the external radiation, inhalation of (re)suspended removable residual radioactivity; and inadvertent ingestion of removable residual radioactivity. The screening value represents the surface concentration of individual radionuclides that would be deemed in compliance with the 25 mrem/year unrestricted release dose limit in 10 CFR 20.1402 and is derived using conservative assumptions. Given the conservatism built into screening-level DCGLs, analysis to demonstrate that the dose to the average member of the critical group is '[ALARA]' is not required" (NRC 2006).

The "Screening Values of Common Radionuclides for Building-Surface Contamination Levels," as defined in NRC SECY-98-242, lists "Decommissioning and Demolition (D&D) Screening Values." These screening-level DCGLs specified represent the 90^{th} percentile of the output dose distribution equivalent to 25 mrem/year for each of the listed radionuclides. The NRC staff acknowledged that there are several areas in which modeling used to develop screening-level DCGLs was overly conservative. One such area is in the selection of resuspension factors. Consequently, NRC issued guidance in "*Re-*

Evaluation of the Indoor Resuspension Factor for the Screening Analysis of the Building Occupancy Scenario for NRC's License Termination Rule - Draft Report," NUREG-1720 (NRC 2002), which recommends a resuspension factor of 1×10^{-6} m^{-1}. SAIC recalculated screening-level DCGLs using D&D Version 2.1 with the only change being the modification of the value of the resuspension factor to the recommended value of 1×10^{-6} m^{-1}. Using a 95 percent confidence level, this change resulted in derivation of the screening-level DCGLs as specified in Table 4-2. Consistent with NUREG-1757, Volume 1, Revision 2, Group 2 licensees include those "that can demonstrate compliance with 10 CFR Part 20.1402 (Radiological criteria for unrestricted use) using the screening methodology." Given the use of such criteria for building surveys at Fort Monroe, NRC licensees would reasonably be categorized as "Group 2 Licensees" (NRC 2006).

Highlighted in Table 4-3, the most restrictive screening level DCGL is 400 dpm/100 cm^2 screening level for Am-241 (alpha) and 1.8×10^6 dpm/100 cm^2 screening level for Ni-63 (low energy beta).

Table 4-3. Fort Monroe Radiological Constituents of Potential Concern Fort Monroe, Hampton, Virginia

Isotope	Half-Life[1]	Screening-Level DCGL[2] (dpm/100 cm^2)
Am-241	458 years	4.0×10^2
Ni-63[3]	92 years	1.8×10^6
Miscellaneous Activation Products	Variable	Isotope-specific DCGLs

[1]Radionuclides with atomic numbers exceeding 82 (lead) commonly decay through one or more daughter products prior to decaying to a stable, non-radioactive, constituent. Daughter products of radiological COPCs will be fully evaluated if the parent is detected.
[2]NRC Screening level DCGLs adjusted pursuant to *Re-Evaluation of the Indoor Resuspension Factor for the Screening Analysis of the Building Occupancy Scenario for NRC's License Termination Rule - Draft Report* (NUREG-1720) by use of a resuspension factor of 1×10^{-6} m^{-1} while maintaining all other parameters constant.
[3]Denotes radionuclide with no appreciable gamma emissions.

4.6 DECISION ERRORS

There are two types of decision error: Type I (alpha) and Type II (beta). Type I error is described as the probability of determining that the median concentration of a particular constituent is below a criterion when it is actually not (false positive). Type II error is described as the probability of determining that the median is higher than criteria when it is not (false negative). The probability of making decision errors can be controlled by adopting an approach called hypothesis testing.

H_0 = the median concentration in the SU exceeds that in the reference area by more than the DCGL.

This means the site is assumed to be contaminated above criteria until proven otherwise. The Type I error, therefore, refers to the probability of determining that the area is below the criterion when it is really above the criterion (incorrectly releasing the SU). The Type II error refers to the probability of determining that the area is above the criterion when it is really below the criterion (incorrectly failing to release the SU).

Based on the above null hypothesis (H_0), that the areas in question exceed DCGLs, lowering the Type I error decreases the probability of residual contamination exceeding site criteria while increasing the Type I error would have the inverse effect. By contrast, lowering the Type II error decreases the probability of releasing an SU in which residual concentrations of contamination are below site criteria.

Failure to release SUs that achieve standards results in increased costs for the removal of residuals that actually achieve criteria but does not impact on human health or the environment. Increasing the Type II error, by contrast, typically results in increased sampling costs but a reduced probability of failing to release an SU that actually achieves cleanup criteria.

The Type I error for Fort Monroe has been set at 0.05 and the Type II error has been set at 0.25. This means that there is a 5 percent probability of erroneously releasing an SU whose true mean is greater than the DCGL and a 25 percent probability of not releasing a site that has attained the DCGL. This implies that if the mean is at a concentration that would produce an exposure at the criterion level, there would be a 5 percent probability of erroneously finding it below the criterion or a 25 percent probability of erroneously finding it to be greater than the criterion.

4.7 RELATIVE SHIFT

The relative shift (Δ/σ) is defined as the Δ/σ where Δ is the DCGL minus the lower bound of the gray region (LBGR) and standard deviation (σ) is the standard deviation of the contaminant distribution. MARSSIM recommends that the LBGR initially be set one half of the DCGL, but should be adjusted if necessary to provide a relative shift value between the recommended range of 1 to 3. The DCGLs for Fort Monroe have been set to 400 dpm/100 cm^2 (alpha). Thus Δ can be found by:

$$\Delta = \mathrm{DCGL} - \mathrm{LBGR}$$

$$\Delta = 400\frac{dpm}{100\ cm^2} - \frac{400\frac{dpm}{100\ cm^2}}{2} = 200\frac{dpm}{100\ cm^2}\ (alpha)$$

The value for σ can be estimated in a number of ways. Sometimes there is data from the site that are sufficient to calculate the standard deviation within the SU, σ_s. (Note that σ, as used herein, is the standard deviation at the time of release and after material exceeding applicable criteria are thought to have been effectively removed). Data may also be available from a reference or background area. Reference area data can be used to estimate a standard deviation of the contaminant in naturally occurring background, σ_r, if the contaminant is present in background. The larger of σ_s and σ_r should be used when calculating relative shift. Consistent with MARSSIM guidance and consistent with experience implementing MARSSIM, a coefficient of variance of 0.3 (30 percent) was initially used at Fort Monroe. Thus the standard deviation can be found by:

$$\sigma = DCGL\ (30\%)$$

$$\sigma = 400\frac{dpm}{100\ cm^2}\ (30\%) = 120\frac{dpm}{100\ cm^2}\ (alpha)$$

As such, the relative shift can be determined as:

$$relative\ shift = \frac{\Delta}{\sigma}$$

$$relative\ shift_{alpha} = \frac{200\frac{dpm}{100\ cm^2}}{120\frac{dpm}{100\ cm^2}} = 1.67$$

4.8 THE NUMBER OF SAMPLES PER SURVEY UNIT

The calculated value for Δ/σ can be used to obtain the minimum number of samples/measurements necessary to satisfy requirements using the MARSSIM equation presented below:

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

The calculated value, N, is the combined number of samples/measurements from the reference area and each SU. $Z_{1-\alpha}$ and $Z_{1-\beta}$ are critical values that can be found in MARSSIM, or statistics textbooks and handbooks, and P_r is a measure of probability available from MARSSIM Table 5.1.

Typically, N/2 samples/measurements are collected in each SU and N/2 are collected in the reference area. That is, N/2 samples/measurements are conducted in *each* SU *and* N/2 samples/measurements are conducted in the reference (background) area. However, the statistical methods are still valid if there are an unequal number of samples/measurements in the SU and reference areas. A 20 percent increase in this number is recommended to account for lost or unusable samples/measurements. The calculated values apply to each SU. The number of samples required in each SU will vary by area.

The number of data points, N, for the WRS test of each combination of reference area and SU is calculated using Equation 5-1 and Table 5.1 in MARSSIM, given 5 percent Type I error and 25 percent Type II error.

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

$$N = \frac{(1.645 + 0.674)^2}{3(0.871014 - 0.5)^2} = 13\ samples$$

The uncertainty associated with the calculation, N, should be accounted for during survey planning; thus, the number of data points is increased by 20 percent and rounded up. This is to ensure there are sufficient data points to allow for any possible lost or unusable data.

$$N = 13 + 0.2(13) = 16\ samples$$

The 16 samples include the combined samples/measurements from the reference area and one SU. Therefore a minimum of eight samples/measurements are required in the reference area and eight in each SU. As noted in Appendix A, a sufficient numbers of samples were collected within each of the buildings at Fort Monroe.

Given that equal numbers of samples are obtained from the SU and reference area, it was calculated that eight samples/measurements were required for each. Given the low cost required to obtain fixed point measurements, the quantity of fixed point measurements was increased to 20 per SU for Building 204 and the Building 204 Pier and the associated reference areas to assure adequate statistical power. "The consequence of inadequate power is that an SU that actually meets the release criterion has a higher probability of being deemed not to meet the release criterion" (DOD 2000). In addition, "When the null hypothesis is rejected, the power of the test becomes a somewhat moot question" (DOD 2000). As such, consistent with MARSSIM guidance, retrospective power curves were not developed for the Fort Monroe buildings. This is particularly appropriate in that the number of fixed point measurements per SU was essentially doubled, each of the SUs clearly rejects the null hypothesis, and the number of measurements required based on actual site conditions was less than the number of measurements obtained.

4.9 CLASSIFICATION OF SURVEY UNITS

Surveys including scoping surveys were designed so that, to the extent practicable, data collected could be used for the FSS. Because there were limited data available at the time of the initial survey, certain assumptions were made with regard to survey planning based on the contamination potential of each SU. These assumptions were used to design the radiological survey so that a sufficient quantity and quality of data is collected for potential future use in a FSS. The scanning coverage, SU area, and random versus systematic measurements are the primary issues considered when classifying an SU. Information from the HSA was the primary source for initial "classification" of SUs.

As described in the MARSSIM, SUs are broken into three classes (Table 4-4). An SU is classified as a Class 1 SU if it meets any one of the following criteria:

1. The area is or was impacted (potentially influenced by contamination)
2. The area has potential for delivering a dose or risk above criteria
3. There is potential for small areas of elevated activity
4. There is insufficient evidence to classify the area as Class 2 or Class 3.

An SU is classified as a Class 2 unit if:

1. The area has the potential to have been impacted
2. The area has low potential for delivering a dose or risk above criteria
3. There is little or no potential for small areas of elevated activity.

An SU is classified as a Class 3 unit if:

1. The area has only minimum potential for being impacted
2. The area has little or no potential for delivering a dose or risk above criteria
3. There is little or no potential for small areas of elevated activity.

Table 4-4. MARSSIM "Suggested Survey Unit Areas" (DOD 2000)
Fort Monroe, Hampton, Virginia

Classification	Suggested Area
Class 1	Structure: up to 100 m^2 Land Area: up to 2,000 m^2
Class 2	Structure: 100 to 1,000 m^2 Land Area: 2,000 to 10,000 m^2
Class 3	Structure: No Limit Land Area: No Limit

4.10 OPTIMIZATION OF DESIGN FOR OBTAINING DATA

The following actions, methods, and techniques were utilized throughout the data collection process to minimize cost, field effort, and impacts to future associated work:

- Radiological surveys and collected samples were obtained in a defensible manner. Data were collected and managed so that they will be usable in future area evaluations or investigations, if appropriate.

- Investigations utilize the graded approach of site investigations. Areas of highest potential were scrutinized the most, with less effort expended in areas less likely to contain the target contaminants.

4.11 DATA QUALITY OBJECTIVES, QUALITY ASSURANCE, AND QUALITY CONTROL

The following reflect survey quality considerations:

- Laboratory data are of the appropriate quality to be usable after validation
- All radiological survey instruments were operated and maintained by qualified personnel, in accordance with SAIC Health Physics Program procedures
- QA/QC related data from the analytical laboratory are provided in Appendix C
- The QA/QC data that would validate both the instrument survey measurements and the analytical results are provided in Appendix C.
- Instrument calibration data and source calibration data are provided in Appendix D.

5. SURVEY IMPLMENTATION

As previously noted, surveys were performed to evaluate radiologically impacted areas consisting of the "Calibration Room" in Building 204, "Source Path" from the source storage area in the Calibration Room to the end of the pier (i.e., the areas in which neutron sources were stored and used, respectively), as well as in the "NBC Storage" and "NBC Maintenance" areas of Building 261 (i.e., areas potentially impacted by the storage of chemical agent detection systems). As such, the survey areas were divided into three distinct MARSSIM SUs consisting of the calibration room in Building 204, the "Source Path" external to Building 204 and storage areas inside Building 261. In addition, measurements were obtained for comparative purposes from nonimpacted reference areas. Although most reference area data was collected for various construction materials in Building 205, reference counts for painted brick were obtained from the Building 204 boiler room at the opposite end of the building away from the neutron source storage room.

Building 204 Neutron Source Storage Room—Radiological surveys of the "Calibration Room" consisted of gamma scans of the floors and walls to 6 feet above the floors using a Ludlum Model 44-10 2" × 2" NaI scintillation detector coupled with a Ludlum Model 2221 Scaler/Ratemeter. Although these surveys were performed to qualitatively identify areas for more comprehensive surveys, no such areas of elevated gamma activity were encountered. Upon conclusion of the gamma measurements, the floors and walls of the room were subjected to gross alpha/gross beta scan surveys using a Ludlum Model 43-89 dual phosphor scintillation detector coupled with a Ludlum Model 2360 Scaler/Ratemeter to simultaneously measure both alpha and beta radiation. Gross alpha/gross beta and gamma fixed point measurements of 2-minute durations subsequently were obtained at 20 random locations along with 2 duplicate readings for QA purposes.

Building 204 Pier/"Source Path"—Radiological surveys of the "Source Path" initially were accomplished using the general approaches stated above for the "Building 204 Neutron Source Storage Room" to scan 5 to 10 percent of the surface of the pier with 20 random fixed point measurements also being collected. Surveys initially indicated that virtually all gross alpha readings appeared to be potentially elevated especially those from yellow-painted bollards and mooring cleats. As such, additional surveys were performed to evaluate whether the results were likely the result of radon daughter product activity rather than neutron-induced activity and a sample was collected, packaged, and shipped to a fully accredited commercial radiochemistry laboratory for analysis. This composite sample consisted of large area swipes together with paint chips from areas appearing to be radiologically elevated with respect to background and was obtained from the southernmost bollard and the middle mooring cleat, both of which were located on the eastern edge of the pier.

Building 261 "NBC Storage" and "NBC Maintenance" Rooms—Given that Ni-63, the primary isotope of interest in the NBC rooms, emits low-energy beta particles with energies generally below the energy threshold of field instruments, measurements consisted of the collection of swipes for evaluation using a total activity screen by liquid scintillation counting. Pursuant to Army direction, four swipes were collected from random locations in each room, packaged, and shipped to the Army's Rock Island Arsenal Radiological Test Laboratory for analysis. Given that potential radioisotopes of interest included Am-241, the above-noted swipes for liquid scintillation counting were augmented by gamma and gross alpha/gross beta scan and measurements with 5 to 10 percent of the surface areas in the rooms being subjected to scan surveys. In addition, 2-minute fixed point measurements were collected from areas adjacent to the collection locations for each of the eight liquid scintillation swipes. (Procedures and instrumentation used for gross alpha/gross beta and gamma surveys were as described above.)

8. RESULTS AND CONCLUSIONS

Building 261—Building 261 surveys evaluated the presence of elevated radioactivity in the "NBC Storage" and "NBC Maintenance" rooms in the "HHC Supply Warehouse" as historical information suggests that these rooms were used for the storage of radioactive materials contained in chemical agent detection devices (Figure A-3). (Although information suggests that no maintenance of the equipment took place, both the "NBC Storage" and "NBC Maintenance" rooms were investigated.) Consistent with direction from the TACOM LCMC, Warren, Michigan Senior Health Physicist/NRC license RSO, surveys of the cited areas were to include a total of four low-energy beta swipes in each of the two rooms for a total of eight swipes. Swipes were transported to the Rock Island Arsenal Radiation Test Laboratory, Rock Island, Illinois 61299 for analysis. The Rock Island Arsenal Radiation Laboratory Radioisotope Test Results (Rock Island Arsenal 2012) are contained in Appendix C. Results for these analyses reflect low-energy beta emissions of less than 24 dpm/100 cm^2 for all samples. The concentrations encountered are multiple orders of magnitude below both the NRC screening level DCGL of 1.8×10^6 dpm/100cm^2 (NRC 2006) for Ni-63 and the Army screening level for clearance of 6.0×10^5, which is listed in Table 5-1, Department of the Army Pamphlet 385-24.

In addition to the collection and analysis of low-energy beta swipes, up to 10 percent of both floors and wall areas to 6 feet above the floor were subjected to scan surveys and eight (8) each gross alpha/gross beta fixed point measurements were collected. Fixed point measurement results are contained in Table A-6. These results reflect levels of gross alpha and gross beta of up to 8 and 670 dpm/100cm^2, respectively, with the stated beta disintegration rates being the result of background variability. For comparison, the alpha screening level DCGL for Am-241 is 400 dpm/100cm^2. Although beta results are reported for completeness, Ni-63 beta activity is present at energies below the threshold of field instruments and are, therefore, evaluated using total activity screen by liquid scintillation counting. Further, given the absence of radiological COPCs with higher energy beta emissions, the DCGL for Ni-63 is the only applicable DCGL for beta-emitting radionuclides. Nonetheless, informationally, it is noted that the limiting DCGL for beta-emitting radionuclides is commonly that of cobalt-60 at 7,100 dpm/100cm^2 and that gross beta results detected were at least an order of magnitude below this value.

Conclusion—Evaluation of radiological survey results for impacted areas of Fort Monroe are compliant with NRC and Army criteria for unrestricted release as specified in Title 10, CFR, Part 20, Subpart E and in DA Pamphlet 385-24, respectively. Further, the information contained in this report of Radiological HSA and Surveys of Fort Monroe supports the overall conclusion that residual radioactivity exceeding stated criteria is not expected on Fort Monroe.

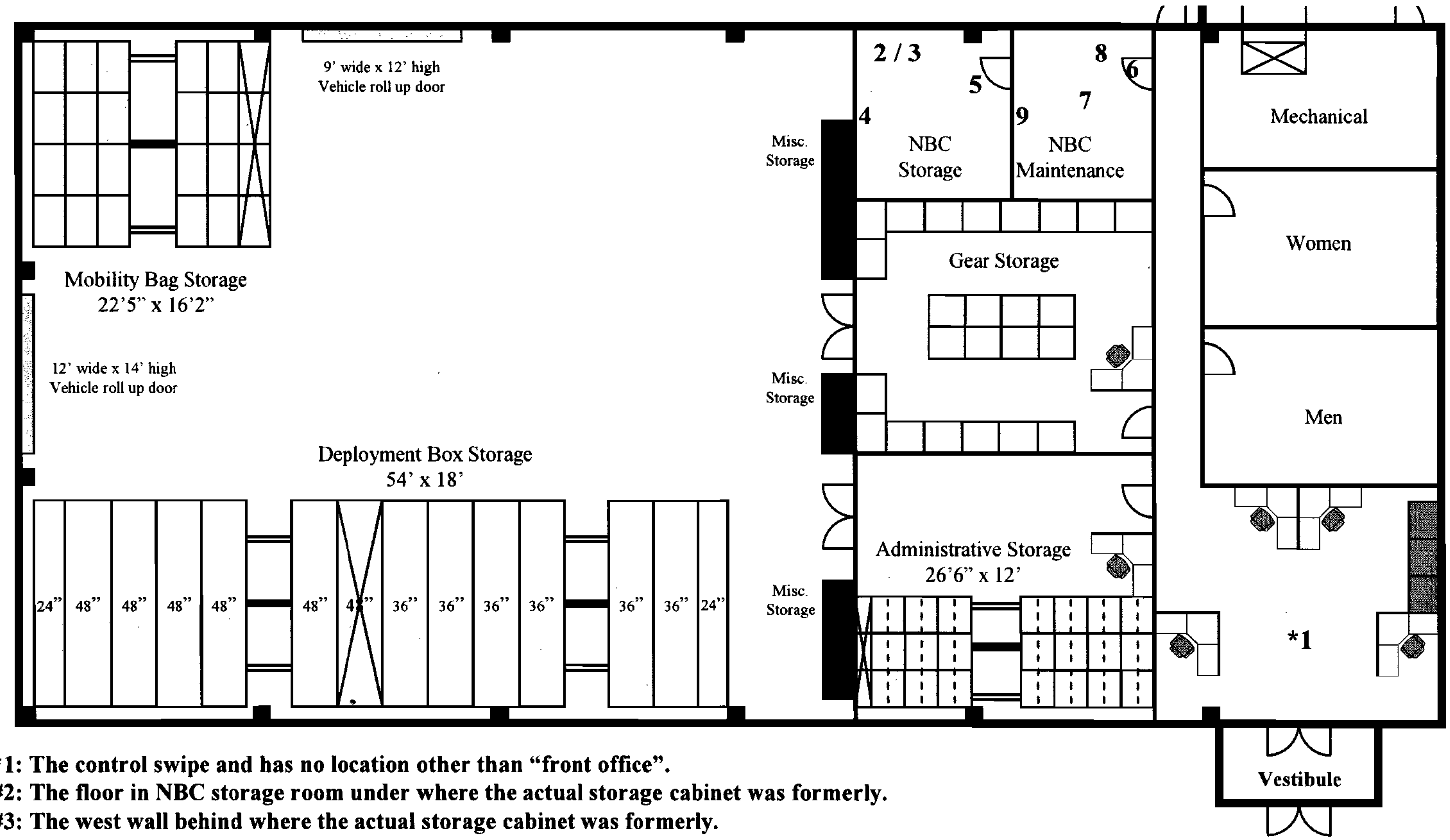
Table A-6. Building 261 Survey Results[1,2,3]
Fort Monroe, Hampton, Virginia

Survey Surface	Sample Number	Alpha Activity[2]			Beta Activity			Sample SOR
		cpm	dpm/100 cm^2	Isotopic SOR	cpm	dpm/100 cm^2	Isotopic SOR	
Tile/linoleum	1	2	0	0.00	243.5	0	0.00	0.00
Tile/linoleum	2	2	0	0.00	268	0	0.00	0.00
Painted gypsum board	3	0	0	0.00	252.5	293	0.00	0.00
Painted gypsum board	4	2	0	0.00	271	397	0.00	0.00
Tile/linoleum	5	4	0	0.00	303.5	0	0.00	0.00
Painted gypsum board	6	3	0	0.00	319	669	0.00	0.00
Painted gypsum board	7	6	8	0.02	294.5	530	0.00	0.02
Metal door handle	8	1	0	0.00	274.5	330	0.00	0.00

[1]The 2 pi instrument efficiency for the Ludlum Model 43-89 detector coupled with Ludlum Model 2360 scaler is 0.364 and 0.283 for alpha and beta, respectively. Background is variable upon the material. Source efficiency is 0.25 for alpha radioactivity and 0.50 for beta radioactivity per MARSSIM Section 3.3.4.

[2]A WRS Test was not required for this SU.

[3]Building 261 low-energy beta emissions were less than 24 dpm/100cm^2 thus these results were within acceptable surface contamination limits as specified in NUREG-1757, Volume 2, Revision 1 and in U.S. Army PAM 385-24. Detailed results can be found in Appendix C.



***1: The control swipe and has no location other than "front office".**
#2: The floor in NBC storage room under where the actual storage cabinet was formerly.
#3: The west wall behind where the actual storage cabinet was formerly.
#4: The middle of the south wall in the NBC storage room.
#5: The interior door handle in the NBC storage room.
#6: The threshold floor just inside the NBC maintenance office door.
#7: Center of floor in NBC maintenance office.
#8: West wall, 4 ft into room, 4 ft up from floor level.
#9: Wall immediately adjacent to thermostat.

North →

This drawing is not to Scale.

Figure A-3. Building 261 HHC Supply Warehouse

Table B-1. Instruments MDCs
Fort Monroe, Hampton, Virginia

Detector Model	Radiation of Interest	Background (cpm)		Instrument Efficiency (cpm/dpm)		Count Time		Scan MDC (dpm/100 cm^2)		Static MDC (dpm/100 cm^2)		Scan Probability
		Beta	Alpha	Beta	Alpha	Sample	Background	Beta	Alpha	Beta	Alpha	Alpha
Ludlum 43-89B SN: 221834	Alpha/Beta	256	1.6	0.283	0.364	2	2	687	85	306	50	99
Ludlum 43-89F SN: 173337	Alpha/Beta	214	0.9	0.230	0.349	2	2	767	65	345	42	99
Ludlum 44-10 SN: 208816	Gamma	10,700 (gamma)[1]		N/A		N/A[2]		N/A[2]		N/A[2]		N/A

[1] Background on concrete.
[2] Used for qualitative purposes only.
SN – Serial Number
N/A – Not Applicable

APPENDIX C

LABORATORY ANALYSIS REPORTS

(Includes "Wipe Test Analysis Request Form and associated Radioisotope Analysis and Laboratory Results")

RADIOISOTOPE TEST RESULTS

RIA-JMTC Radiation Laboratory
(NRC License 12-00722-10)
ROCK ISLAND ARSENAL- JOINT MANUFACTURING and TECHNOLOGY CENTER
Rock Island, IL 61299

Lab Number	Date Rec.	Qty	Received From	Phone Comm	DSN	Fax	Date
R12-0022	1/19/2012	9	Tom Schnitzius	(314) 581-7180	-	-	1/20/2012

MATERIAL: AREA WIPE TEST AND/OR LEAK TEST OF RADIOACTIVE SOURCE OF BETA EMITTER

AREA WIPES 9 Ni63

Non-Standard Samples For Analyses; See Remarks

CUSTOMER REQUESTING ANALYSIS:

SAIC
Attn: Tom Schnitzius
13397 Lakefront Drive, Suite 100
Earth City, MO 63405

Test results were within acceptable surface contamination limits as specified in US Army PAM 385-24 and 10 CFR 835 Appendix D. Removable surface contamination in excess of those limits listed in the above regulations will be reported to:

U.S. Army TACOM LCMC
AMSTA-CSC-Z;
Mailstop: 485
6501 East Eleven Mile Road
Warren, MI 48397-5000
Phone number: 586-282-0891/7635

POCs: Ms. Mary Pettit, Laboratory RSO, DSN 793-4865, Comm. (309) 782-4865
Mr. Ronald Lund, Alternate RSO, DSN 793-7925, Comm. (309) 782-7925

Analyst: mlp

1st Line Reviewer: ab

David Gantzer

Chief, Materials Laboratory Division

RAD FORM BETA IN, 15 APR 05

RIA-JMTC RAD LAB NO. R12-0022

TEST RESULTS

RIA-JMTC RADIATION TEST LABORATORY

Date Received: 1/19/2012

☐ ACADA ☐ CAM ☐ Other

☐ M43A1 Detector ☑ Improved CAM ISOTOPE: Ni63

Alpha Limit of Detectability (LLD) ________X2 = ________DPM
Beta Limit of Detectability (LLD) __24.01______X2 = ______48.02___DPM
10 min recheck (LLD) __10.44_____X2 = ____20.88____DPM

Owning Activity	CELL S/N	Detector/Monitor	Trans Code	Sample Location	Activ/DPM	uci	Pass
B 261	control		W	1	0	0.E+00	YES
B 261	storage S1		W	2	0	0.E+00	YES
B 261	S2		W	3	(10 min reck) 0	0.E+00	YES
B 261	S3		W	4	0	0.E+00	YES
B 261	S4		W	5	0	0.E+00	YES
B 261	maint M1		W	6	0	0.E+00	YES
B 261	M2		W	7	0	0.E+00	YES
B 261	M3		W	8	(10 min reck) 0	0.E+00	YES
B 261	M4		W	9	0	0.E+00	YES

*NOTE: Test results less than 2 X LLD will not be reported

REPORTABLE CONTAMINATION LIMITS:
BETA contamination > 1,000 DPM; ALPHA contamination >= 20 DPM; Tritium contamination > 10,000 DPM.

Remarks:
THIS IS NOT A STANDARD ANALYSIS PROCEDURE. Per guidance from TACOM LCMC License RSO, Tom Gizicki, preparation of these samples consisted of: the wipe sample plus 2ml of fluid (water) removed from each of the original vials (refer to R12-0014). Since each vial contained at least 18 ml fluid, and only using 2 ml (or 11% of each sample); increase each LSC result by a factor of 89%. Suspect samples were rechecked using lab protocols. All samples were under LLD. These were originally Ft Monroe Bldg 261, HHC Supply warehouse NBC Storage wipe samples; email thomas.e.schnitzius@saic.com and also send results to Tom Gizicki (per TG, this will be funded under his license)

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