



DEPARTMENT OF THE ARMY
U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE
5158 BLACKHAWK ROAD
ABERDEEN PROVING GROUND, MARYLAND 21010-5403

REPLY TO
ATTENTION OF

04 JUN 2001

MCHB-TS-OHP (40)

MEMORANDUM FOR Commander, U.S. Army Proponency Office for Preventive Medicine - San Antonio [MCPO-SA (MCHO-CL-W/COL Daxon)], 2050 Worth Road, Suite 10, Fort Sam Houston, TX 78234-6025

SUBJECT: Industrial and Environmental Radiation Survey Protocol No. 26-MF-6209-P-01, Final Status Survey, Walter Reed Army Institute of Research, Washington, D.C., April 2001

1. Copies of the subject protocol are enclosed. This plan was developed for Walter Reed Army Institute of Research, Washington, D.C., with respect to the Multi-Agency Radiation and Site Survey Investigation Manual (NUREG-1575). This plan supercedes the survey protocol dated 9 April, 2001.
2. If you have any questions, please cont Mr. John W. Collins or Mr. Lorus Miller at DSN 584-3502 or commercial (410) 436-3502.

FOR THE COMMANDER:

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

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INDUSTRIAL AND ENVIRONMENTAL RADIATION SURVEY PROTOCOL
NO. 26-MF-6209-P-01
FINAL STATUS SURVEY
WALTER REED ARMY INSTITUTE OF RESEARCH
WASHINGTON, D. C.
APRIL 2001

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Readiness Thru Health

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

The lineage of the U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) can be traced back over 50 years. This organization began as the U.S. Army Industrial Hygiene Laboratory, established during the industrial buildup for World War II, under the direct supervision of the Army Surgeon General. Its original location was at the Johns Hopkins School of Hygiene and Public Health. Its mission was to conduct occupational health surveys and investigations within the Department of Defense's (DOD's) industrial production base. It was staffed with three personnel and had a limited annual operating budget of three thousand dollars.

Most recently, it became internationally known as the U.S. Army Environmental Hygiene Agency (AEHA). Its mission expanded to support worldwide preventive medicine programs of the Army, DOD, and other Federal agencies as directed by the Army Medical Command or the Office of The Surgeon General, through consultations, support services, investigations, on-site visits, and training.

On 1 August 1994, AEHA was redesignated the U.S. Army Center for Health Promotion and Preventive Medicine with a provisional status and a commanding general officer. On 1 October 1995, the nonprovisional status was approved with a mission of providing preventive medicine and health promotion leadership, direction, and services for America's Army.

The organization's quest has always been one of excellence and the provision of quality service. Today, its goal is to be an established world-class center of excellence for achieving and maintaining a fit, healthy, and ready force. To achieve that end, the CHPPM holds firmly to its values which are steeped in rich military heritage:

- ★ *Integrity is the foundation*
 - ★ *Excellence is the standard*
 - ★ *Customer satisfaction is the focus*
 - ★ *Its people are the most valued resource*
 - ★ *Continuous quality improvement is the pathway*

This organization stands on the threshold of even greater challenges and responsibilities. It has been reorganized and reengineered to support the Army of the future. The CHPPM now has three direct support activities located in Fort Meade, Maryland; Fort McPherson, Georgia; and Fitzsimons Army Medical Center, Aurora, Colorado; to provide responsive regional health promotion and preventive medicine support across the U.S. There are also two CHPPM overseas commands in Landstuhl, Germany and Camp Zama, Japan who contribute to the success of CHPPM's increasing global mission. As CHPPM moves into the 21st Century, new programs relating to fitness, health promotion, wellness, and disease surveillance are being added. As always, CHPPM stands firm in its commitment to Army readiness. It is an organization proud of its fine history, yet equally excited about its challenging future.



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KEY PLAYERS FOR THE WRAIR BUILDING 40 SURVEY

1. Walter Reed Army Institute of Research (WRAIR) Property Transition Coordinator. Will provide logistics support as required for facility surveys and temporary workspace. [Mr. Richard Melton, (301) 319-9315].
2. WRAIR Safety Officer. Will provide needed support concerning safety issues. [MS Tanya Henson, (310) 319-9025].
3. Walter Reed Army Medical Center (WRAMC) Radiation Safety Officer (RSO) and Health Physics Office. Will provide historical information and records of past radioactive material surveys; provide onsite assistance to the radioactive material survey team. [COL Johnson and Mr. David Burton, (202) 356-0060/0062].
4. USACHPPM, Health Physics Program (HPP). Will manage the overall radiological survey efforts at the WRAIR. Will assist in coordination and staffing of all Army NRC with the Army, NRC and other regulatory agencies at the WRAIR request. Develop and staff the SP with WRAIR, NRC licensees, NRC and other regulatory agencies. Coordinate survey activities with the WRAIR. [Mr. John Collins, DSN 584-3502, commercial (410) 436-3502].
5. USACHPPM, Radiologic, Classic, and Clinical Chemistry Division (RCCCD). Will manage the overall Radiochemistry Laboratory efforts for the samples collected. Provide technical assistance to HPP, and perform all necessary laboratory analyses for samples generated for this project. [Mr. Gary W. Wright, DSN 584-8235, commercial (410) 436-8235].
6. Quality Assurance Officer. The USACHPPM may have available a Quality Assurance (QA) Officer to provide health physics and QA support to survey teams. The QA Officer may consult with survey officer(s) on compliance with the SP, the QA of collected data, instrumentation calibration and required daily checks, and perform radiological data reviews. In addition, the QA Officer may consult with the installation RSO on radiation protection issues, and advise support staff on proposed changes in the SP, or any identifiable potential radiological health hazard(s) and technical requirement(s). [Sam Dunston, USACHPPM, Henry M. Jackson Foundation (HMJF) Participant, DSN 584-3502, commercial (410) 436-3502].

TENTATIVE SCHEDULE

1. The draft SP completed by USACHPPM in January 2001.
2. Submit SP to WRAIR for staffing to include WRAMC Health Physics Office in January 2001.
3. Coordinate availability of support with WRAIR upon completion of biological and chemical surveys (Tentative chem/bio completion February 2001; facility available April 2001).
4. Coordinate laboratory support with RCCCD at USACHPPM (tentative April 2001).
5. USACHPPM personnel and the QA Officer are scheduled to arrive onsite during Fiscal Year 2001. Time may be scheduled for training, and SP indoctrination sessions, survey instrumentation familiarization sessions, and review of all stakeholders' roles as required.
6. Radiological surveys will start after appropriate training has been completed.

SECTION 1

INTRODUCTION

1.1 This SP pertains to the WRAIR Building 40 facilities and areas (except the reactor and associated areas) that had operations involving radioactive materials that contained NRC licensed and/or DA authorized radioactive materials. Transition of Building 40 for unrestricted use is the intent of this survey.

1.2 This SP follows the content specified in NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). The SP may be submitted for comment by the licensee to the appropriate regulator(s) for their consideration and review. The final SP should be made available to the public through local public repositories, when requested.

1.3 This SP may address radioactive material(s) used under the control of specific NRC licenses, Army Radiation Authorization (ARA), formerly termed DA radiation authorization (DARA), and those radioactive materials that do not require a specific license to possess and use. Radioactive material may have been used at WRAIR to conduct and support medical and research procedures.

1.4 Army Technical Bulletin 43-0116 contains a listing of radioactive items that may be used and stored at Army installations. This is an extensive list, not all of which is applicable to WRAIR.

SECTION 2

HISTORICAL SITE ASSESSMENT

2.1 Historical document and data reviews were conducted to aid in identifying facilities or areas that may have been involved in usage or storage of radioactive material.

2.2 The primary objectives of the Historical Site Assessment are to:

2.2.1 Identify known, likely or potential sources of radioactive material and radioactive contamination based on available information to support the initial classification of areas.

2.2.2 Determine whether or not sites pose a threat to human health and the environment.

2.2.3 Differentiate impacted from non-impacted areas.

2.2.4 Provide information useful in the development of the scoping survey and characterization survey plans.

2.2.5 Provide assessment of the likelihood of contamination migration.

2.2.6 Identify additional potential radiation sites related to the site being investigated.

2.3 Document and data review:

2.3.1 All applicable NRC licenses, ARAs/DARAs, permits and supporting documents which will identify the radioisotopes, quantities, activities, chemical and physical form of the radioactive material authorized for possession, operations, locations and total quantities/activity used at the site during its operating lifetime.

2.3.2 All radiation survey results; leak test results; acquisition, inventory, transfer and disposal records; minutes of the radiation control committee; inspection and audit reports will provide a status of the radiation control program at the site.

2.3.3 Operating records will provide information on demolition, landfilling, spills, fires, pipe or tank leaks, accidents/incidents that may have resulted in the release or spread of radioactive contamination.

2.3.4 Information concerning past site activities beyond expected locations old drawings, maps, photographs, and local newspaper articles.

2.3.5 Interviews should be conducted of the site/ installation RSO, safety officer, public affairs, environmental and property disposal personnel, current and former employees that worked at the site/installation to obtain a balance view of operations involving radioactive material. Typical questions asked may include, but not be limited to the following:

2.3.5.1 What is your name and what is/was your job title/position?

2.3.5.2 During what span of years have you worked at this installation?

2.3.5.3 How many years have you worked with radioactive materials?

2.3.5.4 Were you provided radiation protection training; how involved was the training? Who provided the training? Was there documentation of training?

2.3.5.5 Were you provided personnel monitoring dosimeters, medical examinations, personnel protection equipment, or RADIAC survey meter?

2.3.5.6 Did your supervisors participate in the training? In what way?

2.3.5.7 What type or kind of radiation protection procedures were provided to you and your fellow workers?

2.3.5.8 What is/was your connection with radioactive material use? What isotopes are/were involved?

2.3.5.9 Describe a typical day involving radioactive material in your work area.

2.3.5.10 Can you name or identify the radioactive items or commodities you or anyone else might have worked with on the installation?

2.3.5.11 Can you identify any locations of known use or storage of radioactive material on the installation?

2.3.5.12 Are you aware of any other areas or buildings posted with a radioactivity warning sign on the installation?

2.3.5.13 Are you aware of the presence of any exit signs bearing a radioactive warning label?

2.3.5.14 Did any of the radioactive commodities have radium-226, cesium-137, or cobalt-60? How did you handle items that contained radium-226?

2.3.5.15 Did your Standard Operating Procedure (SOP) address disposal of radioactive materials or contaminated material/waste? Where were they disposed of? Was it ever buried onsite or transferred to a landfill as normal trash?

2.3.5.16 Were electronic maintenance activities performed on equipment with electron tubes?

2.3.5.17 Describe what would happen if a radioactive item or commodity was damaged or broken. Who would you tell? What special procedures would have been implemented?

2.3.5.18 Do you recall any instance of broken or leaking sources or other contamination incidents or accidents?

2.3.5.19 Were any foreign materials ever handled/stored in your work area or elsewhere on the installation?

2.4 Initial classification of areas:

2.4.1 Based on a review of readily available information and a walk-through of the areas/facilities, an initial classification was made on the potential for radioactive contamination per guidance in NUREG/CR-5849.

2.4.2 The classification of areas are:

2.4.2.1 Affected Area(s): Area(s) that have the

potential for radioactive contamination (based on facility operating history) or known radioactive contamination (based on past or preliminary radiological survey/surveillance). This would normally include areas where radioactive materials were used and stored, where records indicate spills or other unusual occurrences that could have resulted in the spread of radioactive contamination, and where radioactive materials were buried. Areas immediately surrounding or adjacent to locations where radioactive materials were used or stored, spilled, or buried are included in this classification because of the potential for the inadvertent spread of radioactive contamination. Affected areas are further divided into those areas that are considered to have a potential for containing small areas of elevated residual radioactivity (hot spots) in excess of the regulatory guideline levels and those in which such areas of elevated radioactivity would not be anticipated. (If there is any doubt, the area should be designated as an affected area).

2.4.2.1.1 Affected/Non-Uniform Area: An area that has the potential for a non-uniform or spotty residual radioactivity pattern. Indoor survey units that are classified as affected/non-uniform will generally consist of a single room.

NOTE: Any area that has been remediated or decontaminated shall be designated as affected/non-uniform. In general, all areas shall be treated as affected/non-uniform until substantial bases are provided to reclassify them to either affected/uniform, unaffected, or non-impacted area.

2.4.2.1.2 Affected/Uniform Area: An area with little or no potential for non-uniform or spotty residual radioactivity.

2.4.2.2 Unaffected Area: Any area that is not expected to contain any residual radioactivity based on a knowledge of site history and previous radiological survey information. The unaffected areas of a facility may consist of a single survey unit of unlimited size.

2.4.2.3 Non-Impacted Area: Any area that has no potential for residual radioactive contamination.

2.5 MARSSIM Guidance for Classification of Areas.

2.5.1 Based upon guidance available from MARSSIM following the initial historical site assessment, a revision to area

classification was warranted.

2.5.2 The classifications of areas are:

2.5.2.1 Class 1 Area: Area(s) that have, or had prior to remediation, a potential for radioactive contamination or known contamination. (Equivalent to affected/non-uniform area).

2.5.2.2 Class 2 Area: Area(s) that have, or had prior to remediation, a potential for radioactive contamination or known contamination, but are not expected to exceed release guidelines. (Equivalent to affected/uniform area).

2.5.2.3 Class 3 Area: Any impacted areas that are not expected to contain any residual radioactivity or are expected to contain levels of residual radioactivity at a small fraction of the release guidelines. (Equivalent to unaffected area).

NOTE: For the USACHPPM close out survey areas an initial Class 3 area designation is assigned. This is based on considerations that areas are not expected to contain any residual radioactivity, or are expected to contain levels of residual activity at a small fraction of the release guidelines based on site operating history, short half-life of many isotopes of concern, past routine surveys, and clean up actions for other survey phases. Area reclassification and resurvey will be evaluated based on survey results.

SECTION 3

DATA QUALITY OBJECTIVES AND STATISTICAL CONCEPTS

3.1 The end-of-use decommissioning process requires designing radiological survey plans that will ensure that the radiological data and samples that are collected and analyzed are of the type, quantity, and adequate quality for decision making purposes that will permit the release of the property for unrestricted or restricted use.

3.2 The Data Quality Objective (DQO) process is intended to:

3.2.1 Clearly and concisely define the radiological study based on the historical site assessment and considering the interaction of technological, economical, societal, and political factors.

3.2.2 Define the appropriate radiological data and samples to be collected.

3.2.3 Determine the appropriate methods and conditions for collecting the radiological data and samples.

3.2.4 Specify acceptable statistical levels of decision errors that will be used as the basis for establishing the quantity and quality of the radiological data and samples required to support the decision making process.

3.3 The DQO approach is to:

3.3.1 Identify radionuclides, pathways, media, and types of measurements and samples.

3.3.2 Review default concentrations for scenario and release criteria.

3.3.3 Determine if the radionuclide is present in the reference or background area and establish the requirements of statistical tests.

3.3.4 Select instrumentation based on radionuclides and detection limits. (The less precise the measurement, the greater the number of measurements that will be required for the statistical tests to achieve the desired level of uncertainty).

3.3.5 Establish personnel and training levels needed to conduct the radiological surveys.

3.4 The 10 CFR 20.1402 specifies that the unrestricted release criteria resulting from residual radioactivity that is distinguishable from background radiation will not exceed 25 milliRoentgen-equivalent-man (mrem) [0.25 millisievert (mSv)] per year total effective dose equivalent (TEDE) to the average member of the critical group and that residual radioactivity has been reduced to levels that are as low as is reasonably achievable (ALARA).

3.5 The TEDE for restricted release is 100 mrem (1 mSv) per year to the average member of the critical group and that residual radioactivity has been reduced to levels that are ALARA, as defined in 10 CFR 20.1403. This dose limit would result in an estimated lifetime risk of premature cancer death of 1 in 300.

3.6 In the practice of radiation protection, the public health risk is modeled as a linear function of dose. Therefore, a 10% change in dose, results in a 10% change in risk, when the risk is linear with dose, then higher values of alpha (α), where alpha is a false positive result, at the release criterion might be considered adequately protective when the design results in a smaller decision error rates at doses greater than the release criterion. False positives will tend to be negated by false negatives across sites and survey units, resulting in minimal human health risks.

3.7 Following the radiological evaluation of the reference area(s), the site survey(s) are designed to support a comparison of the concentration or dose distribution of the radionuclide(s) in the survey unit(s) to the background concentration or dose distribution for the radionuclide(s) in a reference area. The distributions of background and residual radioactivity levels would then be statistically compared to determine whether the difference between the two distributions are distinguishable. If the radioactive concentrations or dose distributions are less than the release criteria at acceptable error rates, then the site or area is acceptable for either unrestricted release or restricted release, respectively.

3.8 For radiological survey measurements or sample analysis results that are at or near background, there may be some data which are at or below instrumental detection limits. Such data

are not easily evaluated using parametric or normal statistical methods. Nonparametric statistical techniques are often a better approach to making inferences from such data.

3.9 Any one nonparametric statistical test may perform better or worse than others, depending on the hypothesis to be tested, i.e., the decision to be made and the alternative. The Wilcoxon Rank Sum (WRS) should be used when the decision is whether or not a degree of residual radioactive contamination remains throughout the entire area or site. In comparison, the Quantile test should be performed to determine smaller areas with somewhat elevated or higher radioactive contamination concentrations. If more than 40% of the data for either the reference area(s) or survey unit(s) are "less than" measurements, do not use the WRS Test, but still conduct the Quantile test. The release standard for the WRS test is $P_r = 0.5$. For the Quantile test, the release standard is $e=0$ and $?/d = 0$.

3.10 Hypotheses testing of the WRS and Quantile tests.

3.10.1 Hypotheses testing of the WRS Test:

3.10.1.1 The Null Hypothesis (H_0) is $P_r=0.5$. The median or mean concentration in the survey unit is the same as that in the reference area.

3.10.1.2 The Alternative Hypothesis (H_a) is $P_r > 0.5$. The median or mean concentration in the survey unit is higher than that in the reference area.

Note: P_r is the probability that a measurement of a sample collected in the survey unit is greater than a measurement of a sample collected in the reference area.

3.10.2 Hypotheses testing of the Quantile Test:

3.10.2.1 The Null Hypothesis H_0 is $e = 0$ and $?/d = 0$.

3.10.2.2 The Alternative Hypothesis (H_a) is $e > 0$ and $?/d > 0$.

Note: e is the proportion of the survey unit that has not been remediated to the reference-area level. σ/d is the amount that the distribution of $e\%$ of the measurements in the survey unit that is shifted to the right (to higher measurements) of the distribution in the reference area.

3.11 There may be two nonparametric tests performed and an elevated measurement comparison be conducted for each survey unit. The WRS test may be used to detect uniform failure of remediation activities throughout a survey unit. The Quantile test will be used to detect when remediation activities have failed in only a few areas within a survey unit. An additional comparison will be made to determine if there are any individual measurements that exceed an investigation or "flagged" level. The investigation level is established at three standard deviations above the mean concentration or dose limit in the survey unit. This comparison acts as a "fail-safe" parameter to ensure that any unusually elevated or high measurement will be investigated further to determine the cause.

3.12 The WRS and Quantile are two-sample tests. Two sample tests are a comparison between the data from the survey unit and the reference area. The Sign test and Quantile (binomial), which are one-sample tests, should be used when there is no need to compare the data from the survey unit with that of the reference area. The one sample test is appropriate when the radionuclide of concern does not appear or exist in the background and when radionuclide-specific measurement methods are used. Large differences between the mean and the median may indicate skewedness in the data. If the distribution of measurements is symmetric, then the median and the mean of the measurements are the same. The Sign test may be used to compare the mean or median of a set of measurements in a survey unit to a fixed or default value, namely the derived concentration or dose conversion factor for a specific radionuclide from NUREG-1500 or the regulator.

3.13 Random fluctuations in measurement data are of no concern provided the mean residual radioactivity satisfies the WRS and Sign tests for meeting the release criteria.

3.14 The use of statistical methods allows for controlling the probability of making decision errors. When designing a statistical test, the acceptable error rate for incorrectly

determining that a site meets or does not meet the applicable release criteria must be specified. In determining these error rates, consideration must be given to the number of sample data points to achieve them. Lower error rates (or greater levels of confidence and statistical power of the test) will require more radiation measurements and samples.

3.15 In the performance of statistical tests, the Null and Alternative hypotheses need to be established. For example, these hypotheses may be stated as follows:

3.15.1 Null Hypothesis (H_0): The survey unit(s) contain no residual radioactivity above the release criteria.

3.15.2 Alternative Hypothesis (H_a): The survey unit(s) contain residual radioactivity above the release criteria.

3.16 In order to incorporate these concepts into the decision-making process, the Null and Alternative hypotheses may be restated as follows:

3.16.1 Null Hypothesis (H_0): The survey unit(s) contain no residual radioactivity that is distinguishable above natural background.

3.16.2 Alternative Hypothesis (H_a): The survey unit(s) contain residual radioactivity that result in a TEDE that is greater than 3 mrem (0.03 mSv) per year above background but less than 15 mrem (0.15 mSv) per year.

3.17 There are two types of decision errors that can be made when performing the statistical tests described herein.

3.17.1 A Type I or "false positive" error would occur if it were concluded from the measurement data that the survey unit had not been successfully remediated when it actually had been. If the Type I error rate is α , then the probability that the value of the parameter specified in the Null Hypothesis of the statistical test lies in the confidence interval is $1 - \alpha$. The $1 - \alpha$ value is many times mistakenly referred to as the confidence level of the statistical test.

3.17.2 A Type II or "false negative" would occur if it were concluded from measurement data that the survey unit had been successfully remediated when it actually had not been.

3.18 The power of a statistical test is defined as the probability of rejecting the Null Hypothesis when it is false. This value is numerically equal to $1 - \beta$, where β is the Type II error rate. The statistical test must have high power value. The power of the statistical tests will tend to increase as the amount of residual radioactivity in the survey unit increases. Type II errors can potentially impact public health and safety and the environment from the excessive residual radioactivity; therefore, there is less tolerance for Type II errors than for Type I errors.

3.19 The following table provides a summary of generally acceptable decision errors. It will be noted that there is a 5% chance that the survey unit would be incorrectly identified as being at the background (Type I error at 5%) and a 2.5% probability that the survey unit would be incorrectly identified as contaminated when it actually met the release criteria (Type II error at 97.5%).

TABLE 3-1
SUMMARY OF TYPES OF DECISION ERRORS

Decision Based on Sample Data	Standard Achieved	Standard Not Achieved
Standard Achieved	Correct Decision (Probability = 2.5%)	Type II (β) Error (Probability = 5%)
Standard Not Achieved	Type I (α) Error (Probability = 97.5%)	Correct Decision (Probability = 95%)

3.20 The consequence of a higher value for the Type I error is that there is a higher probability that the area or site will be identified as contaminated when in fact it is not. The consequences of a higher value for the Type II error is that there is a higher probability that the site or area will be identified as meeting the release criteria (clean) when in fact it does not meet the release criteria. The power ($1 - \beta$) is to detect when the survey unit does not meet the applicable release criteria. The test should have high power, i.e., small β , but smaller values of α and β require a larger number of measurements.

3.21 When survey results/data are used to support a decision, the decision maker needs to ensure that the survey data will support that decision with satisfactory confidence. Appropriate

actions must be taken to manage the uncertainty in the survey results so that sound and defensible decisions may be made. The uncertainty in survey results arises primarily from two sources: the survey design errors and the measurement errors.

3.22 Survey design errors occur when the survey design is unable to capture the complete extent of variability that exists for the radionuclide distribution in a survey unit.

3.23 Measurement errors credit uncertainty by masking the true level of residual radioactivity, and are generally classified as random errors or systematic errors.

3.23.1 Random errors affect the precision of the measurement system, and show up as variations among repeated measurements.

3.23.2 Systematic errors show up as measurements that are biased to give results that are consistently higher or lower than the true value.

3.24 Data Life Cycle (DLC) is used to control, minimize; and to estimate uncertainty in the decisions made based on the survey results. There are four phases of the DLC:

3.24.1 Planning phase.

3.24.2 Implementation phase.

3.24.3 Assessment phase.

3.24.4 Decision phase.

3.25 The concentration of the residual radioactivity and the resulting TEDE are two important parameters used for making decisions based on survey results.

3.26 If the radionuclide is present in the background, then the concentration of residual radioactivity is the difference between the measured concentration of the radionuclide in the survey unit and the measured concentration of the radionuclide in the reference data.

3.27 If the radionuclide is not present in the background, then the concentration of residual radioactivity is simply based on

measurements in the survey unit.

3.28 Radiation dose standards may be calculated for various pathways and scenarios through which potential exposures might occur. These standards, based on risk considerations and scientific data relating dose to risk, are known as the Derived Concentration Guideline Level (DCGL). A generic or default DCGL may be obtained from NUREG-1500 or the regulator. The units for the DCGL are the same as units for measurements performed to demonstrate compliance [picocurie per gram (pCi/g), Becquerel per kilogram (Bq/kg), disintegrations per minute/100 centimeters squared (dpm/100 cm²), Becquerel per meter squared etc.]. This allows the direct comparisons between the survey results and the DCGL.

3.29 There are two potential DCGLs based on the area of radioactive contamination.

3.29.1 DCGL_w, is the DCGL used if residual radioactivity is evenly distributed over an area, such as a survey unit. The DCGL_w is derived based on an average concentration over a large area. (WRS applies for contaminant in background, Sign test otherwise.)

3.29.2 DCGL_{emc}, the DCGL used for elevated measurement comparison; if there are small areas of elevated radioactivity within a larger area, such as a survey unit. The DCGL_{emc} is used for the elevated measurement comparison; that is derived separately for these small areas, generally it is based on different exposure assumptions than those used for larger areas, but does not exceed the release criteria.

3.30 Two statistical tests are used to evaluate data from the Characterization Survey. For radioactive contaminants that are present in the natural background, the WRS test is used. If the radioactive contaminants are not present in the natural background then the Sign test should be used to evaluate the data. The established decision error (Type I or Type II) rates are a function of the amount of residual radioactivity.

3.31 Hypotheses testing of the Sign test, when there is no reference area data or the radionuclide is not present in the background.

3.31.1 The Null Hypothesis (H₀) is that the median is less

than or equal to zero or $p \leq 0.5$.

3.31.2 The Alternative Hypothesis (H_a) is that the median is greater than zero or $p > 0.5$.

3.32 The number of radiation measurements and samples required for nonparametric statistical tests does not directly depend on the survey unit size. However, when the concern is to find areas of elevated data, then the area of the survey unit must be explicitly taken into account. The WRS test will be used to calculate the number of samples required to achieve the decision errors stated (see NUREG-1575, 5.5.2.2 and 3). The total number of measurements or samples required will depend upon the nature of the facility, its size and the probabilities one is willing to accept that release criteria have been achieved. The potential dose increment above background will depend upon the amount of variability in the background values of the radionuclides being investigated. It is desirable for the reference area to be approximately the same size as the applicable survey unit. The reference area should be large enough to encompass variability of background conditions encountered in the survey units to which it is compared. Determine the number of samples using the WRS Test. The effects of variability in the measurement data will be an increase in the required sample size.

3.32.1 The number of survey or sample data points, N , to be obtained from each reference area and survey unit paired for the WRS Test is calculated as follows:

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

WHERE:

N = Total number of data points
 $Z_{1-\alpha}$ = Value from the normal distribution
 $Z_{1-\beta}$ = Value from the normal distribution
 P_r = A specified probability required to detect from the survey unit is greater than a random measurement from the reference area (see Table 5.1, NUREG-1575). It is determined using the specified shift μ/d that must be detected with a power of $1-\beta$.

3.32.2 If:

$$Z_{1-\alpha}(\alpha = 0.05) = 1.645 \text{ and } Z_{1-\beta}(\beta = 0.975) = 1.960$$

$$\text{Then: } (Z_{1-\alpha} + Z_{1-\beta})^2 = (1.645 + 1.960)^2 = 13$$

Example: A site has 14 survey units and 1 reference area. The same radiation survey instruments and method were used to perform the measurements in each area. The radioactive contaminant has a DCGL of 160 dpm; the contaminant is present in the natural background at a level of $45 \pm 7(1d)$ dpm. In the survey unit, the level is $80 \pm 20(1 d)$ dpm. Note: When the estimated standard deviation in the reference area and the survey unit(s) are different, the larger value, in this case 20, should be used. The value of the relative shift (δ/d) is $(160-80)/20=4$; from Table 5.1, NUREG-1575, the value of P_r , is approximately 1.

The number of data points for the WRS Test of each combination of reference area and survey units is calculated using the equation as follows:

$$N = [(1.645 + 1.960)^2] / [3(1 - 0.5)^2] = 13/0.75 = 17.33$$

Therefore, when rounded to next highest even number, $N = 18$

Of this total $18/2 = 9$ would be from the reference area and $18/2$ (9) would be from each survey unit, an additional 20% should be added to ensure that the power of the test will not be underestimated and to allow for missing, lost or unusable data. Therefore, there should be $9 \times 1.2 = 11$ data points for the reference area and 11 for each of the 14 survey units.

3.33 For a radioactive contaminant which is not present in the background the Sign Test may be used to calculate the required total number of survey points and therefore, replaces the two-sample WRS Test. The Sign Test equation:

$$N = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(\text{Sign } p - 0.5)^2}$$

WHERE:

- N = Number of data points
- $Z_{1-\alpha}$ = Value from the normal distribution
- $Z_{1-\beta}$ = Value from the normal distribution
- Sign p = An estimated probability that a random measurement from the survey unit will be less than the $DCGL_w$ when the survey unit median is actually at the LBGR (Table 5.4,

MARSSIM). It is determined using the specified relative shift
?/s.

3.34 The number of samples or data points should be increased by 20% and rounded up to the next even number to ensure that the power of the test will not be underestimated and to allow for missing, lost or unusable data. The number of data points or samples to be collected may be calculated using both the WRS and Sign tests and the larger number of data points or samples may be taken or a determination based on radionuclide being present in background (use WRS) or not present in background (use Sign test).

3.35 The elevated measurement comparison consists of comparing each measurement from a survey unit to release criteria. All areas of elevated residual radioactivity (3 standard deviations above the mean) must be investigated regardless of the outcome of the statistical test.

3.36 Large variability tends to reduce the power of statistical tests. Outliers (unusually large measurements relative to most of the measurements in the data set) should not be removed from the data set unless they can be shown to be actual mistakes or errors. The Quantile test can be viewed as the statistical test for multiple outliers in the survey unit data set, where the standard for comparison is the data set for the site-specific reference area.

3.37 The pooling of data sets should only be done when all the data were selected using the same sample collection, handling and preparation procedures. It is not correct to pool data simply to achieve a desired test result.

3.38 Frequently, measurements of concentrations of radionuclides in a media will be reported by the analytical laboratory as being less than the lower limit of detection. These measurements are often called "less-than data," and the data sets containing less-than data are called censored data sets. The WRS Test will allow for "less-than" measurements to be present, in the reference area and the survey units (see paragraph 3.9).

3.39 Whenever possible all survey units should be approximately the same size so that the number of samples and the distance between samples in the field will not be greatly different for the survey units. For similar reasons, it is desirable for the

reference area to be approximately the same size as that of the applicable survey unit. However, the reference area should be large enough to encompass the full range of background conditions.

3.40 There are many ways to select sampling locations. The following are examples to select sampling locations for assessing if a spill remediation effort has succeeded in attaining the release criteria: simple random sampling, stratified random sampling, systematic sampling, or sequential sampling.

3.41 In general, the probability of detecting an area of elevated radioactivity of elliptical shape, one or more times, is greater using an equilateral triangular grid than a square grid. When the density of sample points is the same for both types of grids for the area being investigated, the use of a random-start is preferred. However, it is impossible to duplicate the assessment for radioactive contamination if this method is used. The midpoint of the northwest corner grid is acceptable for start point. The grid points or sampling locations must not correspond to patterns of high or low concentrations. If such a correspondence exists, the measurements and statistical test results could be very misleading. In that case, simple random sampling within each survey unit could be used, but a uniform coverage would not be achieved. The unaligned grid technique, which incorporates an element of randomness in the choice of sample locations, would do a better job of avoiding biased sampling while retaining the advantage of uniform coverage.

3.42 Data Quality Assessments (DQA) is the evaluation of (scientific and statistical) data to determine if the data are of the proper type, quality and quantity to support the decision-making process.

3.43 There are five basic steps in the DQA process:

3.43.1 Review the DQOs, survey unit classification, sampling plan/survey protocol, and the QA Reports.

3.43.2 Conduct a preliminary data review, which includes calculating the mean, standard deviation, median, maximum, minimum and range, and determine data distribution (symmetric or asymmetric).

3.43.3 Select the appropriate statistical test(s).

3.43.4 Verify the assumptions of the statistical tests.

3.43.5 Perform the statistical tests (it should be noted that the WRS test assumes that reference area data and the survey unit data distribution are the same except for possible shift in the mean).

3.44 Table 3-2 provides conditions for demonstrating compliance based on survey unit classification to be used during the survey planning phase. Large variability tends to reduce the power of statistical tests. Outliers (unusually large positive or negative measurements in the data set) should not be removed from a data set unless they can be shown to be actual mistakes or errors. The Quantile test can be viewed as the statistical test for multiple outliers in the survey unit data set, where the standard for comparison is the data set for the site-specific reference area.

TABLE 3-2

RECOMMENDED CONDITIONS FOR DEMONSTRATING COMPLIANCE BASED ON SURVEY UNIT CLASSIFICATION
(Conditions Adapted from MARSSIM Tables 2.2 and 5.9)
(Survey Unit Size from MARSSIM Section 4.6)

Survey Unit Classification	Wilcoxon Test	Elevated Measurement Comparison	Sampling/ Direct Measurement	Surface Scan	Typical Survey Unit Sizes (m ²)			
					OUTDOOR		INDOOR	
					Maximum	Minimum	Maximum	Minimum
Non-Impacted	No	No	No	None	NA	NA	NA	NA
Class 1	Yes	Yes	Systematic	100%	Up to 2000	NA	Up to 100	NA
Class 2	Yes	Yes	Systematic	10 to 100% (*) (Systematic and Judgmental)	10000	2000	1000	100
Class 3	Yes	Yes	Random	Judgmental	No limit	No limit	No Limit	No limit

(*) In Class 2 areas 10 to 50% surface scan for upper walls and ceilings (above 2 meters). Surface scans are systematic and judgmental.

SECTION 4

SCOPING SURVEY

4.1 The scoping survey is the initial radiological data acquisition survey performed at the site. The scoping survey will consist of surface scans, direct radiation measurements, and samples (e.g., smears/wipes) obtained from site locations considered most likely to have residual radioactivity, site locations immediately adjacent to where radioactive materials were used and stored, and areas not expected to have been affected by site operations. The scoping survey does not require that all radiological parameters be assessed.

4.2 The objectives of the scoping survey are to:

4.2.1 Augment the historical site assessment for sites with the potential for residual radioactive contamination.

4.2.2 Identify what radionuclides are present as contaminants.

4.2.3 Determine the relative ratios in which the radionuclides occur.

4.2.4 Determine the general levels and extent of the radioactive contamination.

4.2.5 Provide information necessary to estimate the level-of-effort required to release the site for unrestricted use.

4.3 The scoping survey provides current radiological assessment of site conditions, relative to established guideline values and enables the refinement in the classification of the site into Class 1, Class 2, or Class 3 impacted areas or "non-impacted" areas (MARSSIM 4.4).

4.4 Areas that have, or had prior to remediation, a potential for radioactive contamination (based on operating history) or known contamination (based on previous radiological surveys) will be classified as Class 1. Examples are:

4.4.1 Site areas previously subjected to remedial action.

4.4.2 Locations where leaks or spills are known to have

occurred.

4.4.3 Former burial or disposal sites.

4.4.4 Waste storage sites.

4.4.5 Areas with contaminants in discrete solid pieces of material high in specific activity.

4.4.6 Areas containing contamination in excess of the DCGL_w prior to remediation.

4.5 Areas that have a low probability of radioactive contamination (areas that stored operational or functional commodities, and areas where there are good records of leak tests, smear/wipe tests or other radiological surveys are available and support the conclusion that radioactive contamination is unlikely) will be surveyed as Class 2 areas.

4.6 Areas that are not expected to contain any residual radioactivity, or are expected to contain levels of residual activity at a small fraction of the release guidelines based on site operating history will be surveyed as Class 3 areas.

4.7 Areas that have no potential for residual radioactive contamination (family housing, post exchange, chapel, library, commissary, gym, auditorium, office suites) are classified as non-impacted areas. No radiological surveys are required.

4.8 The customer should be notified if the residual radioactive contamination exceeds the release criteria or remediation of an area is required. Additionally, the customer should be consulted when a site area requires a change of status or if a Characterization Survey is required.

4.9 The instrumentation, procedures and survey techniques used will meet the standards of a Final Status Survey. This will enable those areas where the survey data meets the requirements for release to unrestricted use to be incorporated into the final report; therefore, eliminating the need for further sampling or surveys.

SECTION 5

CHARACTERIZATION SURVEY

5.1 The characterization survey will be designed to concentrate on those portions of the site which have been identified (by historical site assessments or scoping surveys) to have been affected by operations involving radioactive materials.

5.2 The objectives of the characterization survey are to:

5.2.1 Define the quantities and special distribution of the residual radioactivity onsite.

5.2.2 Define the boundaries of residual radioactivity onsite.

5.2.3 Define the extent and magnitude of residual radioactivity in sufficient detail to produce the data required for the decision making process.

5.2.4 Provide the basis for acquiring the necessary technical information to develop, analyze, and determine appropriate techniques to remediate the area/site.

5.3 The extent of the survey depends on how the survey information will be used. For example, if the site records or the scoping survey show that the area is contaminated, the characterization survey may only be designed to define the boundaries of contamination in support of planning associated with decontamination activities. Alternatively, if the survey area is expected to be uncontaminated, the survey may be more detailed so that the information can be used to support the Final Status Survey (FSS). If the results are to be used to support the FSS, the characterization surveys will be sufficiently detailed to demonstrate compliance with NRC and other regulatory requirements. Characterization surveys are meant to define the extent and magnitude of contamination in sufficient detail to produce data for planning the decontamination effort. The type of information obtained is often limited to that necessary to differentiate a surface or area as contaminated or not contaminated. A high degree of accuracy may not be required for such a decision, when the data indicate levels well above the applicable decommissioning criteria. On the other hand, when data are near the limit, a higher degree of accuracy is usually

necessary to assure the appropriate decision regarding the true radiological condition.

5.4 The source term consists of all residual radioactive materials remaining at the site that is distinguishable from the background. Actual measurements from the site survey data, rather than modeling, should be used to estimate the source term.

5.5 The estimated source term is used to estimate the predicted dose level (PDL) for the site (see NUREG-1505 and NRC Regulatory Guide DG-8017 for details).

5.6 The release criteria in 10 CFR 20, Subpart E, would be difficult and expensive to verify with environmental samples alone. There are models that provide methodologies for translating the residual radioactivity at the site using the estimated Site Source Term (SST) and generic dose conversion factors in NUREG/CR-5512. There are currently two levels of screening which allow the models to be applied in a flexible manner. Level 1 screening uses default pathways and parameter values in NUREG/CR-5512 and require only the SST. Level 2 screening allows that some default pathways and parameters to be changed based on site-specific data. These models can be evaluated using Decontamination and Decommissioning (D & D) screening computer code methodologies (see NUREG/CR-5512 and NRC Regulatory Guide DG-8017 for details). If the PDL is less than the release criteria of 25 mrem/y (0.25 mSv/y) and it can be demonstrated to be in compliance with the ALARA requirements of 10 CFR, Part 20, Subpart E (see NRC Regulatory Guide DG-8019), then the site would meet the criteria for unrestricted release. If the release criteria have not been met at this point, then there is a requirement to develop a decommissioning plan (see NRC NUREG-1727 for guidance).

5.7 A physical inspection of the site to be surveyed is recommended to ensure the condition of the site has not changed since the scoping survey. If the site has been compromised by changes or modifications, then the characterization survey design should be modified to address the changes.

5.8 For characterization surveys, the area of interest may be gridded to comply with survey requirements according to the Survey Unit Plan and/or Survey Unit Graphic.

5.9 Areas where radioactive material concentrations exceed the

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criteria to release for unrestricted use will be remediated or recommended for remediation to meet the release criteria approved by the respective regulatory agencies.

5.10 Characterization survey results that indicate a change of the surveyed areas classification will be presented to the site customer with an estimate of the changes impact on schedules, manpower, and supply needs. For example, a characterization survey is performed anticipating use of the results for the FSS and the area is found contaminated. The customer will be notified and provided with an estimate of the remediation effort impact on schedules, manpower, and supplies.

SECTION 6

REMEDIAL ACTION SUPPORT SURVEYS

6.1 Remedial action support surveys are used to monitor the effectiveness of decontamination efforts in reducing residual radioactivity to acceptable levels and to guide the cleanup in a real-time mode. Such a survey is intended for expediency and does not produce thorough or accurate data describing the final radiological status of the site.

6.2 The objectives of the remedial action support surveys are to:

6.2.1 Provide real-time radiation levels during the remediation or cleanup effort.

6.2.2 Assure that remediation workers, the public, and the environment are adequately protected against exposures to radiation and radioactive materials arising from the remediation/decontamination activities.

6.3 Each survey unit must be characterized with regard to its specific isotopes of interest and mode of decay, e.g., alpha, beta, or gamma. The decontamination effort will depend on the extent and nature of the radioactive contamination.

6.4 Small scale removable contamination will be remediated to meet the NRC criteria to release for unrestricted use. Decontamination operations should be planned and executed by cleaning the areas of least contamination and working into the areas of highest concentration. The area will be scanned with an appropriate survey meter if wipe results warrant such actions. Remedial action control surveys will be performed as frequently as necessary during the decontamination operation to assess its effectiveness.

6.5 Remediation of major incidents of residual radioactivity may be addressed in a separate decommissioning plan as necessary.

6.6 At a minimum, personnel will wear overgarments, gloves and protective shoe covers during the decontamination procedure. Respirators or other specialized protective equipment may be needed depending on the extent and type of hazard associated with the contamination.

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6.7 Instruments that are utilized should be able to detect 75% of the NRC guidelines for release to unrestricted use.

6.8 Waste generated during decontamination operations should be kept to a minimum and collected in appropriate containers. All radioactive waste may be disposed of by Headquarters, Operations Support Command, AMSOS-SF; the Safety/Rad Waste Team is responsible for providing information and guidance to generators of unwanted radioactive material to prevent violations of Federal and other regulatory requirements, thereby ensuring safe and legal transport and disposal of the material.

SECTION 7

FINAL STATUS SURVEY

7.1 The FSS provides radiological data that will demonstrate that all radiological parameters (i.e., total surface activity, removable surface activity, dose rate, and exposure rate) satisfy the release criteria.

7.2 The objectives of the FSS are to:

7.2.1 Select/verify survey unit classification.

7.2.2 Demonstrate that the dose and concentration from residual radioactive contamination is below the release criteria for each survey unit.

7.2.3 Demonstrate that the dose and concentrations from small areas of elevated residual radioactivity is below the release criteria for each survey unit.

7.3 The FSS is also a tool used to show that an NRC licensee's areas of operation are not a hazard to the general public, or it can identify areas where further action is needed. The FSS is also known as a termination survey or close-out survey of operations involving radioactive material. The survey is a planned and reproducible study of an area that results in a formal report. When combined with data from the historical site assessment and other surveys, the licensee will have the data to show that all radiological parameters, (total surface activity, removable surface activity, and exposure rate) are in compliance with all applicable federal, local or other regulatory radiological guidelines for release to unrestricted use.

7.4 Prior to the initiation of the survey, the project officer will review the data from the historical site assessment and all previous surveys to develop a detailed survey plan. A thorough review of the survey procedures, the associated data, and the reports will be conducted prior to developing the sampling plan. The sampling plan will be systematic sampling to comply with the standard set forth in NUREG-1575, in addition, a random and/or bias sampling of other locations should be performed, as determined by the project officer. The formal sampling plan will be written with the goals of reproducibility and final report in mind. It is important to remember that the final report is a

collection of all data. If the FSS is documented in a manner that allows it to be imported directly into the final report, much time may be saved.

7.5 The project officer will coordinate the laboratory, technician, safety, and any other support personnel required to perform the survey. The project officer will be responsible for the collection and review of all pertinent documentation and information. The project officer should also ensure that a sampling plan is written to include sampling methods, equipment, schedules, costs, analysis, and special considerations.

7.6 The performance of the actual survey will vary due to installation size, numbers and diversity of facility operations. The applicability of these factors, as well as the time constraints of the survey, will dictate the use of separate or concurrent surveys. The preparation of the site may include, but is not restricted to the following:

7.6.1 Physical inspection of the site to be surveyed to ensure the condition of the site has not changed since the remediation was finished, if applicable.

7.6.2 Preparation of a grid system will be utilized to verify that the locations of data collection are reproducible. The floor area to be surveyed will be gridded normally in 2 m by 2 m squares or 1 m and 1 m squares for Class 1 and Class 2 areas. The system should be a network of evenly spaced parallel horizontal and vertical lines that can be used for locating sampling points and reproducing the sampling data, if needed. The grid may be marked in the upper left corner to pinpoint its location for future reference. Repeat this process until the area has been completely gridded. Walls should be 2 m by 2 m or 1 x 1 m for Class 1 and Class 2 areas. If classified as a Class 3 area, a grid does not need to be physically constructed as done for the Class 1 and Class 2 areas. As an alternative for reproducibility purposes, a floor plan of the area should be developed and used to document locations of where data points were collected and the data point may be physically marked (e.g., tape around the point in the area). No sampling will be required for areas classified as non-impacted.

7.6.2.1 Spacing interval for Class 1 and Class 2 areas may be determined for a square pattern as follows:

$$L = (A/n)^{0.5}$$

Where: L = spacing interval
A = Area of survey unit
n = number of survey locations

7.6.3 A non-impacted area, building, room, or office, which has not been compromised by the use, storage, or any activity involving radioactive material may be converted into a field office. This is where instrumentation Quality Assurance/Quality Control (QA/QC) functions should be performed and all non-field paperwork filled out. If needed, a field counting laboratory can also be established depending on the needs of the project.

7.6.4 Perform radiological reference set studies to determine the levels and variance of the natural background radiation that are typical to the area and to the type of buildings. Areas that are selected for this reference set should have no past history of any radioactive material use or storage.

7.6.5 Survey design includes, but is not limited to selecting appropriate survey and laboratory instruments; establishment of appropriate survey techniques, and suitable level of dress to prevent or minimize personnel and equipment contamination; and implementation of QC for survey instruments, field data, laboratory data, and final survey data.

7.6.6 The survey will be conducted IAW the guidelines established in NUREG-1575. Field and laboratory data will be combined into a final report. Areas found free of radiological contamination indistinguishable from background should be recommended for release for unrestricted use or transfer as appropriate.

7.7 Sampling Plan. For alpha and beta-gamma emitters, there will be surface activity measurements taken in grids or at highest meter reading within the grid after scanning. The number of data points will be determined by statistical tests.

Additional measurements may be necessary for small areas of elevated activity. Scanning will be performed per Table 3-2. If there are no readings three times background while scanning, then the surface activity measurements can be taken in the center of the grid or as appropriate by sample space interval.

7.7.1 For gamma emitters, there shall be one data survey point in the middle of the grid 1 m above the surface of the grid or as spacing interval dictates. In addition to the three survey points mentioned above, a hard wipe and a liquid scintillation (LS) wipe may be taken, as warranted by the isotope(s) of concern, at the point of the surface activity measurement. If the Flag value is exceeded at more than one point in that grid, the grid will need further evaluation to determine the extent of contamination or whether samples of construction material should be evaluated for increased levels of radioactivity.

- Hard wipe: Dry wipe taken by wiping an area while applying moderate pressure, then later analyzed in a laboratory setting for removable contamination of alpha and beta-gamma emitters.

- LS wipe: Liquid scintillation wipe taken with a moistened Metricel® membrane (or equivalent) that is later dissolved in a scintillation cocktail, and analyzed in a laboratory setting for removable contamination of low energy beta emitters.

- Flag value: A meter reading or sample concentration that is greater than or equivalent to 75% of guidelines for release to unrestricted use for the isotope of interest.

7.7.1.1 For survey unit(s) that used tritium, at least one data set should be taken on the ceiling (paying particular attention to duct work and ventilation systems).

7.8 If contamination is found by instrumental or analytical methods and is greater than the release limit for unrestricted use, the area should be remediated and resurveyed until levels are below the release limits. If unable to decontaminate the area and levels are not due to increased levels of naturally occurring radioactivity in building material, the area will be added to the decontamination list, and handled under a separate decontamination plan.

7.8.1 If contamination is found to be between 75-100% of the release limit, the room will be resurveyed IAW NUREG-1575. If no grids are found to exceed the release limit, then the room will be recommended to be released for unrestricted use. If further contamination over the release limit is found, the room should be added to the remedial action support survey list.

7.8.2 If all methods show contamination less than 75% of the release limit, the room will be documented and recommended to be released for unrestricted use.

Potential Contaminant Of Concern	Contamination Level (dpm/100 cm ²)		
	Removable	Average	Maximum
Alpha emitters	20	100	300
H-3	1000	5000	15000
All other beta-gamma emitters			

Table 7-1
 Acceptable Surface Contamination Levels

Nuclides ^a	Average ^{b, c, f} (dpm/100cm ²)	Maximum ^{b, d, f} (dpm/100cm ²)	Removable ^{b, e, f} (dpm/100cm ²)
U-Nat, ²³⁵ U, ²³⁸ U, and associated products	5,000 a	15,000 a	1,000 a
Transuranics, ²²⁶ Ra, ²²⁸ Ra, ²³⁰ Th, ²²⁸ Th, ²³¹ Pa, ²²⁷ Ac, ¹²⁵ I, ¹²⁹ I	100	300	20
Th-nat, ²³² Th, ⁹⁰ Sr, ²²³ Ra, ²²⁴ Ra, ²³² U, ¹²⁶ I, ¹³¹ I, ¹³³ I	1,000	3,000	200
Beta/gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except ⁹⁰ Sr and other noted above	5,000 β-?	15,000 β-?	1,000 β-?

a: Where surface contamination by both alpha- and beta/gamma-emitting nuclides exists, the limits established for alpha- and beta/gamma-emitting nuclides should apply independently.

b: As used in this table dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

c: Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

d: The maximum contamination level applies to an area of not more than 100 cm²

e: The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, then pertinent levels should be reduced proportionally and the entire surface should be wiped.

f: The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/hr at 1 cm and 1.0 mrad/hr at 10 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.

Reference: Guidelines for Decontamination of Facilities and Equipment prior to Release for Unrestricted use or Termination of Licenses for Byproducts, Source, or Special Nuclear Material, U.S. Nuclear Regulatory Commission, April 1993.

SECTION 8

CONFIRMATION AND VERIFICATION SURVEY

8.1 The confirmation and verification survey is a QA/QC instrument. It may be used to verify or confirm the adequacy and accuracy of an NRC licensee's Final Status Survey (FSS). A verification survey is an independent sampling of the licensee's or facility's more elaborate survey, and not a complete duplication. The verification survey will follow the procedures developed by the independent agency performing the survey. The survey points may be from 1 to 10% random sampling of the licensee's or facility's effort, with additional biased sampling, as determined by the project officer. The survey will ensure compliance with all applicable federal and local radiological regulations.

8.2 The objectives of the verification survey are to:

8.2.1 Ensure the customer and NRC that the residual radioactivity levels in each survey unit meet or are below the release criteria that have been established.

8.2.2 Confirm the adequacy and accuracy of the final status or termination survey.

8.3 Such surveys will be performed only if a termination or FSS has been completed for the area of interest. If a grid system was in place, it will remain for the verification survey. If an area was contaminated and cleaned, then the levels of radiological contamination must have been reduced to the acceptable limits. Once the area has been cleared for unrestricted use, no radioactive material will be brought into the area. In addition, the survey officer shall request that the installation/facility provide specific information relating to each area of interest. Such requested information should consist of but not limited to historical records search and listing of all surveys to include the termination survey report with accompanying data.

SECTION 9

REFERENCE AREA ASSESSMENT

9.1 A reference area is a geographical area from which representative samples of background will be selected for comparison with samples collected in specific survey units at the site or area. Measurements in both the reference area and survey unit should not be spatially correlated. The reference area and the survey unit should be surveyed and sampled during the same or similar time periods to minimize temporal effects.

9.2 The reference areas are defined areas within the reference region that are chosen because of similar physical, chemical, radiological, geological and biological characteristics to the site or area to be surveyed, but should not have been contaminated by operations or activities at the site or area. The distribution of background radiation and radioactivity in the reference area should be the same as that which would be expected on the site or area had it never been contaminated.

9.3 It may be necessary to select more than one reference area for a specific site or area, if the site includes so much physical, chemical, radiological, geological or biological variability that it cannot be represented by a single reference or background area.

9.4 To establish reference areas for building interiors, onsite buildings of similar construction, but with no history that radioactive material or operations with radioactive material occurred, can be used. The reference areas and survey units to which they are compared should have similar age, construction, and materials.

9.5 In some situations, preoperational or historical radiation measurements may be available. These data should be compared to current data.

9.6 The survey methodology used to characterize background must be consistent with the survey methodology used to define radiological conditions at the site and the reference area can be evaluated with the same statistical approach.

9.7 The selection of reference areas and the measurement locations within it should also meet strict criteria to minimize

biases in the comparison. For example, the same sampling procedure, measurement techniques, and instrumentation should be used at both the survey unit and the reference area.

9.8 For radionuclides that occur as part of background, it is necessary to establish what the average background activity concentrations are in the vicinity of the site or area where radioactive materials were used and stored. This will entail conducting radiological surveys in one or more reference area to produce sufficient data to determine the radiological characteristics of background. This can also be done on a non-radionuclide specific basis.

9.9 The objectives of the Reference Area Assessment are to:

9.9.1 Determine the ambient gamma exposure rate ($\mu\text{R/hr}$) in the reference area caused by gamma emitting radionuclides that occur in the natural environment. This exposure rate is comprised of terrestrial and atmospheric gamma radiation from natural background for outdoor or open land areas.

9.9.2 Determine the ambient gamma exposure ($\mu\text{R/hr}$) inside the buildings which are identified as reference areas. These radiation levels are caused by naturally occurring radionuclides present in the building materials and atmospheric gamma radiation.

9.9.3 Determine identity of the radionuclides that are present in the reference area.

9.9.4 Determine the concentration (pCi/g or picocurie per gram) of the identified radionuclides in the reference area.

9.9.5 Determine if the radionuclides in the reference area were caused by operations at the site or are typical of the radionuclide found in the natural environment.

9.10 In situations when the specific radionuclide to be measured is not found in measurable levels in the background, a statistical test is not required to compare to background. In its place, a test of the measured distribution of the radionuclide level as compared to the release criteria is made.

9.11 Where only gamma emitting radioactive contaminants are present, it may be adequate to perform only exposure rate

measurements in the reference area. Background measurements and samples should be taken at non-impacted areas. It is necessary to collect a minimum number of samples or data points for each parameter of concern to determine the background average at a 95% confidence level. If the upper 95% level bound on the background average is less than 10% of the guideline value for that parameter, variation in background may be considered insignificant and no additional determinations are necessary. However, if the upper 95% level bound on the background average is greater than 10% of the guideline value, then the background data should be tested to ensure that the average represents the true mean to within 20% at the 95% confidence level. If necessary, additional background determinations should be performed to satisfy this level of representativeness. See Section 5, NUREG-1575, for determining the number of samples that are needed to satisfy this level of significance. After the number of samples required has been determined, another 20% should be added and rounded up to the next even number to allow for the possibility of sample loss during transportation or analysis.

9.12 Typically the variance in the average background value from a set of 10 measurements will not exceed 40% to 60% of the average at the 95% confidence level.

9.13 Once reference levels have been established, the data should be incorporated into the decision making guidelines. If any area shows radiation levels above the determined background levels, a determination should be made as to whether the increases or differences between background data are due to radioactive contamination that resulted from operations that used radioactive materials, or increased levels of naturally occurring radioactive materials in building or construction materials. This data will be useful in demonstrating compliance with requirements of the NRC and other regulatory agencies.

9.14 Blank wipes and empty sample containers should be submitted to the laboratory for use in determining the background for the medium that is to be analyzed.

SECTION 10

SURVEY PROCEDURES

10.1 The survey procedure provides guidance for determining levels of total surface contamination, to include, type of instruments, and supplies required to conduct a thorough radiation survey to meet the NRC guidelines for release to unrestricted use. It discusses wipe sampling for the removable surface contamination and sampling building material to determine if it contains increased levels of radioactivity. Surveys for surface contamination includes monitoring with a hand held survey meter and wipe smear samples to identify removable surface contamination.

10.2 Surveys to determine total alpha contamination will be conducted with a Ludlum Model 2350, 2360 (or equivalent) survey meter, mated with 126 cm² (physical surface area) gas flow, scintillation (or equivalent) probe.

10.2.1 Prior to beginning any survey, the operator will perform a preoperational check that will include background and QA checks (see Section 12).

Perform battery check.

Check cables if broken or frayed.

Check probes for possible light leaks.

Take background reading and ensure it's within the parameters of the background study.

Perform QC checks on meter to ensure values satisfactory.

10.2.2 Area scan surveys will be done per Table 3-2 with scintillation, gas flow proportional (or equivalent) probes. If no contamination above three times background is found, the surveyor will take a fixed reading in the center of the grid or as spacing interval dictates by holding a 126 cm² probe less than 0.5 cm away from the surface to be surveyed. Any area within the grid found three times above background will be marked and the fixed reading shall be taken in the marked area. The 126 cm² alpha probe should be held in place for the reading, do not "scan".

10.2.2.1 Only 1 data point will be taken per grid or as spacing dictates and recorded or electronically logged.

10.2.2.2 While performing surveys, the alpha probe may be contaminated, causing the count rate to increase. If this is suspected, decontaminate the detector and check the background until the background falls back within the determined count.

10.2.2.3 The thin window of the probe is easily punctured. Care should be taken to protect the surface from sharp objects.

10.2.2.4 Obtain a count of predetermined duration (0.25 min to 1 min) and record the count rate.

10.2.3 Electronically download readings or record readings on appropriate data sheet, making sure all entries are filled in. When form is complete, submit it to the QA Officer for review.

10.3 Surveys for total beta-gamma contamination will be performed with a beta-gamma survey meter, Ludlum Model 2350, 2360 (or equivalent), with a 126 cm² gas flow, scintillation (or equivalent) probe.

10.3.1 Prior to beginning any survey, the operator will perform a preoperational check that will include background and QA checks (see Section 12).

Perform battery check.

Check cables if broken or frayed.

Take background reading and ensure it's within the parameters of the background study.

Perform QC check on meter, ensure values are satisfactory.

10.3.2 The survey will be accomplished by holding the probe approximately 0.5 cm away from the surface to be surveyed.

10.3.2.1 One data point will be taken per grid or as spacing dictates and recorded or electronically logged.

10.3.2.2 While performing surveys, the beta-gamma probe may be contaminated, causing the count rate to increase.

If this is suspected, decontaminate the detector and check the background until the background falls back within the determined count.

10.3.2.3 The thin window of the probe is easily punctured. Care should be taken to protect the surface from sharp objects.

10.3.2.4 Obtain a count of predetermined duration (0.25 min to 1 min) and record the integrated counts.

10.3.3 Electronically download readings or record readings on appropriate data sheet, making sure all entries are filled in. When form is complete, submit it to the QA Officer for review.

10.4 Surveys for total gamma contamination will be performed with a Ludlum Model 2350 (or equivalent) survey meter, mated with 1 inch by 1 inch sodium iodide (NaI) (or equivalent) probe.

10.4.1 Prior to beginning any survey, the operator will perform a preoperational check that will include background and QA checks (see Section 12).

Perform battery check.

Check cables if broken or frayed.

Take background reading and ensure it's within the parameters of the background study.

Perform QC check on meter, ensure values are satisfactory.

10.4.2 Gamma survey instruments will be held about 1 m from the area to be surveyed

10.4.2.1 One data point will be taken in the center of the grid or as spacing dictates approximately 1 m above the surface of the area to be surveyed.

10.4.2.2 While performing surveys, the gamma probe may be contaminated, causing the background count rate to increase. If this is suspected, decontaminate the detector and check the background until the counts fall back within the predetermined rate.

10.4.2.3 Obtain a dose rate.

10.4.3 Electronically download readings or record reading on appropriate data sheet, making sure all entries are filled in. Submit data to the QA Officer for review.

10.5 Elevated gamma readings must be carefully interpreted because uncontaminated areas can demonstrate high readings if they are adjacent to an area contaminated with gamma emitters.

10.6 This procedure provides guidance on using wipe samples to test for removable surface contamination. Gloves should be worn and changed intermittently while taking wipe test samples.

10.6.1 Hard Wipes. Obtain a round swipe pad, 2-inch in diameter and wipe an area of at least 100 cm², close flap over wipe and write sample number and other pertinent data on cover. Wipe tests for alpha and beta-gamma activity are counted using a gas-flow proportional counter, while wipe tests for gamma contamination are counted using a gamma spectrometer.

10.6.1.1 Use sufficient pressure on the swipe to pick up loose contamination without tearing or separating the swipe. During wipe surveys, pay particular attention to areas on equipment where contamination is most likely to occur.

10.6.1.2 Maintain the swipe integrity and ensure that the sample material is not dislodged from the swipe. Labeling will be done as specified in Appendix B. Make sure a sufficient number of swipes are available for the desired tasks. Fill out appropriate chain of custody forms and submit samples to laboratory.

10.6.2 Liquid Scintillation. Moisten Metricel® (or equivalent) with distilled water, and immediately take wipe of affected area. Place Metricel® wipe in cocktail vial and allow to dissolve. Label wipe appropriately, making sure all markings are made on caps and no markings are made on vials. Fill out appropriate chain-of-custody form and submit wipe to laboratory.

SECTION 11

INSTRUMENTATION AND EQUIPMENT

11.1 Each survey meter will be calibrated with a radioisotope traceable to National Institute of Standards and Technology (NIST) with an energy approximately the energy of the isotope of interest. If this condition cannot be achieved, an instrument response as a function of energy may be obtained so a correction factor can be applied. An efficiency factor will be developed to correlate the meter reading to the actual radioactivity traceable to NIST. All NIST traceable sources should be decay corrected at time of efficiency determinations.

$$\text{efficiency (\%)} = \frac{\text{net cpm}}{\text{dpm}} \times 100$$

11.1.1 A conversion factor will be applied to extrapolate from the probe physical surface area to a normalized 100 cm² surface area.

$$\frac{\text{Physical Probe Area}}{100 \text{ cm}^2} \quad (\text{Reference MARSSIM 6.6.1})$$

11.1.2 The efficiency value of the instrument coupled with the conversion factor will convert the final reading into standard units expressed in dpm/100cm².

11.2 The sensitivity, i.e., minimum detectable concentration (MDC) will be established for each type of instrument and documented. A comparison of MDCs with associated DCGL will be made to ensure that the MDC is at most 50% of the DCGL. See NUREG-1575 for equations to calculate MDC values. Scan MDCs should be determined and evaluated as survey requirements dictate.

11.3 All portable survey meters will be calibrated at least annually (or other specified frequency), checked for operability and that calibration period is adequate for the entire survey, prior to packaging and shipping to the survey site. The operability check will include a review of the calibration data sheet, and an operability verification (calculate the efficiencies) using a check source.

11.4 An operability check, as mentioned in the previous

paragraph, to include background radiation readings, will be performed and recorded prior to shipment and after arrival at the survey site. Prior to performing any survey, the appropriate QA checks will be made, to include operability checks. Normal practice is to perform checks three times daily (AM, midday, and PM of each workday) when in use. Values may be recorded on the data collection sheet or electronically logged. This practice may be reduced to checks at the start and end of day based on number of data points logged, likelihood of cross-contaminating instruments, operator judgment and QA Officer approval.

11.4.1 Alpha survey meters will be mated with a 126 cm² gas flow proportional detector, scintillation detector, or equivalent alpha probe, and have operational checks performed with an alpha emitting source that has energies approximating that of the isotope of interest.

11.4.2 Beta-gamma survey meters will be mated with a 126 cm² gas flow proportional detector, scintillation detector, or equivalent beta-gamma probe, and have operational checks performed with a beta emitting source that has energies approximating that of the isotope of interest. For those radioisotopes which emit low-energy beta radiation, e.g., tritium or carbon, LS wipes may be the most practical way to analyze.

11.4.3 A gamma survey meter will be mated with a NaI scintillation detector (or equivalent) for radioisotopes with gamma radiation energies greater than 0.1 million electron volts (MeV), and an operational check performed with a gamma emitting source, with energies approximating that of the isotope of interest. For gamma energies less than 0.1 MeV, the survey meter should be mated to a low energy, thin window NaI scintillation detector. This type of detector has a sensitivity about 12 times below 5 µR/hr guideline and meets the recommended criteria of being no more than 50% of the guideline. (Note that 5 µR/hr is adjusted for background radiation).

SECTION 12

QUALITY ASSURANCE AND QUALITY CONTROL

12.1 FIELD INSTRUMENTATION. Prior to departing for the survey site, all survey meters will be calibrated and have valid calibration certificates, and operability checks noted in Section 11. Calibration sheets and information will be shipped with the instruments to the site. When instruments arrive at the site, operability checks will be repeated and a QA chart started, if not previously established.

12.1.1 The QA chart is created by obtaining 20 to 30 data readings with an appropriate check source. Calculate the mean and the standard deviation using the following equations:

$$\bar{X} = \frac{\sum_{i=1}^n x_i}{n}$$
$$S_x = \sqrt{\frac{\sum_{i=1}^n (\bar{x} - x_i)^2}{n-1}}$$

12.1.2 Create a graph with the date on the horizontal axis and source readings on the vertical axis. The mean is assumed to be the "true" value. The values for the warning limits (? 2d) and control limits (? 3d) are then calculated. Draw horizontal lines at the values that represents the mean, warning limits, and control limits. The graph will be used to plot the daily operability checks for survey meters operated in the integrate mode. The same procedure will be employed for analog meters. However, warning limits will be set at ? 15% and control limits at ± 20% of the mean value.

- If daily operability checks fall outside the warning limits (but inside the control limits), the operability check should be repeated. If it falls in this range again, the QA Officer should be notified and the cause of the potential trend will be investigated.

- If the daily operability check falls outside the control limit, the operability check will be repeated. If the

check falls outside the control limits again, the instrument will be removed from service until it is either repaired, recalibrated or the cause for the out of control reading is identified. The instrument will also be removed from service and recalibrated whenever a malfunction is suspected. A new QA chart will be started when the meter is recalibrated, or repaired, if required.

- All daily operability checks (including any outside the warning or control limits) will be recorded in the instrument QA/QC files.

12.1.3 The counting efficiency (as calculated in Section 11) is used to convert instrument readings to a measure of activity in units of dpm per 100 cm².

12.1.4 Calculate the MDC as follows (adapted from MARSSIM Equation 6-7):

12.1.4.1 For an integrated measurement mode (where background and sample count times are the same):

$$MDC = \frac{3 + 4.65 \sqrt{B_R * t}}{t * E * \frac{A}{100}}$$

Where:

MDC = Minimum Detectable Concentration (dpm/100 cm²)
B_R = background rate (cpm)
t = counting time (minutes)
E = detector efficiency (cpm/dpm)
A = physical probe area (cm²)

12.1.4.1 For an integrated measurement mode (where background and sample count times are different):

$$MDC = \frac{\frac{3}{t_s} + 3.29 \sqrt{\frac{B_R}{t_s} + \frac{B_R}{t_b}}}{E * A/100}$$

Where:

T_s = sample count time (minutes)

T_b = background count time (minutes)

- The actual field count time is used here (t) and is usually 1 minute. Use an average efficiency for the instrument determined with the lowest activity source.

12.1.4.3 For a ratemeter measurement mode:

$$MDC = \frac{4.65 * \sqrt{\frac{B_R}{2t_c}}}{E * \frac{A}{100}}$$

Where:

MDC = Minimum Detectable Concentration (dpm/100 cm²)

B_R = background rate (cpm)

t_c = meter time constant (minutes)

E = detector efficiency (cpm/dpm)

A = physical probe area (cm²)

12.1.4.3 These MDC formulas calculate the activity level in dpm/100 cm² which can be detected with 95% confidence. At this level there is a 5% probability of a false positive and a 5% probability of a false negative.

12.1.4.4 Compare this value to the site guidelines to determine adequate sensitivity of the instrumentation. The MDC should be within 10 to 50% of the applicable criteria.

12.1.5 The responsibility of ensuring quality surveys is that of all members of the survey team. All data obtained during the survey should be reviewed by the QA Officer. At a minimum, the following should be reviewed in the data package which includes the Area Gridding Sheets or Survey Unit Plans, Instrument QA/QC Sheets, Data Collection Sheets or electronic downloads and subsequent laboratory sample analysis reports:

12.1.5.1 Instrument MDCs are within 10% or better to 50% of the applicable guidelines.

12.1.5.2 All data sheets are properly filled out.

12.1.5.3 All instrument operational checks are within the control limits.

12.1.5.4 A Statistical Analysis of all data. Ensure any value above guidelines are explained.

12.2 LABORATORY INSTRUMENTS. Laboratory instruments will have the same or more stringent QA requirements as field instrumentation as implemented by the laboratory QA program. See laboratory requirements detailed in Appendix C.

12.3 LABORATORY PROCEDURES.

12.3.1 QA samples should be introduced in the survey process without the measuring laboratory's knowledge. These spikes along with randomly placed blank samples will serve as QA checks of the measuring laboratory. Percent recoveries may be calculated by the QA Officer or laboratory personnel. Recoveries are expected to fall in the range of 80 to 120%. Spikes outside this range will be investigated and necessary actions, such as reanalyzing samples, will be taken. The QC samples (spikes and blanks) will consist of approximately 0.5 to 1% of the total samples. Blank samples, with results above the MDC, will also be investigated and the necessary corrective actions implemented.

12.3.2 The QA laboratory may perform verification analyses on 5 to 10% of the samples if selected by the QA/QC Officer. Spikes will not be returned and will be retained by the QA laboratory. Sample chain-of-custody will be maintained.

12.4 QA REVIEWS. In addition to the reviews mentioned in paragraph 12.1.5, external reviews may also be performed. These external reviews may be performed by representatives from independent organizations.

SECTION 13

WIPE TEST ANALYSIS

13.1 ALPHA AND BETA-GAMMA WIPE TESTS. The RCCCD Procedure (AB002) will be the methodology utilized for analyzing Hard smear wipe test samples. All calculations will be performed as indicated in Section 13.3.

13.2 LOW-ENERGY BETA EMITTERS. The RCCCD Procedure (H_003) will be the methodology utilized for analyzing LS wipe test samples. The liquid scintillation cocktail to be used is Ecolite(+) or its equivalent.

13.3 CALCULATIONS. All results MDC, activity and counting uncertainty will be calculated in units of dpm per 100 cm².

13.3.1 MDC.

If the sample and background counting times are the same, then the MDC should be calculated as follows:

$$MDC = \frac{3 + 4.65 \sqrt{B_R * t}}{t * E}$$

This equation is often expressed as follows:

$$MDC = \frac{\frac{3}{t} + 4.65 \sqrt{\frac{B_R}{t}}}{E}$$

Where:

MDC = Minimum Detectable Concentration (dpm per 100 cm²)
B_R = background rate (cpm)
t = counting time (minutes)
E = detector efficiency (cpm/dpm)

If the sample and background counting times are different, then the MDC will be calculated as follows:

$$MDC = \frac{\frac{3}{t_{s+b}} + 3.29 \sqrt{\frac{B_R}{t_{s+b}} + \frac{B_R}{t_b}}}{E}$$

Where:

MDC = Minimum Detectable Concentration (dpm per 100 cm²)
 B_R = background rate (cpm)
 t_{s+b} = sample counting time (minutes)
 t_b = background counting time (minutes)
 E = detector efficiency (cpm/dpm)

13.3 Activity. The net activity will be calculated as follows:

$$Activity = \frac{CPM_{s+b} - B_R}{E}$$

Where:

CPM_{s+b} = sample count rate (counts per minute)
 B_R = background rate (cpm)
 E = detector efficiency (cpm/dpm)

13.3.3 Counting Uncertainty. The 2 sigma counting uncertainty will be calculated as follows:

$$Uncertainty = \frac{1.96 * \sqrt{\frac{CPM_{s+b}}{t_{s+b}} + \frac{B_R}{t_b}}}{E}$$

Where:

CPM_{s+b} = sample count rate (counts per minute)
 B_R = background rate (cpm)
 t_{s+b} = sample counting time (minutes)
 t_b = background counting time (minutes)
 E = detector efficiency (cpm/dpm)

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13.4 LABORATORY REQUIREMENTS. The technical requirements for laboratory analysis of wipe test samples for gross alpha, gross beta-gamma, and tritium are outlined in Appendix F. All laboratories analyzing samples will meet these requirements at a minimum.

SECTION 14

PERSONNEL DECONTAMINATION

14.1 The aim of personnel decontamination is cleanliness and all the precepts of good personal hygiene apply. Radioactive contamination gets on a person the same as ordinary "dirt" and the methods that apply to the removal of dirt from the skin apply also to the removal of radioactive contamination. A common misconception is that radioactive isotopes differ from isotopes of the same elements in chemical properties because they are radioactive. Nothing could be further from the truth. All isotopes of the same element are chemically identical.

14.2 The importance of removing the radioactive "dirt" stems directly from the fact that it is radioactive. It is emitting radiation which may be absorbed by the body. If the level of contamination is high, the contaminant must be removed immediately to prevent radiation burns, total body irradiation, or internal deposition of the contaminant. Even low-level contamination may present a hazard if taken into the body.

14.3 The simplest procedures for decontamination should be utilized first. The first step in effective personnel decontamination is a thorough monitoring of the entire body. Procedures when monitoring are:

* Monitor both hands and forearms with palms up; repeat with hands and arms turned over.

* Monitor the entire front of the body, starting at the top of the head. The forehead, nose, mouth, neckline, torso, knees, and ankles should be thoroughly checked. Repeat the procedures for the back.

* Monitor the soles of the feet.

14.4 Next, elevated measurements on the body should be spot cleaned to prevent the spread of this contamination to the rest of the body. Washing with soap and lukewarm water, using cotton swabs or gauze, is a good procedure for spot cleaning. Masking tape is effective in removal of dry contaminants. In stubborn cases, several preparations for skin cleansing have been tried and proved effective. The examples below give several preparations which may be used:

14.4.1 Aqueous.

14.4.1.1 A mixture of 50% Tide and 50% cornmeal made into a paste with water. Scrub, using additional water.

14.4.1.2 Mildly abrasive soap (Lava).

14.4.1.3 A 5-percent water solution of a mixture of 30% Tide, 65% Calgon, and 5% Carbose (carboxymethylcellulose) used with added water.

14.4.2 Waterless.

14.4.2.1 Mechanic's waterless hand-cleansing cream.

14.4.2.2 A homogeneous cream of 8% Carbose, 3% Tide, 1% Versene, and 88% water.

14.5 The final step in decontamination is showering. Large amounts of soap and lukewarm water should be used. Special attention should be given to the hair, hands, and fingernails. In most cases, all the contamination will be removed by use of the above methods.

14.6 If contamination persists, repeat the operations until it is obvious that these methods are ineffective. The following procedures should be used with caution and are presented for the sake of thoroughness and to outline steps to be taken if extremely stubborn contamination is encountered. They are primarily meant as procedures for hand decontamination but can be applied to other parts of the body.

14.7 If physical methods for decontamination fail, chemical methods might be necessary. Two such methods are:

* Apply ammonium citrate or citric acid, rub for approximately 5 minutes, wash with water, dry, and monitor. Citrates form water-soluble complexes with many contaminants. With some contaminants, it might be more efficient to soak the contaminated area in a basin of warm water containing one-half gram each of tartaric and citric acids.

* If the contaminating isotope is known, it is possible to reduce the contamination level by treating the affected area with

a stable isotope of the same element. Rinse or soak in a solution containing a stable isotope of the contaminant. This reduces the concentration of the radioactive atoms through an exchange process with the stable atoms. Monitor after drying.

14.8 If the foregoing methods fail and the contamination level is still dangerously high after two or three trials, an attempt can be made to remove the outer layers of skin on which the contamination has been deposited. This method should be used only with a doctor's consent and under his supervision. The procedure involves rubbing the contaminated area with a swab soaked with a 4% solution of potassium permanganate and then removing the stain with a 4% solution of sodium bisulfate.

14.9 The removal of contamination from a person should be as complete as practicable. However, it should be realized that the removal of the last few radioactive atoms does not justify injury to the skin. The biological significance of a small amount of contamination must be compared with the damage produced when vigorous decontamination techniques are employed. When in doubt, always consult a competent authority before proceeding with any decontamination technique that may injure the body tissues.

14.10 Bioassay will be performed on personnel who have a potential of receiving an internal dose 10% of the limits set forth in Table 1 of Appendix B to 10 CFR 20.

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SECTION 15

FINAL REPORT

A final report will be generated by USACHPPM upon completion of FSS and all other parts of the surveying process. It will contain all survey data to include instrumentation and QA. It will explain all pertinent data, information or occurrences not included in the protocol, and will make a recommendation to release all areas found free of contamination to unrestricted use. Note that this recommendation is based upon review by USACHPPM; appropriate regulatory approval is also recommended. The report will be staffed through the WRAMC Health Physics Office for approval.

SECTION 16

SITE SAFETY PLAN

16.1 Safety is the responsibility of everyone involved in every aspect of this survey. It will be the number one concern and under no circumstances will any compromises be made on established safety standards.

16.1.1 All individuals involved in this project may receive a general safety and radiation safety briefing from the Safety and Radiation Safety Officer(s). They will be required to follow all pertinent SOPs. They will be familiar with the location and magnitude of any contamination to which they may be exposed and the radiological health hazards associated with the use of NRC licensed radioactive commodities for any areas or buildings identified as potential usage areas.

16.1.2 The survey team may consist of: Department of the Army personnel; Department of the Army Civilian employees from USACHPPM; personnel from a USACHPPM managed contract; and one independent USACHPPM QA Officer. All surveying personnel who may be exposed to contamination levels exceeding unrestricted area limits will be enrolled in a medical surveillance program, as required by the program, which may include a preemployment screening, and annual medical examinations which are appropriate for handling radiological materials. They will be approved as necessary to wear appropriate personnel protective equipment including a respirator. If personnel are known or suspected to have been exposed to a potentially harmful substance during this project, all appropriate medical and health officials, safety officials and environmental staffers will be notified immediately.

16.2 Key personnel(tentative)/title/organization: (personnel tentative)---

- LTC Mark Melanson, Manager, HP Program, USACHPPM.

- Mr. John W. Collins, Project Manager, Health Physics Technician, HPP, USACHPPM, HMJF Participant.

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- Mr. Lorus Miller, Health Physics Technician/Survey Team Coordinator, HPP, USACHPPM, HMJF Participant.

- Mr. David Collins, Health Physics Technician, HPP, USACHPPM, HMJF Participant.

- Mr. Jerry Collins, Health Physics Technician, HPP, USACHPPM, HMJF Participant.

- Mr. Sam Dunston, QA Officer, HPP, USACHPPM, HMJF Participant.

- Mr. Richard Melton, Property Transition Coordinator, WRAIR.

- LCDR Daniel Simpson, Safety Manager, WRAIR.

- Mr. Dave Burton, Health Physics, WRAMC.

16.3 Hazard Analysis. The potential hazards associated with this project are described and actions used to mitigate specific hazards are also identified as follows:

16.3.1 Biological Hazards. A previous effort to remove biological agents was conducted. Contact safety personnel if any areas appear suspect.

16.3.2 Chemical Hazards. A previous effort to remove chemical agents was conducted. Contact safety personnel if any areas appear suspect. The survey teams are not to open any containers that may be encountered. Any suspect containers will be reported to the Safety Office.

16.3.3 Climatic Hazards/Temperature. This project will be conducted indoors. If outdoor work is required team members will be required to evaluate conditions daily and dress accordingly.

16.3.4 Electrical/Utility. Team members will not enter wiring boxes or electrical fixtures. Areas should not be sampled without the team leader evaluating the potential for electrical and other safety hazards.

16.3.5 Flammable/Explosive. None apparent, however, smoking is not permitted during project operations nor is it permitted in government buildings.

16.3.6 Infectious. None should be encountered. If evidence of rodent droppings is present contact the Safety Office.

16.3.7 Oxygen. All areas are designed for human occupancy. Team members will not be allowed to enter confined space areas without the required training and authorization by the Safety Office. Areas that may have been sealed will be opened and time allotted for air to circulate prior to the survey team entering.

16.3.8 Noise. Noise hazards are not expected. If high noise area(s) encountered, utilize hearing protection. Do not linger in such areas.

16.3.9 Physical.

16.3.9.1 Tripping. Tripping hazards are minimal since buildings should be vacant and empty of furnishings.

16.3.9.2 Falling. Ladders and appropriate safety equipment will be used to reach areas greater than 6 feet in height. They will be placed on solid, horizontal surfaces and not leaned against walls or other vertical surfaces unless specifically designed for such use. Ladders will be held by a team member if sampling is to be done above 10 feet.

16.3.9.3 Cuts, burns, punctures, and crushing is not normally associated with the survey equipment, or procedures. If building construction material is to be removed, then team members will wear leather gloves to protect their hands.

16.3.9.4 Eye hazards are not associated with the survey equipment, however, if any building construction material is to be removed or other destructive work is done team members should wear eye protection.

16.3.10 Radioactive. Radioactive hazards are minimal.

Team members may be issued dosimeters at the discretion of the facility RSO, and contamination control procedures will be established. The USACHPPM issued thermoluminescent dosimeters (TLDs) may also be used, as needed.

16.3.11 Fauna. Evidence of indigenous fauna, including, but may not be limited to, birds, raccoons, rodents, cats, and bats has been noted in the building. Avoid any contact with these animals and their droppings. Droppings should be treated with a chlorine based disinfectant.

16.4 Confined Space. Spaces not designed for human occupancy will not be entered by the team members without permission of the Safety Officer. For the purpose of this plan, garages, closets, halls, outdoors, and other such areas are for human occupancy. Any space with limited access such as by ladder will not be entered without permission of the Safety Officer.

16.5 Monitoring. All survey personnel will be required to comply with AR 11-9 and DA PAM 40-18 personnel monitoring requirements which implement 10 CFR 20 and 29 CFR 1910.96. The TLD monitoring devices will be utilized at the discretion of the local RSO. Additionally, the RSO will have access to survey meters for personnel monitoring, in the unlikely event there is an incident whereby personnel or equipment would be contaminated.

16.6 Personnel Protective Equipment. If required, all surveying personnel will wear protective clothing, to include shoe covers and latex gloves while performing wipe surveys. Each outdoor site will have a site control area, as needed.

16.7 Decontamination Procedures. Decontamination procedures for personnel and equipment should be performed IAW Section 14 and IAW sound radiological worker practices.

16.8 Emergency Response Procedures. The WRAIR Safety Office will ensure that all surveying personnel understand local safety procedures prior to the start of the survey. The Safety Office has agreed to assist in staffing this plan through appropriate organizations and safety.

16.9 Emergency Numbers. The following numbers will be obtained

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and presented to personnel in case of an emergency. The surveying personnel will remain in contact with the site survey point of contact, Mr. John Collins, to discuss daily activities.

NOTE: For all emergencies contact the WRAMC Fire Department dispatch at **(202)-782-3317** to obtain the appropriate response regarding security, police, fire, ambulance and other related needs.

16.9.1 Fire Department Telephone Number: (202) 782-3317

16.9.2 Provost Marshall (Security)
Telephone Number: (202) 782-7511/7512/7513

16.9.3 Police Department:
Telephone Number: (202) 782-7511/7512/7513

16.9.4 Mr. Richard Melton, Property Transition Coordinator
Telephone Number: (301) 319-9315

16.9.5 LCDR Daniel Simpson, Safety Manager, Telephone
Number: (301) 319-7518

16.9.6 Ms. Tanya Henson, Safety Officer,
Telephone Number: (301) 319-9025

16.9.7 COL William B. Johnson, Radiation Protection
Officer, Telephone Number: (202) 356-0060

16.9.8 Mr. Dave Burton, Health Physics Office,
Telephone Number: (202) 356-0062

16.10 All incident injuries or accidents will be reported to the Safety Officer, who should refer all minor illnesses and injuries to the appropriate medical support center.

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APPENDIX A

REFERENCES

- A.1. AR 40-5, 15 October 1992, Preventive Medicine.
- A.2. AR 11-9, 28 May 1999, The Army Radiation Safety Program.
- A.3. DA Pam 40-18, 30 June 1995, Personnel Dosimetry Guidance and Dose Recording Procedures for Personnel Occupationally Exposed to Ionizing Radiation.
- A.4. DOD Instruction No. 6055.8, 19 September 1987, Occupational Radiation Protection Program.
- A.5. 10 CFR 20, Chapter I, Nuclear Regulatory Commission.
- A.6. 29 CFR, Chapter I, Department of Labor.
- A.7. 49 CFR, Parts 100-177, Transportation.
- A.8. TM 3-261, 12 May 1988, Handling and Disposal of Unwanted Radioactive Material.
- A.9. NUREG/CR-5849, ORAU-92/C57, 1 June 1992, Manual for Conducting Radiological Surveys in Support of License Termination.
- A.10. NUREG-1505, August 1995, A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys.
- A.11. Historical Data Review No. 28-MF-6209-98, WRAIR, WRAMC, August-December 1997, USACHPPM and U.S. Army Corps of Engineers.
- A.12. NUREG/CR-5512, Volume 3, October 1999, Residual Radioactive Contamination From Decommissioning.
- A.13. Guidelines for U.S. Atomic Energy Commission Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors, June 1974.

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A.14. Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material, U.S. Nuclear Regulatory Commission, Division of Fuel Cycle and Material Safety, April 1993.

A.15. Draft Nuclear Regulatory Guide DG-8017, Radiological Criteria for Decommissioning - Dose Calculations and Surveys, September 22, 1995.

A.16. Nuclear Regulatory Guide DG-8019.

A.17. NUREG-1727, NMSS Decommissioning Standard Review Plan, September 2000 (Note: contains guidance previously in Draft Regulatory Guide DG-4006, Demonstrating Compliance With the Radiological Criteria for License Termination, August 1998, Division 4).

A.18. NUREG-1575, Revision 1 (EPA 402-R-97-016, Rev 1), Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), August 2000.

A.19. NUREG-1507, Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Various Contaminants and Field Conditions, June 1998.

APPENDIX B

INDOOR AREA GRIDDING INSTRUCTIONS

B.1.1 This appendix provides guidance on the survey unit gridding and mapping procedures. Class 1 and Class 2 areas should be gridded. Class 3 areas may be paced off and labeled as needed.

B.2.1 To grid a room or area:

B.2.1.1 Identify the north most wall. Locate the west most corner of that wall. (Compasses may be used.) All measurements are then made from this base corner.

B.2.1.2 Walls are alphabetically labeled in a clockwise pattern around the room. The north most wall is Wall A. The first adjacent wall is Wall B. The next Wall C, and so on.

B.2.1.3 From the base corner, the appropriate length (1 m or 2 m) is measured. Recesses and outcroppings, such as door jams, will be measured with an appropriate measuring device. The actual surface area will be gridded. Recesses and outcroppings less than 1m will be considered as part of the same wall. Recesses and outcroppings 1m and greater will be gridded as another wall.

B.2.1.4 On walls, a pattern of intersecting lines/marks will be constructed. Each grid will be designated by the wall identifier combined with a horizontal and vertical component. The horizontal component will be designated with a number and the vertical component with a letter. The grid at floor level will be designated with the letter "A." For example, grid designator WA2A is located on Wall A (WA) and is in the second (2) grid column and in the floor level (A) grid row.

B.2.1.5 For floors, a pattern of intersecting lines/marks will also be constructed. Each grid will be designated with a floor identifier combined with a number and letter component.

The number identifies grids from the base corner toward the east wall. The letter identifies grids from the base corner toward

APPENDIX C

INSTRUMENT QA/QC AND SAMPLING SHEETS

C.1.1 This appendix provides guidance on the completion of the Instrument QA/QC Sheets and the Data Collection Sheet.

NOTE: ALL BLANKS ON THE SHEETS WILL BE FILLED IN, IF IT DOES NOT APPLY TO A PARTICULAR INSTRUMENT, PLACE N/A (NOT APPLICABLE) IN THE BLANK SO THAT IT IS CLEAR THAT IT WAS NOT FORGOTTEN!

C.2.1 Instrument QA/QC Sheets.

C.2.1.2 Complete the blanks as described below:

(1) Instrument and S/N: Enter survey meter make, model and serial number.

(2) Probe and S/N: Enter probe make, model, serial number.

(3) Probe Area (alpha and beta instruments) or Probe Size (gamma $\mu\text{R/hr}$ instruments): Enter the probes active area in cm^2 for alpha and beta probes. For NaI gamma probes, enter the crystal size (usually 1 inch by 1 inch or 2 inches by 2 inches).

(4) Cal Date and Cal Due Date: Enter the meter/probe calibration date and calibration due date.

(5) Source and S/N: Enter the check/calibration source isotope and serial number.

(6) Activity and Cal Date: Enter source activity and calibration date.

(7) Limits: Calculate and record the warning ($\pm 2s/\pm 15\%$ ratemeter) and control limits ($\pm 3s/\pm 20\%$ ratemeter).

(8) Counts / ___ min: Record check source count time (for scaler instruments only).

(9) Date: Record date of source check.

- (10) Source: Record source check counts or $\mu\text{R/hr}$ reading.
- (11) Bkg: Enter area background in counts or $\mu\text{R/hr}$.
- (12) Net: Calculate the net result.
- (13) Eff: Record determined QC efficiency or calculate and record the efficiency factor with the following equation:

$$\text{Efficiency} = \frac{\text{Net cpm}}{\text{dpm}}$$

- (14) Init: Enter initials of person performing the check.
- (15) Comment: Enter comment(s) (Start/End of day or other check).

C.3.1 Data Collection Sheet.

C.3.1.1 Complete the blanks as follows:

- (1) Building: Enter building or area being surveyed
- (2) Survey Unit: Enter Survey Unit number or other unique area identifier.
- (3) Date: Enter the survey date.
- (4) Surveyor(s): Print the names of the members of the survey team. Each member should also sign above printed name.
- (5) Efficiency (Alpha and Beta): Enter the efficiency factor calculated with the first check/calibration of the day.
- (6) Probe physical area (MARSSIM 6.6.1): Enter the alpha and beta-gamma probe physical area in cm^2 .
- (7) Reference readings: Enter the reference area reading for the area being surveyed. This reading is usually taken in a non-impacted of the building being surveyed.

(8) Ref Cnt time: Enter the reference area count time.

(9) MDC: Calculate the instrument MDC. The MDC for integrated counts is calculated as follows:

$$MDC = \frac{\frac{3}{t_s} + 3.29 \sqrt{\frac{B_R}{t_s} + \frac{B_R}{t_b}}}{E * A/100}$$

Where:

- MDC = Minimum Detectable Concentration (dpm per 100 cm²)
- B_R = background rate (cpm)
- t_s = sample counting time (minutes)
- t_b = background counting time (minutes)
- E = instrument efficiency (cpm/dpm)
- A = probe physical area (cm²)

(10) Flags: The flag is the gross count value that warrants possible investigation. The formula to calculate the flag (for alpha and beta) is as follows:

$$FLAG = (N * 0.75 * E * (A/100) + B_R) * \frac{t_s(\text{sec})}{60}$$

Where:

- N = Derived Concentration Guideline Level for isotope of concern
- ** Gamma emitters - 5 µR/hr above background is the flag
- E = instrument efficiency
- A = probe physical area (cm²)
- B = background rate (cpm)
- t_s = sample counting time (seconds)

(11) Count time: Enter the integrate mode time.

(12) Inst/Probe S/N: Enter the survey meter and probe serial numbers.

(13) Specific Features: Enter any unique characteristics to assist in relocating the sampling point.

(14) Location Code: enter the grid identifier to uniquely identify the area from which the readings and samples are taken.

(15) Gross Alpha: Enter the gross alpha reading from the survey instrument.

(16) Gross Beta: Enter the gross beta reading from the survey instrument.

(17) Direct Gamma: Enter the gamma exposure rate at 1 meter from the center of the grid.

(18) Sample ID: Enter the unique identifiers placed on the cap of the LS vial and/or on the hard wipe. This identifier should be a two letter prefix (first letter to designate base, second letter to designate team leader) concatenated with a 5 digit number. The number portion is sequentially incremented. The first sample taken at WRAIR by the "A" survey team could be designated as ZA00001.

(19) Reviewer: QA Officer should Print/Sign name and date.

(20) Grid Size: Indicate the grid size.

(21) Comments/Notes: Use this area to enter any useful information that survey teams or the reviewer deems necessary or helpful to identify or analyze the data.

APPENDIX D

ABBREVIATIONS & ACRONYMS

α	alpha
ALARA	As Low As Reasonably is Achievable
Am-241	Americium-241
AR	Army Regulation
?	beta
Bkg	background
BRAC	Base Realignment and Closure
CFR	Code of Federal Regulations
cm ²	centimeter squared
cpm	counts per minute
Cs-137	cesium-137
Co-60	cobalt-60
DA	Department of the Army
DARA	Department of the Army Radiation Authorization
DCGL	Derived Concentration Guideline Level
DCGL _{emc}	Derived Concentration Guideline Level - elevated Measurement comparison
DCGL _w	Derived Concentration Guideline Level - Wilcoxon Rank Sum
DLC	Data Life Cycle
DOD	Department of Defense
dpm	disintegrations per minute
DQA	Data Quality Assessments
DQO	Data Quality Objectives
EPA	Environmental Protection Agency
FSS	Final Status Survey
?	gamma
H _o	Null Hypothesis
H _a	Alternative Hypothesis
H-3	tritium
HMJF	Henry M. Jackson Foundation
HPP	Health Physics Program
IAW	in accordance with
LS	liquid scintillation
m	meter
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
μ Ci	microcurie

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µR/hr	microroentgen per hour
mCi	millicurie
MDC	minimum detectable concentration
MeV	million electron volts
mrem	milliRoentgen-equivalent-man
mSv	millisievert
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
NSN	National Stock Number
NUREG	Nuclear Regulatory Guide
OSC	Operations Support Command
pCi/g	picocurie/gram
PDL	predicted dose level
QA	quality assurance
QC	quality control
Ra-226	radium-226
RSO	Radiation Safety Officer
RCCCD	Radiologic, Classic, and Clinical Chemistry Division
SOP	Standard (or Standing) Operating Procedure
SP	Survey Plan
SST	Site Source Term
TEDE	Total Effective Dose Equivalent
Th-232	thorium-232
TLD	thermoluminescent dosimeter
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
WRAIR	Walter Reed Army Institute of Research
WRAMC	Walter Reed Army Medical Center
WRS	Wilcoxon Rank Sum

APPENDIX E

NRC LICENSES

1. U.S. Nuclear Regulatory Commission Materials License Number 08-01738-02, Department of the Army, Walter Reed Army Medical Center, expiration date 30 June 2004. (For medical diagnosis, therapy and research. Also for shielding in linear accelerators).
2. U.S. Nuclear Regulatory Commission Materials License Number 08-01738-03, Department of the Army, Walter Reed Army Medical Center, expired November 30, 1996. (For Co-60 and Cs-137 sealed sources).

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APPENDIX F

QUALITY ASSURANCE CHECKLIST

F.1.1 Purpose.

F.1.1.1 Provide the USACHPPM key radiological data checks to ensure compliance with 10 CFR 19, 20, 30, and 40; and NUREG-1575.

F.1.1.2 Provide decommissioning personnel with QA overview of key data.

F.1.1.3 Provide overview of survey procedures and health physics practices.

F.2.1 References:

F.2.1.1 10 CFR Parts 19, 20, 30 and 40.

F.2.1.2 NUREG/CR-5849, June 1992, Manual for Conducting Radiological Surveys in Support of Licenses Termination (Draft Report for Comment).

F.2.1.3 NUREG-1505, A Nonparametric Statistical Methodology for the Design and Analysis of Final Status Decommissioning Surveys (Draft Report for Comment).

F.2.1.4 The DA, NRC Licenses for world-wide use of DA Radioactive Commodities.

F.2.1.5 Guidelines for U.S. Atomic Energy Commission Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors, June 1974.

F.2.1.6 NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual, Revision 1, August 2000.

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Independent QA Checklist

ITEM TO BE CHECKED	YES	NO	COMMENT
Personnel wearing TLDs			NA: not expected >10% of limit
Survey meters operational			
Operational Checks Performed and Logged			Minimum start and end of day
Background checked and corrected			
Gridding/spacing done properly/as needed			
Meter readings IAW 10 CFR 30.36			
- alpha readings @ = 0.5 cm			
- alpha readings in dpm/100 cm ²			
- beta-gamma readings @ = 0.5 cm			
- beta-gamma readings in dpm/100cm ²			
- gamma readings @ 1 meter			
- gamma readings in µR/hr			
Meter download reviewed in timely manner			
Wipe test samples labeled			
Can wipe test be reproduced?			
Meter readings within DCGL?			
- less than 5 µR/hr > bkg for gamma			
Was decon needed?			
Did survey team know what to do?			
Was survey team familiar with protocol?			
Did survey team ask questions?			
Did RCCCC Lab follow plan procedures?			
Did RCCCC Lab QA data?			
Did RCCCC Lab determine MDC?			
Was MDC adequate? (10 to 50% DCGL)			
Sample controls in place			

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Independent QA Checklist (continued)

ITEM TO BE CHECKED	YES	NO	COMMENT
Data exceed DCGL? Reg Guide 1.86?			
Was rad waste managed?			
Was mixed-waste present?			
Was mixed-waste managed?			
Were air samples needed?			
- indicate isotope(s) present	NA	NA	
- indicate # of people exposed/tracked	NA	NA	
Was bioassay needed?			
All personnel trained			
Training documented			
Appropriate instruments used			
- calibration performed	NA	NA	DATE(S):
- MDC within 10 to 50 % of DCGLs			
Wipe test results in dpm/100cm ²			
ADDITIONAL NOTES/COMMENTS			

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APPENDIX G
SURVEY AREAS

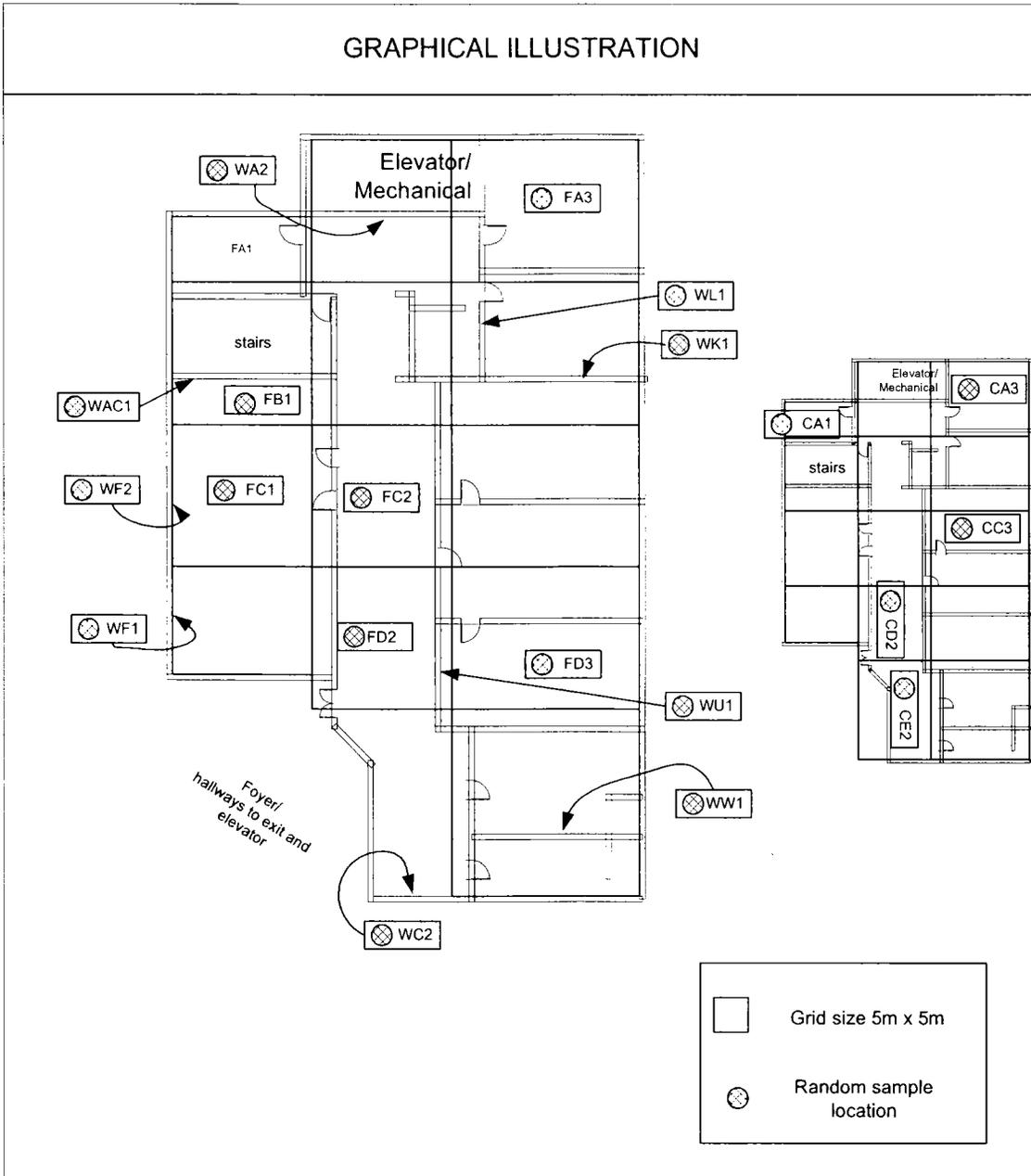
TABLE G-1
 SUMMARY OF SURVEY AREAS FOR WRAIR BUILDING 40

SURVEY UNIT	WIPES		COMMENT
	WRS TEST	JUDGMENTAL	
FOURTH FLOOR			
North Hallway	20	3	
North Hallway North Rooms	20	60	
North Hallway South Rooms	20	60	Noted C-14 Room 4010
West Hallway	20	3	
West Hallway West Rooms	20	51	
West Hallway East Rooms	20	24	
East Hallway and Rooms	20	39	
South Hallway	Non-impacted: attic and admin areas		
THIRD FLOOR			
North Hallway	20	3	
North Hallway North Rooms	20	48	
North Hallway South Rooms	20	30	Noted H-3 Room 3004
West Hallway	20	3	
West Hallway West Rooms	20	63	
West Hallway East Rooms	20	42	
South Hallway	20	3	
South Hallway North Rooms	20	48	
South Hallway South Rooms	20	48	
East Hallway and Rooms	Non-impacted: office and admin areas		
SECOND FLOOR			
North Hallway and impacted rooms	20	20	
West Hallway	20	3	
West Hallway West Rooms	20	66	
West Hallway East Rooms	20	39	
South Hallway	20	3	
South Hallway North Rooms	20	51	
South Hallway South Rooms	20	45	
East Hallway and Rooms	Non-impacted: Office Headquarters		

TABLE G-1 (Continued)
SUMMARY OF SURVEY AREAS FOR WRAIR BUILDING 40

SURVEY UNIT	WIPES		COMMENT
	WRS TEST	JUDGMENTAL	
FIRST FLOOR			
North Hallway	20	3	
North Hallway North Rooms	20	42	
North Hallway South Rooms	20	33	
West Hallway	20	3	
West Hallway West Rooms	20	66	
West Hallway East Rooms	20	42	
East Hallway and Rooms	Non-impacted: Entry/auditorium/offices		
South Hallway and impacted rooms	20	20	
BASEMENT FLOOR			
North Hallway and impacted rooms	20	20	
West Hallway	20	3	
West Hallway West Rooms	20	48	
West Hallway East Rooms	20	33	
South Hallway	20	3	
South Hallway North Rooms	20	48	
South Hallway South Rooms	20	30	
East Hallway and Rooms	20	42	
SUBBASEMENT FLOOR			
Subbasement impacted areas	20	10	
ROOF			
Roof vents and drains	NA	10	As required
HEPA FILTERS			
Possible survey of Filters removed from trains, estimated 6 filters @ 3 wipes/filter = 18 wipes			
JUDGMENTAL SURVEY/SAMPLE POINTS			
Ventilation hoods and sinks in impacted survey units; estimate of 3 judgmental points per survey unit or each room within survey unit used.			
Obtain wipe(s) above two meters in survey units which may have used H-3			
Note that this potentially includes all rooms except B099 and B101			

EXAMPLE SURVEY UNIT GRAPHIC:



<p>WALTER REED ARMY INSTITUTE OF RESEARCH BUILDING 40 SUB BASEMENT IMPACTED ROOMS</p>	<p>DATE: 22 MAY 01</p>
<p>U.S. ARMY CENTER FOR HEALTH PROMOTION AND PREVENTIVE MEDICINE UNITED STATES ARMY MEDICAL DEPARTMENT</p>	<p>DRAWN: JC</p>
	<p>APPROVED: MM</p>
	<p>SCALE: NTS</p>
	<p>PLATE: N/A</p>