Radiological Decontamination and Decommissioning
(D&D)

Final Status Survey Report

AUGUST 2000

NMRC Main Buildings and the Nicholson Building
Bethesda, Maryland 20889-5607

Prepared by
Radiation Safety Office
Naval Medical Research Center
Bethesda, Maryland

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I. DEDICATION AND ACKNOWLEDGEMENTS

DEDICATION

This work is dedicated in memory of my father, Mr. John S. Gaiter, Sr. (May 1, 1932 - August 19, 1999) and my youngest sister, Bergenia R. Gaiter (June 13, 1967 - October 11, 1999).

ACKNOWLEDGMENTS

Without the noteworthy contributions, support and assistance of numerous persons, this work would not have been possible.

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II. OVERVIEW

This document, the Naval Medical Research Center (NMRC) Main Buildings Radiological Decontamination and Decommissioning (D&D) Final Status Survey Report, was prepared in support of NMRC's decommissioning efforts. The NMRC Main Buildings consist of buildings 17, 18, 21, 22, 29, 49, 139 and the leased spaces at the Nicholson Building. This report includes all survey results, reference background readings, check-source evaluations, calculations, procedures, problems/deviations from plans, recommendations for survey-site status, and other pertinent information.

This report describes the actions and levels of effort that NMRC undertook to demonstrate to regulatory authorities that the vacated NMRC Main Buildings met the release criteria for unrestricted future use. To achieve this objective, guidance provided in the Multi-Agency Survey and Site Investigation Manual (MARSSIM, ref 11.1) and other regulatory documents were followed and parameters chosen to meet or exceed the release criteria.

The NMRC Historical Site Assessment (HSA, ref 11.2) served as the primary document for information regarding potential contaminants, potential contaminated areas, and potential contaminated media.

The NMRC Main Buildings are located at 8901 Wisconsin Avenue, Bethesda, Maryland 20889-5607 on the NNMC Bethesda campus. The Nicholson Building is located at 5516 Nicholson Lane, Kensington, Maryland. NMRC operations will continue in the Nicholson Building; however, use of radioactive materials by NMRC staff ceased in February 2000. **Table A** provides a list of tables in Sections I through XI.

Table 1 provides a summary of the buildings that comprise the NMRC Main Buildings. Medical studies and biomedical research were conducted which involved the use of chemicals and other hazardous materials, biological materials, animals and animal products, and radiological materials. All the surrounding properties are located upon the NNMC campus (ref 11.3, ESA 1997).

Table 2 provides a list of radionuclides that were used in the NMRC Main Buildings. This list also includes isotopes that are

not of concern for this decommissioning work because of the elapsed time since their last use in the buildings.

Table A. List of Tables in Sections I through XI

Table 1. NMRC Main-Buildings Information				
Building Number	Utilization	Most Recent Year of RAM Use	Floor Area (square feet)	Isotopes of Concern
Nicholson Building (2 rooms only)	Office, Laboratory, Storage, etc.	1999	634	H-3
17	Office, Laboratory, Storage, etc.	1999	51526	H-3, C-14, S-35, Cr-51, I-125
18	Office, Laboratory, Storage, etc.	1999	8254	H-3, C-14, S-35, Cr-51
21	Office, Laboratory, Storage, etc.	1999	21818	H-3, C-14, S-35, Cr-51
22	Storage		100	
29	Office, etc.		489	
49	Storage, etc.		1089	
139	Office, Laboratory, Storage, etc.	1999	4343	H-3, C-14, I-125
174/219	Storage, etc.		2142	
Sub-total			90395	

Table 2. Radioisotopes Used in NMRC Main Buildings					
SYMBOL	RADIOISOTOPE	YEAR OF LAST USE	HALF LIFE	MAJOR RADIATIONS	OF DECOM-MISSIONING CONCERN DURING THESE D&D EFFORTS?
Ba133	Barium-133 (rooms 112 and 122)	1992	7.2 Y	Gamma	N
C14	Carbon-14	1999	5730 Y	Beta	Y
Co57	Cobalt-57	1992	270.9 D	Gamma	N
Cs137	Cesium-137	2000	30 Y	Beta, Gamma	N
H3	Hydrogen-3	1999	12.3 Y	Beta	Y
S35	Sulfur-35	1999	87.4 D	Beta	Y
Ar41	Argon-41	1992	1.83 H	Beta, Gamma	N
Ca45	Calcium-45	1997	165 D	Beta	N
Ce141	Cerium-141	1993	32.5 D	Beta, Gamma	N
Cr51	Chromium-51	1999	27.7 D	Gamma	Y
I125	Iodine-125	1999	60.2 D	Gamma	Y
I131	Iodine-131	1991	8.1 D	Beta, Gamma	N
In111	Indium-111	1990	2.8 D	Beta, Gamma	N
Kr79	Krypton-79	1992	34.9 D	Gamma	N
Kr85m	Krypton-85m	1992	4.4 H	Beta, Gamma	N
Nb95	Niobium-95	1993	35 D	Beta, Gamma	N
P32	Phosphorus-32	1999	14.3 D	Beta	N
P33	Phosphorus-33	1998	24.4 D	Beta	N
Ru103	Ruthenium-103	1993	39.5 D	Gamma	N
Sc46	Scandium-46	1986	83.8 D	Beta, Gamma	N
Sn113	Tin-113	1990	115 D	Gamma	N
Tc99m	Technetium-99m	1992	6.05 H	Gamma	N
Xe127	Xenon-127	1992	36.4 D	Gamma	N
Xe133	Xenon-133	1992	5.3 D	Beta, Gamma	N

NMRC's history of military medical research during the 1940's to 2000 at the Main Building site included the use of unsealed radioactive materials. The use of unsealed radioactive materials in laboratories, rooms, and areas dictated that some level of decommissioning was required for each area of radioactive material-use to ensure and document compliance with the regulatory release criteria for unrestricted use.

The radioactive contaminants of concern were Tritium (H-3), Carbon-14 (C-14), Sulfur-35 (S-35), Chromium-51 (Cr-51), and Iodine-125 (I-125).

The examination for potential radioactive contaminants included surveys, direct measurements, sampling and analysis, and scanning with appropriate instruments and equipment. The examinations included:

(1) all accessible floor space,

(2) the lower half of all walls extending up approximately two meters from the floor, and

(3) other selected locations.

The survey units were classified as either Impacted Class 3 or Non-impacted. There were no survey sites classified as Impacted Class 1 or Class 2, which are the two remaining classifications requiring the most extensive decommissioning effort. Selected common areas, restrooms, and non-impacted areas were evaluated for potential radioactive contamination. After equipment, materials and wastes were removed from radioactive materials-use areas, residual contamination was confined to small areas within a small percentage of the survey units.

The 5-month decommissioning period began in March 2000 and was concluded in August 2000. The cost of performing the necessary decommissioning efforts included instrument and equipment costs, materials, supplies and contracted labor.

III. Abbreviations and Definitions

A. ACRONYMS AND ABBREVIATIONS

µCi	Micro-Curie
µR/hr	Micro-Roentgens per hour (exposure rate)
Annex	NMRC Rockville Annex Laboratories, Washington Avenue, Rockville, MD
BRAC	Base Realignment and Closure
BUMED	Bureau of Medicine and Surgery
CFR	Code of Federal Regulations
cpm	Counts per minute
D&D	decontamination and decommissioning
DOD	Department of Defense
DOT	Department of Transportation
dpm	Disintegrations per minute
Gy	Gray, SI unit of absorbed dose, 1 Gy = 100 rads
Irradiator	Sealed-source, Cesium-137 gamma irradiator
MDA	Minimum detectable activity
NEHC	Navy Environmental Health Center
NMRC	Naval Medical Research Center, formerly NMRI
NMRI	Naval Medical Research Institute
NNMC	National Naval Medical Center
NRC	U. S. Nuclear Regulatory Commission
NRMP	NMRC's Navy Radioactive Materials Permit
NUREG	Nuclear Regulatory Guide
R, R/hr	Roentgen (exposure), Roentgens per hour
Rad, Rad/hr	Rad (dose), Rads per hour (dose rate)
RAM	Radioactive materials
Rem, Rem/hr	Rem (dose equivalent), Rem per hour
SOP	Standard operating procedure
Sv	Sievert, SI unit of dose equivalent, 1 Sv = 100 rems
US	United States
USN	United States Navy
WSSC	Washington Suburban Sanitary Commission

B. KEY TERMS AND DEFINITIONS (reference 11.1, MARSSIM)

α, Alpha	The specified maximum probability of Type I error; i.e., the maximum probability of rejecting the null hypothesis when it is true. Alpha is referred to as the size of the test. Alpha reflects the amount of evidence the decision maker would like to see before abandoning the null hypothesis.
Area	A term referring to any portion of a site, up to and including the entire site.
Background radiation	Radiation from cosmic sources, naturally occurring radioactive material, radon, and global fallout as it exists in the environment from testing of nuclear explosive devices or from nuclear accidents. Background radiation does not include radiation from source, byproduct, or special nuclear materials regulated by the Federal or State agency.
Becquerel (Bq)	The unit of radioactivity equivalent to one nuclear transformation per second.
β, Beta	The probability of a Type II error; i.e., the probability of accepting the null hypothesis when it is false. The compliment of beta ($1-\beta$) is referred to as the power of test.
Beta emitter	A radioactive material emitting beta particles. Beta particles are electrons emitted from the nucleus during radioactive decay.
Byproduct material	Licensed or radioactive material regulated by the NRC.
Class 1 areas	Impacted areas with the highest potential for contamination or insufficient evidence to support reclassification as Class 2 or 3.
Class 2 areas	Impacted areas with low potential for delivering a dose above the release criterion and little or no potential for small areas of elevated activity.
Class 3 areas	Impacted areas with little or no potential for delivering a dose above the release criterion and little or no potential for small areas of elevated activity.

Classification	The act or result of separating areas or survey units into one of the three designated classes: Class 1 area, Class 2 area, or Class 3 area.
Cleanup standard	A numerical limit set by a regulatory agency as a requirement for releasing a site after cleanup.
Contamination	The presence of residual radioactivity in excess of levels which are acceptable for release of a site or facility for unrestricted use.
Curie	A unit of radioactivity equal to 37 billion becquerels.
Derived Concentration Guideline Level (DCGL)	A derived, radionuclide-specific activity concentration within a survey unit corresponding to the release criterion. The DCGL is based on the spatial (uniform) distribution of the contaminant and hence is derived differently for the non-parametric statistical test ($DCGL_w$) and the elevated measurement comparison ($DCGL_{EMC}$). DCGLs are derived from activity/dose relationships through various exposure pathway scenarios.
Decommission	To remove (as a facility) safely from service and reduce residual radioactivity to a level that permits release of the property for unrestricted use and termination of the Nuclear Regulatory Commission license or Navy radioactive material permit.
Decommissioning	The process of removing a facility or site from operation, followed by decontamination, and license termination (or termination of authorization for operation) if appropriate.
Decontamination	The removal of radiological contaminants from persons, objects, or areas to within regulatory levels.
Direct measurement	Radioactivity measurement obtained by placing the detector near the surface or media being surveyed. An indication of the resulting radioactivity level is read out directly.

Final status survey	Measurements and sampling to describe the radiological conditions of a site, following completion of decontamination activities (if warranted) in preparation for release.
Gamma (γ) radiation	Penetrating high-energy, short-wavelength electromagnetic radiation (similar to X-rays) emitted during radioactive decay. Gamma rays are very penetrating and require dense materials (such as lead or steel) for shielding.
Impacted areas	Any area that is not classified as non-impacted. Areas with a possibility of containing residual radioactivity in excess of natural background or fallout levels.
Investigation level	A derived media-specific, radionuclide-specific concentration or activity level of radioactivity that is based on the regulatory release criteria and triggers a response that further investigation or action is necessary if exceeded.
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual (DOE,DOD, EPA, NRC); provides for conducting decommissioning activities to satisfy regulatory release criteria.
Non-impacted areas	Areas where there is no reasonable possibility (extremely low probability) of residual contamination.
Non-parametric test	A test based on relatively few assumptions about the underlying probability distributions of the measurements. As a consequence, non-parametric tests are generally valid for a fairly broad class of distributions. The Wilcoxon Rank Sum test and the Sign test are examples of non-parametric tests.
Outlier	Measurements that are unusually large or small relative to the rest and therefore are suspect of misrepresenting the population from which they were collected.

Radioactive material (RAM)	Solid, liquid or gaseous material that contains radionuclides regulated by the NRC.
Radioactive waste	Solid or liquid trash or excess material that contains radionuclides regulated by the NRC.
Release criterion	A regulatory limit expressed in terms of dose or risk; compliance demonstration is simply a decision as to whether or not a survey unit meets the release criterion.
Residual radioactivity	Radioactivity in structures, materials, soil, groundwater, and other media at a site resulting from activities under the cognizant organization's control.
Scanning	An evaluation technique performed by moving a detection device over a surface at a specified speed and distance above the surface to detect radiation.
Sign test	A non-parametric statistical test used to demonstrate compliance with the release criterion when the radionuclide of interest is not present in background and the distribution of the data is not symmetric.
Site	Any installation, facility, or discrete, physically separate parcel of land, or any building or structure or portion thereof, that is being considered for survey and investigation.
Survey	A systematic evaluation and documentation of radiological measurements with a correctly calibrated instrument or instruments that meet the sensitivity required by the objective of the evaluation.
Survey unit	A geographical area consisting of a room, hallway, structures or land areas of specified size and shape for which a separate decision will be made whether the unit attains the cleanup standard; are established to facilitate the survey process and the statistical analysis of the survey data.

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

IV. EXECUTIVE SUMMARY

A. PURPOSE

A final status decommissioning survey was conducted to determine the presence and extent of any radiological health hazards in the Main Buildings used by NMRC at the National Naval Medical Center (NNMC) Bethesda campus and in the two laboratories used at the Nicholson Building in Kensington, Maryland. Appropriate actions were taken to verify that any residual radioactivity in the NMRC buildings was in compliance with regulatory guidelines for the decontamination of facilities prior to release for unrestricted use.

B. PLAN

- Develop and implement an approved decontamination and decommissioning plan.
- Stop all work involving the use of radioactive materials.
- Dispose, remove or transfer all licensed, radioactive materials and equipment to authorized recipients.
- Minimize hazardous and low-level radioactive waste generated.
- Decontaminate known areas of contamination to background levels.
- Meet regulatory radiological, environmental, and safety regulations.
- Control costs and complete closure within the allocated timeframe.
- Prepare final status survey reports.

A radiological survey plan was developed to survey over 93,000 square feet (of floor and wall surface area) with portable instrumentation and to take and analyze over 2,500 swipe samples and more than 250 direct readings throughout the NMRC Main Buildings. The work history and probability of residual radioactive material were used to identify areas selected for surveying and sampling. The closure operations used basic engineering principles and common industrial practices. Those few areas where low-level radioactivity in excess of permissible limits was detected were remediated and released for unrestricted use. After completing final status survey efforts for contaminated floor and work bench areas, it was determined that no further decontamination efforts were necessary and that the residual-radioactivity level was well below the NRC screening values for residual contamination.

C. CONCLUSIONS

The plan described in item B above has been fully implemented, completed, and documented.

The decontamination and decommissioning efforts involved the performance of final status surveys for 100% (102 of 102) of the Impacted Class 3 survey units and 39% (121 of 308) of the non-impacted survey units. The number of survey units referenced in this report could differ from the number of rooms because some rooms were sub-divided into two or more survey units and some rooms were combined to form a single survey unit.

Operations involving the use of licensed, radioactive materials at the NMRC Main Buildings have had no adverse effect on occupied buildings and their surroundings. All radioactive materials as a result of NMRC operations have been removed from the building. Regulatory agency criteria for release of the building for unrestricted use have been fulfilled.

V. REASON FOR DECOMMISSIONING

Base Realignment and Closure (BRAC) legislation passed and signed into law in 1995 mandated that the Naval Medical Research Center (NMRC) relocate some of its programs and research efforts and cease operations at the NNMC campus in Bethesda, Maryland and at the NMRC Rockville Annex in 1999. The NMRC Bone Marrow Registry Program will continue at its off-site Nicholson Building location. However, use of radioactive materials at the Nicholson Building has been terminated. This report contains the results of satisfactory radiological final status surveys for the Nicholson Building laboratories.

NMRC, the Navy's largest medical research facility, opened its doors in Bethesda on October 27, 1942 to conduct research, development, tests, and evaluations to enhance the health, safety, and readiness of Navy and Marine Corps personnel in the effective performance of peacetime and contingency missions. NMRC had specific environmental obligations to fulfill before returning the NMRC Main Buildings to the NNMC. These obligations involved the completion of biological, chemical, environmental and radiological decommissioning efforts.

VI. GUIDANCE FOR DECOMMISSIONING EFFORTS

Regulatory guidance for conducting this radiological decommissioning activity was obtained from various sources. The Environmental Protection Agency (EPA), the Nuclear Regulatory Commission (NRC), and the Department of Energy (DOE) are responsible for the release of sites following cleanup. These responsibilities apply to facilities under the control of federal agencies, such as the DOE and the Department of Defense (DOD), and to sites licensed by the NRC and its Agreement States. Some states have responsibilities for similar sites under their control.

The NRC requires the radiological decommissioning of sites, buildings and outdoor areas where licensed activities have ceased radiological operations, even while licensed activities continue to be conducted at other site locations. Use of licensed materials at the NMRC Main Buildings at Bethesda, Maryland ceased in December 1999. These sites required decommissioning and return to the NNMC for unrestricted use.

The detailed guidance provided in the Multi-Agency Survey and Site Investigation Manual (MARSSIM, ref 11.1) was used for planning, implementing, and evaluating environmental and facility radiological surveys that NMRC conducted to demonstrate compliance with the current dose-based regulation (10CFR20.1402, ref 11.4). Other regulatory documents (referenced in Section XI.) were used to provide estimates for derived concentration guideline values, dose modeling, and other necessary information and techniques.

The MARSSIM provides a nationally consistent consensus approach to conducting radiation surveys and investigations at potentially contaminated sites. The decommissioning that follows remediation will normally require a demonstration to the responsible federal or state agency that the cleanup effort was successful and that the release criterion was met. In MARSSIM, this demonstration is given the name "final status survey." The MARSSIM assists site personnel and others in performing or assessing such a demonstration.

Unique site-specific cases did not arise that required a modified approach beyond what is presently described in MARSSIM.

VII. CONCEPTUAL MODEL AND SITE INFORMATION

A. POTENTIAL RADIOACTIVE CONTAMINANTS

The potential radioactive contaminants included Hydrogen-3 (tritium), Carbon-14, Sulfur-35, Chromium-51 and Iodine-125. **Table 2** summarizes the radioisotopes that were used in the NMRC Main Buildings. Radioactive materials were obtained and used in the form of liquid solutions. There was no likely potential for contamination as a result of airborne release of radioactive materials due to the nature of operations. Therefore, ceiling surfaces were not evaluated or surveyed for residual contamination. Low-level radioactive liquid and solid wastes were generated and properly disposed. Liquid (aqueous) and solid wastes were collected by the user and turned into the NMRC Radiation Safety Office for proper disposal. Radioactive (solid and liquid) wastes were removed from NMRC Main Buildings for disposal.

NMRC researchers and technicians who used radioactive materials were required to maintain separate waste containers for each isotope used. Further segregation occurred for liquids, solids, carcasses, scintillation vials, and sharps. All radioactive material (RAM) wastes were turned in to the Radiation Safety Office for tracking, storage and subsequent disposal and/or transfer. Logbooks were maintained. Burial of waste was prohibited. Solid waste disposal via decay-in-storage occurred for shorter half-life RAM (< 65 days). Long half-life RAM wastes were transferred to the National Naval Medical Center (NNMC) at Bethesda, Maryland, for transfer to a commercial contractor.

The review of NMRC records included summaries of NMRC's annual receipts (inventories) of radioactive materials, annual solid radioactive waste disposal logbook entries, and annual sanitary sewer disposal of liquid radioactive materials logbook entries. **Table 2** provides a list of radioisotopes that were used at NMRC Main Buildings but are not of D&D contamination concern because of the elapsed time since their last use.

B. POTENTIAL CONTAMINATED AREAS

All available NMRC daily, weekly, monthly, and quarterly wipe test and survey monitoring results (1980-1999) were reviewed for evidence of residual contamination in the NMRC Main Buildings. Incident and spills records were also reviewed. When contamination was detected during the course of decommissioning the NMRC buildings, characterization surveys, remediation actions, and remediation action surveys were completed and documented in the final survey summaries.

Table 3 provides a list of all NMRC Main-Building survey units or sites. These sites included offices, lunchrooms, lavatories, storage areas, common areas, laboratories, equipment rooms, and radiological waste storage rooms.

C. IMPACTED AREAS - KNOWN AND POTENTIAL

Impacted areas have some potential for residual contamination. Impacted areas are further divided into three classifications. **Table 3** provides a list of Impacted Class 3 Areas and Non-impacted Areas. No NMRC Main Building areas were classified as Impacted Class 1 or 2.

1. CLASS 1 AREAS

Class 1 areas are impacted areas that, prior to remediation, are expected to have concentrations of residual radioactivity that exceed the DCGL (DCGL is defined in MARSSIM as derived concentration guideline levels or action limits). None of the survey sites were classified as Class 1.

2. CLASS 2 AREAS

Class 2 areas are impacted areas that, prior to remediation, are not likely to have concentrations of residual activity that exceed the DCGL. None of the survey sites were classified as Class 2.

3. CLASS 3 AREAS

Class 3 areas are impacted areas that have a low probability of containing residual radioactivity. **Table 3** lists NMRC Impacted Class 3 Areas. Of the 410 NMRC Main Buildings survey units, 102 were classified as Impacted Class 3. The Impacted Class 3 sites consisted of rooms where radioactive materials were used or stored.

4. NON-IMPACTED AREAS

Non-impacted areas have no reasonable potential for residual contamination. **Table 3** lists NMRC Non-impacted Areas. These Non-impacted areas were offices, common areas, and other non-radioactive-material-use areas.