DEPARTMENT OF THE ARMY
WALTER REED ARMY MEDICAL CENTER
WALTER REED HEALTH CARE SYSTEM
WASHINGTON, DC 20307-5001

REPLY TO
ATTENTION OF

MCHL-HP (385-11p) 7 May 1999

MEMORANDUM FOR Commander, Walter Reed Army Institute of Research, Washington, DC 20307

SUBJECT: Decommissioning of the Northern Half of the Ground Floor of the Gillette Building, Rockville, Maryland

1. REFERENCES. See Appendix A for a list of references.

2. PURPOSE.

a. The Nuclear Regulatory Commission (NRC) requires the radiological decommissioning of sites, buildings and outdoor areas where licensed activities have ceased radiological operations, even while licensed activities continue to be conducted at other site locations. The criteria to decommission a building is when: (1) the licensee has decided to permanently cease principal activities; or (2) no principal activities have been conducted in such an area for a period of 24 months. Principal activities from authorization H05 concluded in February 1999, and there is no planned further planned use of radioactive materials in this building. The WRAIR lease for the laboratory space expires the end of May 1999 and the laboratory space will be returned to the landlord.

b. The Nuclear Regulatory Commission Region I has been notified of the proposed radiological decommissioning of the Gillette building in a letter to the Division of Nuclear Material Safety dated 29 July 1998.

c. This final status decommissioning survey was conducted to determine the presence and extent of any radiological health hazards in the northern wing of the Gillette Building, Rockville, Maryland. This final status survey also verified that any remaining residual radioactivity in the building surveyed is in compliance with the NRC and State of Maryland guidelines for the decontamination of facilities prior to release for unrestricted use.

d. Radioactive material used in the Gillette Building was used by the Walter Reed Institute of Research (WRAIR), Blood Research Group, WRAMC Radioactive Material Authorization H05, under NRC License 08-10738-02, managed by the WRAMC Health

under NRC License 08-10738-02, managed by the WRAMC Health Physics Office. Authorized use locations were rooms 1066 and 1082 in the Gillette Building.

3. GENERAL.

a. Planning Phase. This survey is designed and developed using the Data Quality Objectives (DQO) Process.

(1) Problem. This survey will determine the presence and extent of any radiological health hazards in the northern wing of the Gillette Building, Rockville, Maryland. This survey will verify that any remaining residual radioactivity in the building surveyed is decommissioned in compliance with the NRC, State of Maryland and Army guidelines for the decontamination of facilities prior to release for unrestricted use.

(a) The WRAMC Health Physics Office will be responsible for decommissioning this facility. WRAMC Health Physics Office staff along with five WRAIR soldiers under the direction of the WRAMC Health Physics Office Operations Branch under CPT Arthur Morton will plan, conduct and analyze the survey results. The final approval authority for this decommissioning plan is the WRAMC RPO, COL William B. Johnson.

(b) The resources used in this project will include portable survey meters and laboratory facilities located at the WRAMC Health Physics Office, building 41, WRAMC.

(2) Decision Statement. To determine if all the survey units satisfy the NRC release criteria for unrestricted use.

(3) Inputs to the Decision. A historical site assessment indicated the radionuclides used, stored or disposed of in all survey units. Based on the radionuclides used in each location, and the room final surveys, survey units were designated and classified. Representative background measurements were obtained from the maintenance lounge, which was built with similar construction materials as the two class II laboratories and where it is known that there has been no unsealed radioisotope use.

(4) Boundaries of the Study. The boundaries of the study are the ground floor on the northern half of the Gillette building which encompass room numbers 1002 through 1115. See a

copy of the floor plan in Appendix C. The radionuclide use rooms have had all radioactive materials removed, all radioactive use equipment cleared of any residual contamination, and room contamination finals performed prior to the decommissioning survey.

(5) Decision Rule. If the mean concentration in the survey unit is less than the investigation level, then the survey unit will be in compliance with the release criteria. If the difference between the mean concentration in the survey unit and the mean concentration in the reference area is less than the investigation level, then the survey unit is in compliance with the release criteria. If the average level of residual radioactivity within the survey unit exceeds the regulatory limit, or if small areas within the survey unit with elevated residual activity exceed the regulatory limit then the survey unit will require further remediation before unrestricted release.

(6) Decision Errors. The lower bound for the sample distribution is background determined from a maintenance lounge area in the western end of the building and the upper bound on the sample distribution is three times the $DCGL_W$.

(7) Survey Design. The design goal will be to minimize the number of false negative measurements, or to release a survey unit containing residual radioactivity above three times the DCGL (Type I error). The design goal will also attempt to minimize the number of false positive measurements (Type II error) which will add cost and time to the decommissioning effort. The null hypothesis for this survey is that the survey unit exceeds the release criteria. The design goal for the relative shift (Δ/σ) value will be to achieve a relative shift of two for a Class 2 survey unit and for a relative shift of 3 for a Class 3 survey unit. The values for a Type I decision error (α) and a Type II decision error (β) are equal to 0.05.

b. Implementation Phase. The data collected will be reviewed daily to ensure that the daily quality objectives are met and that the data is consistent over the course of the survey. Both random and systematic sampling designs will be incorporated into this survey based on survey unit classification. The schedule for decommissioning this location is approximately one month beginning 12 April 1999. The

decommissioning effort for this location will not consider using passive controls for releasing a survey unit.

c. Assessment Phase. The assessment phase includes verification and validation of the survey data and an assessment of the quality of the data to ensure the data meet the objectives of the survey.

(1) Data Verification. The performance of tasks by personnel will be conducted according to the SOP, and will be assessed using inspections, and surveillance. The performance of the equipment will be monitored daily using control charts.

(2) Data Validation. Data qualifier codes used in this survey report are:

(a) < MDC. The concentration of the radionuclide of interest was below the minimum detectable concentration (MDC) which is defined in this survey as 3 + 4.65 times the square root of the mean background counts.

(b) J. The associated value was modified, adjusted or an estimated quantity. This qualifier may be used to identify results based on surrogate measurements or gross activity measurements. The implication is that the estimate may be imprecise or inaccurate, and may be inappropriate for statistical evaluations. The potential uncertainty associated with this qualifier will be included with the results.

(c) R. The associated value was determined to be an outlier and is excluded in statistical evaluations.

(d) F. In a Class 2 survey unit, the value exceeds the predetermined investigation level and is flagged for further study as shown in the following table:

Survey Unit Classification	Flag Direct Measurement or Sample Result	Flag Scanning Measurement
Class 2	> $DCGL_W$	> $DCGL_W$ or > MDC
Class 3	> 0.1 times $DCGL_W$	> $DCGL_W$ or > MDC

(3) Preliminary Data Review.

(a) The survey data from the field and laboratory measurements will be converted to DCGL units. Basic statistical

quantities that will be calculated for each data set are the mean, standard deviation, and median values. A quantile plot and background measurements will be prepared for each class 2 survey unit, and any class 3 survey unit that fails the sign test for direct or sample results.

(b) The one sample statistical test (Sign test) will be used since the contaminants, technetium, iodine and chromium are either not present in the background or could be considered insignificant and radionuclide specific measurements will be made. If any measurement in the survey unit exceeds the $DCGL_W$, the Sign test will be used to determine if the survey unit meets release criteria. Since all survey units are designated as Class 2 or Class 3 areas, no area of elevated activity is expected.

(c) The final status survey parameters for the survey units are shown in the following table:

Survey Unit	Type	DQO		Relative Shift	$DCGL_W$			Test
		α	β	Δ/σ	Tc-99m	Cr-51	I-125	
Interior, Prior Rad use removable	Class 2	0.05	0.05	2	1000 dpm per 100 cm²	1000 dpm per 100 cm²	20 dpm per 100 cm²	Sign
Interior, Non-Rad use removable	Class 3	0.05	0.05	3	1000 dpm per 100 cm²	1000 dpm per 100 cm²	20 dpm per 100 cm²	Sign
Interior, Prior Rad use meter	Class 2	0.05	0.05	2	5000 dpm per 100 cm²	5000 dpm per 100 cm²	50000 dpm per 100 cm²	Sign
Interior, Non-Rad use meter	Class 3	0.05	0.05	3	5000 dpm per 125 cm²	5000 dpm per 125 cm²	50000 dpm per 15 cm²	Sign

(d) The minimum number of sample points required for Class 3 survey units using the Sign test when the contaminant is not in the background is 14 from Table 5.5, MARSSIM manual NUREG-1575. For the Class 2 survey units, the survey locations are based on a symmetrical triangular grid with spacing between measurements based on the following formula:

$$L = \sqrt{\frac{A}{0.866 * n_{EA}}}$$

(e) The starting location for each survey unit will be determined using a random number generator in a spreadsheet program with a grid spacing of 10 points per every 3 foot grid square. For a Class 2 survey unit, a symmetrical triangular grid pattern beginning from a randomly selected starting point will be superimposed on the rectangular reference grid. For Class 3 survey units, 14 data points are selected using a random number generator will superimposed on the rectangular reference grid.

Area Classification	Structures	
	Surface Scans	Surface Activity Measurements
Class 2	10 to 100% (10 to 50% of upper walls and ceilings) Systematic and Judgmental	Number of data points from statistical tests
Class 3	Judgmental	Number of data points from statistical tests

(f) The level of scanning effort will be proportional to the potential for finding areas of elevated activity in the survey unit. A larger portion of the survey unit will be scanned if units have residual activity close to the release criterion. Areas that have the highest potential for contamination such as doors, corners, sinks and drains will be performed in all locations. Scanning techniques are not tied to the distance or area between measurement locations, but are rather dependent on the professional judgment of the surveyor.

d. A list of definitions and abbreviations is included in Appendix B.

e. Building diagrams, survey measurements, and resurvey measurements are provided in Appendix C.

f. A list of survey instruments and laboratory counters, calibration records, the minimum detectable activity for each instrument and the quality control charts used for this survey are provided in Appendix D.

4. HISTORICAL REVIEW.

a. A review of the historical records and interviews with personnel who worked in the Gillette was conducted by CPT Morton. The building was used by the WRAIR Blood Research Group, WRAMC Authorization H05 for human use research protocols administering

Tc-99m, Cr-51 or I-125. Sealed sources on the authorization include I-129, Cs-137, and Co-57. Use locations were room 1066 and 1082. A radioactive wash sink was used in room 1082.

b. The possession limit for unsealed radioactive materials were 0.1 mCi for I-125, and 1 mCi for Cr-51 and Tc-99m. All unsealed radioactive material use ceased the end of January 1999. Based on the short half-lives of the radionuclides used, and room final survey results, there is not anticipated that any significant quantity above background will be found during the final status survey.

c. Both of the laboratories using unsealed radioactive materials ceased operations and had their rooms finaled by the Health Physics Office. All records for room finals and equipment finals for the affected rooms are maintained in the Health Physics Office files.

d. During the historical review, all room survey records were examined for any spills, findings of room contamination, or other items of concern. All spills or evidence of contamination were promptly decontaminated at the time of the incident or upon finding elevated readings.

5. RADIATION SURVEY INSTRUMENTATION.

a. Based on the results of the historical review, it was determined that this building would be surveyed for potential beta and gamma emitting radionuclides. The historical review found no unsealed alpha sources were ever used at this location.

b. All portable survey instruments were checked for proper operation prior to use each day. Operational checks for field instrumentation as outlined in NUREG/CR-5849 were used as the standard for this decommissioning process. A series of 10 repetitive measurements of background and the check sources in 1 minute scaler mode are performed, the mean and standard deviation is determined, and an acceptable response range is $+/- 2\sigma$.

c. Portable meters and laboratory counters were function checked and tested against NIST traceable check sources each day prior to use. The following table lists the check sources used during this decommissioning process:

Manufacturer	Isotope	Activity	Date	Serial Number
Dupont	Cd-109	1.16 µCi	2 March 1993	
Packard	I-129	0.05 µCi	September 1997	471
Dupont	Cs-137	0.112 µCi	1 November 1993	
Packard	Co-57	210,900 dpm	13 October 1997	7,018,565
Packard	H-3	267,800 dpm	12 September 1995	
Packard	C-14	113,900 dpm	12 September 1995	
Packard	Cs-137	0.25 µCi	1 February 1997	

d. Blank smear samples were run through both the automated swipe counters. Random check sources were run through the automated swipe counters, using I-129, Co-57 and Cs-137 check sources for the auto-gamma and H-3 and C-14 daily calibration standards and quench standards for the liquid scintillation counter (LSC).

6. RADIATION SURVEY TECHNIQUES.

a. The survey grid system used was an alphanumeric designator system using cardinal coordinates. North was taken as the side of the building most closely aligned with magnetic north. The coordinate system and approximately magnetic north are indicated on the building and room diagrams.

b. The floor and the walls were grided in 1 yard squares. If a grid square had elevated readings, the area was promptly decontaminated. Subsequent measurements of potentially contaminated areas were made by further subdividing the grid square into 9 smaller squares.

c. The entire floor, walls, counter tops, drawers, and any equipment in the affected rooms were surveyed. Judgmental samples in all Class 2 areas were taken in locations chosen by the surveyors where they believed contamination could spread, or could have collected over time. These include cracks in walls or floors, holes in walls, drains, vents, lighting fixtures, etc. The ceilings were classified as unaffected areas and were not surveyed.

d. If an elevated meter reading was found that was at least 3 times background, the area was immediately decontaminated and resurveyed. If the auto-gamma or LSC indicated that an area had

potential contamination measurements of more than 50 dpm above background, the area was decontaminated and resurveyed.

e. The results of the meter surveys, background measurements and check source measurements were recorded on the survey forms, signed and dated by the surveyor.

f. The LSC samples were counted for 5 minutes each. All results were recorded in 3 channels based on contiguous energy regions; H-3 region 0-15 keV, C-14 region 15-150 keV, and a higher energy beta region > 150 keV. The LSC automatically calculates the dpm for H-3 and C-14 based on the daily calibration sources run through each of the LSCs. Each line item in the LSC printout includes the survey location, the dpm for H-3 channel, the dpm for the C-14 channel, and the cpm for the highest energy channel and a color quench indicator. The dpm calculations for C-14 and H-3 are automatically color quenched corrected. The dpm calculation for all other beta emitters will then be determined based on the efficiency of the particular radionuclide as determined by the beta curve.

g. The auto-gamma samples were counted for 5 minutes each in the Cobra autogamma. If a sample indicates gamma contamination, the isotope will be determined using the Packard gamma spectroscopy software and the sample rerun through the isotope specific protocol to determine the activity of the sample.

h. As a minimum, the mean, standard deviation, median, minimum, and maximum measurement for each room excluding the background and check source measurements are shown in Appendix C.

7. INSTRUMENT SURVEY RESULTS.

a. Beta-Gamma Meter Results. A fixed meter reading was obtained using a Ludlum Data Logger with a G-M probe in the digital scaler mode set at 1-minute per sample. Meter readings were made in each grid square at a distance of less than 5-mm from the surface. All results by survey location are included in Appendix C. Some rooms had elevated background activity due to unremovable naturally occurring radioactive materials in the tile, ceramics, brick or other construction materials. For any room that failed the sign test, the data was evaluated using a quantile plot and a linear least squares fit to the data. If all the results showed slightly elevated activity, fit the expected normal distribution, the swipe results were negative, and the

elevated results could be attributed to construction materials then the survey unit was considered to meet the release criteria.

b. Gamma Meter Results. A fixed meter reading was obtained using the Ludlum Data Logger with a FIDDLER probe in the digital scaler mode set at 1-minute per sample. Meter readings were made in each floor grid square at a distance of about 1-m above the floor. All results by survey location are included in Appendix C. Some rooms had elevated background activity due to unremovable naturally occurring radioactive materials in the tile, ceramics, brick or other construction materials. For any room that failed the sign test, the data was evaluated using a quantile plot and a linear least squares fit to the data. If all the results showed slightly elevated activity, fit the expected normal distribution, the swipe results were negative, and the elevated results could be attributed to construction materials then the survey unit was considered to meet the release criteria.

c. LSC Results. Wipe samples were collected for each grid location by swiping approximately 100-cm^2. Blank samples were used to screen for cross contamination, and tritium, and carbon-14 spikes were used as quality control measures. All results by survey location are included in Appendix C. The quality control documentation is included in Appendix D. All of the laboratory results were below the release criteria.

d. Auto-Gamma Results. Wipe samples were collected for each grid location by swiping approximately 100-cm^2. Blank samples were used to screen for cross contamination, and iodine-129, cobolt-57, and cesium-137 spikes were used as quality control measures. All results by survey location are included in Appendix C. The quality control documentation is included in Appendix D. All of the laboratory results were below the release criteria.

8. CONCLUSION. A review of all the survey results indicate that there are no radiological health hazards remaining in the northern half of the Gillette Building, Rockville, Maryland.

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9. RECOMMENDATION. Recommend that the northern half of the ground floor of the Gillette Building be released for unrestricted use.

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APPROVED:

WILLIAM B. JOHNSON
COL, MS
Chief, Health Physics Office

APPENDIX A
REFERENCES

1. AR 385-11, 1 May 1980, Ionizing Radiation Protection (Licensing, Control, Transportation, Disposal, and Radiation Safety).

2. NUREG-1500, Working Draft Regulatory Guide on Release Criteria for Decommissioning: NRC Staff's Draft for Comment, August 1994.

3. NUREG-1501, Background as a Residual Radioactivity Criterion for Decommissioning, Draft Report for Comment, August 1994.

4. NUREG-1505, A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys.

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

6. NUREG-1575, Multiagency Radiation Survey and Site Investigation Manual (MARSSIM), December 1997.

7. NUREG/CR-5849, Manual for Conducting Radiological Surveys in Support of License Termination, Draft Report for Comment, June 1992.

8. NRC Administrative Letter 96-05: Compliance with the Rule "Timeliness in Decommissioning of Material Facilities," (59 FR 36026-36040, 15 July 1996), 5 November 1996.

9. Title 10, Code of Federal Regulations, Part 20, Standards for Protection Against Radiation.

10. Reference letter, MCHL-HP, 29 July 1998, to the Nuclear Regulatory Commission, Region I, Division of Nuclear Material Safety, 475 Alendale Road, King of Prussia, Pennsylvania 19406-1415, Subject: Timeliness Rule Notification for One Wing of the Gillette Building, Rockville, MD.

APPENDIX B
ABBREVIATIONS AND DEFINITIONS

SECTION I

ALARA
as low as reasonably achievable

ALI
annual limit of intake

AR
Army Regulation

Bkd
background

Cal
calibration

CEDE
committed effective dose equivalent

CFR
Code of Federal Regulations

CG
Commanding General

cm
centimeter

cm^2
square centimeter

CPM
counts per minute

DA
Department of the Army

$DCGL_{EMC}$
Derived Concentration Guideline Level - Elevated Measurement Comparison

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$DCGL_w$
Derived Concentration Guideline Level - Wide Area

dpm
disintegrations per minute

eff
efficiency

eV
electron volt

FY
fiscal year

Gy
gray

h
hour

IAW
in accordance with

m
meter

µCi
microcurie

µm
micrometer

µR/hr
microroentgen per hour

mCi
millicurie

mg
milligram

mm
millimeter

mrad
millirad

mSv
millisievert

MDA
minimum detectable activity

NIST
National Institute of Standards and Technology

NRC
U.S. Nuclear Regulatory Commission

NUREG
Nuclear Regulatory Guide

QA
quality assurance

RAM
radioactive material

RCC
radiation control committee

RPO
radiation protection officer

sn
serial number

SOP
standing operating procedure

Sv
sievert

TEDE
total effective dose equivalent

USACHPPM
U.S. Army Center for Health Promotion and Preventive Medicine

Section II Terms

ALARA
Acronym for "as low as is reasonably achievable" means making every reasonable effort to maintain exposures to radiation as far below applicable dose limits as is practical consistent with the purpose for which the activity is undertaken, taking into account the state of technology, the economics of improvements in relation to benefits to the public health and safety, and other societal and socioeconomic considerations and in relation to utilization of nuclear energy and licensed materials in the public interest.

Alpha (α)
The specified maximum probability of a Type I error. In other words, the maximum probability of rejecting the null hypothesis when it is true. Alpha is also referred to as the size of the test. Alpha reflects the amount of evidence the decision maker would like to see before abandoning the null hypothesis.

Annual limit of intake (ALI)
The derived limit for the amount of radioactive material taken into the body of an adult worker by inhalation or ingestion in a year. ALI is the smaller value of intake of a given radionuclide in a year that would result in a committed effective dose equivalent of 5rems (0.05Sv) or a committed dose equivalent of 50rems (0.5Sv) to any organ or tissue.

Army regulation
A directive that sets forth missions, responsibilities, and policies, and establishes procedures to ensure uniform compliance with those policies.

Background Radiation
Radiation from cosmic sources, naturally occurring radioactive material, radon, and global fallout as it exists in the environment from the testing of nuclear explosive devices or from nuclear accidents. Background radiation does not include radiation from source, byproduct, or special nuclear materials regulated by the Federal or State agency.

Becquerel (Bq)
The SI unit of radioactivity equivalent to one nuclear transformation per second.

Beta (β)
The probability of a Type II error, the probability of accepting the null hypothesis when it is false. The complement of beta ($1-\beta$) is referred to as the power of the test.

Beta particle
An electron emitted from the nucleus during radioactive transformation.

Byproduct material
Any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material.

Chain of Custody
An unbroken trail of accountability that ensures the physical security of samples, data and records.

Class 1 Area
A type of final status survey that applies to areas with the highest potential for contamination, and meet the following criteria: (1) impacted; (2) potential for delivering a dose above the release criterion; (3) potential for small areas of elevated activity; and (4) insufficient evidence to support reclassification as Class 2 or Class 3.

Class 2 Area
A type of final status survey that applies to areas that meet the following criteria: (1) impacted; (2) low potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

Class 3 Area
A type of final status survey that applies to areas that meet the following criteria: (1) impacted; (2) little or no potential for delivering a dose above the release criterion; and (3) little or no potential for small areas of elevated activity.

Committed dose equivalent
The dose equivalent to organs or tissue of reference that will be received from an intake of radioactive material by an individual during the 50 year period following the intake.

Committed effective dose equivalent
The sum of the products of the weighting factors applicable to each of the body organs or tissues that are irradiated and the committed dose equivalent to these organs or tissues.

Commodity, radioactive
See Radioactive commodity

Curie
A unit of radioactivity equal to 37 billion becquerels.

Data Quality Assessment (DQA)
The scientific and statistical evaluation of data to determine if the data are of the right type, quality, and quantity to support their intended use.

Data Quality Objectives (DQO)
Qualitative and quantitative statements derived from the DQO process that clarify study technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision error that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

$DCGL_W$
Derived Concentration Guideline Level. Derived assuming the residual activity is uniformly distributed over a wide area, i.e., the entire survey unit.

$DCGL_{EMC}$
Derived Concentration Guideline Level - Elevated Measurement Comparison. Derived assuming the residual activity is concentrated in a small percentage of a survey unit. The $DCGL_{EMC}$ can never be less than the $DCGL_W$, but may be significantly greater.

Decommission
To remove (as a facility) safely from service and reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of the Nuclear Regulatory Commission license, Army reactor permit, or Army radiation authorization.

Decontamination
The removal of radiological contaminants from, or their neutralization on a person, object or area to within levels established by governing regulatory agencies.

Deep-dose equivalent
Applies to external whole-body exposure and is the dose equivalent at a tissue depth of 1 centimeter (1000 mg/cm2).

Delta (D)
The width of the gray region.

Dose equivalent
The product of absorbed dose in tissue, quality factor and all other necessary modifying factors at the location of interest in tissue. The units of dose equivalent are the rem and sievert (Sv).

Effective dose equivalent
The sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated.

Electron volt (eV)
A unit of energy equal to 1.6×10^{-19} joule.

Eye dose equivalent
Applies to the external exposure of the lens of the eye and is taken as the dose equivalent at a tissue depth of 0.3 centimeter (300 mg/cm^2).

Final Status Survey
Measurements and sampling to describe the radiological conditions of a site, following completion of decontamination activities (if any) in preparation for release.

Giga- (G)
An SI unit prefix indicating a factor of one billion (10^9).

Gamma radiation
Penetrating high-energy, short wavelength electromagnetic radiation emitted during radioactive transformation. Gamma rays are very penetrating and require dense materials for shielding.

Gray (Gy)
The SI unit of absorbed dose. One gray is equal to an absorbed dose 1 joule/kilogram (100 rads).

Gray region
A range of values of the parameter of interest for a survey unit where the consequences of making a decision error are relatively minor. The upper bound of the gray region in MARSSIM is set equal to the $DCGL_W$, and the lower bound of the gray region is a site-specific variable.

Impacted area
Areas with a possibility of containing residual radioactivity in excess of natural background or fallout levels.

Indistinguishable from background
The detectable concentration distribution of a radionuclide is not statistically different from the background concentration distribution of that radionuclide in the vicinity of the site or, in the case of structures, in similar materials using adequate measurement technology, survey, and statistical techniques.

Installation
A grouping of facilities located in the same vicinity, which support particular functions. Installations may be elements of a base. Land and improvements permanently affixed thereto which are under the control of the Department of the Army and used by Army organizations. Where installations are located contiguously, the combined property is designated as one installation and the separate functions are designated as activities of that installation. In addition to those used primarily by troops, the term "installation" applies to real properties such as depots, arsenals, ammunition plants (both contractor and Government operated), hospitals, terminals, and other special mission installations.

Investigation level
A derived media-specific, radionuclide specific concentration or activity level of radioactivity that: 1) is based on the release criterion; 2) triggers a response, such as further investigation or cleanup, if exceeded.

Ionizing radiation
Charged subatomic particles and ionized atoms with kinetic energies greater than 12.4 eV, electromagnetic radiation with photon energies greater than 12.4 eV, and all free neutrons and

other uncharged subatomic particles (except neutrinos and antineutrinos because they produce negligible ionization).

Kilo- (k)
An SI unit prefix indicating a factor of 1000.

Lower limit of detection (L_D)
The smallest amount of radiation or radioactivity that statistically yields a net result above the background. The critical detection level, L_C, is the lower bound of the 95% detection interval defined for L_D and is the level at which there is a 5% chance of calling a background value "greater than background." This value should be used when actually counting samples or making direct radiation measurements. Any response above this level should be considered as above background. This will ensure 95% detection capability for L_D. A 95% confidence interval should be calculated for all responses greater than L_C.

Micro- (m)
An SI unit prefix indicating a factor of one one-millionth (10^{-6}).

Milli- (m)
An SI unit prefix indicating a factor of one one-thousandth (0.001).

Minimum Detectable Concentration (MDC)
The minimum detectable concentration is the a priori activity level that a specific instrument and technique can be expected to detect 95% of the time. When stating the detection capability of an instrument, this value should be used. The MDC is the detection limit, L_D, multiplied by an appropriate conversion factor to give units of activity.

Non-impacted area
Areas where there is no reasonable possibility (extremely low probability) of residual contamination. Non-impacted areas are typically located off-site and may be used as background reference areas.

Nonparametric test
A test based on relatively few assumptions about the exact form of the underlying probability distributions of the measurements. As a consequence, nonparametric tests are generally valid for a fairly broad class of distributions. The Wilcoxon Rank Sum test and the Sign test are examples of nonparametric tests.

Outlier
Measurements that are unusually large or small relative to the rest and therefore are suspect of misrepresenting the population from which they were collected.

Qualified expert
A person who by virtue of training and experience can provide competent authoritative guidance about certain aspects of radiation protection. Being a qualified expert in one aspect of radiation protection does not necessarily imply that a person is a qualified expert in another aspect. *Forward requests for* determination of whether a certain individual is a qualified expert through command channels to the MACOM RPSO as necessary. Forward these requests to HQDA (DACS-SF), Washington, DC 203100200, for further evaluation as necessary.

Quality factor
The modifying factor [listed in tables 1004(b).1 and 1004(b).2 of 10 CFR20.1004] that is used to derive dose equivalent from absorbed dose.

Rad
A unit of absorbed dose. One rad is equal to an absorbed dose of 0.01 joule/kilogram (0.01 gray).

Radiation
For the purposes of this regulation, unless otherwise specified, radiation includes both ionizing and non-ionizing radiation.

Radiation area
An area, accessible to individuals, in which radiation levels could result in an individual receiving a dose equivalent in excess of 0.005rem (0.05mSv) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates.

Radiation protection
For the purposes of this regulation, a scientific discipline whose objective is the protection of people and the environment from unnecessary exposure to radiation. Radiation protection is concerned with understanding, evaluating, and controlling the risks from radiation exposure relative to the benefits derived. Also called "health physics" and "radiation safety."

Radiation Control Committee
An advisory committee for the commander to assess the adequacy of the command's radiation protection program.

Radiation Protection Officer
The person that the commander designates, in writing, as the executive agent for the command's radiation protection program. Also called "radiation safety officer" or "health physics officer."

Radiation protection program
A program to implement the objective of radiation protection.

a. The Army's radiation protection program includes all aspects of measurement and evaluation of radiation and radioactive material as they pertain to protection of personnel and the environment, and of the Army's radiation dosimetry, radiation bioassay, radioactive waste disposal, radiation protection training, and radiation instrument TMDE and calibration programs.

b. A command's radiation protection program includes all aspects of measurement and evaluation of radiation and radioactive material within the command as they pertain to protection of personnel and the environment.

Radioactive commodity
An item of Government property made up in whole or in part of radioactive material. A national stock number (NSN) or part number is assigned to commodities containing radioactive material greater than 0.01 microcurie.

Radioactive waste
Solid, liquid, or gaseous material that contains radionuclides regulated under the Atomic Energy Act, as amended, or is of sufficient quantity to require an Army radiation authorization, and is of negligible economic value considering the cost of recovery.

Radioactive waste, low-level
Material the NRC classifies as low-level radioactive waste (see 10 CFR 62.2); waste not classified as high-level radioactive waste (spent nuclear fuel), as transuranic waste, or as uranium or thorium tailings and waste; material acceptable for burial in a land disposal facility (10CFR 61).

Relative shift (Δ/σ)
The standard deviation of the measurements, is the relative shift expressed in multiples of the standard deviations.

Rem
A unit of any of the quantities expressed as dose equivalent. The dose equivalent in rems is equal to the absorbed dose in rads multiplied by the quality factor (1 rem = 0.01 sievert).

Shallow dose equivalent
Applies to the external exposure of the skin or an extremity and is taken as the dose equivalent at a tissue depth of 0.007 centimeter (7 mg/cm^2) averaged over an area 1 square centimeter.

Sievert (Sv)
The SI unit of any of the quantities expressed as dose equivalent. The dose equivalent in sieverts is equal to the absorbed dose in grays multiplied by the quality factor (1 Sv = 100 rems).

Sign test
A nonparametric statistical test used to demonstrate compliance with the release criterion when the radionuclide of interest is not present in background and the distribution of data is not symmetric.

Standing Operating Procedure (SOP)
A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps, and that is officially approved as the method for performing certain routine or repetitive tasks.

Survey
A systematic evaluation and documentation of radiological measurements with a correctly calibrated instrument or instruments that meet the sensitivity required by the objective of the evaluation.

Total effective dose equivalent
The sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

Unrestricted release
Release of a site from regulatory control without requirements for future radiological restrictions.

Weighting factor
For an organ or tissue, the proportion of the risk of stochastic effects resulting from irradiation of that organ or tissue to the total risk of stochastic effects when the whole body is irradiated uniformly.

Wilcoxon Sum Rank test
A nonparametric statistical test used to demonstrate compliance with the release criterion when the radionuclide of interest is present in background and the distribution of data is not symmetric.

APPENDIX C

BUILDING DIAGRAMS, SURVEY MEASUREMENTS, RESURVEY MEASUREMENTS

Historical Review of Affected Areas					
Room	Auth.	Final	Isotopes	mCi	Comments
1066	H05	2/99	Cr-51	1	
			Tc-99m	1	
			I-125	0.1	
There should be no long lived radionuclides in this room at the time of the survey. There were no records of spills or incidents in this room.					

Historical Review of Affected Areas					
Room	Auth.	Cleared	Isotopes	mCi	Comments
1082	H05	2/99	Cr-51	1	
			Tc-99m	1	
			I-125	0.1	
There should be no long lived radionuclides in this room at the time of the survey. A radioactive wash sink was used in this room. There were no records of spills or incidents in this room.					

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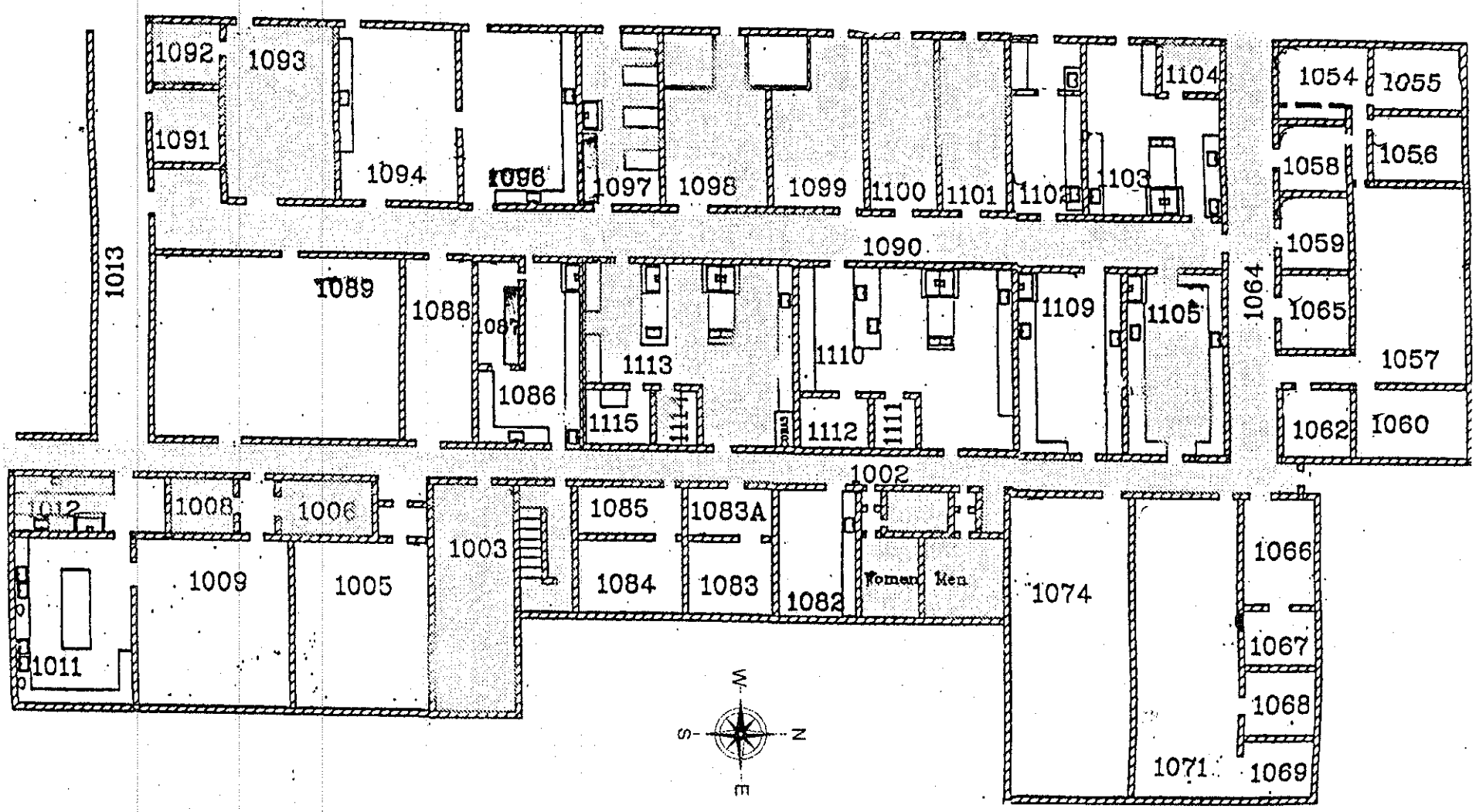
Room	Survey Unit	Sign Test				Notes
		Lab NaI	Lab LSC	GM Meter	NaI Meter	
Men	Class III	Pass	Pass	Fail	Fail	Higher background room
Women	Class III	Pass	Pass	Fail	Fail	Higher background room
Stairs	Class III	Pass	Pass	Fail	Fail	Higher background room
1,002	Class III	Pass	Pass	Pass	Fail	Higher background E&W walls
1,003	Class III	Pass	Pass	Pass	Fail	Higher background N&S walls
1,005	Class III	Pass	Pass	Pass	Pass	
1,006	Class III	Pass	Pass	Pass	Fail	Higher background N,E,W walls
1,008	Class III	Pass	Pass	Pass	Fail	Higher background all walls
1,009	Class III	Pass	Pass	Pass	Pass	
1,011	Class III	Pass	Pass	Pass	Pass	
1,012	Class III	Pass	Pass	Pass	Fail	Higher background all walls
1,013	Class III	Pass	Pass	Pass	Pass	
1,054	Class III	Pass	Pass	Pass	Pass	
1,055	Class III	Pass	Pass	Pass	Pass	
1,056	Class III	Pass	Pass	Pass	Pass	
1,057	Class III	Pass	Pass	Pass	Pass	
1,058	Class III	Pass	Pass	Pass	Pass	
1,059	Class III	Pass	Pass	Pass	Pass	
1,060	Class III	Pass	Pass	Pass	Pass	
1,062	Class II	Pass	Pass	Pass	Pass	
1,063	Class III	Pass	Pass	Pass	Pass	
1,064	Class III	Pass	Pass	Pass	Fail	Higher background all walls
1,066	Class II	Pass	Pass	Pass	Pass	
1,067	Class III	Pass	Pass	Pass	Pass	
1,068	Class III	Pass	Pass	Pass	Pass	
1,069	Class III	Pass	Pass	Pass	Pass	
1,071	Class III	Pass	Pass	Pass	Pass	
1,074	Class III	Pass	Pass	Pass	Pass	
1,076	Class III	Pass	Pass	Fail	Fail	Higher background room
1,080	Class III	Pass	Pass	Pass	Fail	Higher background room
1,082	Class II	Pass	Pass	Pass	Pass	
1,083	Class III	Pass	Pass	Pass	Pass	
1083A	Class III	Pass	Pass	Pass	Pass	
1,084	Class III	Pass	Pass	Pass	Pass	
1,085	Class III	Pass	Pass	Pass	Pass	

1,086	Class III	Pass	Pass	Pass	Pass	
1,087	Class III	Pass	Pass	Pass	Pass	
1,088	Class III	Pass	Pass	Pass	Pass	
1,089	Class III	Pass	Pass	Pass	Pass	
1,090	Class III	Pass	Pass	Pass	Fail	Higher background E&W walls
1,091	Class III	Pass	Pass	Pass	Fail	Higher background all walls
1,092	Class III	Pass	Pass	Pass	Fail	Higher background all walls
1,093	Class III	Pass	Pass	Pass	Fail	Higher background S,E,W walls
1,094	Class III	Pass	Pass	Pass	Pass	
1,096	Class III	Pass	Pass	Pass	Pass	
1,097	Class III	Pass	Pass	Pass	Fail	Higher background room
1,098	Class III	Pass	Pass	Pass	Fail	Higher background N,S,E walls
1,099	Class III	Pass	Pass	Pass	Fail	Higher background all walls
1,100	Class III	Pass	Pass	Pass	Fail	Higher background all walls
1,101	Class III	Pass	Pass	Pass	Fail	Higher background all walls
1,102	Class III	Pass	Pass	Pass	Pass	
1,103	Class III	Pass	Pass	Pass	Pass	
1,104	Class III	Pass	Pass	Pass	Fail	Higher background room
1,105	Class III	Pass	Pass	Pass	Fail	Higher background all walls
1,109	Class III	Pass	Pass	Pass	Pass	
1,110	Class III	Pass	Pass	Pass	Pass	
1,111	Class III	Pass	Pass	Pass	Pass	
1,112	Class III	Pass	Pass	Pass	Pass	
1,113	Class III	Pass	Pass	Pass	Fail	Higher background room
1,114	Class III	Pass	Pass	Pass	Fail	Higher background E&W walls
1,115	Class III	Pass	Pass	Pass	Pass	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APPENDIX D

SURVEY METERS, LABORATORY COUNTERS, QUALITY CONTROL DATA

1. The portable meters used in this survey include:

Manufacturer	Model	Serial Number	Calibrated	Calibration Due
Ludlum	Datalogger 2350	82942	23 Mar 99	19 Sep 99
Ludlum	Datalogger 2350	82953	23 Mar 99	19 Sep 99
Ludlum	Datalogger 2350	82941	25 Mar 99	21 Sep 99
Ludlum	Datalogger 2350	82960	25 Mar 99	21 Sep 99

2. The laboratory counters used in this survey include:

Manufacturer	Model	Serial Number	Calibrated	Calibration Due
Packard	2500TR	408523	Mar 99	Sep 99
Packard	2500TR	103407	Mar 99	Sep 99
Packard	5530	400577	Mar 99	Sep 99
Packard	Cobra	416334	Feb 99	Aug 99

3. All rooms surveyed on 15 April 1999 using the Ludlum Datalogger with the NaI probe were resurveyed on 23 April 1999 due the failure of the QC tests with the Cs-137 check source. The rooms resurveyed were the men's room, rooms 1009, 1067, 1068, 1071, and 1074.