Radiological Decontamination and Decommissioning (D&D)

Final Status Survey Report

JUNE 16, 2000

NMRC Diving Buildings
Bethesda, Maryland 20889-5607

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

TABLE OF CONTENTS

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.

NMRC Radiological Decontamination and Decommissioning (D&D) Team

- Schleurious L. Gaiter; LCDR, MSC, USN: Radiation Safety Officer, Decommissioning Officer, and Quality Control Officer
- Saifeddin Ahmad; Assistant Radiation Safety Officer, Team Leader, Lead Health Physics Technician, Chief of Office and Laboratory Operations
- Willie Deadwyler; Team Leader, Health Physics Technician, Chief of Field Operations
- Carolyn Hall; Technical Writer, Chief Editor, Publications Officer
- Glen Garth; Health Physics Assistant, Data Processing Specialist
- Rodney McGhee; Health Physics Assistant, Data Processing Specialist
- HM2 Michelle McGhee; USN: Safety Assistant

Command and Navy Personnel

- Dr. Charles Odeyale; Ph.D., NMRC Environmental and Chemical Hygiene Officer
- HM1 James Bruce; USN, Hazardous Materials Technician
- Daniel Fischer; NMRC Safety Assistant
- Stephen Krauz; LT, MSC, USN, Supply Officer
- Veronica Serrano; NMRC Purchase and Contract Specialist
- Raymond Albright; NMRC Purchase and Contract Specialist
- Donald Chandler; NMRC BRAC Officer
- Sandra Hawkins; NMRC Comptroller
- Regina Hunt; NMRC Historian
- Michael Bush; LT, MSC, USN, Navy Environmental Health Center
- Paul Tveten; Navy Environmental Health Center
- Sandy J. Wolff; LCDR, MSC, USN, Navy Environmental Health Center

II. OVERVIEW

This document, the Naval Medical Research Center (NMRC) Diving Buildings Radiological Decontamination and Decommissioning (D&D) Final Status Survey Report, was prepared in support of NMRC's decommissioning efforts. The NMRC Diving Buildings consist of buildings 28, 53, 59, 69 and 79. 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 Diving Buildings meet 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 Diving Buildings are located at 8901 Wisconsin Avenue, Bethesda, Maryland 20889-5607 on the NNMC Bethesda campus. **Table A** provides a list of tables in Sections I through XI.

Table 1 provides a list of radionuclides that were used in the NMRC Diving Buildings. This list includes isotopes that are not of concern for this decommissioning work because of the elapsed time since their last use in the buildings.

Table 2 provides a summary of the buildings that comprise the NMRC Diving 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 National Naval Medical Center (NNMC) campus (ref 11.3, ESA 1997).

Table A. List of Tables in Sections I through XI

Table 1. Radioisotopes Used At NMRC Diving 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	Y
C14	Carbon-14	1999	5730 Y	Beta	Y
Co57	Cobalt-57	1992	270.9 D	Gamma	Y
Cs137	Cesium-137 (rooms 112 and 122)	1992	30 Y	Beta, Gamma	Y
H3	Hydrogen-3	1999	12.3 Y	Beta	Y
S35	Sulfur-35	1998	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	1992	27.7 D	Gamma	N
I125	Iodine-125	1994	60.2 D	Gamma	N
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

Table 2. NMRC Diving Buildings Information

Building Number	Building Uses	Floor Area (square feet)	Occupancy or Years of RAM Use		Isotopes of Concern
			Start	Stop	
28	Offices, labs, storerooms, machine rooms	5,856	1952	1999	None
53	Diving facility, offices, labs, store rooms	22,136	1976	1999	H3, C14, Co57, Ba133, Cs137
59	Diving facility	2,695	1989	1999	None
69	Diving facility	805	1992	1999	None
79	Equipment facility	1,195	1992	1999	None
Total		32,687			

NMRC's history of military medical research during 1976 to 1999 at the Diving Buildings 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 Hydrogen-3, Carbon-14, Cobalt-57, Barium-133, and Cesium-137.

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 February 2000 and was concluded in June 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-β) 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. Survey units 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 Diving Buildings used by NMRC at the National Naval Medical Center (NNMC) Bethesda campus. Appropriate actions were taken to verify that any residual radioactivity in the vacated 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 29,000 square feet (of floor and wall surface area) with portable instrumentation and to take and analyze over 600 swipe samples and more than 100 direct readings throughout the NMRC Diving 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 workbench 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 satisfactory performance of final status surveys for 100% (12 of 12) of the Impacted Class 3 units and 44% (34 of 78) of the Non-impacted units.

Operations involving the use of licensed, radioactive materials at the NMRC Diving Buildings have had no adverse effect on the leased commercial building. 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.

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 Diving 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 Diving 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, Cobalt-57, Barium-133 and Cesium-137. The Barium-133 and Cesium-137 sources were small sealed sources of millicurie activity that were used only in rooms 112 and 122 of Building 53. **Table** 1 summarizes the radioisotopes that were used in the Diving Buildings, more specifically, Building 53. Radioactive materials were obtained and used in the form of gaseous and liquid solutions. There was no likely potential for contamination as a result of airborne release of radioactive materials due to the nature of operations and the elapsed period since the gaseous materials were used. 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 Diving 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 Diving 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 Diving Buildings. Incident and spills records were also reviewed. When contamination was detected during the course of decommissioning the NMRC buildings, characterization surveys, remedial actions, and remediation action surveys were completed and documented in the final survey summaries.

Description of spill incident, leakage of Xenon-127 gas in hood, 16 August to 25 October 1985: The laboratory in Room 112, Building 53, NMRC, had recently obtained a radiation dose calibrator to determine the actual doses of radioactive Xenon gas utilized during experiments. On 16 August 1985, a vial of Xenon-127 gas was obtained from Oak Ridge. The gas was presumed to contain 208 mCi of gas based on information obtained from Oak Ridge.

The gas was transferred without incident into an RGD 700 container that had previously held a vacuum for periods up to a week of leak testing. Over the following nine weeks, the gas was withdrawn into a sample syringe for equipment calibration and then returned into the container; no samples were used in actual experiments. No evidence of leakage was noted on the Xenon-133 monitor, which was continuously sampling the air in the hood of Room 112 during this time.

The monitor was periodically checked and found to be very sensitive to minute quantities of Xenon-127 and Xenon-133. On 25 October 1985, the amount of Xenon-

127 gas in the RGD container was estimated to be 56 mCi. Two samples of gas were assayed from the container and had an average activity of 3.55 mCi/5 cc in the radiation dose calibrator. Back calculation revealed that there was 0.2 mCi of gas in the container on 16 August 1985; this implied a loss between 100 mCi (if lost on 16 August) and 28 mCi (if lost on 25 October) of gas from the container. Assuming a worst case of a gradual 100 mCi loss over 9.4 weeks, this would have amounted to approximately 1% MPC (maximum permissible concentration) for a restricted area and 12% MPC for unrestricted areas.

Further testing revealed a light leak at the syringe/container junction during gas transfer. This leak was too small to account for the amount of gas lost so an episode in which the RGD 700 container was left with the valves cracked open was presumed to explain the amount of gas lost. Procedures were revised to prevent recurrence of this incident. No decontamination efforts were required. No residual contamination exists in 2000 as a result of this 1985 Xenon-127 leakage.

Table 3 provides a list of all NMRC Diving-Building survey 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 Diving-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 90 NMRC Diving Buildings survey units, 12 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.

Table 3. NMRC Diving-Buildings Impacted Class 3 Areas and Non-impacted Areas

BUILDING	ROOM OR AREA	DESCRIPTION	ISOTOPES OF CONCERN	D&D CLASSIFICATION
53	101	Laboratory	H3, C14, Co57	Impacted, Class 3
53	102	Laboratory	H3, C14, Co57	Impacted, Class 3
53	111	Laboratory	H3, C14, Co57	Impacted, Class 3
53	112	Office/Lab	H3, C14, Co57, Ba133, Cs137	Impacted, Class 3
53	112A	Laboratory	H3, C14, Co57, Ba133, Cs137	Impacted, Class 3
53	113	Laboratory	H3, C14, Co57	Impacted, Class 3
53	117	Laboratory	H3, C14, Co57	Impacted, Class 3
53	118	Laboratory	H3, C14, Co57	Impacted, Class 3
53	119	Laboratory	H3, C14, Co57	Impacted, Class 3
53	120	Office	H3, C14, Co57	Impacted, Class 3
53	121	Laboratory	H3, C14, Co57	Impacted, Class 3
53	122	Laboratory	H3, C14, Co57, Ba133, Cs137	Impacted, Class 3
28	100	Supply		Non-impacted
28	101	Mechanical		Non-impacted
28	102	Storage		Non-impacted
28	103	Storage		Non-impacted
28	106	Office		Non-impacted
28	106 A	Laboratory		Non-impacted
28	107	Office		Non-impacted
28	108	Office		Non-impacted
28	200	Office		Non-impacted
28	201	Office		Non-impacted
28	201 A	Office		Non-impacted
28	202 A	Office		Non-impacted
28	202 B	Storage		Non-impacted
28	203	Supply		Non-impacted
28	204	Shop		Non-impacted
28	205	Entryway		Non-impacted
53	10	Shop		Non-impacted
53	100	Foyer		Non-impacted
53	100 B	Office		Non-impacted

53	103	Laboratory		Non-impacted
53	104	Office		Non-impacted
53	105	Office		Non-impacted
53	108	Conference room		Non-impacted
53	109	Office		Non-impacted
53	11	Shop		Non-impacted
53	110	Office		Non-impacted
53	114	Office		Non-impacted
53	115	Gear Lab		Non-impacted
53	116	Office		Non-impacted
53	120 B	Office		Non-impacted
53	120 C	Office		Non-impacted
53	120 D	Office		Non-impacted
53	123	Office		Non-impacted
53	124	Office		Non-impacted
53	124 A	Office		Non-impacted
53	125	Office		Non-impacted
53	126	Office		Non-impacted
53	126 A	Office		Non-impacted
53	126 B	Office		Non-impacted
53	127	Office		Non-impacted
53	128	Telephone		Non-impacted
53	13	Office		Non-impacted
53	14	Storage		Non-impacted
53	15	Storage		Non-impacted
53	22	Galley		Non-impacted
53	23	Compressors		Non-impacted
53	24	NRCC		Non-impacted
53	25	Office		Non-impacted
53	25 A	Office		Non-impacted
53	25 B	Office		Non-impacted
53	26	Office		Non-impacted
53	26 A	Sickbay		Non-impacted
53	26 B	Office		Non-impacted
53	28	Sickbay		Non-impacted
53	29	Office		Non-impacted
53	30	Office		Non-impacted
53	31	Instrument room		Non-impacted
53	32	Mechanical		Non-impacted
53	33	Mechanical		Non-impacted
53	S-1	Entryway		Non-impacted
59	100	Research tank		Non-impacted
59	101	Laboratory		Non-impacted
59	102	Laboratory		Non-impacted
59	103	Electrical room		Non-impacted
59	104	Closet		Non-impacted

59	106	Laboratory		Non-impacted
59	11	Scuba Locker		Non-impacted
69	100	Shop/mech. room		Non-impacted
69	102	Laboratory		Non-impacted
69	103	Laboratory		Non-impacted
69	104	Control room		Non-impacted
79	100	Storage		Non-impacted
79	101	Mechanical shop		Non-impacted
79	103	Office		Non-impacted
79	104	Laboratory		Non-impacted
79	107	Laboratory		Non-impacted
79	120A	Office		Non-impacted
79	S-1	Entryway		Non-impacted

D. POTENTIAL CONTAMINATED MEDIA

The potential contaminated media were building surfaces such as walls, floors, workbenches, sinks and shelves.

E. CONCEPTUAL MODEL FOR DECOMMISSIONING

For the convenience of scheduling necessary radiological activities and to maximize the use of available resources, NMRC's Decontamination and Decommissioning (D&D) Plan was divided into four distinct phases. The NMRC Annex was the first phase to undergo radiological D&D efforts. The NMRC Diving Buildings comprised the second D&D phase. The other two phases included the NMRC main buildings and NMRC Building 150. **Table 4** summarizes the NMRC Diving Buildings Radiological D&D Conceptual Model Information. To accommodate radiological monitoring and surveys, some of the survey units were sub-divided.

TABLE 4. NMRC Diving-Buildings Radiological D&D Conceptual Model Information

Building Number	Number of Survey Units (Rooms)		Floor Area (square feet)	
	Non-impacted Areas	Impacted Class 3 Areas	Non-impacted Areas	Impacted Class 3 Areas
28	16	0	3,415	0
53	44	12	14,026	7,673
59	7	0	2,695	0
69	4	0	805	0
79	7	0	1,195	0
Total	78	12	22,136	7,673

The examination for potential radioactive contaminants included direct measurements using a gas proportional counter, sampling and analysis using a liquid scintillation counter, scanning with appropriate

instruments and equipment, and data analyses. For Impacted Class 3 areas, the survey unit 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.

After equipment, materials and wastes were removed from radioactive-materials-use areas, it was found that residual contamination was confined to small areas within a small percentage of the survey units.

VIII. DECOMMISSIONING ACTIVITIES

A. OBJECTIVE

The objective of this decommissioning effort was to demonstrate that the sites are suitable for unrestricted release in accordance with the criteria for decommissioning in Subpart E, "Radiological Criteria for License Termination," of 10 CFR Part 20, "Standards of Protection Against Radiation" (ref 11.4).

To achieve this objective, guidance provided in MARSSIM and other regulatory documents was followed. Parameters were chosen to ensure that the following objectives were met:

(1) Identification of the premises and radiological operations;

(2) Demonstration that reasonable efforts were planned to reduce/eliminate residual contamination to as low as practicable;

(3) Documentation of decontamination and decommissioning plan and survey standard operating procedures;

(4) Preparation of the Final Status Survey Report.

B. COST ESTIMATES FOR DECOMMISSIONING ACTIVITIES

Cost estimates were prepared to approximate the cost for various decommissioning activities, including labor, materials, equipment, services, shipping expenses, and other related expenses. Estimates from commercial firms were received regarding some of NMRC's planned decommissioning efforts. In addition, estimates for equipment purchases and disposals were obtained. One vendor quoted a labor rate of $55.00 per hour for technician support working under NMRC supervision. The manpower, equipment and other

essential resources for the radiological D&D operations for the NMRC Diving Buildings cost approximately $25,000.

C. RELEASE LIMITS AND DOSE PATHWAY MODELING

The release limits, which include fixed and loose surface contamination, were based upon the NRC guideline screening values. Because NMRC established action limits at a fraction of NRC screening values, dose modeling was not required. Site-specific parameters were not required and were not developed. Dose/pathway modeling was not required because detectable radioactivity was remediated to background levels by decontamination efforts or removal of the contaminated media.

D. CRITERIA FOR LICENSE TERMINATION (NUREG-1549)

The criteria for releasing a site for unrestricted use is described below; the criteria for releasing a site for unrestricted and restricted use are summarized in **Table 5**.

Subpart E, 10 CFR 20, paragraph 20.1402 - Criteria for unrestricted use - a site is considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a Total Effective Dose Equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem/yr, including that from groundwater sources of drinking water, and the residual radioactivity has been reduced to levels that are as low as reasonably achievable (ALARA).

Table 5. Summary of 10 CFR Part 20 Subpart E

	Unrestricted Use	Restricted Release	
Dose Criterion	25 mrem TEDE per year peak annual dose to the average member of the critical group	25 mrem TEDE per year peak annual dose to the average member of the critical group while controls are in place	100 mrem or 500 mrem TEDE per year peak annual dose to the average member of the critical group upon failure of controls
Time Frame	1000 years	1000 years	1000 years
Other Requirements	ALARA	ALARA, financial assurance, public participation	ALARA, financial assurance, public participation

E. DERIVED CONCENTRATION GUIDELINE LEVELS (DCGLS)

A concentration of residual radioactivity distinguishable from background that, if distributed uniformly throughout a survey unit, would result in a total effective dose equivalent (TEDE) of 25 millirems per year to an average member of the critical group is called the derived concentration guideline level(DCGL).

Residual levels of radioactive material that correspond to allowable radiation dose standards are calculated (derived) by analysis of various pathways and scenarios (direct radiation, inhalation, ingestion, etc.) through which exposures occur. These derived levels, DCGLs, usually refer to average levels of radiation or radioactivity above appropriate background levels.

For NMRC, as would be the case for the majority of MARSSIM users, the applicable DCGLs were obtained using regulatory agency guidance (screening values)

based on default values. Other users may elect to perform site-specific pathway modeling to determine DCGLs. In both cases, the DCGL is based on the spatial distribution of the contaminant, and each derivation can produce different values depending on the specific radionuclide distribution and pathway modeling. Because residual activity levels, when found, were reduced to background levels, DCGLs or screening values were compared directly to survey data to demonstrate compliance. It is understood that this simple approach would not have been possible if more than one radionuclide was present (in the contaminated area). Residual radioactivity limits for the radionuclides present at the site were predetermined. NMRC action limits were set at a small fraction of D&D screening values and were set such that the NRC release criteria would be satisfied.

Table 6 provides the NRC D&D screening values for common radionuclides. The screening values provided in **Table 6** will serve as basis for establishing the action limits or DCGLs for NMRC's D&D final status survey data analysis. NMRC's action limit will be set at a small fraction of applicable NRC screening values, 700 dpm, for H-3 and C-14 swipe analyses and be set at a level of two to three times background levels for all other measurements (e.g., beta-gamma scans and fixed-contamination evaluations). Procedures provided in the MARSSIM and 10 CFR 20, Appendix B, would have been used if multiple radionuclides were present. Also provided in **Table 6** are NMRC action limits for other beta emitters and gamma emitters.

Table 6. Acceptable License Termination Screening Values of Common Radionuclides for Building Surface Contamination (ref 11.13)

Radionuclide	Symbol	Acceptable screening levels[1] for unrestricted release (dpm/100 cm^2)[2]	NMRC Action Limits (dpm/100 cm^2)
Hydrogen-3 (Tritium)	^{3}H	1.2E+08	700
Carbon-14	^{14}C	3.7E+06	700
Sodium-22	^{22}Na	9.5E+03	
Sulfur-35	^{35}S	1.3E+07	700
Chlorine-36	^{36}Cl	5.0E+05	
Manganese-54	^{54}Mn	3.2E+04	
Iron-55	^{55}Fe	4.5E+06	
Cobalt-60	^{60}Co	7.1E+03	700
Nickel-63	^{63}Ni	1.8E+06	
Strontium-90	^{90}Sr	8.7E+03	
Technitium-99	^{99}Tc	1.3E+06	
Iodine-129	^{129}I	3.5E+04	
Cesium-137	^{137}Cs	2.8E+04	
Iridium-192	^{192}Ir	7.4E+04	
Other beta emitters	^{32}P, ^{33}P, ^{45}Ca		700
Other gamma emitters	^{51}Cr, ^{133}Ba, ^{137}Cs		700

[1] Screening levels are based on the assumption that the fraction of removable surface contamination is equal to 0.1. For cases when the fraction of removable contamination is undetermined or higher than 0.1, users may assume, for screening purposes, that 100% of surface contamination is removable, and therefore the screening values should be decreased by a factor of 10. Alternatively, users having site-specific data on the fraction of removable contamination (e.g., within the 10% to 100% range) may calculate the site-specific screening levels using DandD Version 1.

[2] Units are disintegrations per minute per 100 square centimeters (dpm/100 cm^2). One dpm is equivalent to 0.0167 becquerel (Bq). The screening values represent surface concentrations of individual radionuclides that would be deemed in compliance with the 0.25 Sv/year (25 mrem/year) unrestricted dose limit in 10 CFR 20.1402. For radionuclides in a mixture, the "sum of fractions" rule applies; see 10 CFR Part 20, Appendix B, Note 4. Refer to NRC Draft Guidance DG-4006 for further information on application of the values in this table.

F. PRE-SURVEY SAFETY ACTIONS

Pre-survey walk-through inspections were conducted to identify and remedy safety concerns before the designated sites were surveyed.

G. BACKGROUND/BASELINE LEVELS

The primary contaminants of interest (H-3, C-14, Co-57, Ba-133, and Cs-137) did not occur in background at the survey sites, or the background levels were small fractions of the radionuclide-specific $DCGL_w$ values. Therefore, the survey unit radiological conditions, in dpm, were compared directly to the NMRC action limit (a small fraction of the DCGL). Reference area background surveys were conducted on each day that impacted areas were surveyed. The reference area background survey data is included in this final status survey report.

From the vicinity of a survey site or group of survey sites, background survey-meter readings were recorded, and background swipe samples were collected, analyzed and documented.

H. SURVEY UNITS

A survey unit was defined as a physical area consisting of a specified size and shape for which a separate decision will be made as to whether or not that area exceeds the release criterion. The survey unit is the primary entity for demonstrating compliance with the release criteria.

Per MARSSIM, survey units should be limited in size based on classification, exposure pathway modeling assumptions, and site-specific conditions. The suggested areas for survey units are provided in **Table 7** as follows:

Table 7. Suggested Areas for Survey Units (MARSSIM, Roadmap Table 1)		
CLASSIFICATION		SUGGESTED AREA
Class 1	Structures	Up to 100 m^2 floor area
	Land Areas	Up to 2,000 m^2
Class 2	Structures	100 to 1,000 m^2
	Land Areas	2,000 to 10,000 m^2
Class 3	Structures	No limit
	Land Areas	No limit

A NMRC survey unit was defined as a room or other discrete area. Every room and area in the NMRC Diving Buildings was examined for residual contamination. Large rooms or areas were sub-divided into smaller sections to facilitate surveying and monitoring. All known licensed-materials use and/or storage areas were classified as Class 3 survey units. Offices, hallways, lavatories, and other common non-license-material-use areas were treated as non-impacted areas. As a quality control (QC) measure, all survey units or areas received some level of survey effort.

I. QUALITY ASSURANCE AND QUALITY CONTROL

Quality Control (QC) and Quality Assurance (QA) measures were incorporated into the decommissioning efforts to ensure the security and integrity of the data and procedures. Maintenance and calibration of equipment were key considerations. In addition, daily and weekly quality control checks for all monitoring equipment and instruments were performed, analyzed and recorded. Periodic training was provided to maintain a competent work force. Redundant survey efforts, which included collecting and analyzing numerous additional swipe samples were planned, completed and documented.

Quality control measures and standard operating procedures were implemented before initiating decommissioning actions. Quality control procedures and data for ensuring the validity of survey results

are included in this report in Appendix D. These procedures and plans included:

(1) properly calibrated instrumentation,

(2) necessary replicate, reference and blank measurements, and

(3) comparison of field measurement results to laboratory sample analyses.

For comparison of survey data to DCGLs, the survey data obtained from swipe-analyses via laboratory measurements was reported in dpm. The swipe analyses results for H-3 and C-14 were compared directly to the NMRC Radiological action limits in **Table 6.**

Data verification ensured that operating procedures were implemented as prescribed. Data verification means that deficiencies or problems that occurred during implementation were documented and presented in this report. This also means that NMRC D&D efforts were assessed regularly and findings were documented. Corrective actions were reviewed for adequacy and appropriateness and documented in response to findings. Data verification activities included, but are not limited to, inspections, QC checks, surveillance, technical reviews, performance evaluations and audits.

To ensure that the conditions requiring corrective actions were identified and addressed promptly, data verification activities were initiated as part of sample collection and data preparation phases of the survey.

The performance of tasks by personnel was compared to standard procedures and was assessed using inspections, surveillance and audits. Self-assessments and independent assessments were planned, scheduled and performed as part of the survey. Self-assessment also means that personnel performing the work were required to document and report deficiencies

or problems that they encountered to the D&D supervisor.

The performance of equipment such as radiation detectors or measurement was monitored using control charts. Control charts were be used to record the results of quantitative QC checks such as background and daily calibration or performance checks. Control charts were used to document instrument and measurement system performance on a daily or as-needed basis to identify conditions requiring real-time corrective actions. Periodic technical reviews may be requested as an independent-assessment measure.

Data validation activities ensured that the results of data collection activities supported the objectives of the survey. Data verification compared the collected data with the investigational levels (action limits) or DCGLs provided in **Table 6**.

J. FIELD MEASUREMENT METHODS AND INSTRUMENTATION

1. FIELD MEASUREMENTS

Surveys for decommissioning required the collection of two types of radiological data:

(1) direct field measurements using portable instruments and

(2) sample analyses using fixed laboratory equipment or systems.

For either type of measurement, the selection and proper use of appropriate instruments were the most critical factors in assuring that the survey accurately determined the radiological status of the site. **Table 8** summarizes equipment and instrument sensitivities for laboratory and field measurements.

Table 8. Typical Measurement Sensitivities for Laboratory Radiometric Procedures (MARSSIM, Chapter 7)

Sample Type	Radionuclides or Radiation Measured	Procedure	Approximate Measurement Sensitivity
Smears (filter paper)	Gross beta	Gas-flow proportional counter; 5-min count	10 dpm
		End window GM with scaler; 5-min count (unshielded detector)	80 dpm
	Low energy beta (H-3, C-14)	Liquid scintillation spectrometer; 5-min count	30 dpm
Soil Sediment	Co-60	Germanium detector (25% relative efficiency) with multi-channel analyzer; pulse height analyzer; 200-min count	0.04 - 0.1 Bq/g (1-3 pCi/g)
Water	Gross beta	Gas-flow proportional counter; 100-ml sample, 200-min count	0.04 Bq/L (1 pCi/L)
	Co-60	Germanium detector (25% relative efficiency) with multi-channel analyzer; pulse height analyzer; 3.5L sample, 16-hour count	0.4 Bq/L (10 pCi/L)
	H-3	Liquid scintillation spectrometer; 5-min count	100 Bq/L (300 pCi/L)

2. INSTRUMENTS, EQUIPMENT, MEASUREMENT AND SAMPLING TECHNIQUES

Instruments for alpha detection were not required. Instrumentation and equipment were selected such that radiation detection procedures (scanning, direct measurements, and sample analyses) could be completed for the radionuclides of interest. Specifications and calibrations of radioactive check sources and radiation-monitoring equipment and instruments are provided in Appendix D, sections 3 and 4, respectively.

For beta radiation detection, the following instruments and equipment were used:

(1) Samples were analyzed using standard procedures and calibrated liquid scintillation counters.

(2) Scanning was performed using appropriate Geiger-Mueller detectors with pancake probes or digital-scaler, gas proportional counter with appropriate detectors.

For gamma radiation detection, scanning was performed using appropriate Geiger-Mueller detectors with appropriate probes.

Exposure rate measurements, when necessary, were obtained using appropriate instrumentation.

A combination of two approaches was used for scanning Class 3 areas. The two approaches included uniformly scanning for the radionuclides of interest and/or performing scans in areas with the greatest potential for residual contamination based on professional judgment and the objectives of the survey. The investigation level was set at an elevated activity reading that exceeded 2 to 3 times the background readings.

Appropriate calibration check sources were obtained to perform instrument background and check-source (quality assurance and quality control) checks.

Instrument response (background and check source) was tested and recorded a minimum of once daily – prior to beginning the day's measurements – to ensure continued acceptable operation. If an instrument's response did not satisfy the established acceptable range, the instrument was removed from use until the reason for the deviation could be determined and resolved and acceptable response again demonstrated. If repair and/or recalibration were necessary, acceptable response ranges were reestablished and documented.

K. SAMPLING AND PREPARATION FOR LABORATORY MEASUREMENTS

1. FIELD SAMPLE PREPARATION AND PRESERVATION

Proper sample preparation and preservation are essential parts of any radioactivity-sampling program. The sampling objectives were specified in the D&D Standard Operating Procedures (D&D SOP) manual and Appendix C. Precise records of sample collection and handling were performed to ensure that data obtained from different locations or timeframes were correctly compared.

According to MARSSIM, Chapter 7, field and preparation of building surfaces, including smear samples, is generally not required. Smear samples were collected from randomly selected locations and other areas, labeled, packaged, tracked, and delivered to the on-site counting laboratory for analyses.

2. OTHER MEASUREMENTS AND SAMPLING LOCATIONS

In addition to building surface areas, there were numerous other locations where measurements and/or sampling were performed. Examples include items of equipment and furnishings, workbenches, shelves, building fixtures, drains, ducts, and piping. Many of these items or locations had both internal and external surfaces, requiring evaluation. Each such location classified as impacted was scanned and individual measurements and/or sampling were performed. Non-impacted locations were also surveyed, but at lower frequencies, consistent with contamination potential and findings as the survey progressed.

IX. DECONTAMINATION PROCEDURES

Using the guidance, procedures, and checklists provided in the MARSSIM, characterization surveys, reclassification of survey areas, remedial actions, and remediation-action support surveys were performed and documented, when necessary. When contamination was identified in a survey unit, characterization surveys (via scanning or swipe-sample counting) were performed to determine the extent of the contamination. After a characterization survey was completed, remedial actions were completed. The remediation actions consisted of repeated washings or scrubbing or removal of the contaminated media. Waste generated from this process was treated as radioactive waste and disposed of accordingly. Remediation action surveys were completed following iterations of decontamination efforts to measure the effectiveness of the efforts. Final surveys of the contaminated areas were completed and documented.

X. FINAL STATUS SURVEY

A. OVERVIEW

The guidance provided in MARSSIM, Section 5.5, Final Status Surveys, was closely followed. The final status surveys were performed to demonstrate that residual radioactivity in each survey unit satisfied the predetermined release criteria for unrestricted future use. The survey provided data to demonstrate that all radiological conditions did not exceed the established DCGLs or NMRC action limits.

In demonstrating that the objective was met, the null hypothesis (H_o) tested was that residual contamination exceeded the release criterion; the alternate hypothesis (H_a) was that residual contamination met the release criterion. Two statistical tests could be used to evaluate data from final status surveys. For contaminants that are present in background, the Wilcoxon Rank Sum (WRS) test would be used. When contaminants are not present in background, the Sign test is used.

Since contaminants at the Diving Buildings were not present in background in significant amounts, the Sign test was used. Statistical parameters (α and β) were chosen such that there was less than a 5% probability that radioactivity would be reported present when it was really absent (Type I error) or reported absent when it was really present (Type II error).

B. SURVEY PREPARATIONS

Residual radioactivity limits for the radionuclides present at the site were selected. NMRC action limits or investigational levels were equivalent to a small fraction of D&D screening values and were set such that the NRC release criteria were satisfied. **Table 6** provides the NRC D&D screening values for NMRC isotopes of concern (ref 11.13), action plan values, and NMRC's residual radioactivity limits. Guidance in **Table 9** was used to interpret the survey results.

Table 9. Interpretation of Sample Measurements When No Reference Area Is Used (MARSSIM, Table 2.5)	
SURVEY UNIT MEASUREMENT RESULTS	CONCLUSION
All concentrations are less than $DCGL_w$ (or NMRC action limit)	Survey unit meets release criteria
Average concentration is greater than $DCGL_w$ (or NMRC action limit)	Survey unit fails
Any concentration is greater than $DCGL_w$ and average concentration is less than $DCGL_w$	Conduct Sign test and elevated measurement comparison

Representative reference (background) areas were selected for the survey units. Reference areas were selected from non-impacted areas and were:

(1) free of contamination from site operations,

(2) exhibited similar physical, chemical, and biological characteristics as the survey unit, and

(3) had similar construction, but had no history of radioactive operations.

If swipe samples were collected for impacted survey units on the first floor during a day's operations, background samples were collected on the first floor as well. Similarly, if swipe samples were collected in impacted areas on the second floor during a day's operations then background samples were collected from second floor locations.

Survey instruments were selected based upon the techniques to be employed (scanning, direct measurements, and sampling) and the radionuclides of concern. The selected instruments were capable of detecting the contamination at 10-50% of the DCGLs.

The survey unit was prepared before conducting the final survey by clearing and providing access to the areas to be surveyed, including the floor, lower walls, workbenches, shelves and fixtures.

Reference coordinate systems using grid maps were established and followed.

C. Survey Design

Sample collection and analysis procedures were developed and implemented as D&D Standard Operating Procedures in Appendix C. All radiological workers received initial and periodic training.

The number of data points for statistical tests were determined using the assumption that the radionuclides were not present in background. The Sign test was used. The number of samples for Class 3 areas were determined using the following statistical values, Type I error where $\alpha = 0.025$, Type II error where $\beta = 0.025$, and the relative shift, $\Delta/\sigma_s = 2$. The relative shift was determined by using data from a contaminated area and the formulae provided in MARSSIM. The data and the determination of the relative shift are provided in **Table 10**. The number of data points, N, was determined to be 21. Per MARSSIM, this N value added an extra 20% to account for unusable data or uncertainty in the value of N.

The number of random data samples collected for each Impacted Class 3 survey unit was 21. Additional samples/measurements were taken for quality control and to allow for possible loss of data and increased sampling with survey units. The additional data points were not used when conducting statistical tests of survey data. In conjunction with completing surveys for all impacted areas, reference background readings and samples were collected.

Table 10. Determination of the Relative Shift, Δ/σ, using swipe data from a contaminated area (MARSSIM, MARSSIM, Section 5.5.2.3)

Let Δ = 2500 dpm - 700 dpm

Basis of Δ: one-half of the conservative Regulatory Guide 1.86 contamination limit of 5,000 dpm and NMRC action limit of 700 dpm

In this table, σ is calculated using H-3 swipe data from a contaminated area

Sample Number	H-3, dpm
1	345
2	700
3	621
4	391
5	2884
6	160
7	205
8	203
9	153
10	2892
11	642
12	1009
13	74
14	43
15	104
16	67
17	1161
18	172
19	51
20	58
21	77
22	2795
23	110
24	183
Average	629
Standard deviation	913
Set Δ = 2500 - 700 dpm	1800
Δ/σ, calculated	1.97 ~= 2

Table 11 provides recommended survey coverage for structures and land areas (MARSSIM, table 5.9).

Table 11. Recommended Survey Coverage For Structures and Land Areas (MARSSIM, Table 5.9)

AREA CLASSIFICATION	STRUCTURES		LAND AREAS	
	Surface Scans	Surface Activity Measurements	Surface Scans	Soil Samples
Class 1	100%	Number of data points from statistical tests and additional measurements may be necessary for small areas of elevated activity	100%	Number of data points from statistical tests and additional measurements may be necessary for small areas of elevated
Class 2	10 to 100% (10 to 50% for upper walls and ceilings) Systematic and Judgmental	Number of data points from statistical tests	10 to 100% Systematic and Judgmental	Number of data points from statistical tests
Class 3	Judgmental	Number of data points from statistical tests	Judgmental	Number of data points from statistical tests

Sampling locations for Impacted Class 3 areas utilized a rectangular grid system that used a local landmark, such as doors in survey units. Grid systems were established for the impacted survey sites to:

- Facilitate systematic selection of measuring/sampling locations,
- Provide a mechanism for referencing a measurement/sample back to a specific location so that the same survey point can be relocated, and
- Provide a convenient means for determining average activity levels.

The grids consisted of a system of intersecting lines created by using colored paper or plastic adhesive tape and referenced to a fixed site location or benchmark. The grid lines were arranged in a perpendicular pattern, dividing the survey location into approximately one-meter squares or blocks. Grid patterns on horizontal surfaces were identified numerically on one axis and numerically on the other axis. Grids on vertical surfaces are shown as flat surfaces on the grid maps. Grid maps used during the survey efforts are provided with the data and summaries in Appendix XII. Gridding was limited to the floor and lower (up to 2 meters height) walls.

Because radioactive-material use during the last 10 years has involved the use of small quantities in liquid form in hoods or workbench areas, only the lower two meters of the walls in Impacted Class 3 areas will be surveyed. No airborne residual contamination is anticipated.

For the Class 3 survey units, the locations of the 21 random data points were determined using lists of random numbers. Additional measurements were selected to ensure good coverage of the survey unit and to survey selected areas within the survey unit.

Quality control procedures for ensuring the validity of survey results were included in D&D Standard Operating Procedures. These procedures included:

(1) survey procedures and techniques,

(2) sample collection and processing procedures,

(3) data-analysis procedures,

(4) equipment and instrument procedures, and

(5) source-standards, background-standards and reference-background measurements.

D. CONDUCTING SURVEYS

The reference (background) area measurements and sampling were performed and documented.

Final status survey activities were conducted. The activities included:

(1) performing surface scans of Class 3 areas and a percentage of non-impacted areas,

(2) conducting surface activity measurements and sampling at previously selected sampling locations, and

(3) conducting additional direct measurements and sampling at locations based on professional judgment.

Necessary investigation activities, including remediation and re-survey were performed and documented. Reclassifications of survey units were not required.

Measurement and sample locations were documented on grid maps. The grids with sample locations and sample numbers are provided in Appendix E with survey data for each impacted survey unit.

Observations, abnormalities, and deviations from the standard operating procedures were documented.

E. DATA CONVERSION

Data conversion was not required for results obtained by evaluating swipe samples using the liquid scintillation counter. The results for each swipe sample were reported in dpm for both H-3 and C-14 for an area of approximately 100 cm^2. Data conversion was required for surface activity measurements that were obtained using a hand-held, gas proportional detector. Guidance provided in chapter 6 of MARSSIM was used to convert the meter readings to the conventional surface activity units of dpm per 100 cm^2. **Table 12** provides the applicable MARSSIM equation and a sample calculation.

Table 12. Data Conversion for Direct Readings of Surface Activity Using a Gas Proportional Detector (MARSSIM, Section 6.6.1)

MARSSIM formula 6-4:

$$\frac{dpm}{(100\ cm^2)} = \frac{(C_s/T_s)-(C_b/T_b)}{(E_i \times (A/100))}$$

where, A = physical probe area in cm^2, E_i = instrument efficiency, sample and background count times, T_s and T_b in seconds, C_s = sample counts during time T_s, and C_b = background counts during time, T_b

Note: Interpret negative values of the calculated dpm as equal to zero.

Sample calculation:

Let A = 126 cm^2; $T_s = T_b$ = 1 minute; E_i = 15%; C_s = 361 and C_b = 211

$$\frac{dpm}{(100\ cm^2)} = \frac{((361/1)-(211/1))}{(0.15 * (126/100))} = 794$$

F. EVALUATING AND DOCUMENTING SURVEY RESULTS

Samples were analyzed using the procedures detailed in the SOP and Appendix C. Swipe-sample results in dpm were compared directly to DCGL values and NMRC action limits. Individual measurements and sample concentrations were first compared to DCGL levels for evidence of small areas of elevated activity. No additional data comparisons were necessary. The initial swipe results or results following remediation efforts did not exceed NMRC action limits.

Verification of assumptions of statistical tests was not necessary. Per MARSSIM, Appendix B, "The results of the survey should be compared to derived concentration guideline levels (DCGLs) using an appropriate statistical test, such as Student's t test or Wilcoxon test. If all measurements are less than the $DCGL_w$, then statistics do not need to be addressed because the conclusions are obvious. If the mean of the measurements exceeds the $DCGL_w$, the survey unit obviously fails to demonstrate compliance and the statistics do not need to be addressed."

Survey results for each survey unit were compared with NMRC residual radioactivity investigational levels or action levels. These action levels represented small fractions of DCGLs (NRC D&D screening values). Elevated measurement comparisons were not performed and were not needed.

This final status survey report includes the standard operating procedures, quality assurance information and procedures, data, results, interpretations, deviations from standard procedures, and other applicable information.

XI. REFERENCES

11.1 **NUREG-1575**, MARSSIM, Multi-Agency Survey and Site Investigation Manual (December 1997).

11.2 **NMRC Historical Site Assessment**, Naval Medical Research Center (NMRC, formerly NMRI), June 1999.

11.3 **ESA 1997**, Environmental Site Assessment, Naval Medical Research Institute (NMRI), by the Environmental Company, Inc., May 1998.

11.4 **10CFR20.1402**, Title 10, Code of Federal Regulations, Part 20 - Standards for Protection Against Radiation, Subpart E.

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

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

11.7 **NUREG-1505**, A Non-parametric Statistical Methodology for Design and Analysis of Final Status Decommissioning Surveys.

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

11.9 **NUREG-1549**, Decision Methods for Dose Assessment to Comply With Radiological Criteria for License Termination (Draft, July 1998).

11.10 **NUREG/CR-5512**, Residual Radioactive Contamination from Decommissioning (Draft, April 1996).

11.11 **NUREG/CR-5849**, Manual for Conducting Radiological Surveys in Support of License Termination, Draft for Comment June 1992 (superseded by NUREG-1575, MARSSIM).

11.12 **Draft Regulatory Guide DG-4006**, Demonstrating Compliance with the Radiological Criteria for License Termination (supersedes NUREG 1500), August 1998.

11.13 **Federal Register**, Volume 63, Number 222, November 18, 1998, page 64134.

11.14 **REG GUIDE 1.86**, Nuclear Regulatory Commission Regulatory Guide 1.86 (1974).

XII. APPENDICES

A. Conceptual Model and Site Diagram

B. Documents, Figures and Photographs

C. Standard Operating Procedures and Quality Assurance Program

D. Survey Unit Release Reports (Narratives, Data, Floor Plans, and Grid Maps)

E. Quality Assurance Information and Data

APPENDIX A. CONCEPTUAL MODEL AND FLOOR DIAGRAMS

Appendix A-1. CONCEPTUAL MODEL

NMRC D&D Phase IV (2/2000- 6/2000)
NMRC Bethesda Diving Buildings (28, 53, 59, 69, 79)

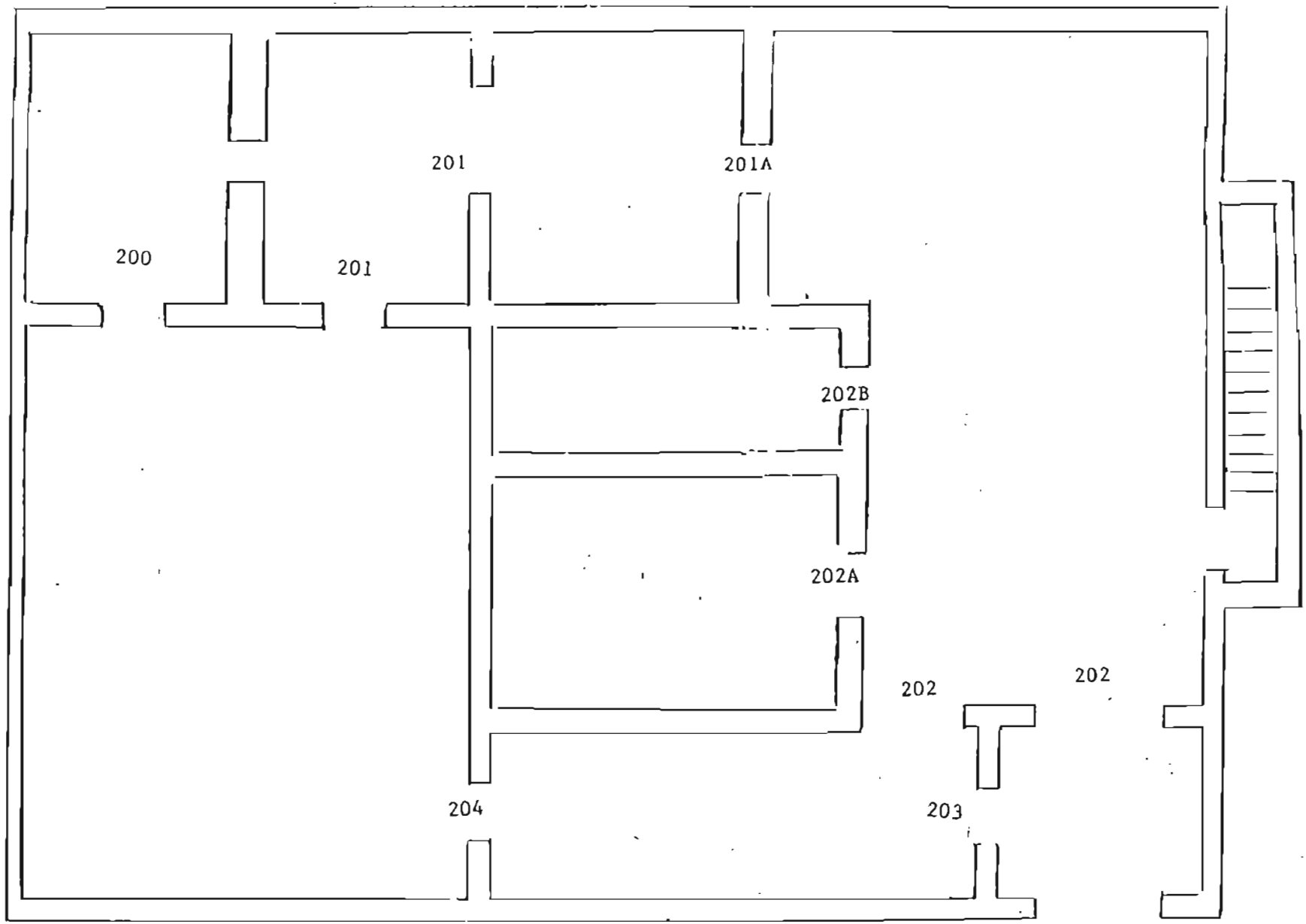
Contaminants of concern:
H-3, C-14, P-32, P-33, Ca-45, Ba-133, Co-57

BUILDING SURFACE CLASSIFICATIONS

	Number Of Survey Units	Total Area (SF)
Non-impacted	78	22,136
Impacted Class 3	12	7,673
Totals	90	29,809

Appendix A-2. FLOOR DIAGRAM, FIRST FLOOR, BUILDING 28

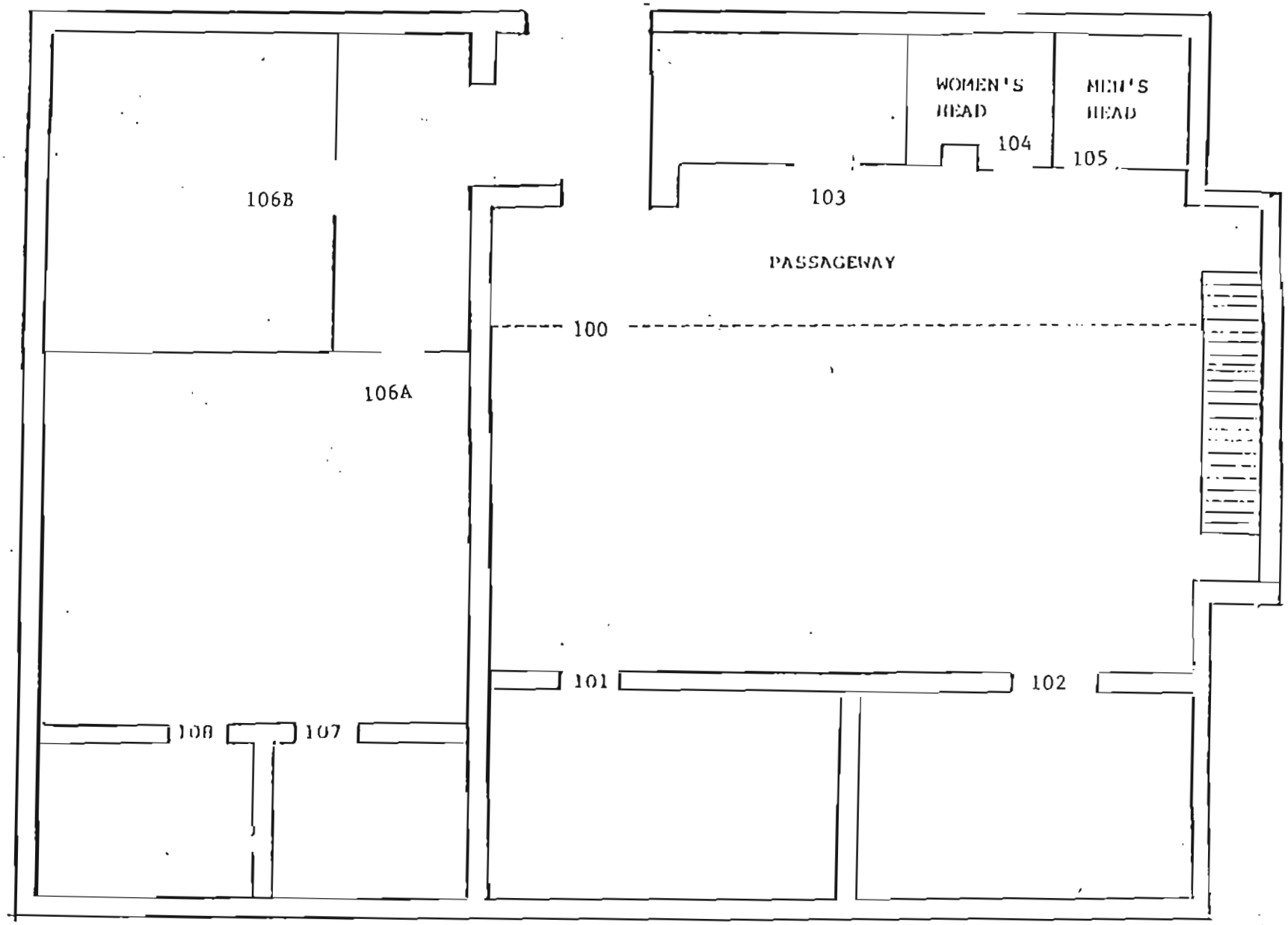
BUILDING 28, FIRST FLOOR



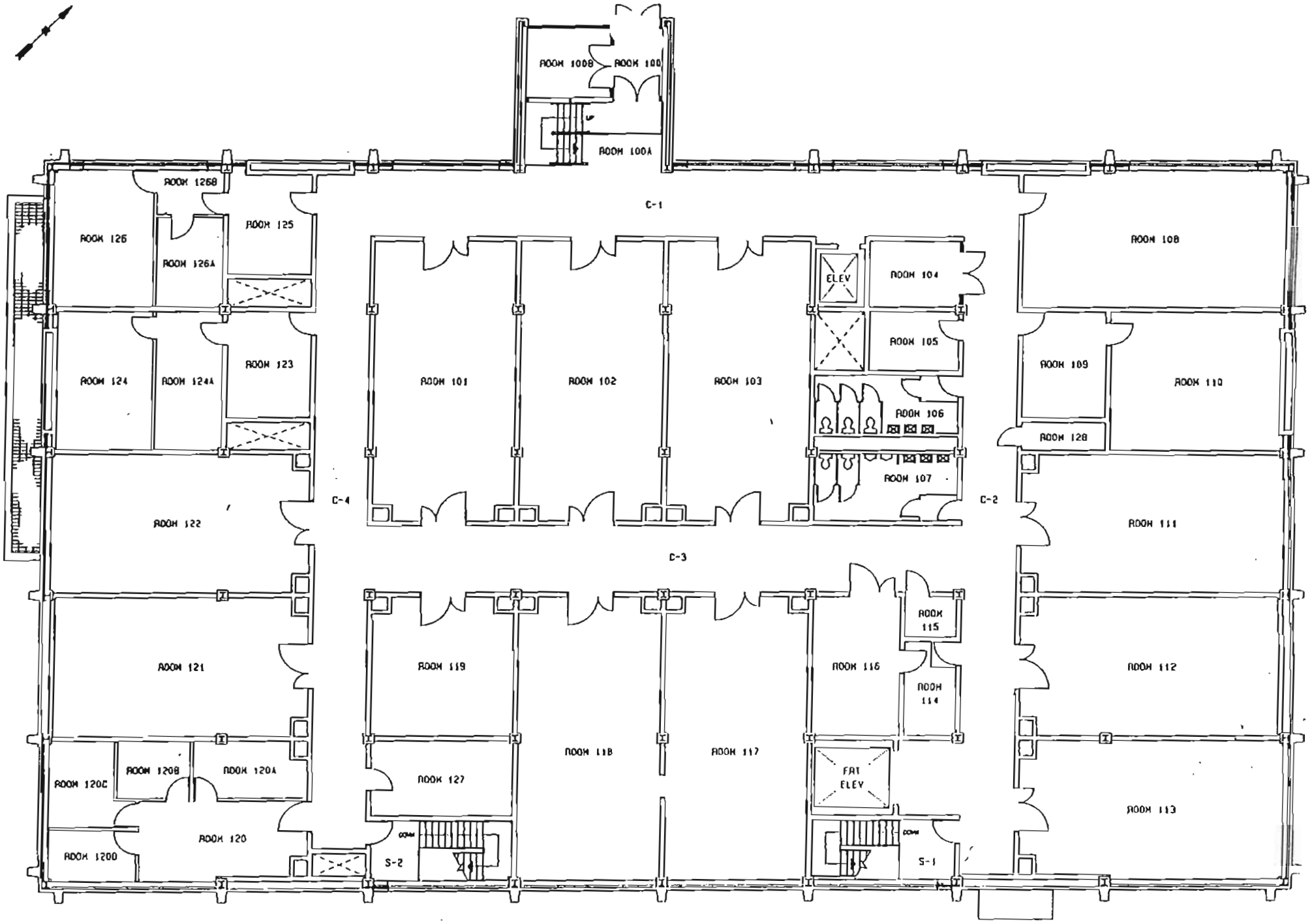
Appendix A-3. FLOOR DIAGRAM, BASEMENT FLOOR, BUILDING 28

EXIT 28-2

BUILDING 28, BASEMENT FLOOR

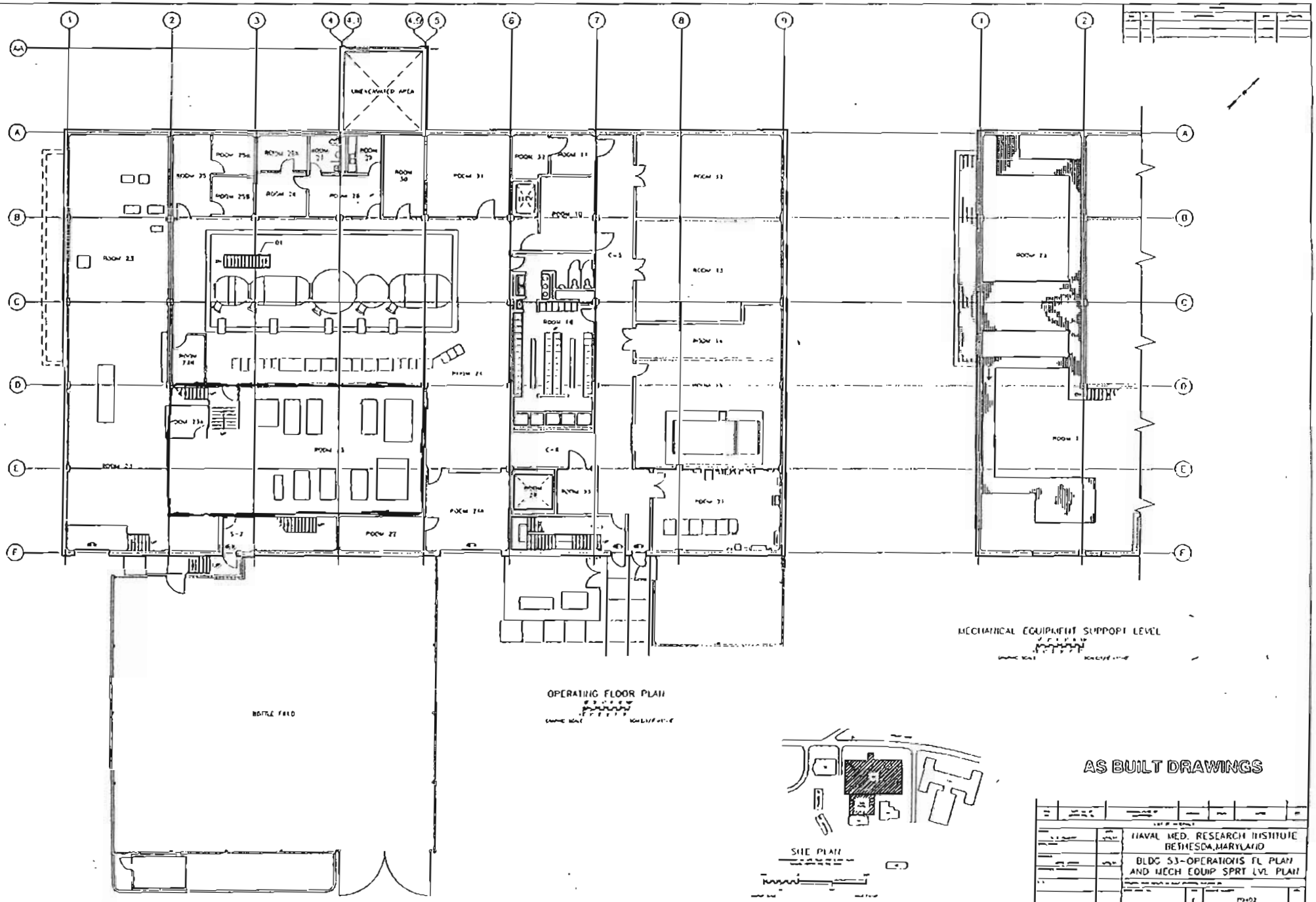


Appendix A-4. FLOOR DIAGRAM, FIRST FLOOR, BUILDING 53



FIRST FLOOR PLAN BUILDING 53

Appendix A-5. FLOOR DIAGRAM, BASEMENT FLOOR, BUILDING 53

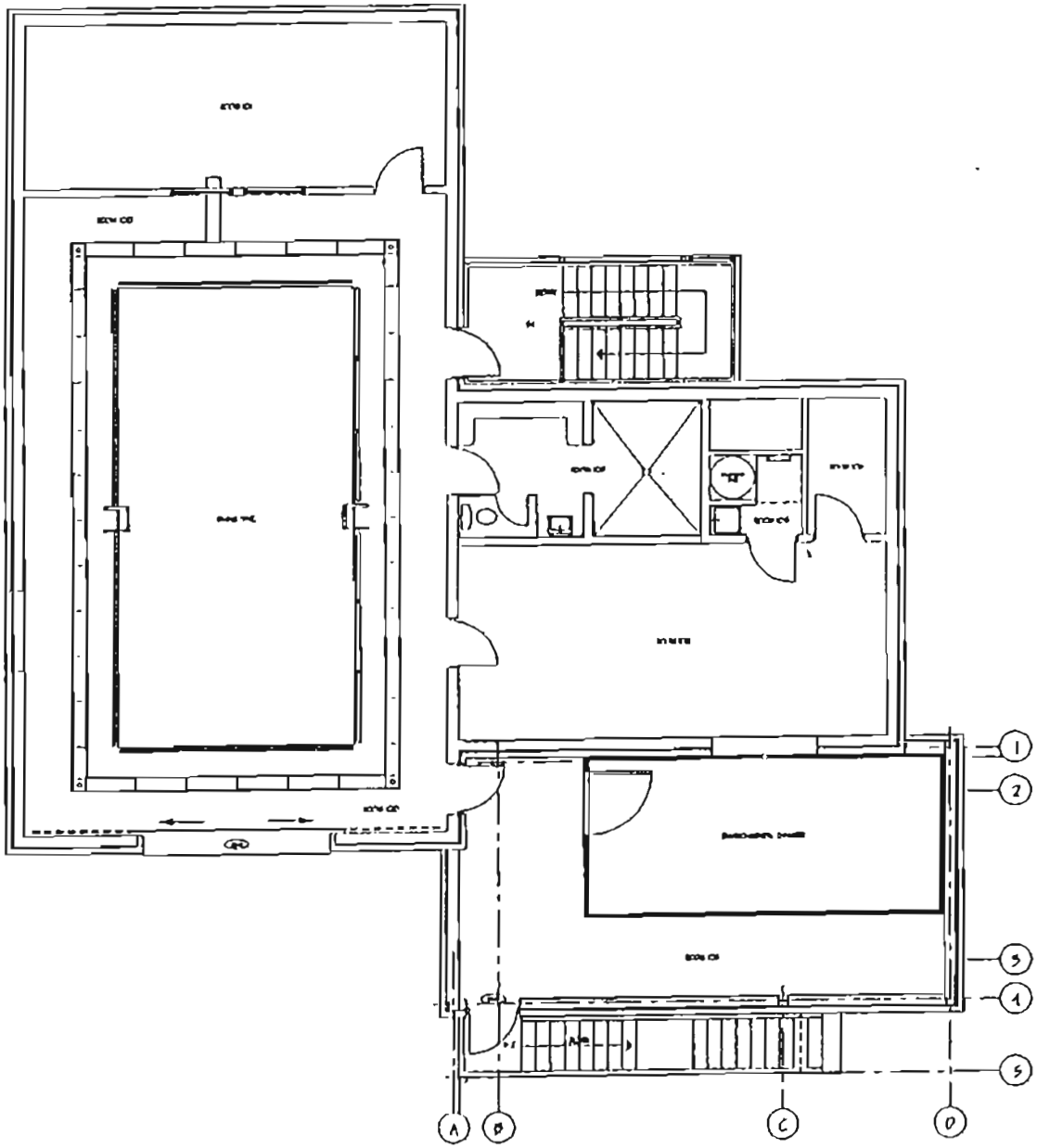


AS BUILT DRAWINGS

NAVAL MED. RESEARCH INSTITUTE
BETHESDA, MARYLAND

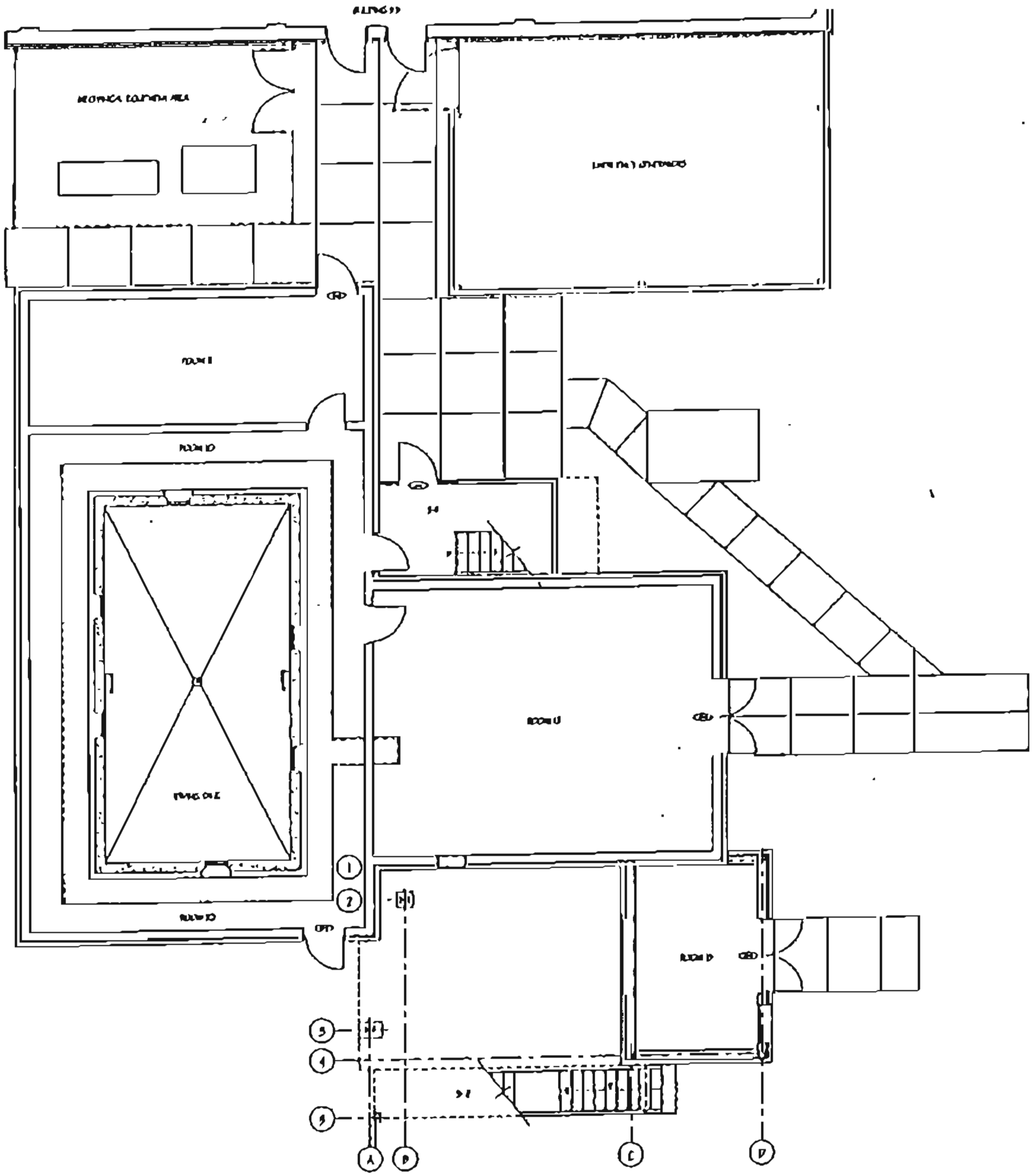
BLDG 53-OPERATIONS FL PLAN AND MECH EQUIP SPRT LVL PLAN

Appendix A-6. FLOOR DIAGRAM, FIRST FLOOR, BUILDING 59



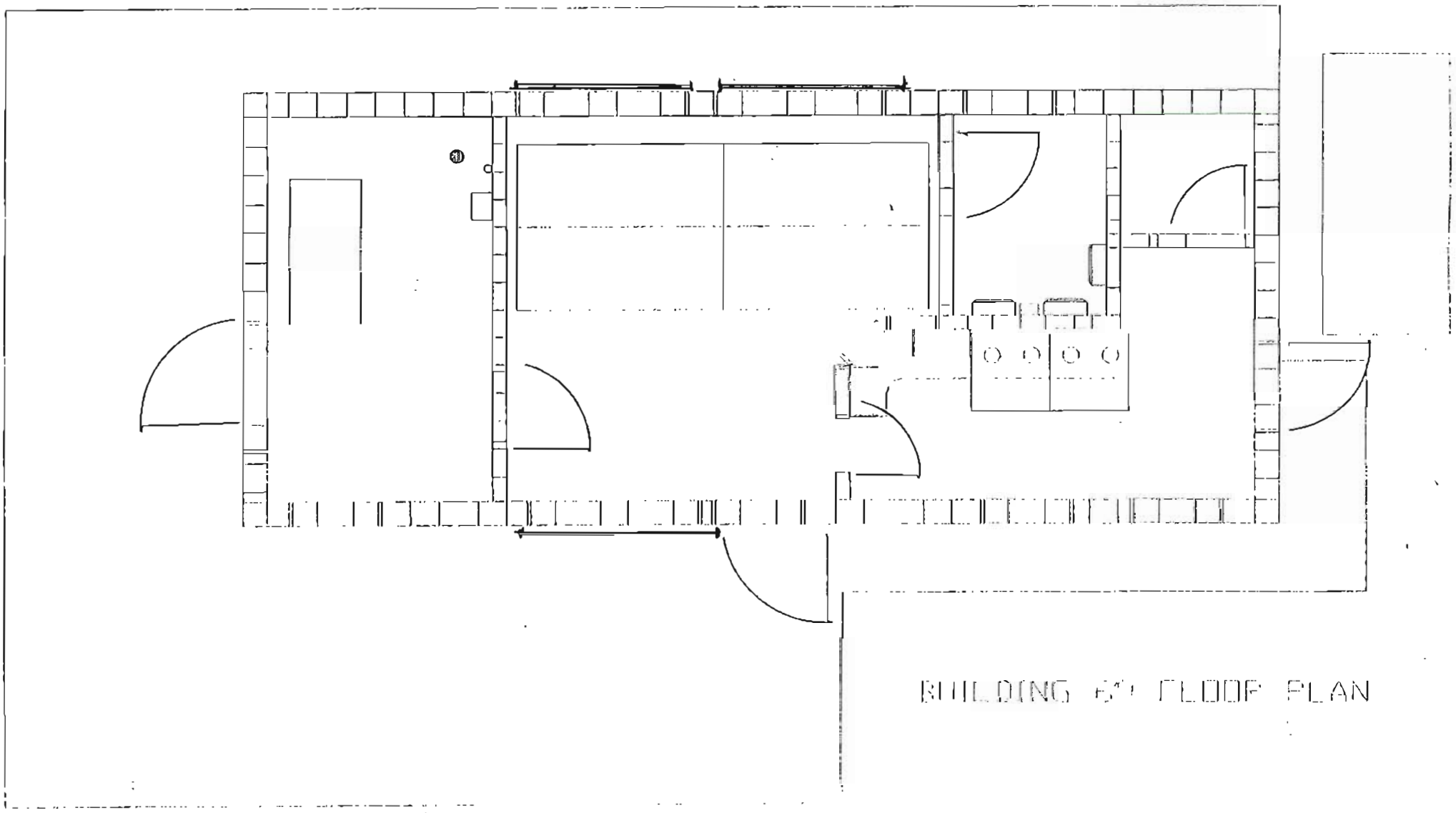
UTER LEVEL FLOOR PLAN

Appendix A-7. FLOOR DIAGRAM, BASEMENT FLOOR, BUILDING 59



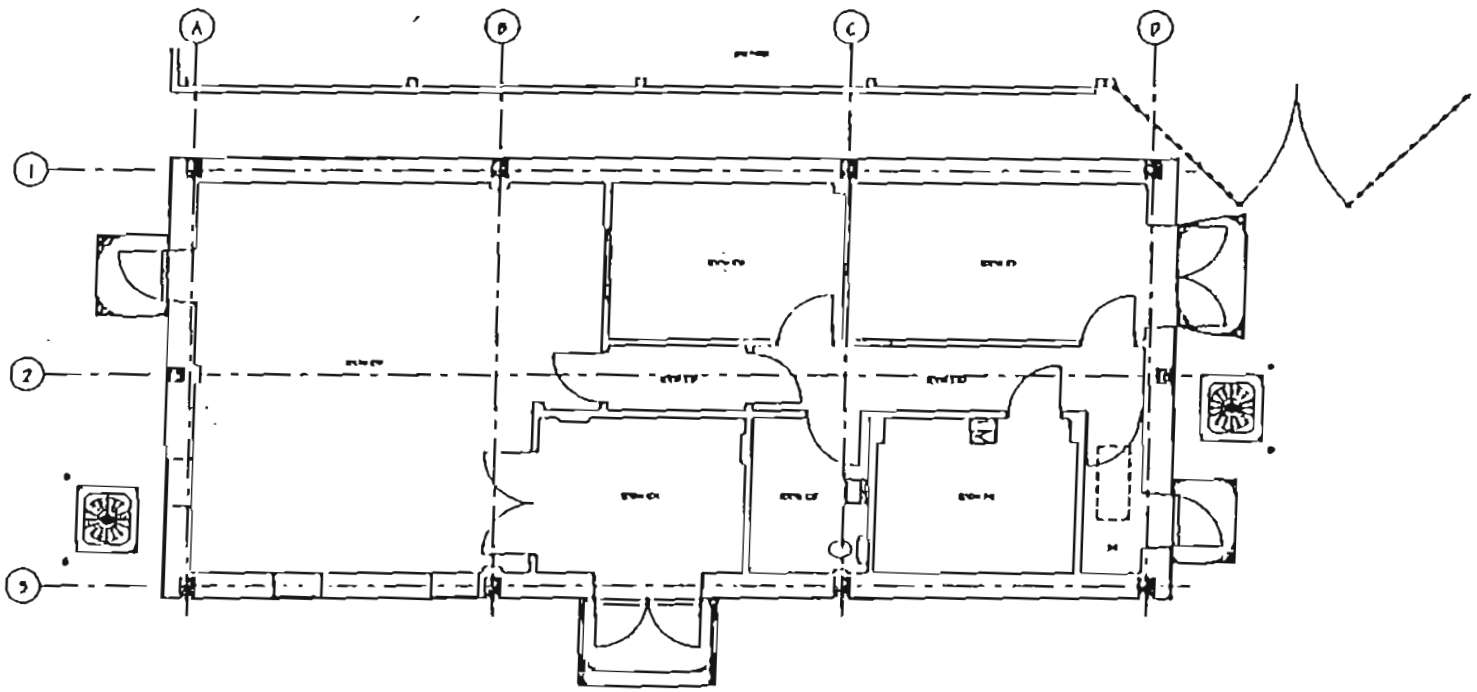
LOWER LEVEL FLOOR PLAN

Appendix A-8. FLOOR DIAGRAM, BUILDING 69

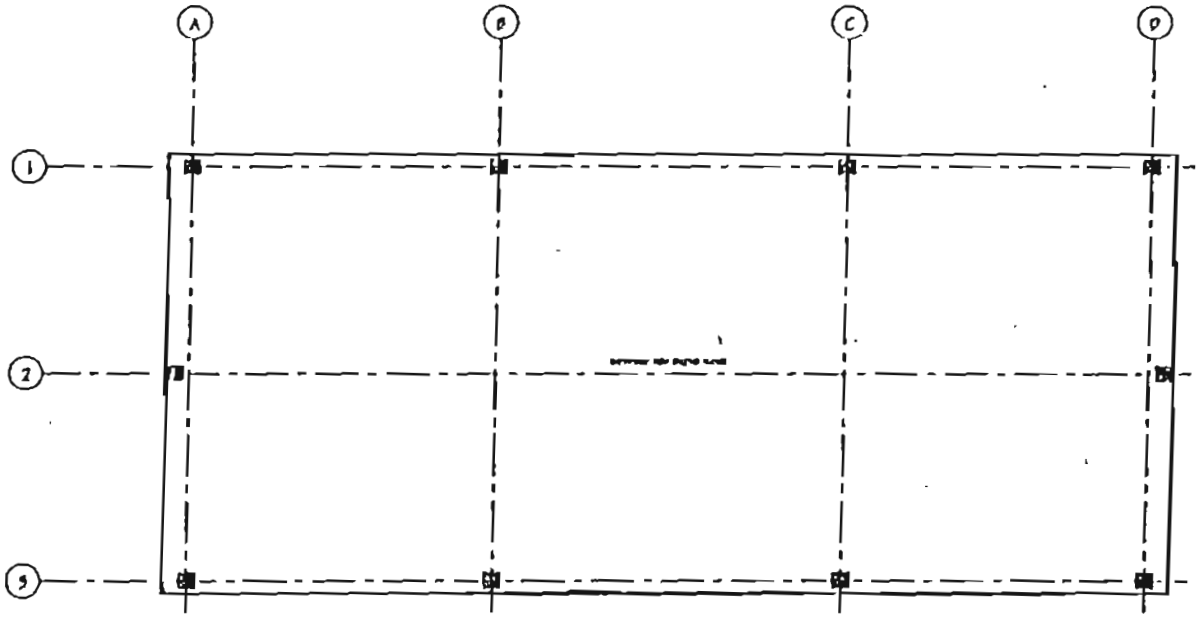


BUILDING 6" FLOOR PLAN

Appendix A-9. FLOOR DIAGRAM, FIRST FLOOR, BUILDING 79


A
B
C
D
1
2
3

Appendix A-10. FLOOR DIAGRAM, BASEMENT FLOOR, BUILDING 79



SECOND FLOOR PLAN

APPENDIX B. PHOTOGRAPHS

Appendix B-1. PHOTOGRAPHS

Photo #1 - Building 28, Front View

Photo #2 - Building 28, Rear View

Photo #3 - Building 53, Front View

Photo #4 - Building 53, Front View

Photo #5 - Building 53, Rear and Side Views

Photo #6 - Building 59, Side View (building on left)

Photo #7 - Building 59, Rear View (building in center)

Photo #8 - Building 69, Front View (in background)

Photo #9 - Building 69, Side View

Photo #10 - Building 79, Side View (in background)

Photo #11 - Building 59, Side View

Photo #12 - Building 79, Side and Rear Views

Photo #13 - Building 53, Typical Floor Grids

Photo #14A - Building 53, Lab 117 Pressure Vessel
(yellow-blocked areas were contaminated with C-14)

Photo #14B - Building 53, Lab 117 Pressure Vessel

Photo #14C - Building 53, Lab 117 Pressure Vessel

Photo #14D - Building 53, Lab 117 Pressure Vessel

Photo #15 - Floor Area in Building 53, Lab 117 (pre-decon = before commencing decontamination efforts)

Photo #16 - Bench Area in Building 53, Lab 122
(pre-decon)

Photo #17 - Bench and Floor Building 53, Lab 122
(pre-decon)

Photo #18 - Bench and Floor Area in Building 53, Lab 122
(post-decon = after surveys following decontamination efforts)

Photo #19 - Bench in Building 53, Lab 122 (post-decon)

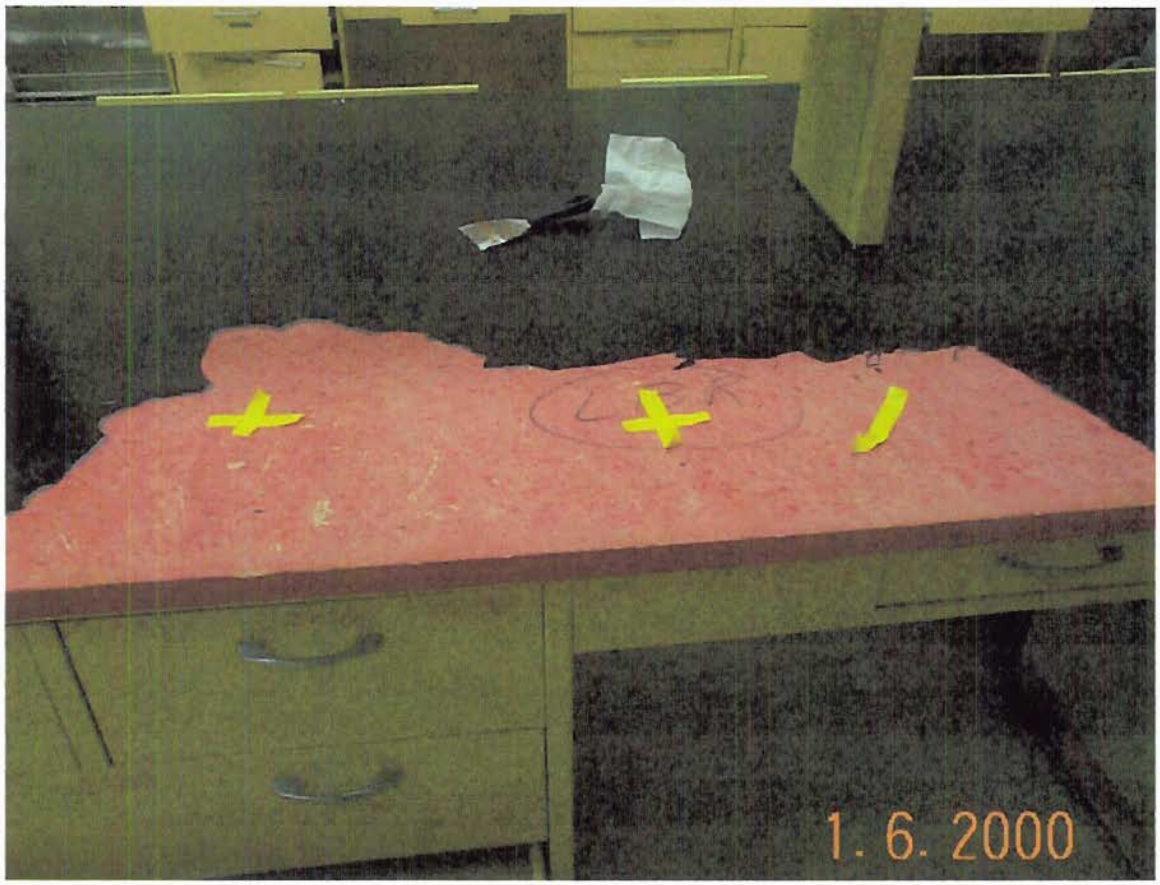


Photo #20 - Bench in Building 53, Lab 122 (post-decon)

APPENDIX C. STANDARD OPERATING PROCEDURES AND QUALITY ASSURANCE PROGRAM

Appendix C-1. Radiological D&D Action Plan Checklist

1. Select appropriate monitoring instruments and equipment and ensure satisfactory daily and weekly calibration checks for your selected instruments. Record serial numbers. Choose from:

_____ Ludlum Model 3 with pancake probe (beta)
_____ Ludlum Model 3 with 1inch diameter NaI probe (gamma)
_____ Ludlum with 2-inch diameter NaI probe (gamma)
_____ Cart-mounted gas proportional counter (beta; not H-3)
_____ Hand-held gas proportional counter (beta; not H-3)
_____ Liquid scintillation counter (beta and gamma)
_____ Gamma Counter (gamma)

2. Select materials to take to the scene. In addition to items you deem appropriate, the following items may be needed:

_____ tape measure or meter stick or yard stick
_____ water in a spray bottle
_____ zip lock bags to secure paper swipes after sampling
_____ pens, note pad, chalk
_____ D&D forms
_____ paper swipes
_____ masking tape and reinforced tape
_____ scissors
_____ tool kit

3. Pre-Survey Activities

_____ Review room layouts and floor diagrams for survey units to be monitored.
_____ Verify possession of room diagrams and generic grid diagrams.
_____ Select a list of random numbers for each survey unit that is classified as Impacted Class 3 (known RAM-use area).
_____ Use a grid map of the size closely fitting the size of the survey unit, mark the locations of the random measurements. Use the digits of each random number to simulate a position on the grid map.

_____ As soon as samples have been analyzed, assemble a D&D information package for submission to the Project Manager/Technical Writer. Your D&D information package should include:

(a) completed action checklist,
(b) floor plans and grid maps with locations of sample annotated on the grid,
(c) a completed summary sheet for the completed survey units,
(d) list or order of swipe sample loading and LSC data printouts, and
(e) a summary of deviations from procedures, problems encountered, and remediation actions, and other information (if applicable).

_____ Pre-label swipes for field sample collection; use a labeling technique that ensures the ability to track all samples throughout the collection and processing periods. Place the swipes for a particular area or room in a sealable plastic bag or fold the swipes into a latex glove after the swipe samples have been taken.

4. Survey and Monitoring Activities

_____ Prepare the survey unit (room, office, or other area)

(a) remedy safety or other items of concern that may impact your work,
(b) if necessary remove excess materials,
(c) if necessary, use masking tape, chalk lines or other means to mark grid lines within the survey unit

_____ Perform background data collection for each instrument that will be used; choose a non-radiation area where construction materials and environment is similar to the selected survey units; additional information:

(a) For scanning instruments, record the meters' responses after a 1-minute stability period; ensure proper battery check.
(b) For gamma and liquid scintillation counter background data collection, collect 21 samples for each counter, building and/or floor if necessary.
(c) For scaler counts (gas proportional or NaI), record a select number of 1-minute background counts and desired-location counts
(d) Perform background measurements on the day of selected measurements.
(e) The same background data can be used for multiple survey units.

_____ Perform scanning operations using appropriate instruments; hold the probe at a one to three inch distance from the floor or wall; scan at a rate of approximately one foot per second; annotate all "hot" spots on the survey grid map by recording the maximum observed reading. Record any readings other than background.

Appendix C-2. CHECKLIST FOR IMPACTED CLASS 3 AREAS OR SURVEY UNITS (known radiation use or storage locations)

Team Leader, Chief of Field Operations

1. Prepare grid floor maps and select random swipe locations (using sets of random numbers) and additional (control) swipe locations (as needed).

2. Grid the room (survey unit) and perform the swipes at the designated locations.

3. Oversee operations and monitor the day's progress.

4. Deliver swipe samples and survey summary sheets to the Chief of Office and Laboratory Operations for processing.

TEAM MEMBERS

1. Prepare the room or area for surveying. Remove debris and excess materials. Practice safety first. Remedy unsafe conditions before beginning survey efforts.

2. Label the background swipes -> B1 - B21. Perform the reference background swipes for each floor, if necessary. A set of background swipes is required for each floor and each day that swipes for impacted areas are collected. Collect the reference background samples from non-impacted areas in proximity to survey units to be surveyed.

3. Label the standard control swipes -> C1 - C5. Perform the standard controls: C1-floor inside room at door; C-2-floor outside room at door, C3-inside doorknob, C4-outside doorknob, and C5-inside light switch at door. Use additional controls as needed to ensure good swiping coverage in the survey unit.

4. Prepare a sketch of the room with door(s) and draw in lab benches or other built-ins.

5. Number the benches and proceed to perform additional control swipes -> staring with C6, C7, etc. or the consecutive C- number.

6. Using a survey meter, beta-gamma scan all drawers and shelves.

7. Using a survey meter, beta-gamma scan 50-100% of floor and wall areas.

8. Document the room number for the above actions; include date, serial numbers of meters, room number, and the total number of control (C1-C5, or other). Annotate quality control concerns or issues on survey summary sheets.

9. Verify the quantity and sequence of the swipes. Place the swipes in a latex glove and then insert into a labeled plastic bag when transporting samples. Deliver the swipes and other information to the Laboratory and Office Team leader for processing.

Appendix C-3. Checklist for Non-Impacted Areas or Survey Units (radiation-free labs, offices, lavatories, storage areas, closets, hallways, stairways, and other common areas and rooms)

Team Leader, Chief of Field Operations

1. Oversee operations and monitor the day's progress.

2. Deliver swipe samples and survey summary sheets to the Chief of Office and Laboratory Operations for processing.

Team Members

1. Prepare the room or area for surveying. Remove debris and excess materials. Practice safety first.

2. If impacted areas will be surveyed, label background swipes -> B1 - B21. Perform the reference background swipes for each floor, if necessary. Collect the reference background samples from non-impacted areas in proximity to survey units to be surveyed.

3. Label the standard control swipes -> C1 - C5. Perform the standard controls: C1-floor inside room at door; C-2-floor outside room at door, C3-inside door knob, C4-outside doorknob, and C5-inside light switch at door. Use additional controls as needed to ensure good swiping coverage in the survey unit.

4. Using a survey meter, beta-gamma scan 10-50% of floor and wall areas.

5. Document the room number for the above actions; include date, serial numbers of meters, room number, and the total number of control (C1-C5, or other). Annotate quality control concerns or issues on survey summary sheets.

6. Verify the quantity and sequence of the swipes. Place the swipes in a latex glove and then insert into a labeled plastic bag when transporting samples. Deliver the swipes and other information to the Office and Laboratory Team leader for processing.

Appendix C-4. Sample Collection Procedures

Team Leader, Chief of Office and Laboratory Operations

1. Perform daily quality control equipment and instrument checks before initiating the day's field and laboratory operations. Record appropriate data. Investigate and document observations that are outside the norm.

2. Ensure that adequate supplies are on hand, including swipes, liquid scintillation counter (LSC) fluid, batteries, calibrated meters and instruments, and other materials.

3. Coordinate the training of personnel who will assist in sample-analysis operations

4. Coordinate the servicing of equipment and instruments.

5. Audit swipe-sample packages and survey-summary sheets received from the Chief of Field Operations. Resolve inconsistencies or discrepancies before analyzing the samples using the laboratory liquid scintillation counter (LSC) or gamma counter.

6. Prepare the samples for evaluation by loading individual swipes into 7-milli-liter glass vials and topping off the vials with biodegradable liquid scintillation fluid or appropriate vials for gamma counting without topping off with fluid. Label the caps of each vial by assigning sequential numbers. Load the vials into racks into the LSC or gamma counter. For LSC evaluations, to prevent elevated results due to chemi-luminescence, store the samples for two to three hours out of ambient light before counting the samples. Chemi-luminescence may be attributed to the swipe or its contents interacting with the LSC fluid. For LSC evaluations, select and initiate the dual-dpm (H-3 and C-14) protocol for evaluating the swipe samples. For gamma counting samples, follow procedures provided in the vendor's operating manual.

7. Monitor the progress of the LSC operations during the swipe evaluations.

8. Remove the computer printout of the swipe evaluations. For each survey unit or data set, make appropriate annotations on the computer printout.

9. Review the data and the survey summary sheets to verify that they match. Resolve discrepancies.

10. Report all questionable observations, discrepancies and deviations from procedures.

11. Submit the LSC printout, grid maps, and survey summaries to the Quality Control Officer for review.

12. Assist the Quality Control Officer as needed.

Appendix C-5. Sample Control. Sample control procedures were implemented to ensure the integrity of samples, sample identification, collection, chain of custody, and retention.

1. Samples collected were traceable from the time collected through the analysis phase, during the retention period, and until they were disposed of properly.

   - Sample Custody: All samples collected were maintained under secure conditions. There were fewer than five individuals in the chain-of-custody.

   - Transfer of Custody and Shipment: Samples collected were delivered directly to the laboratory operations office.

   - Sample Packaging: Samples were collected, labeled, and placed in bags at the point of generation by trained personnel. These bags were brought directly to the laboratory operations office. The bags were opened and inventoried by the chief of laboratory operations before evaluation.

2. Samples were retained in storage for as long as feasible to support data analysis. Samples, when analyzed, were retained in secure storage until after final report review and then disposed.

Appendix C-6. Data Analysis Procedures

1. Survey information packets were delivered to the Quality Control Officer for review and incorporation into the final status report. The survey information packets consisted of computer printouts of liquid scintillation (LSC) counter or gamma counter results, grid maps (for impacted survey units), survey summary sheets, and other supportive information.

2. The number of samples to be collected for impacted class 3 areas were determined using guidance provided in MARSSIM and analysis results for a known contaminated area. The number of random, statistical data samples collected for each impacted area was 21. An exception to the 21 samples taken for an impacted area was when 100% of the grid locations were sampled. For each impacted area surveyed, 21 reference background samples were also collected. Additional swipes, called control swipes, were collected to ensure good coverage of sampling within a survey unit and to sample selected locations.

3. At least five control samples were collected for each impacted and non-impacted survey unit. These five control swipes were collected using a pre-selected set of locations within each survey unit.

4. For each impacted survey unit, applicable survey data was assembled and analyzed. This data consisted of reference background data, direct surface readings, scanning results, and LSC swipe evaluations. The direct surface readings required conversion from cpm values to readings in dpm per 100 cm^2. After the data conversion of the direct readings, all survey data was then compared directly to the NMRC direct-reading action limit of 2,000 dpm. The NMRC action limit represented a value that was a small fraction of the NMRC screening values or DCGLs. Scanning results were called satisfactory when results did not exceed two to three times the background readings. Any individual reading that exceeded the NMRC action limit or the scanning limit was further investigated. For any area exceeding the limits, remediation efforts were completed until subsequent surveys yielded results that were below NMRC action limits. Additional scanning and swipes were completed as deemed necessary. All results have been included in this final report.

5. For non-impacted survey units (common areas, offices, storage rooms, halls, and stairs), control swipes for selected areas were collected and analyzed. In addition, 10-50% of the floor area was beta-gamma scanned.

6. All original computer printouts, grid maps, survey summary sheets and applicable documents have been maintained for inclusion in permanent, radiation-safety-program files.

7. Grid maps with applicable sample locations have been included in this final report.

8. All data entries in the final report were verified (for accuracy and completeness) by at least two persons on the D&D team.

Appendix C-7. Equipment and Instrument Procedures

1. All equipment and instruments designated for use in NMRC radiological D&D operations were properly calibrated and kept in a secure location when not in use. Operators were trained in the proper use of the equipment and instruments.

2. Daily operational and check-source tests were performed and documented by trained personnel.

3. Radiation equipment and instruments were used for direct surveys, scanning, and sample analyses.

   a. FIXED CONTAMINATION MEASUREMENTS. Direct surveys or measurements for fixed contamination were performed using a portable gas proportional detector. Prior to its daily quality control tests, the detector was purged with gas per the manufacturer's operating procedures. Readings for one-minute samples were collected for desired locations. The primary isotopes of concern were Carbon-14 and Sulfur-35.

   b. WALK-THROUGH SURVEYS. Scan surveys were performed using portable, Geiger-Mueller (GM) meters with either pancake probes or gamma scintillation probes. The beta-gamma scanning consisted of walk-through surveys carried out by holding the detector probe approximately one to two inches above the floor or area and walking slowly (about one foot per second) through the specific site—stopping when increases in count rates were observed. Areas where the count rates exceeded two to three times background were investigated by a more detailed survey in the suspect area. Scanning practices included using the audible response of the meter for detection and, after stabilization, using the meter response for measurement. The primary isotopes of concern included Carbon-14, Cobalt-57, Barium-133 and Cesium-137.

   c. REMOVABLE SURFACE CONTAMINATION SURVEYS (Swipes/Smears and Swabs). Swipes (swipes, smears and swabs) were collected as deemed necessary to determine if radioactivity above the limit was removable (or loose). Swipes were performed by lightly misting the area with a water spray and wiping a 100 cm^2 surface (applying moderate pressure) with a dry filter paper (swipe/smear/swab). Swipes were evaluated using a liquid scintillation or gamma counter, depending upon the isotopes of concern for the survey unit. For

liquid-scintillation-counter evaluations, tritium (H-3) and Carbon-14 were the principal isotopes of concern.

4. Information about the D&D radiological monitoring equipment and instruments is provided in Appendix D. Documents summarizing instrument calibrations and specifications are provided in Appendix D.

Appendix C-8. Source-Standards, Background-Standards, and Reference-Background Measurements

1. All available source standards (Hydrogen-3, Carbon-14, and Iodine-129) and background standards were collected for use during the duration of the radiological decontamination and decommissioning operations.

2. NIST-traceable, source standards (Carbon-14 and Cobalt-60) were purchased and kept stored in a secure location. Only trained and authorized personnel handled the check sources and used the sources to verify proper instrument response to radioactivity.

3. Daily-check-source and operational calibration checks were performed. Document results, maintaining logs and control charts as necessary.

4. Inventories and leak tests of check sources were performed, at least semi-annually. The leak tests and documentation satisfied regulatory requirements.

5. Information about the various check sources used during the D&D effort is provided in Appendix D.

APPENDIX D. QUALITY ASSURANCE INFORMATION AND DATA

Appendix D-1. Training Information and Certificates

All personnel who participated in radiological decontamination and decommissioning (D&D) efforts received a level of training commensurate with the work assignments and level of participation. The incumbent Radiation Safety Officer, LCDR S. L. Gaiter, held the primary D&D positions of Decommissioning Officer and Quality Control Officer. The Chief of Office and Laboratory Operations was the incumbent Assistant Radiation Safety Officer, Mr. Saifeddin Ahmad. The Chief of Field Operations, Mr. Willie Deadwyler, had previously held numerous positions as a Navy radiation health technician. The personnel listed above received basic radiation safety training and instrument training in conjunction with their participation in NMRC D&D efforts. Mr. Glen Garth and Mr. Rodney McGhee received basic radiation safety training and on-the-job training. Mr. Garth and Mr. McGhee worked under the direct supervision of Mr. Ahmad or Mr. Deadwyler. Ms. Carolyn Hall served as the Project Coordinator and Editor. Her assignments were completed in an office environment or infrequent visits to the field. LCDR Gaiter or Mr. Ahmad performed all radiological materials-handling and decontamination work.

Document D-1 provides training and experience information for LCDR Gaiter. **Documents D-2** through **D-11** provide pertinent radiation safety training certificates for the participants in the NMRC radiological D&D efforts. **Table D-1** lists the training documents included in this final report.

Table D-1. TRAINING INFORMATION AND CERTIFICATES

Document Number	Training Certificate or Form
D-1-1	Training and Experience of Authorized Radioisotope User, LCDR Gaiter
D-1-2	Radiation Safety Training, LCDR Gaiter
D-1-3	Ludlum Measurements Instruments, LCDR Gaiter
D-1-4	Radiation Safety Training, Mr. Ahmad
D-1-5	Ludlum Measurements Instruments, Mr. Ahmad
D-1-6	Radiation Safety Training, Mr. Deadwyler
D-1-7	Ludlum Measurements Instruments, Mr. Deadwyler
D-1-8	Radiation Safety Training, Ms. Hall
D-1-9	Ludlum Measurements Instruments, Ms. Hall
D-1-10	Radiation Safety Training, Mr. Garth
D-1-11	Radiation Safety Training, Mr. McGhee

DOCUMENT D-1-1. TRAINING AND EXPERIENCE OF AUTHORIZED RADIOISOTOPE USERS
(TYPE OR PRINT LEGIBLY)

A. GENERAL INFORMATION

AUTHORIZATION NUMBER:	DATE OF APPLICATION: 31 March 1999
NAME OF AUTHORIZED USER *(LAST, FIRST, MI)* **Gaiter, Schleurious L.**	RANK / GS GRADE: LCDR, MSC,USN
ORGANIZATION / ORGANIZATION DIVISION: Naval Medical Research Center, Safety Program	BUILDING AND ROOM NUMBER: All NMRC Bethesda and Rockville Buildings

B. CERTIFICATIONS N/A

SPECIALTY BOARD	CATEGORY	DATE CERTIFIED
American Academy of Health Physics	Part I of II (Associate Member status)	7/1995

C. FORMAL EDUCATION

TYPES OF LICENSES : None

TERRITORY OR STATE IN WHICH LICENSED *(MD, DDS, DVM, ETC.)*: N/A

HIGHER EDUCATIONAL INSTITUTIONS ATTENDED	MAJOR COURSE OF STUDY AND DATES ATTENDED	DEGREE, DIPLOMA OR CERIFICATE RECEIVED AND DATE
Florida Community College (FCC), Jacksonville, FL	Pre-Engineering	Associate in Arts, 4/1978
University of Florida (UF), Gainesville, FL	Chemical Engineering	B.S. Chemical Engineering, 12/1981
University of Florida (UF)	Chemical Engineering	Master of Science, 4/1983
Georgetown University (GU) Washington, DC	Radiation Science	Master of Science, 2/1995

D. TRAINING RECEIVED IN BASIC RADIOISOTOPE HANDLING TECHNIQUES

FIELD OF TRAINING A	LOCATION AND DATES OF TRAINING *(INCLUDE COURSE TITLE IF KNOWN)* B	TYPE AND LENGTH OF TRAINING LECTURE/ LABORATORY COURSES *(HOURS)* C	TYPE AND LENGTH OF TRAINING SUPERVISED LABORATORY EXPERIENCE *(HOURS)* D
1. RADIATION PHYSICS AND INSTRUMENTATION	Navy Radiation Health Officer Course, 1988 Radiologic Physics I , GU, 1991 Health Physics, GU, 1992 Radiation Detection, GU, 1993 Radiation Dosimetry, GU, 1993 Health Physicist/Instructor, Armed Forces Radiobiology Research Institute (AFRRI), Bethesda, MD. Radiation Safety Officer, NMRC, Bethesda	160 hours 30 hours 30 hours 20 hours lectures; 20 hours lab experience 20 hours lectures; 20 hours lab experience work experience (1990-1995) work experience (1995-1999)	
2. RADIATION PROTECTION	Navy Radiation Health Officer Course, 1988 Operational Health Physics, GU, 1992 Radiation Biology, GU, 1993 Health Physicist/Instructor, AFRRI Radiation Safety Officer, NMRC, Bethesda	160 hours 30 hours 30 hours work experience (1990-1995) work experience (1995-1999)	
3. MATHEMATICS PERTAINING TO THE USE AND MEASUREMENT OF RADIOACTIVITY	Navy Radiation Health Officer Course, 1988 Radiologic Physics I , GU, 1991 Health Physics, GU, 1992 Health Physics Internships I and II Radiation Detection, GU, 1993 Radiation Dosimetry, GU, 1993 Health Physicist/Instructor, AFRRI Radiation Safety Officer, NMRC, Bethesda	160 hours 30 hours 30 hours 150 hours laboratory experience 20 hours lectures; 20 hours lab experience 20 hours lectures; 20 hours lab experience work experience (1990-1995) work experience (1995-1999)	
4. RADIATION BIOLOGY	Radiation Biology, GU, 1993 Medical Effects of Nuclear Weapons Courses, AFRRI, 1990-1995	30 hours 300 hours	
5. RADIOPHARMACEUTICAL CHEMISTRY	N/A	N/A	

PAGE 1

E. ACTUAL EXPERIENCE WITH RADIOISOTOPES (SEALED AND/OR UNSEALED SOURCE)

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
Cobalt-60 (sealed) Cesium-137 (sealed)	150,000 Ci 14,500 Ci	AFRRI, Bethesda, MD NMRC, Bethesda, MD	1990-1995 1995-1999	Open-air irradiations Closed-chamber irradiations; provided training to users
H-3 C-14 P-32 P-33 Ca-45 Cr-51 I-125	50 Ci 10 Ci 10 Ci 25 mCi 10 mCi 5 Ci 1 Ci	NMRC, Bethesda, MD	1995-1999	Receipt, handling, monitoring and disposal of unsealed materials for use by Authorized Users performing biomedical research efforts

F. EXPERIENCE WITH RADIATION PRODUCING DEVICES *(X-RAY MACHINES, IRRADIATORS, ETC.)*

DEVICES	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
Gamma Irradiators (Cesium-137) Shepherd Mark I (9000 Ci) Best Industries Model (2500 Ci) Isomedix Gammator Unit (300 Ci)	NMRC, Bethesda, MD	1995-1999	Train personnel and maintain units for use by staff scientist, technicians, and other researchers to irradiate specimens, non-human animals, cells, etc.

G. CERTIFICATION

I CERTIFY THAT THE ABOVE INFORMATION PROVIDED HEREON IS TRUE AND COMPLETE TO THE BEST OF MY KNOWLEDGE

SIGNATURE OF APPLICANT DATE SIGNED

PAGE 2 TRAININING AND EXPERIENCE OF AUTHORIZED RADIOISOTOPE USERS

Certificate of Training

This Certifies That

Schleurious Gaiter

has successfully completed the 1-day course of instruction for

Radiation Safety Training

February 23, 2000

Presented By

CSI-Radiation Safety
481 North Frederick Avenue, Suite 302
Gaithersburg, Maryland 20877

For

Naval Medical Research Center
Bethesda, MD

Ray Johnson

Raymond Johnson, C.H.P., P.E.
Training Director

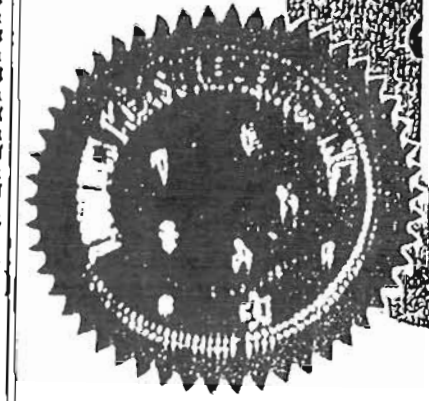
Certificate of Completion

This certifies that

Solemnious Gaiter

has successfully completed a 4 hour training session on Calibration and Repair of Ludlum Measurements Instruments.

Given on December 20, 1999



Donald C. Ludlum
President
Ludlum Measurements, Inc.

Certificate of Training

This Certifies That

Saifeddin Ahmad

has successfully completed the 1-day course of instruction for

Radiation Safety Training

February 23, 2000

Presented By

CSI-Radiation Safety
481 North Frederick Avenue, Suite 302
Gaithersburg, Maryland 20877

For

Naval Medical Research Center
Bethesda, MD

Ray Johnson

Raymond Johnson, C.H.P., P.E.
Training Director

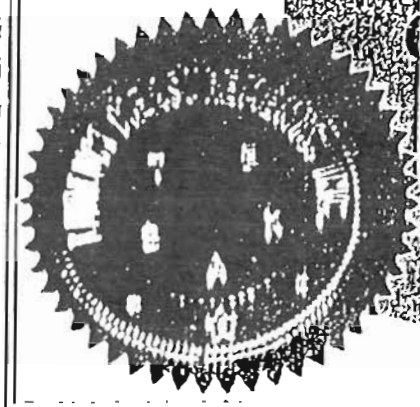
Certificate of Completion

This certifies that

Saifeldin Ahmad

has successfully completed a 8 hour training session on Calibration and Repair of Ludlum Measurements Instruments.

Given on December 20, 1999



Donald G. Ludlum
President
Ludlum Measurements, Inc.

Certificate of Training

This Certifies That

Willie Deadwyler

has successfully completed the 16-hour course of instruction for

Fundamentals of Radiation Safety

November 9-10, 1999

Presented By

CSI-Radiation Safety Training
481 North Frederick Avenue. Suite 302
Gaithersburg, Maryland 20877

in association with

Radiation Service Organization. Inc.
Post Office Box 1526
Laurel, Maryland 20725

Raymond Johnson, C.H.P., P.E.
Training Director

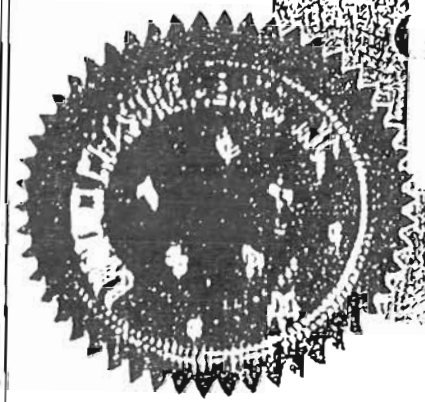
Certificate of Completion

This certifies that

Willie Deadwyler

has successfully completed a 8 hour training session on Calibration and Repair of Ludlum Measurements Instruments.

Given on December 20, 1999



Donald G. Ludlum
President
Ludlum Measurements, Inc.

Certificate of Training

This Certifies That

Carolyn Hall

has successfully completed the 16-hour course of instruction for

Fundamentals of Radiation Safety

November 9-10, 1999

Presented By

CSI-Radiation Safety Training
481 North Frederick Avenue, Suite 302
Gaithersburg, Maryland 20877

in association with

Radiation Service Organization, Inc.
Post Office Box 1526
Laurel, Maryland 20725

Ray Johnson

Raymond Johnson, C.H.P., P.E.
Training Director

Certificate of Completion

This certifies that

Carolyn Hall

has successfully completed a 16 hour training session on Calibration and Repair of Ludlum Measurements instruments.

Given on December 20, 1999

Donald C. Ludlum
President
Ludlum Measurements, Inc

Certificate of Training

This Certifies That

Glen Garth

has successfully completed the 1-day course of instruction for

Radiation Safety Training

February 23, 2000

Presented By

CSI-Radiation Safety
481 North Frederick Avenue, Suite 302
Gaithersburg, Maryland 20877

For

Naval Medical Research Center
Bethesda, MD

Raymond Johnson, C.H.P., P.E.
Training Director

Certificate of Training

This Certifies That

Rodney McGhee

has successfully completed the 1-day course of instruction for

Radiation Safety Training

February 23, 2000

Presented By

CSI-Radiation Safety
481 North Frederick Avenue, Suite 302
Gaithersburg, Maryland 20877

For

Naval Medical Research Center
Bethesda, MD

Ray Johnson

Raymond Johnson, C.H.P., P.E.
Training Director

Appendix D-2. Service and Calibration Certificates for Instruments, Equipment, and Check Sources

Table D-2 lists the service and calibration certificates for the instruments, equipment and check sources used in the D&D effort described in this final report.

Table D-2. SERVICE AND CALIBRATION CERTIFICATES FOR INSTRUMENTS, EQUIPMENT AND CHECK SOURCES

Document Number	Service and/or Calibration Certificate
D-2-1	Packard Liquid Scintillation Counter, S/N 403848, 4/5/99
D-2-2	Packard Liquid Scintillation Counter, S/N 403848, 3/10/00
D-2-3	Packard Liquid Scintillation Counter, S/N 403848, 4/6/00
D-2-4	Statement of Data Analysis by Packard, 4/7/00
D-2-5	EG&G Wallac, Inc. Gamma Counter, S/N 82-324, 8/23/99
D-2-6	Bicron Meter, S/N B602G, 7/22/99
D-2-7	Ludlum Model 3, S/N 54537, 7/22/99
D-2-8	Ludlum Model 3, S/N 114886, 7/22/99
D-2-9	Ludlum Model 3, S/N 121461, 8/12/99
D-2-10	Ludlum Model 3, S/N 121816, 2/22/00
D-2-11	Ludlum Model 3, S/N 132946, 2/22/00
D-2-12	Certificate of Participation, Reports of Traceability to NIST, Analytics, Inc., 1999
D-2-13	Certificate of Calibration, Analytics, Inc., Carbon-14 check source, S/N 58806A-530
D-2-14	Certificate of Calibration, Analytics, Inc., Carbon-14 check source, S/N 58807-530
D-2-15	Certificate of Calibration, Analytics, Inc., Cobalt-60 check source, S/N 58808-530
D-2-16	Certificate of Calibration, Analytics, Inc., Cobalt-60 check source, S/N 58809-530
D-2-17	Certificate of Calibration, Ludlum Measurements, Inc., Model 2350-1, S/N 157674, Gas Proportional Unit with Detectors
D-2-18	Certificate of Calibration, Ludlum Measurements, Inc., Model 2350-1, S/N 157669, Gas Proportional Unit with Detectors

Packard A Packard Company

CUSTOMER NAME: S. Ahmad

CUSTOMER TEL: 295-0002

RECEIPT FOR SERVICE

BILL TO:

DIST	TECH	ZONE	PAYEE NO.	CUSTOMER NUMBER	SERVICE ORDER #
433	3	1	064316		6405442

DEPARTMENT: Receipts Control Section Bldg. 17 Room S-20

PACKARD SYSTEM SERIAL NUMBER: B2570Q-A0B8148

INSTITUTION'S NAME: Naval Medical Research Center

RIC SYSTEM SERIAL NUMBER: -----9

ADDRESS: 8901 Wisconsin Avenue

CALL NUMBER: 82933

CITY: Bethesda STATE: MD COUNTRY: ZIP: 20889-5607

COPY TO:

DATE OF SERVICE MO	DAY	YEAR	SERVICE HOURS	TRAVEL HOURS
4	5	99	1 0	2 5
TOTALS			1 0	2 5

ITEM #	PART NUMBER OF REPLACED ITEM	PART DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL PRICE
1	166550-75	Printer ribbon cartridge	1	27 00	27 00
2					
3					
4					
5					
6					
7					
8					
9					
10					

PARTS TRANSFER ITEM _____ PAYEE # _____

TOTAL MATERIAL 27 00

SUMMARY OF CHARGES TO CUSTOMER

ITEM	HOURS	RATES	CHARGES
ZONE ___ MIN.	1 0	350.00	350 00
LABOR			
SUB TOTAL			350 00
MATERIAL			27 00
SHIPPING CHARGES			
VENDOR CHARGES			
SUB TOTAL			27 00
TRAVEL			
TAX			
MISC.			
TOTAL			377 00

EXPLANATION: Instrument Calibration and preventative maintenance. Normalize/Calibrated. Cleaned and lubricated printer, replaced ribbon. Cleaned fan filter, checked cooling fans. Blew dust from keyboard & detector & static controller. Cleaned sample changer deck & monitor face. Adjusted drag plate tension detector end to improve sample changer operation. Inspected and lubricated external std. Checked and reset error log; Approx 3,319 elevator cycles since 27 Apr 98.

3H EFF. 100% BKG. 7 CPM

14C EFF. 96.4% BKG. 23 CPM

125I EFF. _____ BKG. _____

CUSTOMER'S P.O. (IF MISSING EXPLAIN) N32398 99RC7019

CUSTOMER SIGNATURE: Seifeddin Ahmed

TSE SIGNATURE: Robert L Palmer

REASON FOR SERVICE

PRIMARY	SECONDARY
0 OPERATOR ERROR 1 POWER SUPPLY 2 MECHANICAL/ ELECTROMECHANICAL 3 ANALOG 4 DIGITAL 5 SOFTWARE & FIRMWARE 6 UPDATE 7 NO PROBLEM FOUND	0 INCORRECT OPERATION 1 OUTSIDE SYSTEM SPECS 2 ADJUST 3 REPAIR 4 REPLACE 5 MECHANICAL 6 ANALOG 7 DIGITAL 8 SOFT & FIRMWARE 9 OTHER (PLEASE EXPLAIN)
7	9

TYPE OF SERVICE

40 LOAN
50 WARRANTY
51 ENG CHANGES
52 TRAINING / APPLICATION SUPPORT
55 INSTALLATION
63 SALES ASSIST / DEMO / SHOW
6C COMPREHENSIVE AGREEMENT (1)
64 COMPREHENSIVE AGREEMENT (2)
6D DEPOT REPAIR
6L LIMITED USE AGREEMENT
6P PM ONLY AGREEMENT
68 BILLABLE SERVICE
69 PREVENTIVE MAINTENANCE
71 SALE

6 8

CUSTOMER COPY

Packard
A Packard BioScience Company

CUSTOMER NAME: S. AHMAD
CUSTO 30 TEL: 95-0002

RECEIPT FOR SERVICE

BILL TO: RECEIPT CONTROL SECTION
N.M.R.C.

DEPARTMENT 8401 WISCONSIN AVE.
BLDG 17, RM. 132 BETHESDA, MD 20889-5607

INSTITUTION'S NAME
NAVAL MEDICAL RESEARCH CTR.

ADDRESS 8401 WISCONSIN AVE
RADIATION SFTY. BLDG 17, ROOM 10

CITY BETHESDA STATE MD COUNTRY ZIP 20889-5607

DIST	TERR	ZONE	PAYEE NO.	CUSTOMER NUMBER	SERVICE ORDER #
433		1	054310		6 412773

PACKARD SYSTEM SERIAL NUMBER: B2500 - 4938X8

RIC SYSTEM SERIAL NUMBER: - - - - - - - - 9

CALL NUMBER:

COPY TO:

DATE OF SERVICE MO	DAY	YEAR	SERVICE HOURS	TRAVEL HOURS
3	10	00	6.0	2.5
TOTALS				

ITEM #	PART NUMBER OF REPLACED ITEM	PART DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL PRICE
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

PARTS TRANSFER ITEM _____ PAYEE # _____ TOTAL MATERIAL

SUMMARY OF CHARGES TO CUSTOMER

ITEM	HOURS	RATES	CHARGES
ZONE 1 MIN.	1.0	390	390.00
LABOR	5.0	195	975.00
SUB TOTAL			1365.00
MATERIAL			
SHIPPING CHARGES			
VENDOR CHARGES			
SUB TOTAL			
TRAVEL			
TAX			
MISC.			
TOTAL			1365.00

EXPLANATION: INSPECTED COUNTER. CLEANED DETECTOR ASSEMBLY. CLEANED AND LUBRICATED SAMPLE CHANGER. CALIBRATED HIGH VOLTAGE. CHECKED 3H & C14 EFFICIENCIES.

NOTE:

ALTHOUGH THIS COUNTER IS NOT Y2K COMPLIANT (CORRECT DATE CANNOT BE ENTERED.), THE CORRECTED DPM VALUES FOR 3H AND C14 ARE CORRECT. THE 3H AND C14 QUENCH CURVES INSTALLED ARE NOT DEPENDANT UPON A DATE, BUT ARE DEPENDENT UPON THE ACTUAL DPM'S

3H EFF. 68.9% BKG. 16 IN THE QUENCH STDS AT THE TIME

14C EFF 96.3% BKG. 20 THE CURVES WERE INSTALLED

125I EFF. _____ BKG. _____

CUSTOMER'S P.O. (IF MISSING EXPLAIN) N3239800RC72023

CUSTOMER SIGNATURE Safeddin Ahmad 10/3/00

TSE SIGNATURE Bob McAllister

REASON FOR SERVICE

PRIMARY	SECONDARY
0 OPERATOR ERROR 1 POWER SUPPLY 2 MECHANICAL/ ELECTROMECHANICAL 3 ANALOG 4 DIGITAL 5 SOFTWARE & FIRMWARE 6 UPDATE 7 NO PROBLEM FOUND	0 INCORRECT OPERATION 1 OUTSIDE SYSTEM SPECS 2 ADJUST 3 REPAIR 4 REPLACE 5 MECHANICAL 6 ANALOG 7 DIGITAL 8 SOFT & FIRMWARE 9 OTHER (PLEASE EXPLAIN)

TYPE OF SERVICE

41 LOAN
50 WARRANTY
51 ENG CHANGES
52 TRAINING / APPLICATION SUPPORT
55 INSTALLATION
63 SALES ASSIST / DEMO / SHOW
6C COMPREHENSIVE AGREEMENT (1)
6K COMPREHENSIVE AGREEMENT (2)
6D DEPOT REPAIR
6L LIMITED USE AGREEMENT
6P PM ONLY AGREEMENT
6B BILLABLE SERVICE
69 PREVENTIVE MAINTENANCE
71 SALE

6 8

CUSTOMER COPY

Pa ard
A Packard Company

CUSTOMER NAME: NNMC

CUST R TEL:

RECEIPT FO SERVICE

BILL TO:

DEPARTMENT

INSTITUTION'S NAME

ADDRESS

CITY STATE COUNTRY ZIP

DIST	TER	ZONE	PAYEE NO.
4 3 3	3 2	1	3 3 6 4

CUSTOMER NUMBER

SE E ORDER #
6 404587

PACKARD SYSTEM SERIAL NUMBER
- 4 0 3 8 4 8

RIC SYSTEM SERIAL NUMBER
- - - - - 9

CALL NUMBER
9 5 2 5 8

COPY TO:

DATE OF SERVICE MO	DAY	YEAR	SERVICE HOURS	TRAVEL HOURS
04	06	00	2 00	1 00
TOTALS				

ITEM #	PART NUMBER OF REPLACED ITEM	PART DESCRIPTION	QUANTITY	UNIT PRICE	TOTAL PRICE
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

PARTS TRANSFER ITEM_____ PAYEE #_____ TOTAL MATERIAL

SUMMARY OF CHARGES TO CUSTOMER

ITEM	HOURS	RATES	CHARGES
ZONE_____ MIN.			
LABOR			
SUB TOTAL			
MATERIAL			
SHIPPING CHARGES			
VENDOR CHARGES			
SUB TOTAL			
TRAVEL			
TAX			
MISC.			
TOTAL			

EXPLANATION: Removed sample changer deck. Removed and checked PMTs. Reseated PMT's in sockets. Checked mechanical movement of elevator. Cleaned coolant from elevator body. Re~~assembled~~ connected instrument. Performed customers QC test & SAC. Results looked good.

CUSTOMER'S P.O. (IF MISSING EXPLAIN)

CUSTOMER SIGNATURE

TSE SIGNATURE

3H EFF. 60 BKG. 10

14C EFF. 96 0 BKG. 15.9

1125 EFF._____ BKG._____

REASON FOR SERVICE

PRIMARY	SECONDARY
0 OPERATOR ERROR 1 POWER SUPPLY 2 MECHANICAL/ ELECTROMECHANICAL 3 ANALOG 4 DIGITAL 5 SOFTWARE & FIRMWARE 6 UPDATE 7 NO PROBLEM FOUND	0 INCORRECT OPERATION 1 OUTSIDE SYSTEM SPECS 2 ADJUST 3 REPAIR 4 REPLACE 5 MECHANICAL 6 ANALOG 7 DIGITAL 8 SOFT & FIRMWARE 9 OTHER (PLEASE EXPLAIN)
7	5

TYPE OF SERVICE

44 LOAN
50 WARRANTY
51 ENG CHANGES
52 TRAINING / APPLICATION SUPPORT
55 INSTALLATION
63 SALES ASSIST / DEMO / SHOW
6C COMPREHENSIVE AGREEMENT (1)
64 COMPREHENSIVE AGREEMENT (2)
6D DEPOT REPAIR
6L LIMITED USE AGREEMENT
6P PM ONLY AGREEMENT
68 BILLABLE SERVICE
69 PREVENTIVE MAINTENANCE
71 SALE

6 8

CUSTOMER COPY

Packard
A Packard BioScience Company

DATE:04/07/2000

FAX# 301-295-5651

TO: Dr. Jaifeddin Ahmad

FROM: TOM GERBER

RE: Packard B2500 LSA

I have analyzed your data and have found the data to be in control. The procedure that I used was to take 2 square roots of the mean and look for random events on both sides of the mean. The data should stay within 677 counts 95 % of the time. It passes this test quite well. An assumption that I made is that the CPM value was taken at 1 minute.

Thank you,
Tom Gerber

EG&G WALLAC, INC.
9238 Gaither Rd, Gaithersburg, Maryland 20877 (800) 638-6710

SERVICE REPORT

39915

Q. A. DATA
AGE - MONTHS: 0 - 3 | 4 - 11

USER

INSTRUMENT LOCATION

	TELEPHONE
Radiation Safety	(301) 2950002

ORGANIZATION: NAVAL Medical Research Ctr.
DEPARTMENT: BLD 17, Rm 546
STREET: 8901 Wisconsin Ave
CITY: Bethesda STATE: MD ZIP: 20889

PROBLEM

PM
WILL NOT INITIALIZE!
(RAD CPU Bd - ECC)

ACTION TAKEN

Replaced ECC Rd BAD Power Switch, checked Alignments, Conveyor, Tests, cleaned counting chamber, checked Efficiency F-129: 64.5%
Background: 42

SOFTWARE VERSION: ULTIMA III V1.5
DVM

REPAIR DATE (MO. DAY YR.)	JOB NUMBER	EMPLOYEE NO.
6/23/95	115161	5963

MODEL #	SERIAL #	DEPART	ARRIVE	COMPLETE	PROBLEM	REPAIR
1282	820324	8 00	9 00	11 00	21	21

☒ P. O. NO. ☐ WARRANTY ☐ CONTRACT ☐ RENTAL
NUMBER

IF INCOMPLETE:

DEPART	ARRIVE	COMPLETE

PROBLEM CODES

01	NO FAULT
02	OPERATOR ERROR
03	SCHEDULED PREVENTIVE MAINTENANCE
04	UNKNOWN FAILURE
10	MECHANICAL ADJUSTMENT FAILURE
11	MECHANICAL COMPONENT FAILURE
20	ELECTRICAL ADJUSTMENT FAILURE
21	ELECTRICAL COMPONENT FAILURE
30	SOFTWARE FAILURE INSTRUMENT
31	SOFTWARE FAILURE INTERNAL
40	REAGENT FAILURE

REPAIR CODES

01	NO ACTION
02	TRAINED AND REPEAT
03	PREVENTIVE MAINTENANCE
10	ADJUST MECHANICS
11	REPLACE MECHANICAL PARTS & ADJUST
20	ADJUST ELECTRONICS
21	REPLACE ELECTRICAL COMPONENTS & ADJUST
30	REBOOT INSTRUMENT
31	REBOOT COMPUTERS
32	REPLACE FAULTY SOFTWARE
33	UPGRADE TO NEW VERSION SOFTWARE
40	REPEAT ASSAY
41	REPLACE REAGENT

PARTS USED

QUAN.	DESCRIPTION	PART NUMBER	UNIT PRICE	TOTAL PRICE
1	ECC Bd CPU	1084527	600 00	600 00
1	Power Switch	1184/5021	12 00	12 00

TOTAL PARTS $ 617 00

LABOR HOURS 2 @ $ 175 00 — TOTAL LABOR $ 350 00

OTHER CHARGES (Description) — $

TRAVEL ZONE 1 — CHARGE $ 125 00

TOTAL CHARGE ▶ $ 1142 00

I/O DEVICES AND BETA PLATE ACCESSORIES

PART NUMBER	S/N
COMPUTER	USED
MONITOR	USED

ALL WORK HAS BEEN DONE TO MY SATISFACTION AND THE EQUIPMENT IS IN ACCEPTABLE WORKING CONDITION UNLESS CALL IS MARKED INCOMPLETE.

Seifeddin Ahmed
CUSTOMER SIGNATURE

HLL
ENGINEER INITIALS

Rev. 1
4.19.P2.F1

EG&G WALLAC

Gamma Preventive Maintenance

Wallac Inc.
9238 Gaither Road
Gaithersburg, MD 20877
(800) 638-6710

Date 8.23-99 Engineer HARRY CULLINS
Job # 115615 Contract # None
Model 1282 Serial # 820324
Instrument Software Version ULTRATERM TH Ver 1.5

(Leave yellow copy of this PM form and spectrum plot inside the instrument.)

BEFORE PM		AFTER PM		SPECTRUM PLOT	
I-129 Efficiency	64.5 %	I-129 Efficiency	64.5 %	I-129	☐
Background	42 cpm	Background	40 cpm	CS137	☐

MECHANICAL TESTS			ELECTRICAL TESTS					
Counterweights		☒	Sensors					☒
Tube Shields		☒	Display/Keyboard					☒
Elevator Tips/Forks		☒	ID Decoder					☒
Conveyor	Belts	☒	Power Line				1W vac	☒
	Chains/Teeth	☒	Low Volt DC	+/- 5	+/- 12			☒
	Clutches	☒	Battery					☒
	Motors/Brakes	☒	Master Clear				15.79 vdc	☒
Lubrication	Elevator	☒	Power Up				9.57 vdc	☒
›sors	Levers	☒	High Voltage					
	Position	☒	1 1033	2	3	4	5	
Test Meter			6	7	8	9	10	
Model KLUKE 75			11	12	13	14	15	
Serial # 55660519			16	17	18	19	20	

1260/1261		1470	
Sample Switch	☐	Fan	☐
Detector LED Grounds	☐	Video	☐
1282		Power Switch	☐
Fan	☒	Disk Drives	☐
Slide Arm	☒	Robotics	☐

I/O DEVICES AND SOFTWARE		TESTS	
Printer		Printout Clarity	☐
Model ____ Serial # ____		Ribbon	☐
		Mechanical (gears, platen, motors, print head)	☐
		Cables	☐
VDU/PC		Fan	☐
Model ____ Serial # USER		Keyboard	☐
Monitor		Disk Drives	☐
Model ____ Serial # USER		Video	☐
		Cables	☐
Computer Software			
Type ULTRA TERM TH		Version 1.5	

Customer's Signature Sayeddin Ahmad

Engineer's Signature Harry R. Cullins

DOC 4.09.035 Rev. 2

White Copy - Customer *Yellow Copy - With Instrument* *Pink Copy - Instrument File*

RSO, Inc.
P.O. Box 1526
Laurel, MD 20725
(301) 953-2482

RSO Order No. 1315

Certificate of Calibration

ISSUED TO: Naval Medical Research
Bethesda, MD 20889-5607
CONTACT: HM3 AHMAD
PHONE: (301) 295-0001
PO NO:

INSTRUMENT: BICRON
MODEL: SURVEYOR 50
TYPE: RATEMETER
SN: B602G

RSO, Inc. certifies that on 07/22/1999 the above described instrument was calibrated using a radioactive source to determine the efficiency for a specific radionuclide(s) and using electronically generated pulse for the linearity.

The results are tabulated below. Calibration is traceable to NIST.

Calibration Data

	RANGE	EXPECTED	OBSERVED		C.F.
X	1.00	100.00	100.000	cpm	1.000
		500.00	500.000	cpm	1.000
X	10.00	1000.00	1000.000	cpm	1.000
		5000.00	5000.000	cpm	1.000
X	100.00	10000.00	10000.000	cpm	1.000
		50000.00	50000.000	cpm	1.000
				C.F. AVERAGE	1.000

Probe type(s) Probe1: PANCAKE Probe2: Probe3:

MODEL	SER#	WINDOW	GEOMETRY	VOLT	ISOTOPE 1	EFF.(%)	ISOTOPE 2	EFF.(%)	ISOTOPE 3	EFF.(%)	ISOTOPE 4	EFF.(%)
PGM	B716G	OPEN	CONTACT	900	32P*	31	35S**	7	33P***	14	45Ca**	7

* Simulated using 90Sr with source at contact with probe.
** Simulated using 14C with source at contact with probe.
*** Simulated using 99Tc with source at contact with probe.
** Simulated using 14C with source at contact with probe.

INSTRUMENT CHECKS

BATTERY CHECK: NORMAL
CHECK SOURCE 1: NA READING:
CHECK SOURCE 2: READING:

ENVIRONMENTAL

TEMP: 25°C
PRESS: 755 mmHg
HUMID: 65 %

THE SUGGESTED RECALIBRATION DATE FOR THIS INSTRUMENT IS 07/22/2000

Calibrated By: Dorsey Austin Reviewed By: Cal Date: 07/22/1999

Maryland License MD-33-021-01

RSO, Inc.
P.O. Box 1526
Laurel, MD 20725
(301) 953-2482

RSO Order No. 1315

Certificate of Calibration

ISSUED TO: Naval Medical Research
Bethesda, MD 20889-5607
CONTACT: HM3 AHMAD
PHONE: (301) 295-0001
PO NO:

INSTRUMENT: LUDLUM
MODEL: 3
TYPE: RATEMETER
SN: 54537

RSO, Inc. certifies that on 07/22/1999 the above described instrument was calibrated using a radioactive source to determine the efficiency for a specific radionuclide(s) and using electronically generated pulse for the linearity.

The results are tabulated below. Calibration is traceable to NIST.

Calibration Data

	RANGE	EXPECTED	OBSERVED		C.F.
X	0.10	100.00	100.000	cpm	1.000
		300.00	300.000	cpm	1.000
X	1.00	1000.00	1000.000	cpm	1.000
		3000.00	3000.000	cpm	1.000
X	10.00	10000.00	10000.000	cpm	1.000
		30000.00	30000.000	cpm	1.000
X	100.00	100000.00	100000.000	cpm	1.000
		300000.00	300000.000	cpm	1.000
			C.F. AVERAGE		1.000

Probe type(s) Probe1: PANCAKE Probe2: Probe3:

MODEL	SER#	WINDOW	GEOMETRY	VOLT	ISOTOPE 1	EFF.(%)	ISOTOPE 2	EFF.(%)	ISOTOPE 3	EFF.(%)	ISOTOPE 4	EFF.(%)
44-9	39815	OPEN	CONTACT	900	32P*	29	35S**	7	33P***	14	45Ca**	7

* Simulated using 90Sr with source at contact with probe.
** Simulated using 14C with source at contact with probe.
*** Simulated using 99Tc with source at contact with probe.
** Simulated using 14C with source at contact with probe.

INSTRUMENT CHECKS

BATTERY CHECK: NORMAL
CHECK SOURCE 1: NA READING:
CHECK SOURCE 2: READING:

ENVIRONMENTAL

TEMP: 25°C
PRESS: 755 mmHg
HUMID: 65 %

THE SUGGESTED RECALIBRATION DATE FOR THIS INSTRUMENT IS 07/22/2000

Calibrated By: Anthony Austin Reviewed By: GDS Cal Date: 07/22/1999

Maryland License MD-33-021-01

RSO, Inc.
P.O. Box 1526
Laurel, MD 20725
(301) 953-2482

RSO Order No. 1315

Certificate of Calibration

ISSUED TO: Naval Medical Research
Bethesda, MD 20889-5607
CONTACT: HM3 AHMAD
PHONE: (301) 295-0001
PO NO:

INSTRUMENT: LUDLUM
MODEL: 3
TYPE: RATEMETER
SN: 114886

RSO, Inc. certifies that on 07/22/1999 the above described instrument was calibrated using a radioactive source to determine the efficiency for a specific radionuclide(s) and using electronically generated pulse for the linearity.
The results are tabulated below. Calibration is traceable to NIST.

Calibration Data

	RANGE	EXPECTED	OBSERVED		C.E.
X	0.10	100.00	100.000	cpm	1.000
		400.00	400.000	cpm	1.000
X	1.00	1000.00	1000.000	cpm	1.000
		4000.00	4000.000	cpm	1.000
X	10.00	10000.00	10000.000	cpm	1.000
		40000.00	40000.000	cpm	1.000
X	100.00	100000.00	100000.000	cpm	1.000
		400000.00	400000.000	cpm	1.000
				C.F. AVERAGE	1.000

Probe type(s) Probe1: SCINTILATOR Probe2: Probe3:

MODEL	SER#	WINDOW	GEOMETRY	VOLT	ISOTOPE 1	EFF.(%)	ISOTOPE 2	EFF.(%)	ISOTOPE 3	EFF.(%)	ISOTOPE 4	EFF.(%)
44-21	132842	OPEN	CONTACT	750	32P*	34	125I**	18	51Cr***	1		

* Simulated using 90Sr with source at contact with probe.
** Simulated using 129I with source at contact with probe.
*** Simulated using 133Ba with source at contact with probe.

INSTRUMENT CHECKS

BATTERY CHECK: NORMAL
CHECK SOURCE 1: NA READING:
CHECK SOURCE 2: READING:

ENVIRONMENTAL

TEMP: 25°C
PRESS: 755 mmHg
HUMID: 65 %

THE SUGGESTED RECALIBRATION DATE FOR THIS INSTRUMENT IS 07/22/2000

Calibrated By: Dorsey Austin Reviewed By: GDS Cal Date: 07/22/1999

Maryland License MD-33-021-01

RSO, Inc.
P.O. Box 1526
Laurel, MD 20725
(301) 953-2482

RSO Order No. 1361

Certificate of Calibration

ISSUED TO: Naval Medical Research
Bethesda, MD 20889-5607
CONTACT: HM3 Ahmad
PHONE: (301) 295-0001 PO NO: CC

INSTRUMENT: LUDLUM
MODEL: 3
TYPE: RATEMETER
SN: 121461

RSO, Inc. certifies that on 08/12/1999 the above described instrument was calibrated using a radioactive source to determine the efficiency for a specific radionuclide(s) and using electronically generated pulse for the linearity.

The results are tabulated below. Calibration is traceable to NIST.

Calibration Data

	RANGE	EXPECTED	OBSERVED		C.F.
X	0.10	100.00	100.000	cpm	1.000
		400.00	400.000	cpm	1.000
X	1.00	1000.00	1000.000	cpm	1.000
		4000.00	4000.000	cpm	1.000
X	10.00	10000.00	10000.000	cpm	1.000
		40000.00	40000.000	cpm	1.000
X	100.00	100000.00	100000.000	cpm	1.000
		400000.00	400000.000	cpm	1.000
				C.F. AVERAGE	1.000

Probe type(s) Probe1: SCINTILATOR Probe2: Probe3:

MODEL	SER#	WINDOW	GEOMETRY	VOLT	ISOTOPE 1	EFF.(%)	ISOTOPE 2	EFF.(%)	ISOTOPE 3	EFF.(%)	ISOTOPE 4	EFF.(%)
44-21	121786	OPEN	CONTACT	1050	125I*	17	32P**	29	51Cr***	1		

* Simulated using 129I with source at contact with probe..
** Simulated using 90Sr with source at contact with probe.
*** Simulated using 133Ba with source at contact with probe.

INSTRUMENT CHECKS

BATTERY CHECK: NORMAL
CHECK SOURCE 1: NA READING:
CHECK SOURCE 2: READING:

ENVIRONMENTAL

TEMP: 25°C
PRESS: 750 mmHg
HUMID: 65 %

THE SUGGESTED RECALIBRATION DATE FOR THIS INSTRUMENT IS 08/12/2000

Calibrated By: Dorsey Austin Reviewed By: Cal Date: 08/12/1999

Maryland License MD-33-021-01

RSO, Inc.
P.O. Box 1526
Laurel, MD 20725
(301) 953-2482

RSO Order No. 1761

Certificate of Calibration

ISSUED TO: Naval Medical Research
8901 Wisconsin Ave.
Bethesda, MD 20889-5607
CONTACT: S. Ahmad
PHONE: (301) 295-0002 PO NO:

INSTRUMENT: LUDLUM
MODEL: 3
TYPE: RATEMETER
SN: 121816

RSO, Inc. certifies that on 02/22/2000 the above described instrument was calibrated using a radioactive source to determine the efficiency for a specific radionuclide(s) and using electronically generated pulse for the linearity.
The results are tabulated below. Calibration is traceable to NIST.

Calibration Data

	RANGE	EXPECTED	OBSERVED		C.F.
x	.1	100	100	cpm	1.00
		500	500	cpm	1.00
x	1	1000	1000	cpm	1.00
		5000	5000	cpm	1.00
x	10	10000	10000	cpm	1.00
		5000	5000	cpm	1.00
x	100	100000	100000	cpm	1.00
		500000	500000	cpm	1.00
			C.F. AVERAGE		1.00

Probe type(s) Probe1: PANCAKE Probe2: Probe3:

MODEL	SER#	WINDOW	GEOMETRY	VOLT	ISOTOPE 1	EFF.(%)	ISOTOPE 2	EFF.(%)	ISOTOPE 3	EFF.(%)	ISOTOPE 4	EFF.(%)
44-9	119401	FIXED	CONTACT	906	14C*	7	32P**	35	33P***	14		

* 35S=7%, 45Ca=7%; Simulated using 14C with source at contact with probe.
** Simulated using 90Sr with source at contact with probe.
*** Simulated using 99Tc with source at contact with probe.

INSTRUMENT CHECKS

BATTERY CHECK: NORMAL
CHECK SOURCE 1: READING:
CHECK SOURCE 2: READING:

ENVIRONMENTAL

TEMP: 26°C
PRESS: 768 mmHg
HUMID: 55 %

THE SUGGESTED RECALIBRATION DATE FOR THIS INSTRUMENT IS 02/22/2001

Calibrated By: Richard Emmons Reviewed By: DB Cal Date: 02/22/2000

Maryland License MD-33-021-01

1440

RSO, Inc.
P.O. Box 1526
Laurel, MD 20725
(301) 953-2482

RSO Order No. 1761

Certificate of Calibration

ISSUED TO: Naval Medical Research
8901 Wisconsin Ave.
Bethesda, MD 20889-5607
CONTACT: S. Ahmad
PHONE: (301) 295-0002 PO NO:

INSTRUMENT: LUDLUM
MODEL: 3
TYPE: RATEMETER
SN: 132946

RSO, Inc. certifies that on 02/22/2000 the above described instrument was calibrated using a radioactive source to determine the efficiency for a specific radionuclide(s) and using electronically generated pulse for the linearity.
The results are tabulated below. Calibration is traceable to NIST.

Calibration Data

	RANGE	EXPECTED	OBSERVED		C.F.
x	.1	100	100	cpm	1.00
		400	400	cpm	1.00
x	1	1000	1000	cpm	1.00
		4000	4000	cpm	1.00
x	10	10000	10000	cpm	1.00
		40000	40000	cpm	1.00
x	100	100000	100000	cpm	1.00
		400000	400000	cpm	1.00
			C.F. AVERAGE		1.00

Probe type(s) Probe1: SCINTILATOR Probe2: Probe3:

MODEL	SER#	WINDOW	GEOMETRY	VOLT	ISOTOPE 1	EFF.(%)	ISOTOPE 2	EFF.(%)	ISOTOPE 3	EFF.(%)	ISOTOPE 4	EFF.(%)
44-21	135670	FIXED	CONTACT	756	125I*	16	51Cr**	2.6				

* Simulated using 129I with source at contact with probe.
** Simulated using 133Ba with source at contact with probe, using correction factor of X0.1

INSTRUMENT CHECKS

BATTERY CHECK: NORMAL
CHECK SOURCE 1: READING:
CHECK SOURCE 2: READING:

ENVIRONMENTAL

TEMP: 27°C
PRESS: 768 mmHg
HUMID: 55 %

THE SUGGESTED RECALIBRATION DATE FOR THIS INSTRUMENT IS 02/22/2001

Calibrated By: Richard Emmons Reviewed By: DB Cal Date: 02/22/2000

Richard Emmons

Maryland License MD-33-021-01

1447

U.S. DEPARTMENT OF COMMERCE
National Institute of Standards & Technology
Gaithersburg, MD 20899

Certificate of Participation

Analytics, Incorporated
Atlanta, Georgia

is a participant for the period January 1, 1999, through December 31, 1999, in a radioactivity measurements assurance program conducted by the National Institute of Standards and Technology, in cooperation with the Nuclear Energy Institute. Continued participation is evidenced by dated Reports of Traceability issued for particular radionuclides, which indicate the deviation of the participant's reported value from that measured by the National Institute of Standards and Technology. The significance of these Reports is addressed below.*

For the Director,

Lisa R. Karam, Group Leader
Radioactivity Group
Physics Laboratory

*As guidance for the proper use of Reports of Traceability, it should be emphasized that the National Institute of Standards and Technology is concerned only with fostering good measurements capability and consistency with the national measurements system. The assurance of the proper application of that capability to the ultimate consumer products is the responsibility of each manufacturer of these products and of the Federal regulatory agencies.

A continuing traceability program in radioactivity demonstrates, to the degree established by the periodic assays of calibrated radioactivity samples, a continuing competence to maintain the instrument systems and standards necessary for accurate measurement. Such a program cannot, however, endorse each and every measurement nor the final product, any more than a spot check can vouch for every unchecked item. Care should be taken, therefore, not to imply such endorsement. The proper use of this Report is governed by section 200.114 of Title 15 of the Code of Federal Regulations. These regulations may be met if Reports are quoted only in their entirety. Excerpts out of context may be misleading.

ANALYTICS

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318 · U.S.A.

Phone (404) 352-8677
Fax (404) 352-2837

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

58806A-530

C-14 32 mm Diameter x 3 mm Thick Plastic Disk

This standard radionuclide source was prepared using an aliquot measured gravimetrically from a master radionuclide solution standard. The master radionuclide solution standard was calibrated by the Department Des Applications Et De La Metrologie Des Rayonnements Ionisants (DAMRI), Paris, France, as number 22453. ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1. After source preparation the calibration was checked by beta counting using a gas flow proportional counter.

ISOTOPE:	C-14
ACTIVITY (dps):	5049
HALF-LIFE:	5730 years
CALIBRATION DATE:	November 18, 1999 12:00 EST
TOTAL UNCERTAINTY*:	5.0%

*99% Confidence Level

Diameter of active area: 16 mm. Source covering 0.5 mg/cm^2 mylar.

No expiration date has been given for this source due to the fragile nature of the mylar covering. This source should be carefully tested for leakage at least every six months. If leakage is detected this source should be disposed of by approved radioactive waste disposal procedures.

P O NUMBER N32398-99-M-0228, Item 1

SOURCE PREPARED BY: M Taskaeva
M. Taskaeva, Radiochemist

Q A APPROVED: W M Mat 11-19-99

ANALYTICS

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318 · U.S.A.

Phone (404) 352-8677
Fax (404) 352-2837

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

58807-530

C-14 32 mm Diameter x 3 mm Thick Plastic Disk

This standard radionuclide source was prepared using an aliquot measured gravimetrically from a master radionuclide solution standard. The master radionuclide solution standard was calibrated by the Department Des Applications Et De La Metrologie Des Rayonnements Ionisants (DAMRI), Paris, France, as number 22453. ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1. After source preparation the calibration was checked by beta counting using a gas flow proportional counter.

ISOTOPE:	C-14
ACTIVITY (dps):	5347
HALF-LIFE:	5730 years
CALIBRATION DATE:	November 18, 1999 12:00 EST
TOTAL UNCERTAINTY*:	5.0%

*99% Confidence Level

Diameter of active area: 16 mm. Source covering 0.5 mg/cm^2 mylar.

No expiration date has been given for this source due to the fragile nature of the mylar covering. This source should be carefully tested for leakage at least every six months. If leakage is detected this source should be disposed of by approved radioactive waste disposal procedures.

P O NUMBER N32398-99-M-0228, Item 1

SOURCE PREPARED BY: M Taskaeva
M. Taskaeva, Radiochemist

Q A APPROVED: NM Mof 11-19-99

ANALYTICS

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318 · U.S.A.

Phone (404) 352-8677
Fax (404) 352-2837

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

58808-530

Co-60 32 mm Diameter x 3 mm Thick Plastic Disk

This standard radionuclide source was prepared using aliquots measured gravimetrically from calibrated master liquid radionuclide solutions. The master sources were calibrated with an ion chamber that was calibrated by the National Physical Laboratory, Teddington, U.K., and is directly traceable to national standards.

Radionuclide purity and calibration were checked using a germanium gamma spectrometer system. The nuclear decay rate and assay date for this source are given below.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

ISOTOPE:	Co-60
ACTIVITY (dps):	3.599 E+04
HALF-LIFE:	5.2714 years
CALIBRATION DATE:	November 18, 1999 12:00 EST
TOTAL UNCERTAINTY*:	4.8%
SYSTEMATIC:	4.5%
RANDOM:	0.3%

*99% confidence level.

Diameter of active area: 25 mm. Source covering 0.85 mg/cm^2 mylar.

No expiration date has been given for this source due to the fragile nature of the mylar covering. This source should be carefully tested for leakage at least every six months. If leakage is detected this source should be disposed of by approved radioactive waste disposal procedures.

P O NUMBER N32398-99-M-0228, Item 2

SOURCE PREPARED BY: M. Taskaeva

M. Taskaeva, Radiochemist

Q A APPROVED: 11-19-99

ANALYTICS

1380 Seaboard Industrial Blvd.
Atlanta, Georgia 30318 - U.S.A.

Phone (404) 352-8677
Fax (404) 352-2837

CERTIFICATE OF CALIBRATION

Standard Radionuclide Source

58809-530

Co-60 32 mm Diameter x 3 mm Thick Plastic Disk

This standard radionuclide source was prepared using aliquots measured gravimetrically from calibrated master liquid radionuclide solutions. The master sources were calibrated with an ion chamber that was calibrated by the National Physical Laboratory, Teddington, U.K., and is directly traceable to national standards.

Radionuclide purity and calibration were checked using a germanium gamma spectrometer system. The nuclear decay rate and assay date for this source are given below.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

ISOTOPE:	Co-60
ACTIVITY (dps):	3.730 E+04
HALF-LIFE:	5.2714 years
CALIBRATION DATE:	November 18, 1999 12:00 EST
TOTAL UNCERTAINTY*:	4.8%
SYSTEMATIC:	4.5%
RANDOM:	0.3%

*99% confidence level.

Diameter of active area: 25 mm. Source covering 0.85 mg/cm^2 mylar.

No expiration date has been given for this source due to the fragile nature of the mylar covering. This source should be carefully tested for leakage at least every six months. If leakage is detected this source should be disposed of by approved radioactive waste disposal procedures.

P O NUMBER N32398-99-M-0228, Item 2

SOURCE PREPARED BY: M. Taskaeva

M. Taskaeva, Radiochemist

Q A APPROVED: 11-19-99

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER NAVAL MEDICAL RESEARCH CTR ORDER NO. 237400

Ludlum Measurements, Inc. Model 2350-1 Serial No. 157674

Cal. Date 27-Sep-99 Cal Due Date 27-Sep-00 Cal. Interval 1 Year Meterface N/A

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 76 °F RH 56 % Atl 700.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical check
☑ F/S Resp. check ☑ Reset check ☑ Window Operation ☑ Input Sens. Linearity
☑ Audio check ☑ Alarm Setting check ☑ Battery check (Min. Volt) 4.4 VDC
☑ Ratemeter Linearity check ☑ Integrated Dose check ☑ Recycle Mode check
☑ Data Log check ☑ Overload check ☑ Scaler Readout check Threshold Dial Ratio 100 = 4 mV
☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89. ☑ Calibrated in accordance with LMI SOP 14.9 rev 12/19/89.

☑ HV Readout (2 points) Ref./Inst. 498 / 500 V Ref./Inst. 2002 / 2000 V

COMMENTS: *Firmware: 37122N27*

I/O firmware : 37123N05 Resolution for 44-10 = 9.36 % for Cs137. Model 2350-1 and all probes calibrated using 6 ft. cable only. See ATTACHMENT 1 for efficiencies.

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

	Probe Model	Serial #	High Voltage	Threshold	Units/ Time Base	Dead Time Correction Factor	Calibration Constant	Linearity =10%*
Detector # 1	LMI43-68	PR149314	1750	100	7 / 1	2.342273E-05	1.000000E+00	
Detector # 2	LMI43-68	PR149314	1750	100	7 / 1	2.342273E-05	1.000000E+00	
Detector # 3	LMI43-68	PR149314	1750	100	7 / 1	2.342273E-05	1.000000E+00	
Detector # 4	LMI43-37	PR148947	1800	100	7 / 1	2.361271E-05	1.000000E+00	
Detector # 5	LMI43-37	PR148947	1800	100	7 / 1	2.361271E-05	1.000000E+00	
Detector # 6	LMI43-37	PR148947	1800	100	7 / 1	2.361271E-05	1.000000E+00	
Detector # 7	LMI44-10	PR164841	1200	250	4 / 2	1.577578E-05	5.406332E+10	✓
Detector # 8	LMI44-10	PR164841	1200	250	4 / 2	1.577578E-05	5.406332E+10	✓
Detector # 9	LMI44-10	PR164841	1200	250	4 / 2	1.577578E-05	5.406332E+10	✓
Detector # 10	PEAK	CO-60	660	560	7 / 1	0.000000E+00	1.000000E+00	
Detector # 11	PEAK	CO-60	660	560	7 / 1	0.000000E+00	1.000000E+00	
Detector # 12	PEAK	CO-60	660	560	7 / 1	0.000000E+00	1.000000E+00	
Detector # 13	PEAK	CS-137	660	321	7 / 1	0.000000E+00	1.000000E+00	
Detector # 14	LMI44-10	PR164841	1200	250	7 / 1	1.577578E-05	1.000000E+00	
Detector #								
Detector #								

Units: 0 – rad, 1 – Gray, 2 – rem, 3 – Sv, 4 – R, 5 – C/Kg, 6 – Disintegrations, 7 – Counts, 8 – C/cm sq., 9 – Bq/cm sq.
Time Base: 0 – Seconds, 1 – Minutes, 2 – Hours

* See attached detector documentation, if applicable.

Digital Readout	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
	400kcpm		399969	400cpm		400
	40kcpm		40014	40cpm		40
	4kcpm		4004			

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978. State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: Cs-137 Gamma S/N

☐ 1162 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☑ T879 ☑ E552 ☐ E551 ☐ Neutron Am-241 Be S/N T-304

Alpha S/N ____ ☑ Beta S/N 1C99 C14 3132 635/83, I-659, 422-44 ☑ Other Am241 ~ 1.73µCi/I 129 0.076 µCi

☑ m 500 S/N 141233 ☑ Multimeter S/N 59120574

Calibrated By: Elias Chavez Date 27-SEP-99

Reviewed By: Eva Ybarra Date 27-Sep-99

LUDLUM MEASUREMENTS, INC.
501 OAK ST./PO BOX 810
SWEETWATER, TEXAS 79556
Phone: 915/235-5494 800/622-0828(USA)
Fax: 915/235-4672

DESIGNER AND MANUFACTURER
OF
Scientific and Industrial
Instruments

ATTACHMENT 1

4 π efficiencies for 43-68 :

Efficiencies for 43-68 taken
at 1750v.

Factory background ≈ 261cpm

Ca45 and P33 were substituted with Tc99
Tc99 is ≈ 38.55% net
Tc99 reading ≈ 8568 net

S35 was substituted with C14
C14 is ≈ 10.82% net
C14 reading ≈ 33740 net

I 125 was substituted with I 129
I 129 is ≈ 0.25% net
I 129 reading is ≈ 428 net

P 32 was substituted with Si 32
Si 32 is ≈ 35% net
Si 32 reading is ≈ 34460 net

4 π efficiencies for 43-37 :

Efficiencies for 43-37 taken
at 1800v.

Factory background ≈ 908cpm

Ca45 and P33 were substituted with Tc99
Tc99 is ≈ 35.9% net
Tc99 reading ≈ 8223 net

S35 was substituted with C14
C14 is ≈ 10.42% net
C14 reading is ≈ 32507 net

I 125 was substituted with I 129
I 129 is ≈ 0.44% net
I 129 reading is ≈ 738 net

P 32 was substituted with Si 32
Si 32 is ≈ 35.16% net
Si 32 reading is ≈ 34521 net

4 π efficiency for 44-10 :

Efficiencies for 44-10 taken at 1200v. using Det.14
and 1 minute counts.

Factory background ≈ 7508 cpm

Co 57 is ≈ 28.70 % net
Co 57 reading is ≈ 25801 cpm net

Co 60 is ≈ 22.17 % net
Co 60 reading is ≈ 9045 cpm net

Cs137 is ≈ 12.13 % net
Cs137 reading is ≈ 1854 cpm net

Elvis Chavez 27-SEP-99

DETECTOR SETUP CHECK LIST REPORT

The following list is stored as detector setup D14 in the Model 2350.
Today's date is 09/27/1999.
The current time of day is: 09:36:33.

I have verified the list below
has NO discrepancies with the DETECTOR SETTINGS TABLE: EL

Comments:

Model 2350 Serial # =	157674.
User I.D. =	
High Voltage =	1200 volts.
Threshold =	250.
Window =	100,Off.
Overload Current =	40.0 micro amperes.
Scaler Count Time =	60 seconds.
Readout Units =	counts.
Readout Time Base =	min.
Readout Range Multiplier =	auto.
Detector Dead Time =	1.577578E-05.
Detector Calibration Constant =	1.000000E+00.
Detector Model =	LMI44-10.
Detector Serial # =	PR164841.
Ratemeter Alarm Setting =	1.000000E+09.
Scaler Alarm Setting =	1000000.
Integrated Dose Alarm Setting =	1.000000E+09.
Low Count Alarm Setting =	X.
Operating Battery Voltage =	6.1 volts.

Designer and Manufacturer
of
Scientific and Industrial
Instruments

POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Model 2350 Bench Test Data

Customer NAVAL MEDICAL RESEARCH CTR Date 25-Sep-99 Order #. 237400

Model 2350-1 Serial No. 157674 Detector 44-10 Serial No. PR164841

Source Cs137 21mCi, 2.47mCi

High Voltage 1200 V As Found _____ V. Input 10.00 mV As Found _____ mV.

Cal. Constant 5.406332E+10 as found _____

Dead Time 1.577578E-05 as found _____

Alarm Setting: Ratemeter EC ~~1000000000.000000~~ 0.002000 as found _____

Scaler 1000000.000000 as found _____

Integrated dose 1000000000.0000 as found _____

Overload ☐ On ☑ Off as found ☐ On ☐ Off Window 100 (OFF) as found _____

Detector Received: ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

Reference Point	"As Found" Readings: Meter Reading	After Adjustment Readings: Meter Reading
2.0 mR/hr		1.93 mR/hr
1.5		1.50
1.0		1.03
500 µR/hr		508 µR/hr
200		204
150		149
100		102

Other Calibrated using 6 ft. cable.

Signature Elias Chavez Date 25-SEP-99

Designer and Manufacturer
of
Scientific and Industrial
Instruments

POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data For Detector

Detector 44-10 Serial No. PR164841

Customer NAVAL MEDICAL RESEARCH CTR Order #. 237400

Counter 2350-1 Serial No. 157674 Counter Input Sensitivity 10.00 mV

Count Time 6 SEC. Distance Source to Detector Surface

Other Cal Constant = 1.000000E+00 Dead Time = 1.577578E-05

High Voltage	Background	Isotope Am241 Size ≈1.73μCi	Isotope Size	Isotope Size	Isotope Size
1000	573	11013			
1050	609	12508			
1100	636	12519			
1150	567	12753			
1200	586	12879			
1250	582	12803			
1300	618	12934			
1350	608	12954			
1400	622	12883			

Signature Elias Chavez Date 25-SEP-99

FORM C4A 02/23/94

Designer and Manufacturer of Scientific and Industrial Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

CERTIFICATE OF CALIBRATION

CUSTOMER NAVAL MEDICAL RESEARCH CTR ORDER NO. 237400

Ludlum Measurements, Inc. Model 2350-1 Serial No. 157669

Cal. Date 27-Sep-99 Cal Due Date 27-Sep-00 Cal. Interval 1 Year Meterface N/A

Check mark ☑ applies to applicable instr. and/or detector IAW mfg. spec. T. 76 °F RH 56 % Atl 700.8 mm Hg

☑ New Instrument Instrument Received ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

☑ Mechanical check
☑ F/S Resp. check
☑ Audio check
☑ Ratemeter Linearity check
☑ Data Log check
☑ Reset check
☑ Alarm Setting check
☑ Integrated Dose check
☑ Overload check
☑ Window Operation
☑ Battery check (Min. Volt) 4.4 VDC
☑ Recycle Mode check
☑ Scaler Readout check
☑ Input Sens. Linearity
Threshold Dial Ratio .100 = 4 mV
☑ Calibrated in accordance with LMI SOP 14.8 rev 12/05/89.
☐ Calibrated in accordance with LMI SOP 14.9 rev 12/19/89.

☑ HV Readout (2 points) Ref./Inst. 499 / 500 V Ref./Inst. 1998 / 2000 V

COMMENTS: *Firmware: 37122N27*

I/O firmware : 37123N05 Resolution for 44-10 = 9.36 % for Cs137. Model 2350-1 and all probes calibrated using 6 ft. cable only. See ATTACHMENT 1 for efficiencies.

Gamma Calibration: GM detectors positioned perpendicular to source except for M 44-9 in which the front of probe faces source.

	Probe Model	Serial #	High Voltage	Threshold	Units/ Time Base	Dead Time Correction Factor	Calibration Constant	Linearity ±10%*
Detector # 1	LMI43-68	PR149314	1750	100	7 / 1	2.342273E-05	1.000000E+00	
Detector # 2	LMI43-68	PR149314	1750	100	7 / 1	2.342273E-05	1.000000E+00	
Detector # 3	LMI43-68	PR149314	1750	100	7 / 1	2.342273E-05	1.000000E+00	
Detector # 4	LMI43-37	PR148947	1800	100	7 / 1	2.361271E-05	1.000000E+00	
Detector # 5	LMI43-37	PR148947	1800	100	7 / 1	2.361271E-05	1.000000E+00	
De	LMI43-37	PR148947	1800	100	7 / 1	2.361271E-05	1.000000E+00	
Det... # 7	LMI44-10	PR164841	1200	250	4 / 2	1.577578E-05	5.406332E+10	✓
Detector # 8	LMI44-10	PR164841	1200	250	4 / 2	1.577578E-05	5.406332E+10	✓
Detector # 9	LMI44-10	PR164841	1200	250	4 / 2	1.577578E-05	5.406332E+10	✓
Detector # 10	PEAK	CO-60	660	560	7 / 1	0.000000E+00	1.000000E+00	
Detector # 11	PEAK	CO-60	660	560	7 / 1	0.000000E+00	1.000000E+00	
Detector # 12	PEAK	CO-60	660	560	7 / 1	0.000000E+00	1.000000E+00	
Detector # 13	PEAK	CS-137	660	321	7 / 1	0.000000E+00	1.000000E+00	
Detector # 14	LMI44-10	PR164841	1200	250	7 / 1	1.577578E-05	1.000000E+00	
Detector #								
Detector #								

Units: 0 – rad, 1 – Gray, 2 – rem, 3 – Sv, 4 – R, 5 – C/Kg, 6 – Disintegrations, 7 – Counts, 8 – Ci/cm sq., 9 – Bq/cm sq.

Time Base: 0 – Seconds, 1 – Minutes, 2 – Hours

* See attached detector documentation, if applicable.

Digital Readout	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*	REFERENCE CAL. POINT	INSTRUMENT RECEIVED	INSTRUMENT METER READING*
	400kcpm		399905	400cpm		400
	40kcpm		39993	40cpm		40
	4kcpm		4000			

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1978. State of Texas Calibration License No. LO-1963

Reference Instruments and/or Sources: Cs-137 Gamma S/N

☐ 2 ☐ G112 ☐ M565 ☐ 5105 ☐ T1008 ☑ T879 ☑ E552 ☐ E551 ☐ Neutron Am-241 Be S/N T-304

Alpha S/N ____ ☑ Beta S/N T99 C14 5132 635/83, I-659, 422-44 ☑ Other Am241 ~1.73μCi/I 129 0.076 μCi

☑ m 500 S/N 141233 ☑ Multimeter S/N 59120574

Calibrated By: Elias Chavez Date 27-SEP-99

Reviewed By: Eric Thorsen Date 27-Sept-99

LUDLUM MEASUREMENTS, INC.
501 OAK ST./PO BOX 810
SWEETWATER, TEXAS 79556
Phone: 915/235-5494 800/622-0828(USA)
FAX: 915/235-4672

DESIGNER AND MANUFACTURER
OF
Scientific and Industrial
Instruments

ATTACHMENT 1

4 π efficiencies for 43-68 :

Efficiencies for 43-68 taken
at 1750v.

Factory background ≈ 261cpm

Ca45 and P33 were substituted with Tc99
Tc99 is ≈ 38.55% net
Tc99 reading ≈ 8568 net

S35 was substituted with C14
C14 is ≈ 10.82% net
C14 reading ≈ 33740 net

I 125 was substituted with I 129
I 129 is ≈ 0.25% net
I 129 reading is ≈ 428 net

P 32 was substituted with Si 32
Si 32 is ≈ 35% net
Si 32 reading is ≈ 34460 net

4 π efficiencies for 43-37 :

Efficiencies for 43-37 taken
at 1800v.

Factory background ≈ 908cpm

Ca45 and P33 were substituted with Tc99
Tc99 is ≈ 35.9% net
Tc99 reading ≈ 8223 net

S35 was substituted with C14
C14 is ≈ 10.42% net
C14 reading is ≈ 32507 net

I 125 was substituted with I 129
I 129 is ≈ 0.44% net
I 129 reading is ≈ 738 net

P 32 was substituted with Si 32
Si 32 is ≈ 35.16% net
Si 32 reading is ≈ 34521 net

4 π efficiency for 44-10 :

Efficiencies for 44-10 taken at 1200v. using Det.14
and 1 minute counts.

Factory background ≈ 7508 cpm

Co 57 is ≈ 28.70 % net
Co 57 reading is ≈ 25801 cpm net

Co 60 is ≈ 22.17 % net
Co 60 reading is ≈ 9045 cpm net

Cs137 is ≈ 12.13 % net
Cs137 reading is ≈ 1854 cpm net

Elvis Chaney 27-SEP-99

DETECTOR SETUP CHECK LIST REPORT

The following list is stored as detector setup D14 in the Model 2350.
Today's date is 09/27/1999.
The current time of day is: 09:33:46.

I have verified the list below
has NO discrepancies with the DETECTOR SETTINGS TABLE: EC

Comments:

Model 2350 Serial # =	157669.
User I.D. =	
High Voltage =	1200 volts.
Threshold =	250.
Window =	100,Off.
Overload Current =	40.0 micro amperes.
Scaler Count Time =	60 seconds.
Readout Units =	counts.
Readout Time Base =	min.
Readout Range Multiplier =	auto.
Detector Dead Time =	1.577578E-05.
Detector Calibration Constant =	1.000000E+00.
Detector Model =	LMI44-10.
Detector Serial # =	PR164841.
Ratemeter Alarm Setting =	1.000000E+09.
Scaler Alarm Setting =	1000000.
Integrated Dose Alarm Setting =	1.000000E+09.
Low Count Alarm Setting =	X.
Operating Battery Voltage =	6.2 volts.

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Model 2350 Bench Test Data

Customer NAVAL MEDICAL RESEARCH CTR Date 25-Sep-99 Order #. 237400

Model 2350-1 Serial No. 157669 Detector 44-10 Serial No. PR164841

Source Cs137 21 mCi, 2.47 mCi

High Voltage 1200 V As Found _____ V. Input 10.00 mV As Found _____ mV.

Cal. Constant 5.406332E+10 as found _____

Dead Time 1.577578E-05 as found _____

Alarm Setting: Ratemeter 0.002000 as found _____

Scaler 1000000.000000 as found _____

Integrated dose 1000000000.0000 as found _____

Overload ☐ On ☑ Off as found ☐ On ☐ Off Window 100 (OFF) as found _____

Detector Received: ☐ Within Toler. +-10% ☐ 10-20% ☐ Out of Tol. ☐ Requiring Repair ☐ Other-See comments

Reference Point	"As Found" Readings: Meter Reading	After Adjustment Readings: Meter Reading
2.0 mR/hr		1.93 mR/hr
1.5		1.50
1.0		1.03
500 µR/hr		508 µR/hr
200		204
150		148
100		102

Other Calibrated using 6 ft. cable.

Signature Elias Chavez Jr. Date 25-SEP-99

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-4672
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data

Detector 43-68 Serial No. PR149314 Order #. 237400

Customer NAVAL MEDICAL RESEARCH CTR

Counter 2350-1 Serial No. 157669 Counter Input Sensitivity 4.00 mV

Count Time 1 min. Distance Source to Detector Surface

Other Cal Constant = 1.000000E+00 Dead Time = 2.342273E-05 Plateau w/6 ft. cable.

High Voltage	Background	Isotope Tc99 Size 22.9Kdpm	Isotope C14 Size 0.140μCi	Isotope Si32 Size 98,168dpm	Isotope I129 Size 0.076μCi
1550	146	7106	28,360	12,794	310
1600	192	8139	32,185	22,419	495
1650	235	8420	33,878	32,120	658
1700	231	8349	34001	33,224	662
1750	261	8829	34,545	34,721	689
1800	265	8869	37,897	38,106	924
1850	2198	31277	80,985	66,936	1073

Gas proportional detector count rate decreased ~ 10% after 15 hour static test using 39" cable.

Signature Elvis Chavez Date 25-SEP-98

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facilities of other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration techniques. The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1997. State of Texas Calibration License No. LO-1963

Designer and Manufacturer
of
Scientific and Industrial
Instruments

LUDLUM MEASUREMENTS, INC.
POST OFFICE BOX 810 PH. 915-235-5494
501 OAK STREET FAX NO. 915-235-467
SWEETWATER, TEXAS 79556, U.S.A.

Bench Test Data

Detector 43-37 Serial No. PR148947 Order #. 237400

Customer NAVAL MEDICAL RESEARCH CTR

Counter 2350-1 Serial No. 157669 Counter Input Sensitivity 4.00 mV

Count Time 1 minute Distance Source to Detector Surface

Other Cal Constant = 1.000000E+00 Dead Time = 2.361271E-05 Plateau w/6ft. cable.

High Voltage	Background	Isotope Tc99 Size 22,800dpm	Isotope C14 Size 0.140μCi	Isotope Sr32 Size 98,168dpm	Isotope I129 Size 0.076μCi
1550	118	2787	13537	3985	294
1600	242	4330	19548	7559	511
1650	388	6228	27468	13230	694
1700	635	7937	30858	21831	1027
1750	824	8760	32323	32023	1505
1800	908	9131	33415	35429	1646
1850	954	9120	33605	35693	1805
1900	991	9214	34319	35922	1774

√ Gas proportional detector count rate decreased ≤ 10% after 15 hour static test using 39" cable.

Signature Elias Chavez Date 25-SEP-99

Ludlum Measurements, Inc. certifies that the above instrument has been calibrated by standards traceable to the National Institute of Standards and Technology, or to the calibration facil other International Standards Organization members, or have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration tech The calibration system conforms to the requirements of ANSI/NCSL Z540-1-1994 and ANSI N323-1997. State of Texas Calibration License No. L

Appendix D-3. Instrument and Equipment Quality Control Data

Table D-3-1 provides the daily quality-control data obtained by evaluating tritium (H-3), Carbon-14 (C-14) and background standards on the in-house Packard Liquid Scintillation Counter that was used to evaluate all swipes for H-3 and C-14 contamination.

Other pertinent equipment information is as follows:

Packard Liquid Scintillation Counter
Model: 2500TR
Serial Number: 403848
Calibration date: 10 March 2000
Efficiencies: H-3 = 60.9%; C-14 = 96.3%
Packard Check (standard) sources:
H-3 (activity < 0.2μCi = 267600 dpm, date 17 May 93)
C-14 (activity < 0.1μCi = 136200 dpm, date 17 May 93)
Background (May 1993)

Table D-3-1 provides quality-control data for liquid-scintillation-counter evaluations in the form of dpm values which were obtained by evaluating H-3 and C-14 radioactive (check source) standards and a background standard. QC data was collected, on a minimum, each day that samples were evaluated and/or equipment tests performed. The upper warning limit (UWL) and lower warning limits (LWL) for H-3 and C-14 were obtained by calculating the mean and adding or subtracting 5% of the mean values for H-13 and C-14. The first ten sets of data (1/19/00-2/4/00) were used to calculate the UWL and LWL for H-3 and C-14. When dpm readings were obtained that exceeded the UWL or LWL, investigations were conducted. If inconsistent operation was evident, the instrument would have been taken out of service and replaced with another instrument or the vendor called for assistance.

Note: Instrument calibration performed by vendor on 3/10/00; the vendor on 4/6/00 performed maintenance service; QC checks were performed by the vendor and it was determined that the instrument was working properly.

Table D-3-1. Quality Control Data - Packard Liquid Scintillation Counter Daily Evaluations of H-3, C-14 and Background Standards

Instrument Use: Beta-Gamma Counting for loose surface contamination

DPM Values: Mean value for H-3 =170631; Mean value for C-14 = 135664

QC DATA SUMMARY: Daily QC readings did not exceed Upper or Lower Warning Limits (UWL, LWL)

QC Date	H-3			C-14			Background (C-14 channel)
	DPM	UWL	LWL	DPM	UWL	LWL	DPM
1/19/00	170573	179162	142447	135519	142447	128881	9
1/20/00	170156	179162	142447	135595	142447	128881	5
1/21/00	169786	179162	142447	135742	142447	128881	11
1/24/00	169724	179162	142447	135937	142447	128881	3
1/27/00	169876	179162	142447	134805	142447	128881	3
1/28/00	169708	179162	142447	135914	142447	128881	7
2/1/00	170667	179162	142447	136135	142447	128881	6
2/2/00	172562	179162	142447	135692	142447	128881	8
2/3/00	171476	179162	142447	135380	142447	128881	6
2/4/00	171783	179162	142447	135919	142447	128881	5
2/7/00	171460	179162	142447	135801	142447	128881	2
2/8/00	171475	179162	142447	135478	142447	128881	7
2/9/00	170774	179162	142447	135808	142447	128881	9
2/10/00	171733	179162	142447	135762	142447	128881	11
2/11/00	171433	179162	142447	135625	142447	128881	4
2/14/00	171341	179162	142447	135616	142447	128881	5
2/15/00	170767	179162	142447	136250	142447	128881	1
2/16/00	171125	179162	142447	136030	142447	128881	6
2/17/00	170122	179162	142447	135130	142447	128881	7
2/18/00	171538	179162	142447	136421	142447	128881	2
2/22/00	171187	179162	142447	135679	142447	128881	8
2/23/00	170449	179162	142447	135378	142447	128881	7
2/24/00	170161	179162	142447	135978	142447	128881	10
2/25/00	170708	179162	142447	136330	142447	128881	5
2/28/00	170363	179162	142447	136677	142447	128881	1
2/29/00	169704	179162	142447	136105	142447	128881	7
3/1/00	170894	179162	142447	136667	142447	128881	3
3/2/00	170568	179162	142447	135452	142447	128881	6
3/3/00	169353	179162	142447	135742	142447	128881	11
3/6/00	169402	179162	142447	135795	142447	128881	7
3/7/00	170117	179162	142447	135779	142447	128881	8
3/8/00	170261	179162	142447	136068	142447	128881	10
3/9/00	169343	179162	142447	136548	142447	128881	5
3/10/00	170124	179162	142447	136041	142447	128881	6
3/13/00	170482	179162	142447	135716	142447	128881	7

3/14/00	168454	179162	142447	135604	142447	128881	4
3/15/00	169482	179162	142447	136194	142447	128881	4
3/16/00	169274	179162	142447	135433	142447	128881	2
3/17/00	169113	179162	142447	136035	142447	128881	6
3/20/00	168952	179162	142447	135484	142447	128881	11
3/21/00	170135	179162	142447	136005	142447	128881	6
3/22/00	169263	179162	142447	136441	142447	128881	3
3/23/00	169197	179162	142447	135920	142447	128881	1
3/24/00	169311	179162	142447	136396	142447	128881	8
3/27/00	169187	179162	142447	134581	142447	128881	5
3/28/00	170543	179162	142447	135647	142447	128881	9
3/29/00	169356	179162	142447	135799	142447	128881	6
3/30/00	168609	179162	142447	136585	142447	128881	6
3/31/00	168114	179162	142447	135115	142447	128881	11
4/3/00	168368	179162	142447	135449	142447	128881	9
4/4/00	169815	179162	142447	136440	142447	128881	1
4/5/00	170876	179162	142447	135859	142447	128881	4
4/6/00	169462	179162	142447	136061	142447	128881	13
4/7/00	169412	179162	142447	135993	142447	128881	1
4/11/00	167894	179162	142447	135638	142447	128881	4
4/12/00	168861	179162	142447	135409	142447	128881	11
4/13/00	167436	179162	142447	135514	142447	128881	6
4/14/00	167649	179162	142447	135896	142447	128881	
4/17/00	168492	179162	142447	135267	142447	128881	2
4/18/00	167391	179162	142447	135261	142447	128881	3
4/19/00	168016	179162	142447	135729	142447	128881	8
4/20/00	168549	179162	142447	134965	142447	128881	8
4/21/00	168412	179162	142447	135453	142447	128881	7
4/24/00	167776	179162	142447	135662	142447	128881	11
4/25/00	167959	179162	142447	136325	142447	128881	12
4/26/00	167591	179162	142447	135617	142447	128881	4
4/27/00	165803	179162	142447	135901	142447	128881	4
4/28/00	167727	179162	142447	135095	142447	128881	6
5/1/00	166078	179162	142447	135681	142447	128881	4
5/2/00	167768	179162	142447	135673	142447	128881	11
5/3/00	166859	179162	142447	136478	142447	128881	1
5/4/00	165253	179162	142447	135087	142447	128881	12
5/5/00	166271	179162	142447	134972	142447	128881	4
5/8/00	166602	179162	142447	134720	142447	128881	2
6/9/00	164570	179162	142447	135904	142447	128881	5

Table D-3-2 provides the daily quality-control data obtained by evaluating an Iodine-129 (sealed-source) standard using a Wallac Gamma Counter. **Table D-3-2** provides daily quality-control data for the gamma counter. The data was obtained by evaluating a I-129 (sealed-source) standard. The upper warning limit (UWL) and lower warning limits (LWL) for I-129 cpm values were obtained by calculating the mean and adding or subtracting 5% of the mean for I-129 cpm values. The first 30 sets of data (3/23/00) were used to calculate the UWL and LWL for I-129. If dpm readings were obtained that exceeded the UWL or LWL, investigations would have been conducted. If inconsistent operation was evident, the instrument would have been taken out of service and replaced with another instrument or the vendor called for assistance.

Other pertinent equipment information is as follows:

Instrument: Wallac LKB Model 1282 Gamma Counter
Serial Number: 324
Calibration Date: 23 Aug 99
Efficiencies: Cr-51 = 3.7 %
Check Source: I-129 (rod-shaped; batch number: 8203, catalog number: 1270-102; activity: 0.0221 μCi; calibration date: July 1982; half life: 15.7 million years, 40 keV gamma at 7.5%)

Table D-3-2. Quality Control Data - Daily Evaluations of I-129 Standard Using the Wallac LKB Model 1282 Gamma Counter

Instrument Use: Gamma Counting for loose surface contamination

CPM Values: Mean = 30261, UWL = 31774, LWL = 28748

QC DATA SUMMARY: Daily QC readings did not exceed Upper or Lower Warning Limits (UWL, LWL)

QC Date	Iodine-129		
	CPM	UWL	LWL
3/23/00	30549	31774	28748
3/23/00	30342	31774	28748
3/23/00	29939	31774	28748
3/23/00	30337	31774	28748
3/23/00	30135	31774	28748
3/23/00	30079	31774	28748
3/23/00	30624	31774	28748
3/23/00	30190	31774	28748
3/23/00	29959	31774	28748
3/23/00	30306	31774	28748
3/23/00	30602	31774	28748
3/23/00	30253	31774	28748
3/23/00	30298	31774	28748
3/23/00	30261	31774	28748
3/23/00	30343	31774	28748
3/23/00	29969	31774	28748
3/23/00	30235	31774	28748
3/23/00	30167	31774	28748
3/23/00	30226	31774	28748
3/23/00	30396	31774	28748
3/24/00	29992	31774	28748
3/27/00	30253	31774	28748
3/28/00	30234	31774	28748
3/29/00	30268	31774	28748
3/30/00	30264	31774	28748
3/31/00	30268	31774	28748
4/3/00	30376	31774	28748
4/4/00	29942	31774	28748
4/5/00	30215	31774	28748
4/6/00	29954	31774	28748
4/7/00	30283	31774	28748
4/10/00	30432	31774	28748

4/11/00	30431	31774	28748
4/12/00	30305	31774	28748
4/13/00	30385	31774	28748
4/14/00	30127	31774	28748
4/18/00	30366	31774	28748
4/19/00	30307	31774	28748
4/20/00	30572	31774	28748
4/21/00	30099	31774	28748
4/24/00	30320	31774	28748
4/25/00	30233	31774	28748
4/26/00	30649	31774	28748
4/27/00	30340	31774	28748
4/28/00	30307	31774	28748
5/1/00	30366	31774	28748
5/2/00	30053	31774	28748
5/3/00	30202	31774	28748
5/4/00	30235	31774	28748
5/5/00	30612	31774	28748

Tables D-3-3 through D-3-12 provide the daily quality control data obtained by evaluating Carbon-14 or Cobalt-60 check sources using portable beta and beta-gamma detection meters.

Table D-3-3. DAILY QUALITY CONTROL PORTABLE METER CHECK SHEET AND DATA

Instrument: Ludlum Model 3	Serial Number: 114886	Calibration Date: 7/22/99
Meter Use: Beta-Gamma Scanning for fixed or loose surface contamination		
Check Source: Cobalt-60; 1.008 µCi; calibration date: 18 Nov 99; Serial number: 58807-530		
Meter Calibration Isotope/Efficiencies: P-32, I-125, Cr-51: 34%, 18%, 1%		
UWL = Upper Warning Limit = mean + 5% of mean (mean was calculated using the first 10 cpm readings = 152000) LWL = Lower Warning Limit = mean - 5% of mean		
QC DATA SUMMARY: Daily QC readings did not exceed Upper or Lower Warning Limits (UWL, LWL)		

DATE	BATTERY CHECK	BACKGROUND (CPM)	CHECK SOURCE READING (CPM)		
			CPM	UWL	LWL
1/19/00	OK	< 300	150000	159600	144400
1/20/00	OK	< 350	150000	159600	144400
1/21/00	OK	< 350	150000	159600	144400
1/24/00	OK	< 300	150000	159600	144400
1/27/00	OK	< 350	150000	159600	144400
1/28/00	OK	< 350	150000	159600	144400
2/1/00	OK	< 400	160000	159600	144400
2/2/00	OK	< 350	150000	159600	144400
2/3/00	OK	< 350	150000	159600	144400
2/4/00	OK	< 300	160000	159600	144400
2/7/00	OK	< 300	150000	159600	144400
2/8/00	OK	< 350	150000	159600	144400
2/9/00	OK	< 350	150000	159600	144400
2/10/00	OK	< 350	150000	159600	144400
2/11/00	OK	< 350	150000	159600	144400
2/14/00	OK	< 350	150000	159600	144400
2/15/00	OK	< 350	150000	159600	144400
2/16/00	OK	< 350	150000	159600	144400
2/17/00	OK	< 300	150000	159600	144400
2/18/00	OK	< 300	150000	159600	144400
2/22/00	OK	< 300	150000	159600	144400
2/23/00	OK	< 350	150000	159600	144400

2/24/00	OK	< 350	150000	159600	144400
2/25/00	OK	< 350	150000	159600	144400
2/28/00	OK	< 300	150000	159600	144400
2/29/00	OK	< 300	150000	159600	144400
3/1/00	OK	< 350	150000	159600	144400
3/2/00	OK	< 350	150000	159600	144400
3/3/00	OK	< 300	150000	159600	144400
3/6/00	OK	< 350	150000	159600	144400
3/7/00	OK	< 350	150000	159600	144400
3/8/00	OK	< 350	150000	159600	144400
3/9/00	OK	< 350	150000	159600	144400
3/10/00	OK	< 350	150000	159600	144400
3/13/00	OK	< 350	150000	159600	144400
3/14/00	OK	< 350	150000	159600	144400
3/15/00	OK	< 350	150000	159600	144400
3/16/00	OK	< 350	150000	159600	144400
3/17/00	OK	< 350	150000	159600	144400
3/20/00	OK	< 350	150000	159600	144400
3/21/00	OK	< 350	150000	159600	144400
3/22/00	OK	< 300	150000	159600	144400
3/23/00	OK	< 350	150000	159600	144400
3/24/00	OK	< 350	150000	159600	144400
3/27/00	OK	< 350	150000	159600	144400
3/28/00	OK	< 350	150000	159600	144400
3/29/00	OK	< 350	150000	159600	144400
3/30/00	OK	< 350	150000	159600	144400
3/31/00	OK	< 350	150000	159600	144400
4/3/00	OK	< 350	150000	159600	144400
4/4/00	OK	< 400	150000	159600	144400
4/5/00	OK	< 350	150000	159600	144400
4/6/00	OK	< 350	150000	159600	144400
4/7/00	OK	< 350	150000	159600	144400
4/10/00	OK	< 350	150000	159600	144400
4/11/00	OK	< 350	150000	159600	144400
4/12/00	OK	< 350	150000	159600	144400
4/13/00	OK	< 350	150000	159600	144400
4/14/00	OK	< 350	150000	159600	144400
4/17/00	OK	< 350	150000	159600	144400
4/18/00	OK	< 350	150000	159600	144400
4/19/00	OK	< 350	150000	159600	144400
4/20/00	OK	< 350	150000	159600	144400
4/21/00	OK	< 350	150000	159600	144400
4/24/00	OK	< 350	150000	159600	144400
4/25/00	OK	< 350	150000	159600	144400
4/26/00	OK	< 350	150000	159600	144400

4/27/00	OK	< 350	150000	159600	144400
4/28/00	OK	< 350	150000	159600	144400
5/1/00	OK	< 350	150000	159600	144400
5/2/00	OK	< 350	150000	159600	144400
5/3/00	OK	< 350	150000	159600	144400
5/4/00	OK	< 350	150000	159600	144400
5/5/00	OK	< 350	150000	159600	144400

Table D-3-4. DAILY QUALITY CONTROL PORTABLE METER CHECK SHEET AND DATA

Instrument: Ludlum Model 3	Serial Number: 132946	Calibration Date: 2/22/00

Instrument Use: Beta-Gamma Scanning for fixed or loose surface contamination

Check Source: Cobalt-60; 1.008 µCi; calibration date: 18 Nov 99; Serial number: 58807-530

Meter Calibration Isotope/Efficiencies: I-125, Cr-51: 16%, 2.6%

UWL = Upper Warning Limit = mean + 5% (mean was calculated using the first 10 cpm readings = 160000)
LWL = Lower Warning Limit = mean - 5%

QC DATA SUMMARY: Daily QC readings did not exceed Upper or Lower Warning Limits (UWL, LWL)

DATE	BATTERY CHECK	BACKGROUND (CPM)	CHECK SOURCE READING (CPM)		
			CPM	UWL	LWL
3/15/00	OK	< 300	160000	168000	152000
3/16/00	OK	< 300	160000	168000	152000
3/17/00	OK	< 300	160000	168000	152000
3/20/00	OK	< 350	160000	168000	152000
3/21/00	OK	< 350	160000	168000	152000
3/22/00	OK	< 300	160000	168000	152000
3/23/00	OK	< 350	160000	168000	152000
3/24/00	OK	< 350	160000	168000	152000
3/27/00	OK	< 350	160000	168000	152000
3/28/00	OK	< 350	160000	168000	152000
3/29/00	OK	< 350	160000	168000	152000
3/30/00	OK	< 350	160000	168000	152000
3/31/00	OK	< 350	160000	168000	152000
4/3/00	OK	< 350	160000	168000	152000
4/4/00	OK	< 400	160000	168000	152000
4/5/00	OK	< 350	160000	168000	152000
4/6/00	OK	< 350	160000	168000	152000
4/7/00	OK	< 350	160000	168000	152000
4/10/00	OK	< 300	160000	168000	152000
4/11/00	OK	< 350	160000	168000	152000
4/12/00	OK	< 350	160000	168000	152000
4/13/00	OK	< 350	160000	168000	152000
4/14/00	OK	< 350	160000	168000	152000
4/17/00	OK	< 300	160000	168000	152000
4/18/00	OK	< 350	160000	168000	152000
4/19/00	OK	< 350	160000	168000	152000

4/20/00	OK	< 300	160000	168000	152000
4/21/00	OK	< 300	160000	168000	152000
4/24/00	OK	< 350	160000	168000	152000
4/25/00	OK	< 300	160000	168000	152000
4/26/00	OK	< 300	160000	168000	152000
4/27/00	OK	< 300	160000	168000	152000
4/28/00	OK	< 300	160000	168000	152000
5/1/00	OK	< 350	160000	168000	152000
5/2/00	OK	< 350	160000	168000	152000
5/3/00	OK	< 350	160000	168000	152000
5/4/00	OK	< 350	160000	168000	152000
5/5/00	OK	< 300	160000	168000	152000

Table D-3-5. DAILY QUALITY CONTROL PORTABLE METER CHECK SHEET AND DATA		
Instrument: Ludlum Model 3	Serial Number: 121461	Calibration Date: 8/12/99
Instrument Use: Beta-Gamma Scanning for fixed or loose surface contamination		
Check Source: Cobalt-60; 1.008 µCi; calibration date: 18 Nov 99; Serial number: 58807-530		
Meter Calibration Isotope/Efficiencies: P-32, I-125, Cr-51: 17%, 29%, 1%		
UWL = Upper Warning Limit = mean + 5% (mean was calculated using the first 10 cpm readings = 150,500) LWL = Lower Warning Limit = mean - 5%		
QC DATA SUMMARY: Daily QC readings did not exceed Upper or Lower Warning Limits (UWL, LWL)		

DATE	BATTERY CHECK	BACKGROUND (CPM)	CHECK SOURCE READING (CPM)		
			CPM	UWL	LWL
1/19/00	OK	< 300	140000	158025	142975
1/20/00	OK	< 350	150000	158025	142975
1/21/00	OK	< 300	145000	158025	142975
1/24/00	OK	< 400	150000	158025	142975
1/27/00	OK	< 350	150000	158025	142975
1/28/00	OK	< 350	150000	158025	142975
2/1/00	OK	< 400	160000	158025	142975
2/2/00	OK	< 300	160000	158025	142975
2/3/00	OK	< 350	150000	158025	142975
2/4/00	OK	< 350	150000	158025	142975
2/7/00	OK	< 350	160000	158025	142975
2/8/00	OK	< 350	150000	158025	142975
2/9/00	OK	< 300	150000	158025	142975
2/10/00	OK	< 300	150000	158025	142975
2/11/00	OK	< 350	150000	158025	142975
2/14/00	OK	< 350	150000	158025	142975
2/15/00	OK	< 350	150000	158025	142975
2/16/00	OK	< 350	150000	158025	142975
2/17/00	OK	< 300	150000	158025	142975
2/18/00	OK	< 300	150000	158025	142975
2/22/00	OK	< 300	150000	158025	142975
2/23/00	OK	< 350	150000	158025	142975
2/24/00	OK	< 350	150000	158025	142975
2/25/00	OK	< 350	150000	158025	142975
2/28/00	OK	< 300	150000	158025	142975
2/29/00	OK	< 350	150000	158025	142975

3/1/00	OK	< 350	150000	158025	142975
3/2/00	OK	< 350	150000	158025	142975
3/3/00	OK	< 300	150000	158025	142975
3/6/00	OK	< 350	150000	158025	142975
3/7/00	OK	< 350	150000	158025	142975
3/8/00	OK	< 350	150000	158025	142975
3/9/00	OK	< 350	150000	158025	142975
3/10/00	OK	< 300	150000	158025	142975
3/13/00	OK	< 350	150000	158025	142975
3/14/00	OK	< 350	150000	158025	142975
3/15/00	OK	< 350	150000	158025	142975
3/16/00	OK	< 350	150000	158025	142975
3/17/00	OK	< 350	150000	158025	142975
3/20/00	OK	< 350	150000	158025	142975
3/21/00	OK	< 300	150000	158025	142975
3/22/00	OK	< 300	150000	158025	142975
3/23/00	OK	< 350	150000	158025	142975
3/24/00	OK	< 350	150000	158025	142975
3/27/00	OK	< 350	150000	158025	142975
3/28/00	OK	< 350	150000	158025	142975
3/29/00	OK	< 350	150000	158025	142975
3/30/00	OK	< 300	150000	158025	142975
3/31/00	OK	< 300	150000	158025	142975
4/3/00	OK	< 300	150000	158025	142975
4/4/00	OK	< 350	150000	158025	142975
4/5/00	OK	< 350	150000	158025	142975
4/6/00	OK	< 350	150000	158025	142975
4/7/00	OK	< 350	150000	158025	142975
4/10/00	OK	< 350	150000	158025	142975
4/11/00	OK	< 350	150000	158025	142975
4/12/00	OK	< 350	150000	158025	142975
4/13/00	OK	< 300	150000	158025	142975
4/14/00	OK	< 300	150000	158025	142975
4/17/00	OK	< 350	150000	158025	142975
4/18/00	OK	< 350	150000	158025	142975
4/19/00	OK	< 350	150000	158025	142975
4/20/00	OK	< 350	150000	158025	142975
4/21/00	OK	< 350	150000	158025	142975
4/24/00	OK	< 350	150000	158025	142975
4/25/00	OK	< 350	150000	158025	142975
4/26/00	OK	< 350	150000	158025	142975
4/27/00	OK	< 350	150000	158025	142975
4/28/00	OK	< 300	150000	158025	142975
5/1/00	OK	< 300	150000	158025	142975
5/2/00	OK	< 350	150000	158025	142975

5/3/00	OK	< 300	150000	158025	142975
5/4/00	OK	< 350	150000	158025	142975
5/5/00	OK	< 350	150000	158025	142975

Table D-3-6. DAILY QUALITY CONTROL PORTABLE METER CHECK SHEET AND DATA		
Instrument: Ludlum Model 3	Serial Number: 121730	Calibration Date: 7/22/99
Instrument Use: Beta-Gamma Scanning for fixed or loose surface contamination		
Check Source: Cobalt-60; 1.008 µCi; calibration date: 18 Nov 99; Serial number: 58807-530		
Meter Calibration Isotope/Efficiencies: P-32, I-125, Cr-51: 32%, 16%, 1%		
UWL = Upper Warning Limit = mean + 5% (mean was calculated using the first 10 cpm readings = 155,000) LWL = Lower Warning Limit = mean - 5%		
QC DATA SUMMARY: Daily QC readings did not exceed Upper or Lower Warning Limits (UWL, LWL)		

DATE	BATTERY CHECK	BACKGROUND (CPM)	CHECK SOURCE READING (CPM)		
			CPM	UWL	LWL
1/19/00	OK	< 300	150000	162750	147250
1/20/00	OK	< 350	150000	162750	147250
1/21/00	OK	< 300	150000	162750	147250
1/24/00	OK	< 350	150000	162750	147250
1/27/00	OK	< 350	150000	162750	147250
1/28/00	OK	< 350	160000	162750	147250
2/1/00	OK	< 300	160000	162750	147250
2/2/00	OK	< 300	160000	162750	147250
2/3/00	OK	< 350	160000	162750	147250
2/4/00	OK	< 300	160000	162750	147250
2/7/00	OK	< 350	160000	162750	147250
2/8/00	OK	< 350	160000	162750	147250
2/9/00	OK	< 350	160000	162750	147250
2/10/00	OK	< 350	160000	162750	147250
2/11/00	OK	< 350	150000	162750	147250
2/14/00	OK	< 350	160000	162750	147250
2/15/00	OK	< 350	160000	162750	147250
2/16/00	OK	< 350	160000	162750	147250
2/17/00	OK	< 350	150000	162750	147250
2/18/00	OK	< 300	160000	162750	147250
2/22/00	OK	< 350	160000	162750	147250
2/23/00	OK	< 300	160000	162750	147250
2/24/00	OK	< 300	160000	162750	147250
2/25/00	OK	< 300	160000	162750	147250
2/28/00	OK	< 300	160000	162750	147250
2/29/00	OK	< 350	160000	162750	147250

3/1/00	OK	< 350	160000	162750	147250
3/2/00	OK	< 350	160000	162750	147250
3/3/00	OK	< 350	160000	162750	147250
3/6/00	OK	< 350	160000	162750	147250
3/7/00	OK	< 350	160000	162750	147250
3/8/00	OK	< 350	160000	162750	147250
3/9/00	OK	< 350	160000	162750	147250
3/10/00	OK	< 300	160000	162750	147250
3/13/00	OK	< 350	160000	162750	147250
3/14/00	OK	< 350	160000	162750	147250
3/15/00	PROBE	BROKEN	ON	THIS	DATE

Table D-3-7. DAILY QUALITY CONTROL PORTABLE METER CHECK SHEET AND DATA

Instrument: Ludlum Model 3	Serial Number: 121816	Calibration Date: 2/22/00
Instrument Use: Beta Scanning for fixed or loose surface contamination		
Check Source: CARBON-14; 0.145 µCi; calibration date: 18 Nov 99; Serial number: 58809-530		
Meter Calibration Isotope/Efficiencies: C-14, P-32, P-33, S-35, CA-45: 7%, 35%, 14%, 7%, 7%		
UWL = Upper Warning Limit = mean + 5% (mean was calculated using the first 10 cpm readings = 26,000) LWL = Lower Warning Limit = mean - 5%		
QC DATA SUMMARY: Daily QC readings did not exceed Upper or Lower Warning Limits (UWL, LWL)		

DATE	BATTERY CHECK	BACKGROUND (CPM)	CHECK SOURCE READING (CPM)		
			CPM	UWL	LWL
3/17/00	OK	< 100	26000	27300	24700
3/20/00	OK	< 100	26000	27300	24700
3/21/00	OK	< 100	26000	27300	24700
3/22/00	OK	< 100	26000	27300	24700
3/23/00	OK	< 100	26000	27300	24700
3/24/00	OK	< 100	26000	27300	24700
3/27/00	OK	< 100	26000	27300	24700
3/28/00	OK	< 100	26000	27300	24700
3/29/00	OK	< 100	26000	27300	24700
3/30/00	OK	< 100	26000	27300	24700
3/31/00	OK	< 100	26000	27300	24700
4/3/00	OK	< 100	26000	27300	24700
4/4/00	OK	< 100	26000	27300	24700
4/5/00	OK	< 100	26000	27300	24700
4/6/00	OK	< 100	26000	27300	24700
4/7/00	OK	< 100	26000	27300	24700
4/10/00	OK	< 100	26000	27300	24700
4/11/00	OK	< 100	26000	27300	24700
4/12/00	OK	< 100	26000	27300	24700
4/13/00	OK	< 100	26000	27300	24700
4/14/00	OK	< 100	26000	27300	24700
4/17/00	OK	< 100	26000	27300	24700
4/18/00	OK	< 100	26000	27300	24700
4/19/00	OK	< 100	26000	27300	24700
4/20/00	OK	< 100	26000	27300	24700
4/21/00	OK	< 100	26000	27300	24700

4/24/00	OK	< 100	26000	27300	24700
4/25/00	OK	< 100	26000	27300	24700
4/26/00	OK	< 100	26000	27300	24700
4/27/00	OK	< 100	26000	27300	24700
4/28/00	OK	< 100	26000	27300	24700
5/1/00	OK	< 100	26000	27300	24700
5/2/00	OK	< 100	26000	27300	24700
5/3/00	OK	< 100	26000	27300	24700
5/4/00	OK	< 100	26000	27300	24700
5/5/00	OK	< 100	26000	27300	24700

Table D-3-8. DAILY QUALITY CONTROL PORTABLE METER CHECK SHEET AND DATA

Instrument: Ludlum Model 3	Serial Number: 54537	Calibration Date: 7/22/99

Instrument Use: Beta Scanning for fixed or loose surface contamination

Check Source: CARBON-14; 0.145 µCi; calibration date: 18 Nov 99; Serial number: 58809-530

Meter Calibration Isotope/Efficiencies: C-14, P-32, P-33, S-35, CA-45: 7%, 35%, 14%, 7%, 7%

UWL = Upper Warning Limit = mean + 7% (mean was calculated using the first 10 cpm readings = 20600)
LWL = Lower Warning Limit = mean - 7%

QC DATA SUMMARY: Daily QC readings did not exceed Upper or Lower Warning Limits (UWL, LWL)

DATE	BATTERY CHECK	BACKGROUND (CPM)	CHECK SOURCE READING (CPM)		
			CPM	UWL	LWL
1/19/00	OK	< 50	19000	22042	19570
1/20/00	OK	< 100	18000	22042	19570
1/21/00	OK	< 100	21000	22042	19570
1/24/00	OK	< 100	21000	22042	19570
1/27/00	OK	< 50	21000	22042	19570
1/28/00	OK	< 50	21000	22042	19570
2/1/00	OK	< 50	22000	22042	19570
2/2/00	OK	< 50	21000	22042	19570
2/3/00	OK	< 50	21000	22042	19570
2/4/00	OK	< 50	21000	22042	19570
2/7/00	OK	< 100	20000	22042	19570
2/8/00	OK	< 100	21000	22042	19570
2/9/00	OK	< 100	21000	22042	19570
2/10/00	OK	< 100	21000	22042	19570
2/11/00	OK	< 100	21000	22042	19570
2/14/00	OK	< 100	22000	22042	19570
2/15/00	OK	< 150	21000	22042	19570
2/16/00	OK	< 100	22000	22042	19570
2/17/00	OK	< 100	21000	22042	19570
2/18/00	OK	< 150	21000	22042	19570
2/22/00	OK	< 100	21000	22042	19570
2/23/00	OK	< 100	22000	22042	19570
2/24/00	OK	< 100	22000	22042	19570
2/25/00	OK	< 100	21000	22042	19570
2/28/00	OK	< 100	21000	22042	19570
2/29/00	OK	< 100	21000	22042	19570

3/1/00	OK	< 100	20000	22042	19570
3/2/00	OK	< 100	21000	22042	19570
3/3/00	OK	< 100	20000	22042	19570
3/6/00	OK	< 100	20000	22042	19570
3/7/00	OK	< 100	22000	22042	19570
3/8/00	OK	< 100	21000	22042	19570
3/9/00	OK	< 100	21000	22042	19570
3/10/00	OK	< 100	21000	22042	19570
3/13/00	OK	< 100	21000	22042	19570
3/14/00	OK	< 100	22000	22042	19570
3/15/00	OK	< 100	21000	22042	19570
3/16/00	OK	< 100	22000	22042	19570
3/17/00	OK	< 100	22000	22042	19570
3/20/00	OK	< 100	22000	22042	19570
3/21/00	OK	< 100	22000	22042	19570
3/22/00	OK	< 100	22000	22042	19570
3/23/00	OK	< 100	22000	22042	19570
3/24/00	OK	< 100	22000	22042	19570
3/27/00	OK	< 100	22000	22042	19570
3/28/00	OK	< 100	21000	22042	19570
3/29/00	OK	< 100	22000	22042	19570
3/30/00	OK	< 100	22000	22042	19570
3/31/00	OK	< 100	22000	22042	19570
4/3/00	OK	< 100	22000	22042	19570
4/4/00	OK	< 100	22000	22042	19570
4/5/00	OK	< 100	22000	22042	19570
4/6/00	OK	< 100	21000	22042	19570
4/7/00	OK	< 100	21000	22042	19570
4/10/00	OK	< 100	22000	22042	19570
4/11/00	OK	< 100	21000	22042	19570
4/12/00	OK	< 100	21000	22042	19570
4/13/00	OK	< 100	22000	22042	19570
4/14/00	OK	< 100	22000	22042	19570
4/17/00	OK	< 100	22000	22042	19570
4/18/00	OK	< 100	22000	22042	19570
4/19/00	OK	< 100	22000	22042	19570
4/20/00	OK	< 100	22000	22042	19570
4/21/00	OK	< 100	22000	22042	19570
4/24/00	OK	< 100	22000	22042	19570
4/25/00	OK	< 100	21000	22042	19570
4/26/00	OK	< 100	22000	22042	19570
4/27/00	OK	< 100	22000	22042	19570
4/28/00	OK	< 100	21000	22042	19570
5/1/00	OK	< 100	22000	22042	19570
5/2/00	OK	< 100	21000	22042	19570

5/3/00	OK	< 100	22000	22042	19570
5/4/00	OK	< 100	22000	22042	19570
5/5/00	OK	< 100	22000	22042	19570

Table D-3-9. DAILY QUALITY CONTROL PORTABLE METER CHECK SHEET AND DATA

Instrument: Bicron Survey 50	Serial Number: B602G	Calibration Date: 7/22/99

Instrument Use: Beta Scanning for fixed or loose surface contamination

Check Source: CARBON-14; 0.145 µCi; calibration date: 18 Nov 99; Serial number: 58809-530

Meter Calibration Isotope/Efficiencies: P-32, P-33, S-35, CA-45: 31%, 7%, 14%, 7%

UWL = Upper Warning Limit = mean + 5% (mean was calculated using the first 10 cpm readings = 21500)
LWL = Lower Warning Limit = mean - 5%

QC DATA SUMMARY: Daily QC readings did not exceed Upper or Lower Warning Limits (UWL, LWL)

DATE	BATTERY CHECK	BACKGROUND (CPM)	CHECK SOURCE READING (CPM)		
			CPM	UWL	LWL
1/19/00	OK	< 50	20000	22575	20425
1/20/00	OK	< 50	21000	22575	20425
1/21/00	OK	< 80	24000	22575	20425
1/24/00	OK	< 50	22000	22575	20425
1/27/00	OK	< 50	22000	22575	20425
1/28/00	OK	< 50	22000	22575	20425
2/1/00	OK	< 60	21000	22575	20425
2/2/00	OK	< 50	21000	22575	20425
2/3/00	OK	< 60	21000	22575	20425
2/4/00	OK	< 60	21000	22575	20425
2/7/00	OK	< 80	21000	22575	20425
2/8/00	OK	< 100	20000	22575	20425
2/9/00	OK	< 100	21000	22575	20425
2/10/00	OK	< 100	21000	22575	20425
2/11/00	OK	< 60	21000	22575	20425
2/14/00	OK	< 100	20000	22575	20425
2/15/00	OK	< 100	20000	22575	20425
2/16/00	OK	< 100	21000	22575	20425
2/17/00	OK	< 100	21000	22575	20425
2/18/00	OK	< 100	21000	22575	20425
2/22/00	OK	< 60	21000	22575	20425
2/23/00	OK	< 100	21000	22575	20425
2/24/00	OK	< 80	21000	22575	20425
2/25/00	OK	< 80	21000	22575	20425
2/28/00	OK	< 100	21000	22575	20425
2/29/00	OK	< 80	21000	22575	20425

3/1/00	OK	< 80	20000	22575	20425
3/2/00	OK	< 100	20000	22575	20425
3/3/00	OK	< 100	20000	22575	20425
3/6/00	OK	< 100	21000	22575	20425
3/7/00	OK	< 100	22000	22575	20425
3/8/00	OK	< 80	22000	22575	20425
3/9/00	OK	< 80	21000	22575	20425
3/10/00	OK	< 80	22000	22575	20425
3/13/00	OK	< 50	21000	22575	20425
3/14/00	OK	< 50	21000	22575	20425
3/15/00	OK	< 80	22000	22575	20425
3/16/00	OK	< 50	21000	22575	20425
3/17/00	OK	< 50	21000	22575	20425
3/20/00	OK	< 80	20000	22575	20425
3/21/00	OK	< 80	22000	22575	20425
3/22/00	OK	< 80	22000	22575	20425
3/23/00	OK	< 100	22000	22575	20425
3/24/00	OK	< 80	21000	22575	20425
3/27/00	OK	< 80	22000	22575	20425
3/28/00	OK	< 80	22000	22575	20425
3/29/00	OK	< 100	21000	22575	20425
3/30/00	OK	< 80	21000	22575	20425
3/31/00	OK	< 80	22000	22575	20425
4/3/00	OK	< 80	21000	22575	20425
4/4/00	OK	< 80	22000	22575	20425
4/5/00	OK	< 80	22000	22575	20425
4/6/00	OK	< 80	22000	22575	20425
4/7/00	OK	< 80	22000	22575	20425
4/10/00	OK	< 60	21000	22575	20425
4/11/00	OK	< 80	21000	22575	20425
4/12/00	OK	< 80	21000	22575	20425
4/13/00	OK	< 80	21000	22575	20425
4/14/00	OK	< 80	22000	22575	20425
4/17/00	OK	< 60	22000	22575	20425
4/18/00	OK	< 80	22000	22575	20425
4/19/00	OK	< 80	21000	22575	20425
4/20/00	OK	< 80	21000	22575	20425
4/21/00	OK	< 80	21000	22575	20425
4/24/00	OK	< 80	22000	22575	20425
4/25/00	OK	< 80	22000	22575	20425
4/26/00	OK	< 80	21000	22575	20425
4/27/00	OK	< 80	22000	22575	20425
4/28/00	OK	< 80	22000	22575	20425
5/1/00	OK	< 80	21000	22575	20425
5/2/00	OK	< 80	22000	22575	20425

5/3/00	OK	< 80	22000	22575	20425
5/4/00	OK	< 80	22000	22575	20425
5/5/00	OK	< 80	22000	22575	20425

Table D-3-10. DAILY QUALITY CONTROL PORTABLE METER CHECK SHEET AND DATA

Instrument: Ludlum Model 3	Serial Number: 121816	Calibration Date: 2/22/00

Instrument Use: Beta Scanning for fixed or loose surface contamination

Check Source: CARBON-14; 0.145 µCi; calibration date: 18 Nov 99; Serial number: 58809-530

Meter Calibration Isotope/Efficiencies: C-14, P-32, P-33, S-35, CA-45: 7%, 35%, 14%, 7%, 7%

UWL = Upper Warning Limit = mean + 3 sigma = 26139
(mean was calculated using all cpm readings = 21344; sigma = standard deviation = 1600)
LWL = Lower Warning Limit = mean - 3 * sigma = 16548

QC DATA SUMMARY: Daily QC readings did not exceed Upper or Lower Warning Limits (UWL, LWL)

DATE	BATTERY CHECK	BACKGROUND (CPM)	CHECK SOURCE READING (CPM)		
			CPM	UWL	LWL
1/19/00	OK	< 100	20000	26139	16548
1/20/00	OK	< 100	15000	26139	16548
1/21/00	OK	< 100	21000	26139	16548
1/24/00	OK	< 100	24000	26139	16548
1/27/00	OK	< 50	25000	26139	16548
1/28/00	OK	< 50	21000	26139	16548
2/1/00	OK	< 50	21000	26139	16548
2/2/00	OK	< 50	21000	26139	16548
2/3/00	OK	< 50	21000	26139	16548
2/4/00	OK	< 50	22000	26139	16548
2/7/00	OK	< 100	21000	26139	16548
2/8/00	OK	< 100	22000	26139	16548
2/9/00	OK	< 100	21000	26139	16548
2/10/00	OK	< 100	21000	26139	16548
2/11/00	OK	< 100	20000	26139	16548
2/14/00	OK	< 100	21000	26139	16548
2/15/00	OK	< 100	21000	26139	16548
2/16/00	OK	< 100	22000	26139	16548
2/17/00	OK	< 80	21000	26139	16548
2/18/00	OK	< 100	21000	26139	16548
2/22/00	OK	< 100	22000	26139	16548
2/23/00	OK	< 100	22000	26139	16548
2/24/00	OK	< 100	22000	26139	16548
2/25/00	OK	< 100	22000	26139	16548
2/28/00	OK	< 100	20000	26139	16548

2/29/00	OK	< 100	22000	26139	16548
3/1/00	OK	< 100	21000	26139	16548
3/2/00	OK	< 100	22000	26139	16548
3/3/00	OK	< 100	21000	26139	16548
3/6/00	OK	< 100	22000	26139	16548
3/7/00	OK	< 100	21000	26139	16548
3/8/00	OK	< 100	24000	26139	16548
3/9/00	METER	TAKEN	OUT	OF	SERVICE

Table D-3-11. DAILY QUALITY CONTROL PORTABLE METER CHECK SHEET AND DATA		
Instrument: Ludlum Model 2350-1	Serial Number: 157674	Calibration Date: 11/18/99
Probe Model/Serial Number: 43-37/149314	Probe: 126cm^2 gas detector	
Instrument Use: Beta Scanning for fixed surface contamination		
Check Source: CARBON-14; 0.145 µCi; calibration date: 18 Nov 99; Serial number: 58809-530		
Notes: Mid-day and End-of-day readings were recorded on days that the instrument was used for radiological monitoring of survey units. Daily QC checks consisted of comparing same-day CPM values.		

DATE	BATTERY VOLTAGE	CPM, POST PURGING WITH P-10 GAS (T-0)	CPM, POST PURGING WITH P-10 GAS (T-10)	CPM, MID DAY READING	CPM, END OF DAY READING
3/28/00	5.9	44922	44740		
3/29/00	5.5	43781	44538		
3/30/00	5.7	44433	44391		
3/31/00	5.6	44214	44052	44992	43262
4/3/00	5.5	45342	45686		
4/4/00	5.6	44675	44888		
4/5/00	5.5	44515	44781	44529	
4/6/00	5.5	45079	45010	44935	45651
4/7/00	5.4	44616	44779	46105	
4/10/00	5.4	44584	44126		
4/11/00	5.4	45057	45266	45183	
4/12/00	5.3	44310	45043	44624	
4/13/00	5.3	45633	45571		
4/14/00	5.3	44848	44448		42976
4/17/00	5.2	44850	44678		
4/18/00	5.2	45564	45241	45614	44376
4/19/00	5.2	45752	45743		45756
4/20/00	5.1	44782	44600	45013	
4/21/00	5.1	44832	45178		
4/24/00	6.3	45560	45554	44437	
4/25/00	6.1	45446	45212		
4/26/00	6.0	44910	45422	44943	44122
4/27/00	6.0	45002	45138	44387	
4/28/00	6.0	44118	44554		43771
5/1/00	5.9	46016	46555	46466	45494

5/2/00	5.8	44891	44695	44040	43221
5/3/00	5.7	46076	45761	43370	
5/4/00	5.6	44819	44616		
5/5/00	5.6	42944	NOT	USED	

Table D-3-12. DAILY QUALITY CONTROL PORTABLE METER CHECK SHEET AND DATA		
Instrument: Ludlum Model 2350-1	Serial Number: 157674	Calibration Date: 11/18/99
Probe Model/Serial Number: 43-37/148947	Probe: 582cm^2 gas detector	
Instrument Use: Beta Scanning for fixed surface contamination		
Check Source: CARBON-14; 0.145 µCi; calibration date: 18 Nov 99; Serial number: 58809-530		
Notes: Mid-day and end-of-day readings were recorded on days that the instrument was used for radiological monitoring of survey units. Daily QC checks consisted of comparing same-day CPM values.		

DATE	BATTERY VOLTAGE	CPM, POST PURGING WITH P-10 GAS (T-0)	CPM, POST PURGING WITH P-10 GAS (T-10)	CPM, MID DAY READING	CPM, END OF DAY READING
3/28/00	5.9	44837	44672		
3/29/00	5.4	43313	43322		
3/30/00	5.7	45122	43346		
3/31/00	5.6	43939	43725	43839	42103
4/3/00	5.6	43532	43488		
4/4/00	5.6	42930	42763		39020
4/5/00	5.5	44658	45066	44073	
4/6/00	5.5	43345	43194	44745	43264
4/7/00	5.4	48062	47715	44503	
4/10/00	5.4	43402	43626		
4/11/00	5.4	44316	43874	42530	
4/12/00	5.4	44847	43458	41096	40547
4/13/00	5.3	43555	43591		
4/14/00	5.3	44004	43881		43996
4/17/00	5.2	44876	44291		
4/18/00	5.2	45312	45565	42341	44979
4/19/00	5.2	47748	48067		43140
4/20/00	5.1	47982	48215	45984	
4/21/00	5.1	47204	46576		
4/24/00	6.3	45551	45282		
4/25/00	6.1	45396	46749		
4/26/00	6.0	44868	44387		
4/27/00	6.0	45295	45009	42548	
4/28/00	6.0	45525	45424		43220
5/1/00	5.9	44254	43733	43161	43250

5/2/00	5.8	47994	47003	43598	
5/3/00	5.7	45166	45155	39031	
5/4/00	5.6	45259	45494		
5/5/00	5.7	42944	41404		
5/8/00	5.7	45554	44264		
5/9/00	5.7	44210	44036		

Appendix D-4. Quality Assurance Checklist (included in sections of the final status survey report)

Building number or location:

Monitoring Date(s):

___ Appropriate and satisfactory daily and weekly calibration checks were completed for the selected survey monitoring equipment and instruments.

___ Selected meters with current calibrations for the isotopes of concern.

___ Survey maps or floor plans (for all survey units) and grid maps (for known RAM-use areas) were available.

___ Background checks were performed when impacted areas were monitored.

___ For known RAM-use survey units, additional checks were performed (workbenches, shelves, sinks, basins, traps, floor at sinks and entrances, wall at hoods and sinks, and/or other areas as deemed appropriate).

___ Mean values, single sample values, and background values were below the action limits, indicating no contamination was found.

___ Representative floor plans, sketches, and photographs were available.

___Deviation from survey plans and objectives were documented.

___Extent of remedial actions were documented.

___ All selected survey units passed D&D tests; units are recommended for unrestricted release.

___ Additional Checks/Data passed D&D tests; unit is recommended for unrestricted release.

Notes: Tests include complying with applicable elements of the MARSSIM Final Status Survey checklist, mean-value and single-value comparisons of survey-unit data to action limits (DCGLs), mean-value comparison to background, completion of required monitoring, and satisfactory scan monitoring results.

Quality Assurance/Control Leader:

APPENDIX E. SURVEY UNIT RELEASE REPORTS (NARRATIVES, DATA, FLOOR PLANS, AND GRID MAPS)

XII. APPENDIX E

Appendix E-1. List of Survey Units, Data Tables, and Figures

A NMRC survey unit was defined as a room or other discrete area. Every room in every NMRC building was first examined for consideration as a survey unit. After review of current and historical survey monitoring results and licensed-material use, NMRC Diving-Building survey units were classified as either Non-impacted or Impacted Class 3. No NMRC Diving-Building survey unit was classified as Class 1 or Class 2.

Per MARSSIM, survey units should be limited in size based on classification, exposure pathway modeling assumptions, and site-specific conditions. In some instances, large rooms were subdivided into sections; each section was then treated as a unique survey unit.

Table 12-1-1 provides a list of tables associated with the completion of the final status surveys for the Non-impacted areas and Impacted Class 3 areas. These tables provide the actual data, reported in dpm per 100 cm^2, obtained by evaluating swipe samples using a liquid scintillation counter.

Table 12-1-2 provides a list of figures associated with the survey-unit data tables and the completion of the final status surveys for the Impacted-Class 3 areas. These figures depict the grid map and survey sampling locations for the impacted areas.

Table 12-1-3 provides a summary of the NMRC Diving-Building survey units. Each survey unit was classified as either Non-impacted or Impacted Class 3. **Table 12-1-3** lists discrete rooms or areas. In some instances, a room may have been sub-divided to accomplish a workable survey unit. These sub-divisions are indicated in column three of **Table 12-1-3** as parenthesized comments or annotated using the room number followed by an alphabetic character.

Table 12-1-1. List of Tables

Table 12-1-2. List of Figures (Grid Maps annotated with survey-data locations)

Table 12-1-3. NMRC Diving-Buildings Survey Units					
DATE FINAL STATUS SURVEY COMPLETED	BUILDING	ROOM OR AREA	DESCRIPTION	ISOTOPES OF CONCERN	D&D CLASSIFICATION IMP = Impacted, Class 3 NON = Non-impacted
	28	100	Supply		Non-impacted
	28	101	Mechanical		Non-impacted
	28	102	Storage		Non-impacted
	28	103	Storage		Non-impacted
	28	106	Office		Non-impacted
	28	106 A	Laboratory		Non-impacted
	28	107	Office		Non-impacted
	28	108	Office		Non-impacted
	28	200	Office		Non-impacted
5/2/00	28	201	Office		Non-impacted
	28	201 A	Office		Non-impacted
5/2/00	28	202 A	Office		Non-impacted
5/2/00	28	202 B	Storage		Non-impacted
	28	203	Supply		Non-impacted
5/2/00	28	204	Shop		Non-impacted
	28	205	Entryway		Non-impacted
	53	S-1	Entryway		Non-impacted
	53	10	Shop		Non-impacted
	53	11	Shop		Non-impacted
	53	13	Office		Non-impacted
	53	14	Storage		Non-impacted
	53	15	Storage		Non-impacted
	53	22	Galley		Non-impacted
	53	23	Compressors		Non-impacted
	53	24	NRCC		Non-impacted
5/2/00	53	25	Office		Non-impacted
5/2/00	53	25 A	Office		Non-impacted
5/2/00	53	25 B	Office		Non-impacted
	53	26	Office		Non-impacted
	53	26 A	Sickbay		Non-impacted
	53	26 B	Office		Non-impacted
	53	28	Sickbay		Non-impacted
	53	29	Office		Non-impacted
	53	30	Office		Non-impacted
	53	31	Instrument room		Non-impacted
	53	32	Mechanical		Non-impacted
	53	33	Mechanical		Non-impacted
	53	100	Foyer		Non-impacted
	53	100 B	Office		Non-impacted
5/9/00	53	101	Laboratory	H3, C14, Co57	Impacted,Class3
3/23/00	53	102	Laboratory	H3, C14, Co57	Impacted,Class3
3/23/00	53	103	Laboratory		Non-impacted
3/23/00	53	104	Office		Non-impacted

3/23/00	53	105	Office		Non-impacted
3/15/00	53	106	Office		Non-impacted
3/15/00	53	107	Office		Non-impacted
	53	108	Conference room		Non-impacted
3/15/00	53	109	Office		Non-impacted
	53	110	Office		Non-impacted
4/26/00	53	111	Laboratory	H3, C14, Co57	Impacted,Class3
3/23/00	53	112	Office/Lab	H3, C14, Co57, Ba133, Cs137	Impacted,Class3
3/23/00	53	112A	Laboratory	H3, C14, Co57	Impacted,Class3
3/23/00	53	113	Laboratory	H3, C14, Co57	Impacted,Class3
3/15/0	53	114	Office		Non-impacted
3/15/00	53	115	Gear Lab		Non-impacted
3/15/00	53	116	Office		Non-impacted
3/23/00	53	117	Laboratory	H3, C14, Co57	Impacted,Class3
3/23/00	53	118	Laboratory	H3, C14, Co57	Impacted,Class3
5/9/00	53	119	Laboratory	H3, C14, Co57	Impacted,Class3
5/9/00	53	120 120D	Office	H3, C14, Co57	Impacted,Class3
3/23/00	53	120 A	Office		Non-impacted
3/23/00	53	120 B	Office		Non-impacted
3/23/00	53	120 C	Office		Non-impacted
4/19/00	53	121	Laboratory	H3, C14, Co57	Impacted,Class3
4/19/00	53	122	Laboratory	H3, C14, Co57, Ba133, Cs137	Impacted,Class3
	53	123	Office		Non-impacted
	53	124	Office		Non-impacted
	53	124 A	Office		Non-impacted
	53	125	Office		Non-impacted
	53	126	Office		Non-impacted
	53	126 A	Office		Non-impacted
	53	126 B	Office		Non-impacted
	53	127	Office		Non-impacted
	53	128	Telephone		Non-impacted
	59	11	Scuba Locker		Non-impacted
5/2/00	59	100	Research tank		Non-impacted
5/2/00	59	101	Laboratory		Non-impacted
5/2/00	59	102	Laboratory		Non-impacted
	59	103	Electrical room		Non-impacted

	59	104	Closet		Non-impacted
5/2/00	59	106	Laboratory		Non-impacted
	69	100	Shop/mech. room		Non-impacted
5/11/00	69	101	Laboratory		Non-impacted
5/11/00	69	102	Laboratory		Non-impacted
5/11/00	69	103	Laboratory		Non-impacted
5/11/00	69	104	Control room		Non-impacted
	79	S-1	Entryway		Non-impacted
	79	100	Storage		Non-impacted
5/11/00	79	101	Mechanical shop		Non-impacted
5/11/00	79	102	Office		Non-impacted
5/11/00	79	103	Office		Non-impacted
5/11/00	79	104	Laboratory		Non-impacted
5/11/00	79	107	Laboratory		Non-impacted
	79	120A	Office		Non-impacted

Appendix E-2. Diving Buildings, Non-impacted Areas

- Location: NMRC Diving Buildings 28, 53, 59, 69, and 79 at NNMC Bethesda, Maryland

- Monitoring Date(s): 3/15/00, 3/23/00, 5/2/00, 5/11/00

- Radioactive Contaminants of Concern: None

- Minimum Control Beta Swipe Locations (performed for every survey unit): (1) floor at door in room; (2) floor at door outside room; (3) doorknob in room; (4) doorknob outside room; and (5) light switch inside room. Additional control samples were taken at the discretion of the D&D team.

- Survey Instrument Information:
  - Beta meters -- serial numbers (background CPM): 11030 (<100CPM), 54537 (<100 CPM)
  - Gamma meters -- serial numbers (background CPM): 114886 (<300 CPM), 121730 (<200 CPM), 121886 (<300 CPM)
  - Liquid Scintillation Counter: Packard 2500TR, S/N 403848

- Radiation-detection Action Limits:
  - 2 to 3 times background for beta and gamma scans
  - 500 – 700 dpm or higher for either H-3 or C-14 beta swipes counted using a liquid scintillation counter

- Summary of Radiological Scans and Swipe Results:
  - Background level for all beta and gamma scans
  - All H-3 and C-14 beta swipe results below Action Limits

- Contamination and Remedial Actions: None

- Conclusion: The radiological monitoring results for all survey units addressed in this section meet the criteria for release for unrestricted use.

TABLE 12-2-1. RADIOLOGICAL FINAL STATUS SURVEY SUMMARY – Non-impacted Areas of NMRC Diving Buildings

Date Final Status Survey Completed	Building Number	Room number or area (Survey Unit) * = at another door	Beta and/or Gamma Scan Monitoring (check if yes)	Maximum Random or Control beta (H-3 or C-14) swipe result (DPM)	Recommend Survey Unit for radio-logical clearance (Y/N) Action Limit = 700 dpm
5/2/00	28	201	Y	38	Y
5/2/00	28	202 *	Y	29	Y
5/2/00	28	202	Y	37	Y
5/2/00	28	204	Y	24	Y
5/2/00	53	25 *	Y	24	Y
5/2/00	53	25 *	Y	25	Y
5/2/00	53	25	Y	28	Y
3/23/00	53	104	Y	34	Y
3/23/00	53	105	Y	46	Y
3/15/00	53	106	Y	24	Y
3/15/00	53	107	Y	27	Y
3/15/00	53	109	Y	18	Y
3/15/00	53	114	Y	31	Y
3/15/00	53	115	Y	17	Y
3/15/00	53	116	Y	32	Y
3/23/00	53	120 A	Y	21	Y
3/23/00	53	120 B	Y	31	Y
3/23/00	53	120 C	Y	17	Y
3/23/00	53	123	Y	23	Y
3/23/00	53	125	Y	39	Y
3/23/00	53	127	Y	24	Y
5/2/00	59	100	Y	22	Y
5/2/00	59	101	Y	44	Y
5/2/00	59	102	Y	32	Y
5/2/00	59	106	Y	62	Y
5/11/00	69	101	Y	41	Y
5/11/00	69	102	Y	79	Y
5/11/00	69	103	Y	24	Y
5/11/00	69	104	Y	17	Y
5/11/00	79	101	Y	30	Y
5/11/00	79	102	Y	24	Y
5/11/00	79	103	Y	30	Y
5/11/00	79	104	Y	22	Y
5/11/00	79	107	Y	24	Y

NON-IMPACTED AREA FINAL STATUS SURVEY DATA

Table 12-2-2. Final Status Survey Summary For Non-Impacted Survey Units								
Building Number: 28								
Monitoring date(s): 5/2/00								
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination (Count Times: 1 minute) Data is reported in DPM for a survey unit (building number/room number)								
SAMPLE NUMBER	ROOM NUMBER: 201		ROOM NUMBER: 202		ROOM NUMBER: 202*		ROOM NUMBER: 204	
	H-3	C-14	H-3	C-14	H-3	C-14	H-3	C-14
1	38	10	18	11	26	13	15	6
2	18	11	16	4	29	6	8	7
3	21	11	12	4	28	10	24	8
4	24	11	27	13	0	12	16	4
5	23	8	37	2	7	7	11	11
6	20	9	35	0			10	7
7	15	4	2	12			19	6
8	3	7	1	17			9	7
9	10	12	17	11			9	9
10	33	10	2	9			0	2
AVERAGE	21	9	17	8	18	10	12	7
STANDARD DEVIATION	10	2	13	5	14	3	7	2
MAXIMUM VALUE	38	12	37	17	29	13	24	11
ACTION LIMIT	700	700	700	700	700	700	700	700

NON-IMPACTED AREA FINAL STATUS SURVEY DATA

Table 12-2-3. Final Status Survey Summary For Non-Impacted Survey Units								
Building Number: 28								
Monitoring date(s): 5/2/00								
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination (Count Times: 1 minute) Data is reported in DPM for a survey unit (building number/room number)								
SAMPLE NUMBER	ROOM NUMBER: Basement Hallway		ROOM NUMBER: Basement Door					
	H-3	C-14	H-3	C-14				
1	12	11	12	7				
2	3	7	34	10				
3	8	4	6	12				
4	28	8	15	9				
5	20	8	10	11				
6	0	13						
7	17	6						
8	22	8						
9	52	4						
10	13	6						
AVERAGE	18	8	15	10				
STANDARD DEVIATION	15	3	11	2				
MAXIMUM VALUE	52	13	34	12				
ACTION LIMIT	700	700	700	700				

NON-IMPACTED AREA FINAL STATUS SURVEY DATA

Table 12-2-4. Final Status Survey Summary For Non-Impacted Survey Units								
Building Number: 53								
Monitoring date(s): 5/2/00								
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination (Count Times: 1 minute) Data is reported in DPM for a survey unit (building number/room number)								
SAMPLE NUMBER	ROOM NUMBER: Basement		ROOM NUMBER: Basement Door		ROOM NUMBER: Basement Door		ROOM NUMBER: 25	
	H-3	C-14	C-14	H-3	H-3	C-14	H-3	C-14
1	14	2	29	14	2	29	6	2
2	9	4	12	9	4	12	27	1
3	32	0	5	32	0	5	18	13
4	24	8	7	24	8	7	26	0
5	28	5	57	28	5	57	23	8
6							17	6
7							15	9
8							0	12
9							28	3
10							2	12
AVERAGE	21	4	22	21	4	22	16	7
STANDARD DEVIATION	10	3	22	10	3	22	10	5
MAXIMUM VALUE	32	8	57	32	8	57	28	13
ACTION LIMIT	700	700	700	700	700	700	700	700

NON-IMPACTED AREA FINAL STATUS SURVEY DATA

Table 12-2-5. Final Status Survey Summary For Non-Impacted Survey Units								
Building Number: 53								
Monitoring date(s): 5/2/00								
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination (Count Times: 1 minute) Data is reported in DPM for a survey unit (building number/room number)								
SAMPLE NUMBER	ROOM NUMBER:25*		ROOM NUMBER:25*		ROOM NUMBER:115		ROOM NUMBER:116	
	H-3	C-14	H-3	C-14	H-3	C-14	H-3	C-14
1	2	10	19	13	8	4	7	9
2	24	8	8	9	17	6	8	4
3	0	22	23	11	12	4	13	6
4	6	12	12	4	8	4	2	9
5	12	4	25	1	8	2	32	12
6					17	9	3	5
7					13	4	0	24
8					13	4	4	5
9					7	7	22	6
10					12	4	1	12
AVERAGE	9	11	17	8	12	5	9	9
STANDARD DEVIATION	10	7	7	5	4	2	10	6
MAXIMUM VALUE	24	22	25	13	17	9	32	24
ACTION LIMIT	700	700	700	700	700	700	700	700

NON-IMPACTED AREA FINAL STATUS SURVEY DATA

Table 12-2-6. Final Status Survey Summary for CONTROL SAMPLES FOR NON-IMPACTED SURVEY UNITS				
Building: 053		Survey Unit or Room Number: 104 and 105		
Survey Date: 3/23/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Room 104		DPM, Room 105	
	H-3	C-14	H-3	C-14
1	10	7	6	14
2	3	7	16	9
3	11	7	16	6
4	0	7	11	11
5	9	7	8	4
6	23	6	8	2
7	5	2	14	0
8	16	14	10	14
9	30	10	7	7
10	11	4	7	9
11	8	4	7	9
12	13	6	4	2
13	5	17	0	19
14	3	7	0	5
15	11	9	8	7
16	0	12	46	0
17	4	7	6	2
18	34	3	0	5
19	8	4	3	10
20	17	4	14	9
21	6	9	12	9

22	11	7	12	9
23	3	10	0	12
24	26	3	3	7
25	4	19	22	18
26	28	13	15	9
27	4	22	14	11
28	20	11	18	13
29	3	7	12	6
30	21	4	11	9
31	0	19	6	12
32	26	10	8	4
33	8	19	22	0
34	2	9	5	16
35	24	11	6	9
36	2	9	12	4
37	7	9	16	4
38	2	9	16	4
Average DPM	11	9	11	8
Standard Deviation, DPM	10	5	8	5
Maximum DPM	34	22	46	19
Action Limit, DPM	700	700	700	700

NON-IMPACTED AREA FINAL STATUS SURVEY DATA

Table 12-2-7. Final Status Survey Summary For Non-Impacted Survey Units

Building Number: 53

Monitoring date(s):03/15/00

Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination (Count Times: 1 minute)

Data is reported in DPM for a survey unit (building number/room number)

SAMPLE NUMBER	ROOM NUMBER:106		ROOM NUMBER: 107		ROOM NUMBER: 109		ROOM NUMBER: 114	
	H-3	C-14	H-3	C-14	H-3	C-14	H-3	C-14
1	16	9	4	2	13	4	31	5
2	13	0	0	12	6	12	12	4
3	8	7	17	6	0	17	29	5
4	11	9	2	12	1	12	12	6
5	8	4	8	7	8	4	3	7
6	16	6	2	10	17	18	14	6
7	8	4	20	6	4	5	22	6
8	3	7	27	8	18	4	0	12
9	24	11	16	9	0	10	7	9
10	24	11	4	5	13	4	0	7
AVERAGE	13	7	10	8	8	9	13	7
STANDARD DEVIATION	7	3	9	3	7	6	11	2
MAXIMUM VALUE	24	11	27	12	18	18	31	12
ACTION LIMIT	700	700	700	700	700	700	700	700

NON-IMPACTED AREA FINAL STATUS SURVEY DATA

Table 12-2-8. Final Status Survey Summary For Non-Impacted Survey Units								
Building Number: 53								
Monitoring date(s):03/15/00								
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination (Count Times: 1 minute) Data is reported in DPM for a survey unit (building number/room number)								
SAMPLE NUMBER	ROOM NUMBER:120A		ROOM NUMBER:120B		ROOM NUMBER:120C		ROOM NUMBER: 123	
	H-3	C-14	H-3	C-14	H-3	C-14	H-3	C-14
1	4	2	24	8	12	4	23	1
2	5	17	17	4	12	11	9	2
3	17	4	6	17	7	14	15	4
4	5	2	11	9	6	9	12	2
5	0	10	12	6	11	6	15	9
6	7	7	14	2	0	10	16	6
7	9	7	5	19	17	11	15	14
8	8	9	1	14	12	6	21	4
9	1	12	31	3	8	4	8	7
10	21	4	31	5	9	4	12	9
AVERAGE	8	7	15	9	9	8	15	6
STANDARD DEVIATION	7	5	11	6	5	4	5	4
MAXIMUM VALUE	21	17	31	19	17	14	23	14
ACTION LIMIT	700	700	700	700	700	700	700	700

NON-IMPACTED AREA FINAL STATUS SURVEY DATA

Table 12-2-9. Final Status Survey Summary For Non-Impacted Survey Units

Building Number: 53

Monitoring date(s):03/15/00

Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination (Count Times: 1 minute)

Data is reported in DPM for a survey unit (building number/room number)

SAMPLE NUMBER	ROOM NUMBER:125		ROOM NUMBER:127		ROOM NUMBER:		ROOM NUMBER:	
	H-3	C-14	H-3	C-14	H-3	C-14	H-3	C-14
1	13	9	18	13				
2	39	2	3	7				
3	4	5	8	7				
4	6	12	12	4				
5	18	13	24	8				
6	11	9	3	5				
7	8	7	7	12				
8	13	4	1	12				
9	13	9	12	14				
10	1	14	16	11				
AVERAGE	13	8	10	9				
STANDARD DEVIATION	11	4	7	4				
MAXIMUM VALUE	39	14	24	14				
ACTION LIMIT	700	700	700	700				

NON-IMPACTED AREA FINAL STATUS SURVEY DATA

Table 12-2-10. Final Status Survey Summary For Non-Impacted Survey Units

Building Number: 59

Monitoring date(s): 5/2/00

Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination (Count Times: 1 minute)

Data is reported in DPM for a survey unit (building number/room number)

SAMPLE NUMBER	ROOM NUMBER: Pool		ROOM NUMBER: 101		ROOM NUMBER: 102		ROOM NUMBER: 106	
	H-3	C-14	H-3	C-14	H-3	C-14	H-3	C-14
1	21	9	0	10	10	9	18	14
2	0	10	10	9	24	1	11	7
3	21	6	31	0	23	18	10	16
4	22	1	21	6	32	17	3	7
5	12	4	18	6	7	24	62	1
6	4	10	10	15	6	5	14	7
7	0	10	5	7	4	10	0	26
8	13	4	22	4	12	9	11	9
9	14	4	44	5	13	22	4	10
10	10	15	28	3	21	6	15	7
AVERAGE	12	7	19	7	15	12	15	10
STANDARD DEVIATION	8	4	13	4	9	8	18	7
MAXIMUM VALUE	22	15	44	15	32	24	62	26
ACTION LIMIT	700	700	700	700	700	700	700	700

NON-IMPACTED AREA FINAL STATUS SURVEY DATA

Table 12-2-11. Final Status Survey Summary For Non-Impacted Survey Units

Building Number: 69

Monitoring date(s): 5/11/00

Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination (Count Times: 1 minute)

Data is reported in DPM for a survey unit (building number/room number)

SAMPLE NUMBER	ROOM NUMBER: 101		ROOM NUMBER: 102		ROOM NUMBER: 103		ROOM NUMBER: 103*	
	H-3	C-14	H-3	C-14	H-3	C-14	H-3	C-14
1	41	35	0	8	7	19	2	10
2	12	16	0	13	0	10	0	17
3	9	29	4	2	0	7	0	13
4	7	12	45	7	13	6	3	7
5	19	33	6	12	8	24	2	12
6	4	30	0	10	0	3		
7	5	7	4	10	13	9		
8	20	12	11	4	3	12		
9	0	18	254	15	11	4		
10	0	22	0		3	12		
AVERAGE	12	21	32	9	6	11	1	12
STANDARD DEVIATION	12	10	79	4	5	7	1	4
MAXIMUM VALUE	41	35	254	15	13	24	3	17
ACTION LIMIT	700	700	700	700	700	700	700	700

NON-IMPACTED AREA FINAL STATUS SURVEY DATA

Table 12-2-12. Final Status Survey Summary For Non-Impacted Survey Units								
Building Number: 69								
Monitoring date(s): 5/11/00								
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination (Count Times: 1 minute) Data is reported in DPM for a survey unit (building number/room number)								
SAMPLE NUMBER	ROOM NUMBER: 104		ROOM NUMBER: 104*		ROOM NUMBER: 104*			
	H-3	C-14	H-3	C-14	H-3	C-14		
1	10	4	14	7	6	2		
2	1	17	10	9	0	15		
3	29	6	2	15	22	16		
4	8	9	8	7	8	7		
5	4	5	8	4	4	5		
6	23	0						
7	14	4						
8	14	14						
9	4	10						
10	14	12						
AVERAGE	12	8	8	8	8	9		
STANDARD DEVIATION	9	5	4	4	8	6		
MAXIMUM VALUE	29	17	14	15	22	16		
ACTION LIMIT	700	700	700	700	700	700		

NON-IMPACTED AREA FINAL STATUS SURVEY DATA

Table 12-2-13. Final Status Survey Summary For Non-Impacted Survey Units								
Building Number: 79								
Monitoring date(s): 5/11/00								
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination (Count Times: 1 minute) Data is reported in DPM for a survey unit (building number/room number)								
SAMPLE NUMBER	ROOM NUMBER: 101		ROOM NUMBER: 102		ROOM NUMBER: 103		ROOM NUMBER: 104	
	H-3	C-14	H-3	C-14	H-3	C-14	H-3	C-14
1	3	10	8	17	0	10	7	0
2	4	10	2	12	12	7	5	5
3	0	2	22	6	22	3	20	8
4	30	8	16	11	30	13	22	3
5	1	14	17	4	21	6	11	11
6	15	7	3	7	4	7	0	8
7	7	2	24	4	19	1	0	20
8	25	4	10	9	0	7	5	5
9	14	7	3	12	0	5	4	10
10	0	20	9	12	11	7	10	7
AVERAGE	10	8	11	9	12	7	8	8
STANDARD DEVIATION	11	6	8	4	11	3	8	5
MAXIMUM VALUE	30	20	24	17	30	13	22	20
ACTION LIMIT	700	700	700	700	700	700	700	700

NON-IMPACTED AREA FINAL STATUS SURVEY DATA

Table 12-2-14. Final Status Survey Summary For Non-Impacted Survey Units								
Building Number: 79								
Monitoring date(s): 5/11/00								
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination (Count Times: 1 minute) Data is reported in DPM for a survey unit (building number/room number)								
SAMPLE NUMBER	ROOM NUMBER: 104*		ROOM NUMBER: 107		ROOM NUMBER: 107*			
	H-3	C-14	H-3	C-14	H-3	C-14		
1	14	9	7	14	5	7		
2	5	22	9	9	13	9		
3	17	4	11	9	10	4		
4	8	4	20	11	9	4		
5	1	12	12	6	24	11		
6			16	11				
7			0	13				
8			3	12				
9			0	12				
10			9	17				
AVERAGE	9	10	9	11	12	7		
STANDARD DEVIATION	7	7	7	3	7	3		
MAXIMUM VALUE	17	22	20	17	24	11		
ACTION LIMIT	700	700	700	700	700	700		

Appendix E-3. Diving Buildings, Impacted Class 3 Areas

- Location: NMRC Diving Buildings, Impacted Class 3 Areas
- Monitoring Date(s): 3/23/00, 4/19/00, 4/26/00
- Radioactive Contaminants of Concern: Beta- and gamma-radiation emitters, Tritium (H-3), Carbon-14 (C-14), Cobalt-57 (Co-57), Barium-133 (Ba-133), and Cesium-137 (Cs-137)

- Minimum Control Beta Swipe Locations (performed for every survey unit): (1) floor at door in room; (2) floor at door outside room; (3) doorknob in room; (4) doorknob outside room; and (5) light switch inside room.

- Survey Instrument Information:
  - Beta meters -- serial numbers (background CPM): 11030 (<100CPM), 54537 (<100 CPM)
  - Gamma meters -- serial numbers (background CPM): 114886 (<300 CPM), 121730 (<200 CPM), 121886 (<300 CPM)
  - Liquid Scintillation Counter: Packard 2500TR, S/N 403848

- Radiation-detection Action Limits:
  - 2 to 3 times background for beta and gamma scans
  - 500 - 700 dpm or higher for either H-3 or C-14 beta swipes counted using a liquid scintillation counter

- Summary of Radiological Scans and Swipe Results:
  - Background level for all beta and gamma scans
  - All H-3 and C-14 beta swipe results below Action Limits

- Contamination and Remedial Actions: Residual carbon-14 contamination was detected in rooms 117 and 122 of building 53. Photographs are included in Appendix B that show the affected areas before and after decontamination efforts were completed. Swipe samples collected at these sites and evaluated using a liquid scintillation counter revealed that the contamination was fixed. The contamination was located on floor tile and upon a high-pressure vessel in room 117. In room 122, the contamination

was limited to four areas on the laminated surface of workbenches. The contamination was detected during the performance of direct readings as part of NMRC's final status surveys. The direct readings at the contaminated areas exceeded two to three times the background readings. Elevated readings ranged from several hundred to several thousand disintegrations per second. Decontamination efforts included spraying the areas with radiological cleaners and washing down the area before re-monitoring. After repeated washings of the areas with no decrease in radioactivity, other measures were taken to decontaminate the affected areas. These measures included removing vinyl floor tiles, removing sections of laminate covering from workbenches, removing paint from metallic surfaces using a liquid paint remover, and sawing off sections of contaminated wood from the stand supporting the high-pressure vessel. All wastes generated from these decontamination efforts were disposed of as radioactive wastes. The affected areas were resurveyed following completion of decontamination efforts.

- Conclusion: All contaminated areas were successfully decontaminated. Remediation surveys following the completion of decontamination efforts revealed that background-radiation levels had been achieved. The radiological monitoring results for all survey units addressed in this section met the criteria for release for unrestricted use.

TABLE 12-3-1. RADIOLOGICAL FINAL STATUS SURVEY SUMMARIES - Diving Building 53, Impacted Class 3 Areas

Date	Room number or area (Survey Unit)	Beta and/or Gamma Scan Monitoring (check if yes)	Maximum Background beta (H-3 or C-14) swipe result (DPM)	Maximum Random or Control beta (H-3 or C-14) swipe result (DPM)	Recommend Survey Unit for radiological clearance (Y/N)
5/9/00	53	101 (101-1, 101-2)	28	424	Y
3/23/00	53	102	31	30	Y
3/23/00	53	103	31	31	Y
4/26/00	53	111	36	35	Y
3/23/00	53	112	31	35	Y
3/23/00	53	112A	31	35	Y
3/23/00	53	113	31	24	Y
3/23/00	53	117	31	30	Y
3/23/00	53	118	31	63	Y
6/9/00	53	119	28	125	Y
6/9/00	53	120, 120D	28	33	Y
4/19/00	53	121	23	76	Y
4/19/00	53	122	23	21	Y

Quality Assurance Checklist

Building number or location: NMRC Diving Buildings Impacted Areas
Monitoring Date(s): 3/23/00, 4/19/00, 4/26/00, 6/9/00

Y - Appropriate and satisfactory daily and weekly calibration checks were completed for the selected survey monitoring equipment and instruments.
Y - Selected meters with current calibrations for the isotopes of concern
Y - Survey maps or floor plans (for all survey units) and grid maps (for known RAM-use areas) were available
Y - Background checks were performed when impacted areas were monitored.
Y - For known RAM-use survey units, additional checks were performed (workbenches, shelves, sinks, basins, traps, floor at sinks and entrances, wall at hoods and sinks, and/or other areas as deemed appropriate)
Y - Mean values, single sample values, and background values were below the action limits, indicating no contamination was found.
Y - Representative floor plans, sketches, and photographs were available.
Y - Deviation from survey plans and objectives were documented.

Y - Extent of remediation actions documented.

Y - All selected survey units passed D&D tests; units are recommended for unrestricted release.
Y - Additional Checks/Data passed D&D tests; unit is recommended for unrestricted release

Notes: Tests included complying with applicable elements of the MARSSIM Final Status Survey checklist, mean-value and single-value comparisons of survey-unit data to action limits (DCGLs), mean-value comparison to background, completion of required monitoring, and satisfactory scan monitoring results.

Quality Assurance Leader: Schleurious L. Gaiter, LCDR, MSC, USN

Table 12-3-2. Final Status Survey Summary For Direct Readings of Impacted Survey Units Using a Gas Proportional Counter

DATA CONVERSION WAS PERFORMED AS DESCRIBED BELOW

Building Number: 53

Monitoring date(s): 5/2/00

Data is reported in DPM for direct readings for Carbon-14

MARSSIM formula 6-4:

$$\frac{dpm}{(100\ cm^2)} = \frac{(C_s/T_s)-(C_b/T_b)}{(E_i \times (A/100))}$$

where, A=126 cm^2, E_i = instrument efficiency = 0.15; sample and background count times = T_s = T_b= 1 min, C_s = sample counts during time T_s, and C_b = background counts during time T_b

Note: Negative values of the calculated dpm were set equal to zero.

All areas with calculated dpm values exceeding the NMRC Action Limit were remediated (decontaminated or materials removed) and re-surveyed. The final surveys revealed readings below the NMRC Action Limit of 2,000 dpm per 100 cm^2 for direct readings.

SAMPLE NUMBER	ROOM NUMBER:101		ROOM NUMBER:102		ROOM NUMBER:103	
	CPM	DPM/ 100 CM^2	CPM	DPM/ 100 CM^2	CPM	DPM/ 100 CM^2
1	294	138	272	0	280	116
2	348	423	306	164	286	148
3	283	79	301	138	318	317
4	273	26	281	32	307	259
5	313	238	307	169	313	291
6	316	254	274	0	288	159
7	296	148	268	0	285	143
8	270	11	289	74	289	164
9	281	69	252	0	284	138
10	327	312	272	0	266	42
11					373	608
12					314	296
AVERAGE	170		58		223	
STANDARD DEVIATION	134		73		148	
MAXIMUM VALUE	423		169		608	
BACKGROUND, CPM	268		275		258	
ACTION LIMIT, DPM/100 CM^2	2,000		2,000		2,000	

Table 12-3-3. Final Status Survey Summary For Direct Readings of Impacted Survey Units Using a Gas Proportional Counter						
Building Number: 53						
Monitoring date(s): 5/2/00						
Data is reported in DPM for direct readings for Carbon-14						
See Table 12-3-2 for the application of MARSSIM formula 6-4 in converting the gas proportional counter data to dpm per 100 cm2.						
The final surveys revealed readings below the Action Limit.						
SAMPLE NUMBER	ROOM NUMBER:111		ROOM NUMBERS: 112,112A		ROOM NUMBER:117	
	CPM	DPM/ 100 CM^2	CPM	DPM/ 100 CM^2	CPM	DPM/ 100 CM^2
1	284	26	265	0	249	0
2	287	42	255	0	276	63
3	286	37	249	0	252	0
4	285	32	240	0	247	0
5	255	0	283	90	280	85
6	271	0	245	0	262	0
7	228	0	254	0	258	0
8	260	0	262	0	292	148
9	268	0	267	5	287	122
10	263	0	241	0	452	995
11	279	0	290	127	289	132
12			269	16	310	243
13			237	0	362	519
14			269	16	389	661
15			254	0	321	302
16					351	460
17					310	243
18					467	1074
19					370	561
20					401	725
AVERAGE	13		17		317	
STANDARD DEVIATION	18		38		338	
MAXIMUM VALUE	42		127		1074	
BACKGROUND, CPM	279		266		258	
ACTION LIMIT, DPM/100 CM^2	2,000		2,000		2,000	

Table 12-3-4. Final Status Survey Summary For Direct Readings of Impacted Survey Units Using a Gas Proportional Counter

Building Number: 53

Monitoring date(s): 5/2/00

Data is reported in DPM for direct readings for Carbon-14

See Table 12-3-2 for the application of MARSSIM formula 6-4 in converting the gas proportional counter data to dpm per 100 cm^2.

After data conversion of the surface activity counts, all areas with calculated dpm values exceeding the NMRC Action Limit were remediated (decontaminated or materials removed) and re-surveyed. The final surveys revealed readings below the Action Limit.

SAMPLE NUMBER	ROOM NUMBER: 118		ROOM NUMBERS: 121		ROOM NUMBER: 122	
	CPM	DPM/ 100 CM^2	CPM	DPM/ 100 CM^2	CPM	DPM/ 100 CM^2
1	254	0	239	0	247	0
2	273	48	312	254	305	217
3	299	185	282	95	284	106
4	312	254	272	42	291	143
5	261	0	281	90	295	164
6	234	0	282	95	277	69
7	280	85	281	90	284	106
8	268	21	272	42	305	217
9	257	0	296	169	251	0
10	248	0	251	0	298	180
11	232	0	268	21	327	333
12	286	0	255	0	329	344
13	300	190	287	122	483	1159
14			257	0	335	376
15			240	0	309	238
16			284	106	299	185
17			248	0	279	79
18					291	143
19					294	159
20					298	180
21					320	296
22					281	90
23					252	0
24					289	132
25					291	143
AVERAGE	30		59		202	

STANDARD DEVIATION	54	68	224
MAXIMUM VALUE	164	243	1159
BACKGROUND, CPM	281	266	264
ACTION LIMIT, DPM/100 CM^2	2,000	2,000	2,000

Table 12-3-5a. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053				
A. Survey Unit or Room Number: 101-1				
Survey Date: 06/09/00			Count Times: 1 minute	
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	4	5	2	10
2	20	1	0	5
3	2	10	15	14
4	1	17	25	4
5	0	3	0	22
6	2	12	1	14
7	4	7	13	4
8	28	1	24	13
9	14	2	4	7
10	7	9	20	11
11	2	12	14	7
12	6	14	0	7
13	8	7	7	9
14	19	4	12	11
15	19	6	0	5
16	7	12	25	4
17	6	14	19	16
18	6	14	17	4
19	0	10	1	17
20	0	7	0	15
21	24	8	0	30
Average DPM	9	8	9	11
Standard Deviation, DPM	9	5	9	7
Maximum DPM	28	17	25	30
Action Limit, DPM	700	700	700	700

Table 12-3-5b. Final Status Survey Summary for CONTROL STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053				
B. Survey Unit or Room Number: 101-1				
Survey Date: 06/09/00			Count Times: 1 minute	
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	4	5	7	14
2	20	1	17	6
3	2	10	22	0
4	6	17	2	10
5	1	17	2	10
6	0	3	13	11
7	2	12	0	13
8	4	5	18	6
9	28	1	1	15
10	14	2	3	10
11	7	9	11	7
12	2	12	4	7
13	6	14	11	2
14	8	7	39	5
15	19	4	11	4
16	19	6	1	17
17	7	12	36	5
18	6	14	17	19
19	6	14		
20	0	10		
21	0	7		
Average DPM	8	9	12	9
Standard Deviation, DPM	8	5	12	5
Maximum DPM	28	17	39	19
Action Limit, DPM	700	700	700	700

Table 12-3-6a. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053				
C. Survey Unit or Room Number: 101-2				
Survey Date: 06/09/00			Count Times: 1 minute	
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	4	5	2	10
2	20	1	5	5
3	2	10	0	13
4	1	17	21	9
5	0	3	15	14
6	2	12	6	12
7	4	5	5	7
8	28	1	0	25
9	14	2	0	8
10	7	9	6	12
11	2	12	14	6
12	6	14	7	0
13	8	7	5	5
14	19	4	91	5
15	19	6	6	14
16	7	12	12	9
17	6	14	8	9
18	6	14	1	18
19	0	10	11	9
20	0	7	25	15
21	24	8	11	7
Average DPM	9	8	12	10
Standard Deviation, DPM	9	5	19	5
Maximum DPM	28	17	91	25
Action Limit, DPM	700	700	700	700

Table 12-3-6b. Final Status Survey Summary for CONTROL STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053				
D. Survey Unit or Room Number: 101-2				
Survey Date: 06/09/00			Count Times: 1 minute	
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	4	5	19	0
2	20	1	7	9
3	2	10	2	10
4	1	17	9	2
5	0	5	14	6
6	2	12	0	28
7	4	5	8	12
8	28	1	424	0
9	14	2	14	19
10	7	9	2	15
11	2	12	3	10
12	6	14	18	6
13	8	7		
14	19	4		
15	19	6		
16	7	12		
17	6	14		
18	6	14		
19	0	10		
20	0	7		
21	24	8		
Average DPM	9	8	43	10
Standard Deviation, DPM	9	5	120	8
Maximum DPM	28	17	424	28
Action Limit, DPM	700	700	700	700

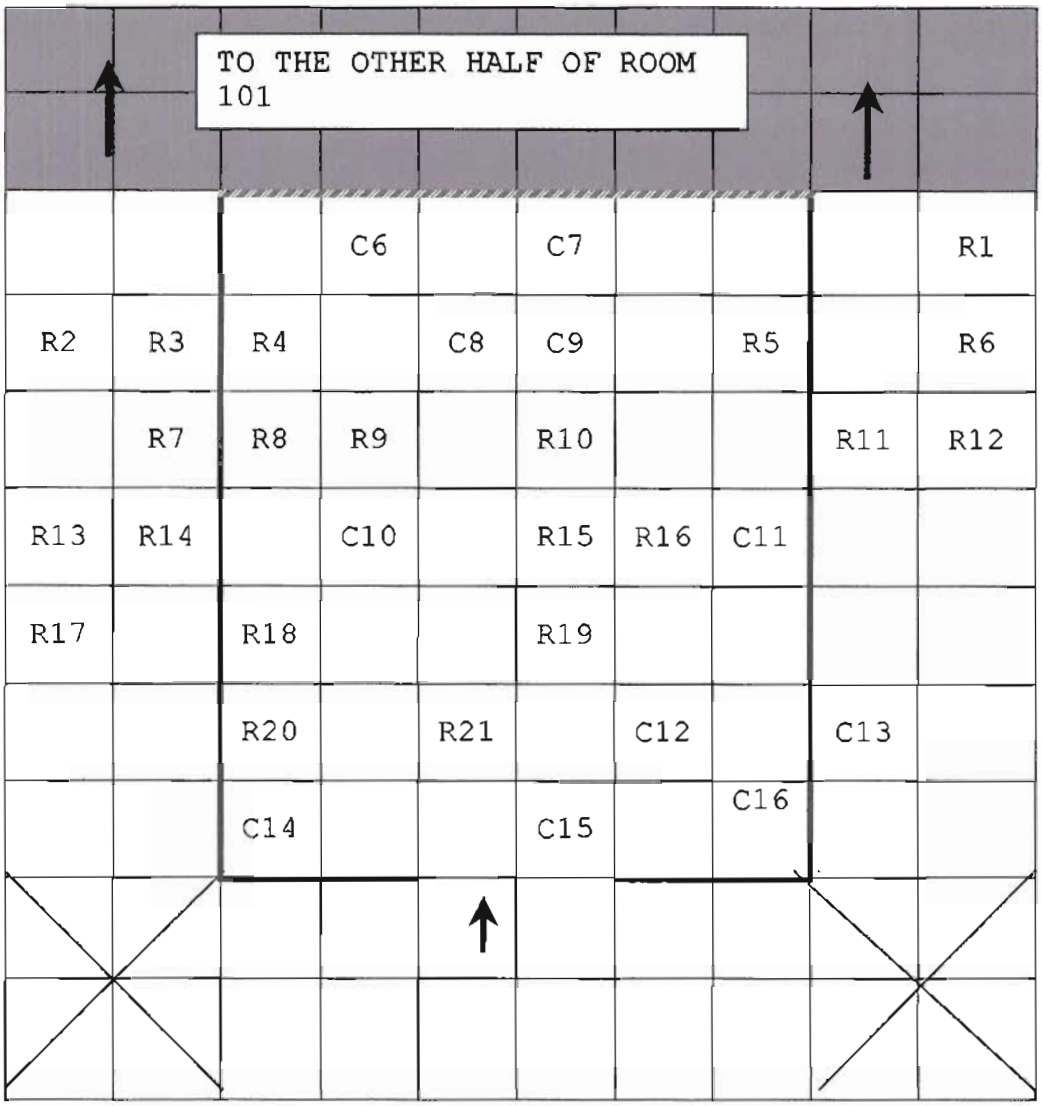


Figure 12-3-1a. Grid Map for Building 53, Room 101-1

Legend:

→ = Main Entrance C17 = Left Sink C18 = Right Sink

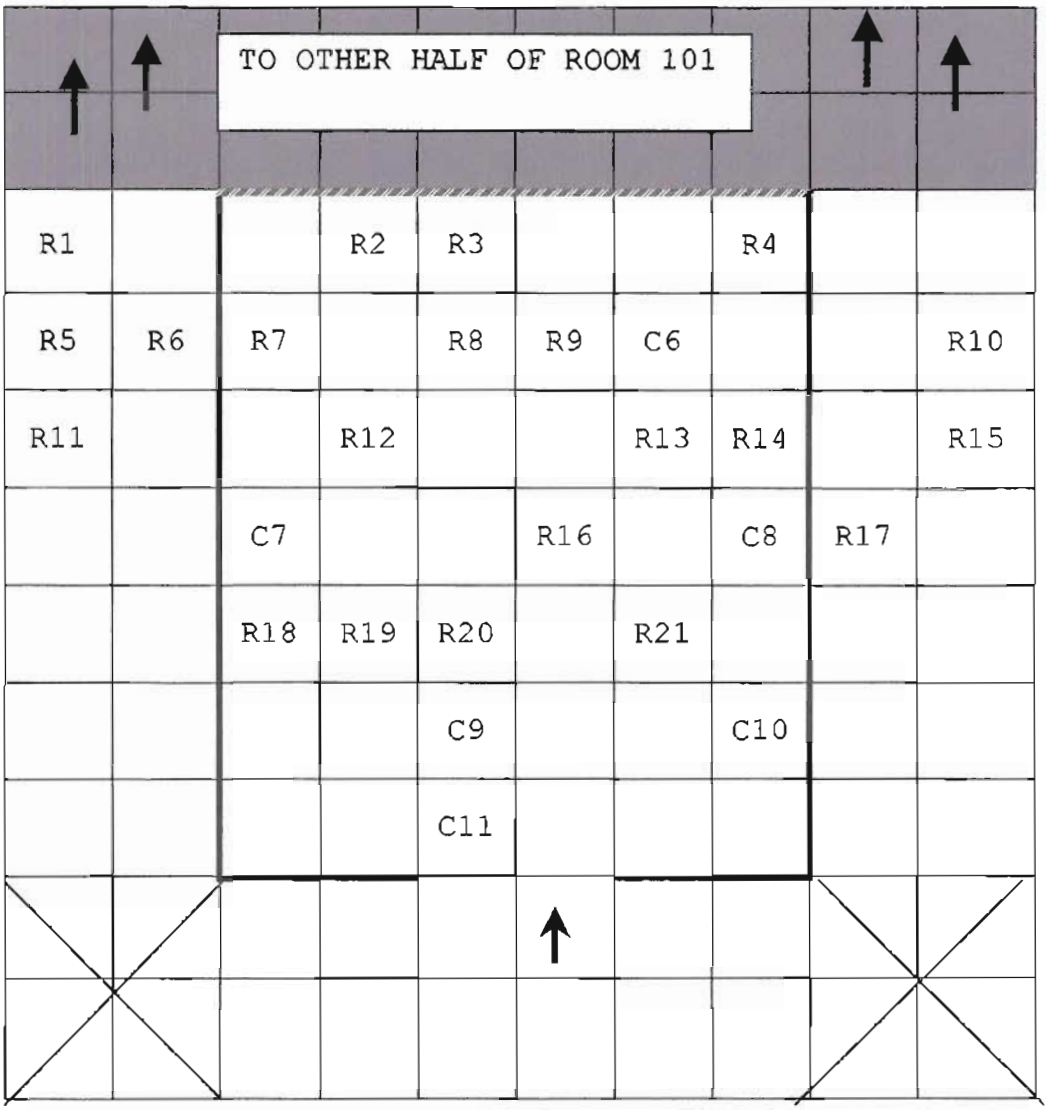


Figure 12-3-1b. Grid Map for Building 53, Room 101-2

Legend:

→ = Main Entrance C12 = Sink

Table 12-3-7. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 102		
Survey Date: 03/23/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	9	4
2	14	9	0	8
3	11	14	7	7
4	8	2	17	6
5	12	4	8	4
6	3	5	0	8
7	0	17	5	17
8	8	7	6	5
9	3	10	6	7
10	13	7	30	14
11	16	14	9	20
12	9	4	0	6
13	7	9	26	12
14	6	12	0	2
15	29	5	13	7
16	0	19	4	19
17	3	10	17	15
18	15	4	1	18
19	10	2	23	12
20	2	10	2	18
21	31	8	9	11
Average DPM	10	9	9	10
Standard Deviation, DPM	8	5	9	6
Maximum DPM	31	19	30	20
Action Limit, DPM	700	700	700	700

Table 12-3-8. Final Status Survey Summary for CONTROL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 102		
Survey Date: 03/23/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	3	5
2	14	9	0	10
3	11	14	6	14
4	8	2	2	10
5	12	4	4	7
6	3	5	0	22
7	0	17	0	18
8	8	7	0	5
9	3	10	15	16
10	13	7	7	9
11	16	14	7	7
12	9	4	13	11
13	7	9	10	14
14	6	12	9	12
15	29	5	24	11
16	0	19	6	17
17	3	10	3	7
18	15	4	1	15
19	10	2	25	6
20	2	10	13	4
21	31	8	2	12
22			11	4
23			3	10
24			7	7
25			11	9
26			0	2
27			0	5
28			2	12
Average DPM	10	9	7	10
Standard Deviation, DPM	8	5	7	5
Maximum DPM	31	19	25	22
Action Limit, DPM	700	700	700	700

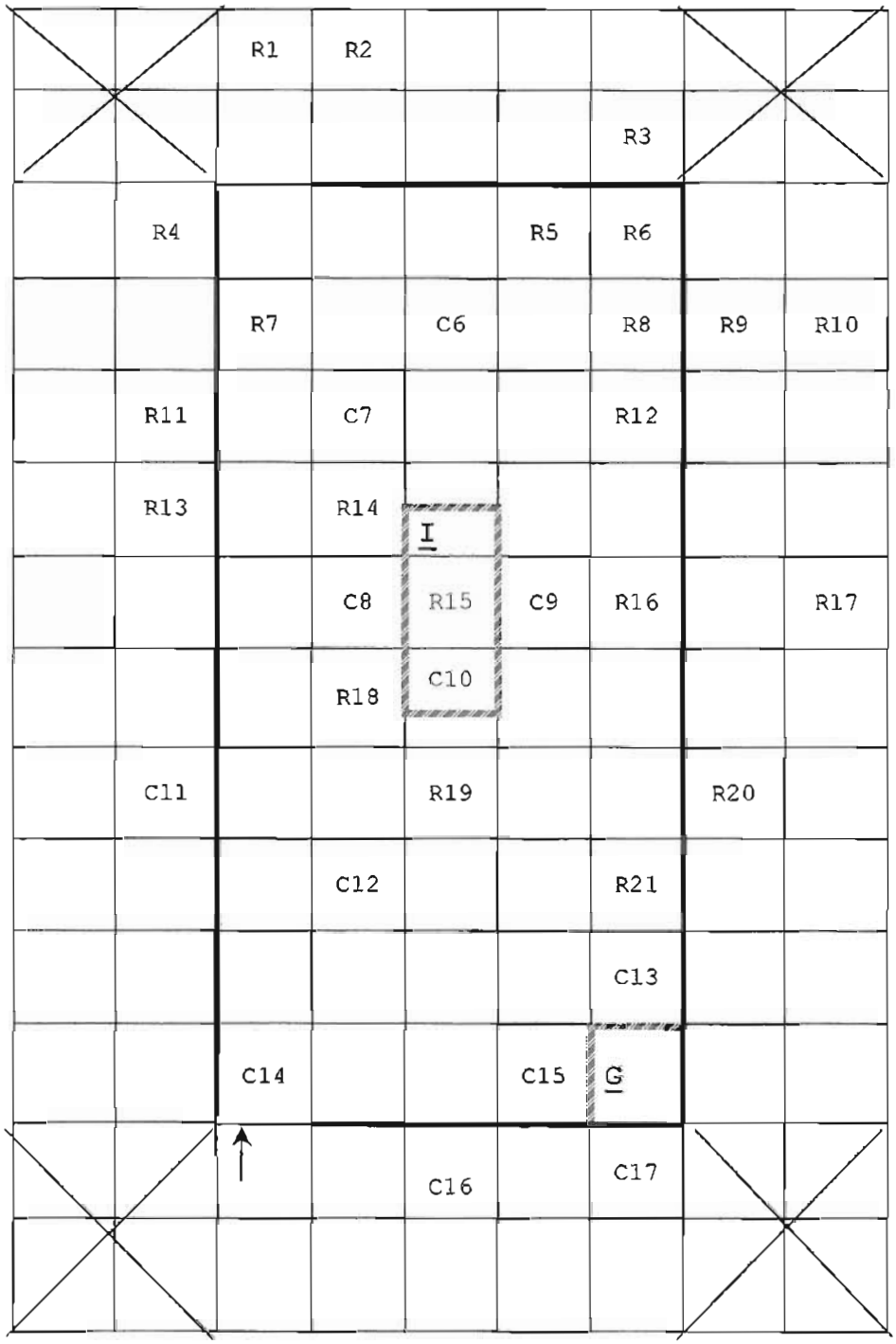


Figure 12-3-2. Grid Map for Building 53, Room 102
Legend: ⟶ Main Entrance; C18 = Sink #1 and Counter; C19 = Sink #2 and Counter; G Gamma Counter; C20 = Sink #3 and Counter; C21- C25 = Secondary Entrance; I = Incubator; C26 = Floor Centrifuge; C27 = Gamma Counter; C28 = Desk Centrifuge

Table 12-3-9. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 103		
Survey Date: 03/23/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	15	6
2	14	9	22	13
3	11	14	12	11
4	8	2	3	5
5	12	4	4	5
6	3	5	6	14
7	0	17	30	13
8	8	7	11	2
9	3	10	9	2
10	13	7	14	14
11	16	14	13	9
12	9	4	7	9
13	7	9	21	13
14	6	12	1	17
15	29	5	12	11
16	0	19	7	7
17	3	10	13	2
18	15	4	31	3
19	10	2	31	1
20	2	10	31	6
21	31	8	20	6
Average DPM	10	9	15	8
Standard Deviation, DPM	8	5	10	5
Maximum DPM	31	19	31	17
Action Limit, DPM	700	700	700	700

Table 12-3-10. Final Status Survey Summary for CONTROL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053	Survey Unit or Room Number: 103			
Survey Date: 03/23/00	Count Times: 1 minute			
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	22	8
2	14	9	0	20
3	11	14	17	9
4	8	2	13	4
5	12	4	4	7
6	3	5	3	7
7	0	17	4	7
8	8	7	4	22
9	3	10	14	6
10	13	7	3	10
11	16	14	3	10
12	9	4	11	14
13	7	9	10	12
14	6	12	10	14
15	29	5	17	16
16	0	19	2	10
17	3	10	0	13
18	15	4	0	13
19	10	2	35	0
20	2	10	0	5
21	31	8	15	4
22			14	14
23			4	5
24			7	7
25			3	24
26			6	12
27			12	9
28			17	11
29			13	9
Average DPM	10	9	9	10
Stand. Deviation, DPM	8	5	8	5
Maximum DPM	31	19	35	24
Action Limit, DPM	700	700	700	700

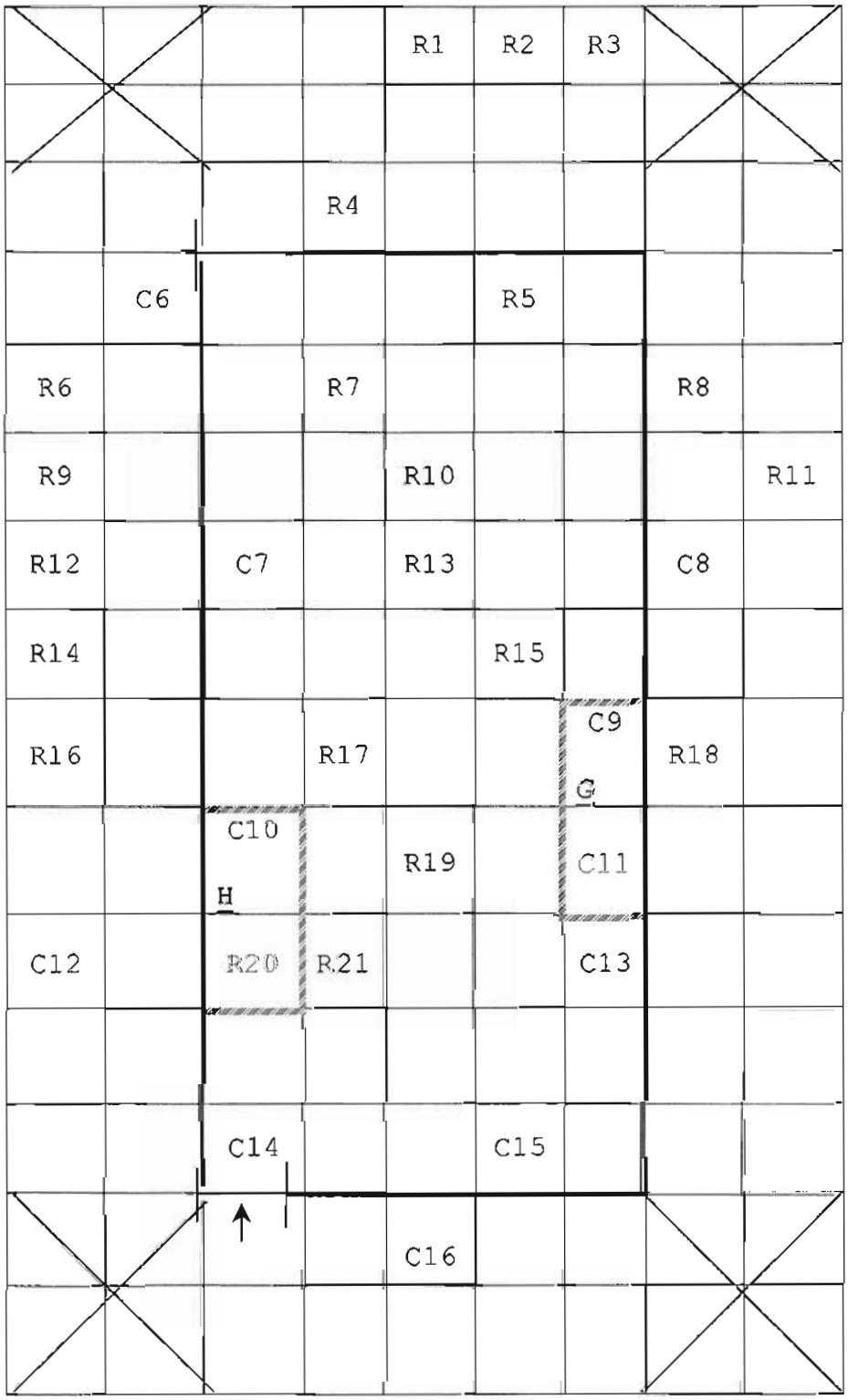


Figure 12-3-3. Grid Map for Building 53, Room 103

Legend: ⟶ = Main Entrance; C18 = Left Rear Counter; C19 = Left Front Counter; G = Liquid Scintillation Counter; C20 = Right Front Counter; C21 = Right Rear Counter; H = Hyperbaric Chamber; C22 = Left Sink; C23 = Right Front Sink; C24 = Right Rear Sink

Table 12-3-11. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 111		
Survey Date: 4/26/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	22	13	7	24
2	26	1	11	9
3	7	12	17	4
4	16	16	14	14
5	15	0	17	9
6	14	6	34	5
7	8	7	16	6
8	11	0	15	14
9	7	12	9	2
10	23	3	35	3
11	14	4	12	6
12	13	6	11	4
13	13	6	17	4
14	36	5	13	9
15	13	9	10	4
16	4	5	4	7
17	9	4	3	7
18	21	4	3	10
19	23	11	0	10
20	24	1	11	9
21	7	14	24	3
Average DPM	16	7	13	8
Standard Deviation, DPM	8	5	9	5
Maximum DPM	36	16	35	24
Action Limit, DPM	700	700	700	700

Table 12-3-12. Final Status Survey Summary for CONTROL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 111		
Survey Date: 4/26/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	22	13	0	12
2	26	1	14	18
3	7	12	15	9
4	16	16	0	0
5	15	0	15	9
6	14	6	0	7
7	8	7	2	12
8	11	0	9	12
9	7	12	33	12
10	23	3	11	11
11	14	4	3	12
12	13	6	21	6
13	13	6	3	7
14	36	5	9	0
15	13	9	12	6
16	4	5	8	4
17	9	4	2	12
18	21	4	0	10
19	23	11	21	6
20	24	1	11	9
21	7	14	19	13
22			8	4
23			7	7
Average DPM	16	7	10	9
Standard Deviation, DPM	8	5	8	4
Maximum DPM	36	16	33	18
Action Limit, DPM	700	700	700	700

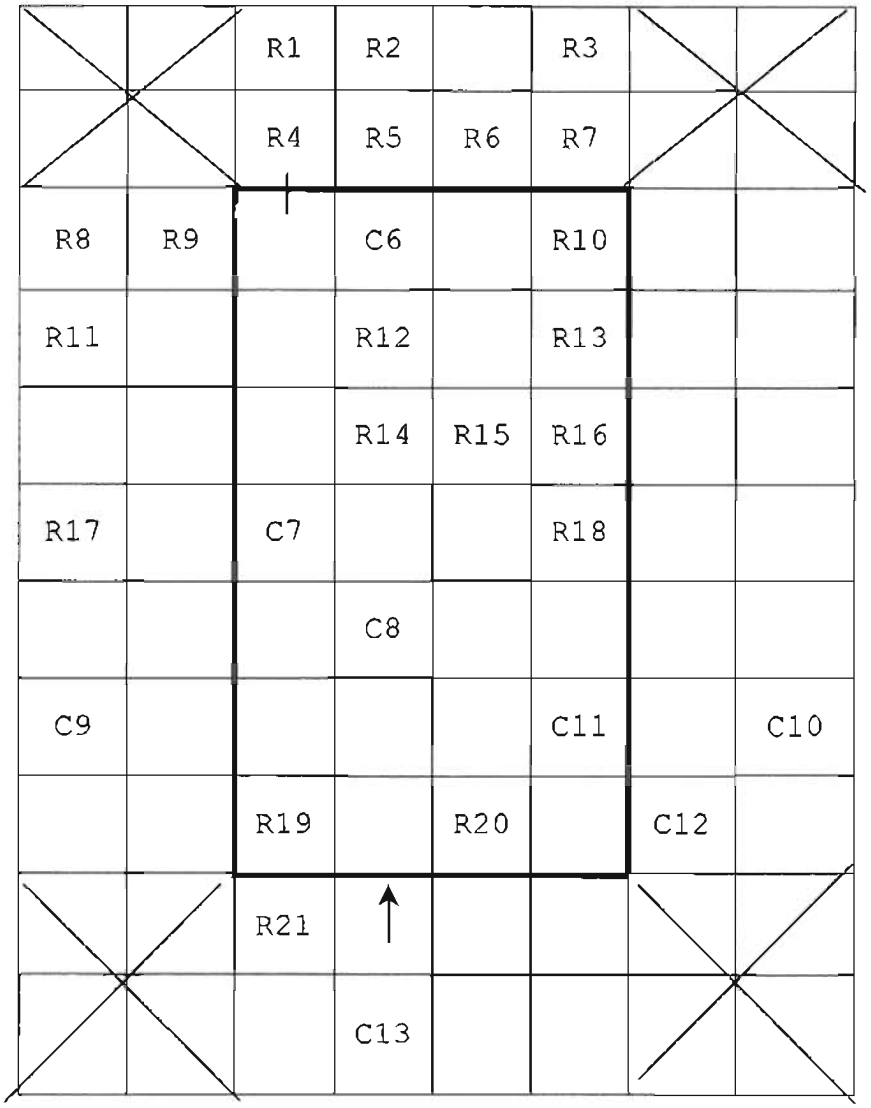


Figure 12-3-4. Grid Map for Building 53, Room 111

Legend:

→ = Main Entrance

Table 12-3-13. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 112		
Survey Date: 03/23/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	21	8
2	14	9	18	4
3	11	14	17	11
4	8	2	3	5
5	12	4	14	14
6	3	5	3	7
7	0	17	10	0
8	8	7	10	2
9	3	10	3	10
10	13	7	2	12
11	16	14	8	7
12	9	4	20	4
13	7	9	3	10
14	6	12	10	11
15	29	5	34	0
16	0	19	4	2
17	3	10	8	9
18	15	4	25	8
19	10	2	6	14
20	2	10	13	9
21	31	8	2	10
Average DPM	10	9	11	7
Standard Deviation, DPM	8	5	9	4
Maximum DPM	31	19	34	14
Action Limit, DPM	700	700	700	700

Table 12-3-14. Final Status Survey Summary for CONTROL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 112		
Survey Date: 03/23/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	35	5
2	14	9	1	15
3	11	14	30	15
4	8	2	7	9
5	12	4	6	7
6	3	5	13	4
7	0	17	19	1
8	8	7	19	13
9	3	10	17	9
10	13	7	17	9
11	16	14	27	6
12	9	4	0	5
13	7	9	0	5
14	6	12	0	8
15	29	5		
16	0	19		
17	3	10		
18	15	4		
19	10	2		
20	2	10		
21	31	8		
Average DPM	10	9	14	8
Standard Deviation, DPM	8	5	12	4
Maximum DPM	31	19	35	15
Action Limit, DPM	700	700	700	700

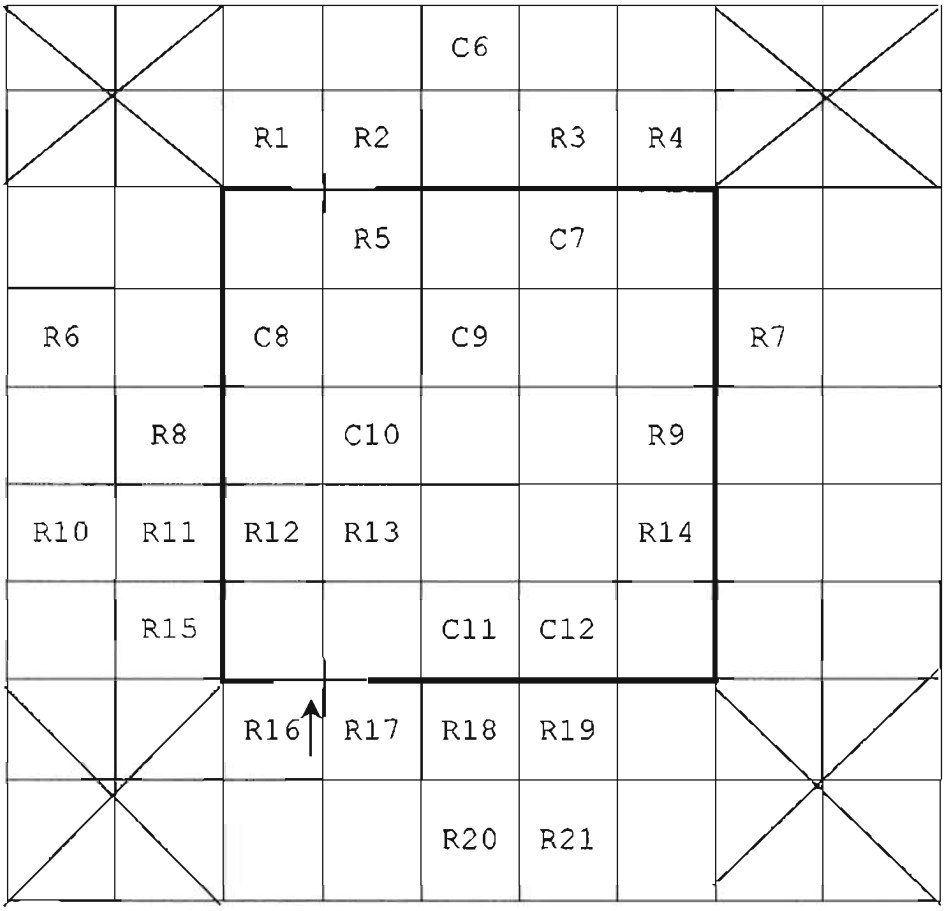


Figure 12-3-5. Grid Map for Building 53, Room 112

Legend:

→ = Main Entrance; C13 = Sink; C14 = Counter

Table 12-3-15. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 112A		
Survey Date: 03/23/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	3	7
2	14	9	22	18
3	11	14	35	5
4	8	2	10	11
5	12	4	13	4
6	3	5	7	9
7	0	17	9	9
8	8	7	10	9
9	3	10	14	9
10	13	7	23	13
11	16	14	12	7
12	9	4	2	10
13	7	9	6	14
14	6	12	5	7
15	29	5	2	12
16	0	19	7	17
17	3	10	14	4
18	15	4	10	9
19	10	2	34	6
20	2	10	18	1
21	31	8	10	7
Average DPM	10	9	13	9
Standard Deviation, DPM	8	5	9	4
Maximum DPM	31	19	35	18
Action Limit, DPM	700	700	700	700

Table 12-3-16. Final Status Survey Summary for CONTROL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 112A		
Survey Date: 03/23/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	6	12
2	14	9	18	0
3	11	14	4	19
4	8	2	3	7
5	12	4	18	9
6	3	5	7	7
7	0	17	27	1
8	8	7	2	10
9	3	10	20	8
10	13	7	12	7
11	16	14	9	12
12	9	4	5	2
13	7	9	14	4
14	6	12	24	1
15	29	5	21	6
16	0	19		
17	3	10		
18	15	4		
19	10	2		
20	2	10		
21	31	8		
Average DPM	10	9	13	7
Standard Deviation, DPM	8	5	8	5
Maximum DPM	31	19	27	19
Action Limit, DPM	700	700	700	700

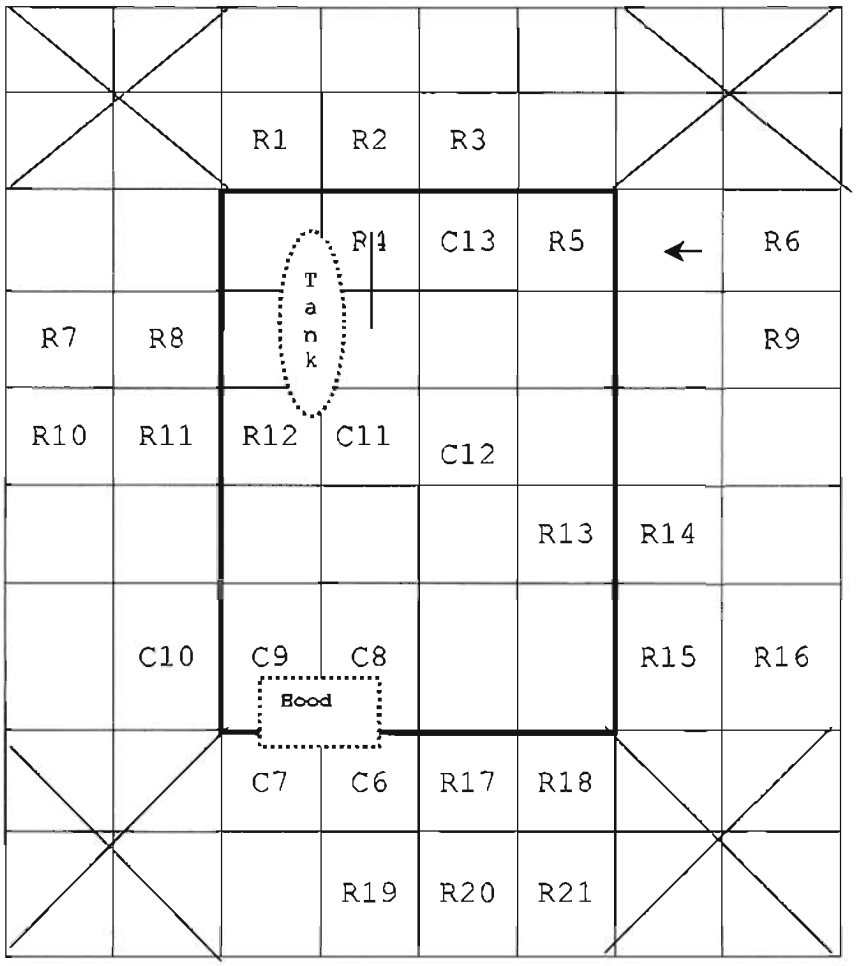


Figure 12-3-6. Grid Map for Building 53, Room 112A

Legend:
← = Main Entrance; C14 = Sink; C15 = Counter

Table 12-3-17. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053				
A. Survey Unit or Room Number: 113				
Survey Date: 03/23/00			Count Times: 1 minute	
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	7	7
2	14	9	16	4
3	11	14	12	7
4	8	2	12	7
5	12	4	4	2
6	3	5	22	1
7	0	17	0	5
8	8	7	23	9
9	3	10	14	14
10	13	7	11	9
11	16	14	13	18
12	9	4	17	4
13	7	9	11	11
14	6	12	4	7
15	29	5	5	0
16	0	19	5	14
17	3	10	9	12
18	15	4	13	0
19	10	2	9	9
20	2	10	7	9
21	31	8	11	2
Average DPM	10	9	11	7
Standard Deviation, DPM	8	5	6	5
Maximum DPM	31	19	23	18
Action Limit, DPM	700	700	700	700

Table 12-3-18. Final Status Survey Summary for CONTROL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053				
B. Survey Unit or Room Number: 113				
Survey Date: 03/23/00			Count Times: 1 minute	
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	13	4
2	14	9	5	17
3	11	14	7	9
4	8	2	8	2
5	12	4	12	9
6	3	5	3	7
7	0	17	8	4
8	8	7	16	9
9	3	10	23	4
10	13	7	4	5
11	16	14	24	5
12	9	4	18	9
13	7	9	11	14
14	6	12	20	11
15	29	5	8	9
16	0	19	6	14
17	3	10	5	2
18	15	4	8	7
19	10	2	0	12
20	2	10	2	10
21	31	8	8	2
22			0	10
Average DPM	10	9	10	8
Standard Deviation, DPM	8	5	7	4
Maximum DPM	31	19	24	17
Action Limit, DPM	700	700	700	700

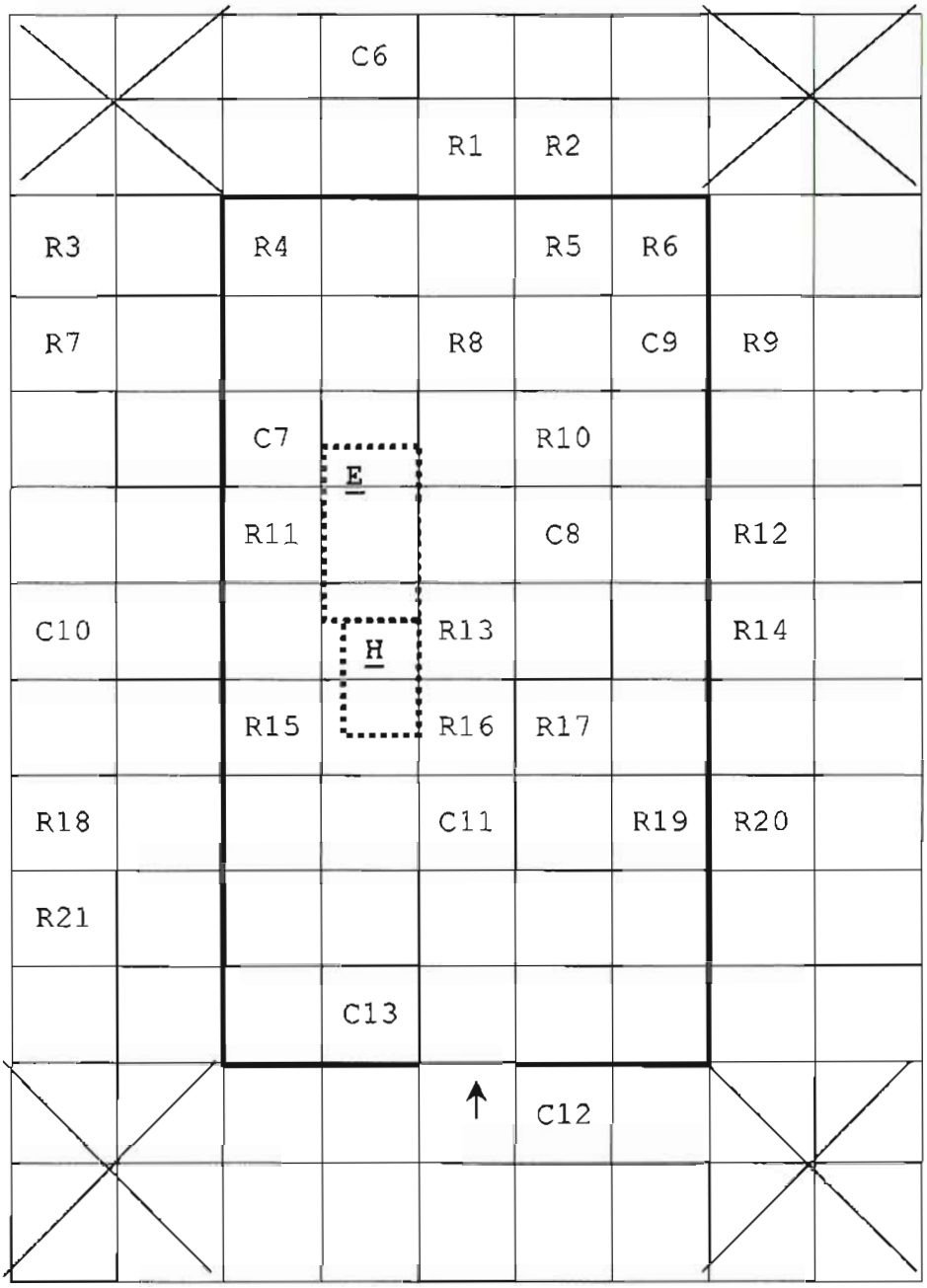


Figure 12-3-7. Grid Map for Building 53, Room 113

Legend:
→ = Main Entrance; E = Equipment; H = Hyperbaric Chamber; C14 = Front Left Counter; C15 = Back Left Counter; C16 = Front Counter; C17 = Hood; C18 = Back Right Counter; C19 = Front Right Counter; C20 = Front Left Sink; C21 = Back Left Sink; C22 = Right Sink

Table 12-3-19. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 117		
Survey Date: 03/23/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	12	9
2	14	9	10	2
3	11	14	14	6
4	8	2	2	5
5	12	4	22	1
6	3	5	17	4
7	0	17	26	8
8	8	7	4	7
9	3	10	13	6
10	13	7	9	7
11	16	14	10	4
12	9	4	26	11
13	7	9	12	11
14	6	12	2	10
15	29	5	15	11
16	0	19	16	4
17	3	10	21	2
18	15	4	0	7
19	10	2	8	7
20	2	10	13	7
21	31	8	12	14
Average DPM	10	9	13	7
Standard Deviation, DPM	8	5	7	3
Maximum DPM	31	19	26	14
Action Limit, DPM	700	700	700	700

Table 12-3-20. Final Status Survey Summary for CONTROL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 117		
Survey Date: 03/23/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	21	131
2	14	9	5	17
3	11	14	17	16
4	8	2	21	8
5	12	4	26	18
6	3	5	6	12
7	0	17	7	7
8	8	7	17	4
9	3	10	2	12
10	13	7	0	13
11	16	14	8	20
12	9	4	8	7
13	7	9	12	9
14	6	12	7	7
15	29	5	30	6
16	0	19	0	3
17	3	10	5	2
18	15	4	23	15
19	10	2	4	7
20	2	10	13	14
21	31	8	0	7
22			4	5
23			9	2
24			8	4
Average DPM	10	9	11	14
Standard Deviation, DPM	8	5	9	25
Maximum DPM	31	19	30	131
Action Limit, DPM	700	700	700	700

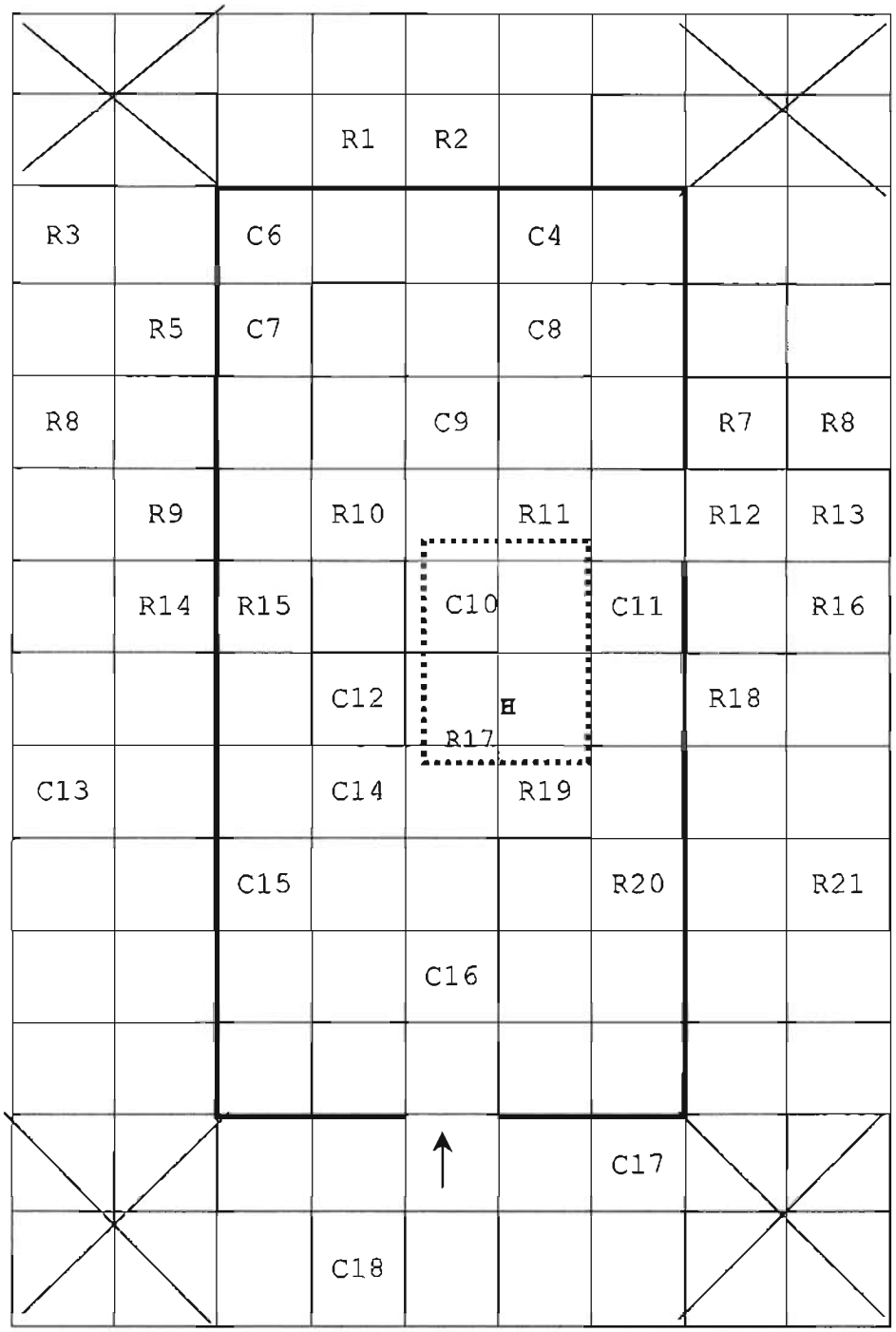


Figure 12-3-8. Grid Map for Building 53, Room 117

Legend:
→ = Main entrance; H = Hyperbaric Chamber;
Extra Controls = Sink, Counters and Benches

Table 12-3-21. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 118		
Survey Date: 03/23/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	62	0
2	14	9	63	6
3	11	14	5	17
4	8	2	18	11
5	12	4	32	6
6	3	5	0	3
7	0	17	21	14
8	8	7	2	12
9	3	10	3	10
10	13	7	11	9
11	16	14	9	7
12	9	4	28	18
13	7	9	20	4
14	6	12	8	2
15	29	5	11	9
16	0	19	15	4
17	3	10	13	7
18	15	14	20	13
19	10	2	15	16
20	2	10	20	6
21	31	8	4	5
Average DPM	10	9	18	9
Standard Deviation, DPM	8	5	17	5
Maximum DPM	31	19	63	18
Action Limit, DPM	700	700	700	700

Table 12-3-22. Final Status Survey Summary for CONTROL STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 118		
Survey Date: 03/23/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	3	7	7	9
2	14	9	6	14
3	11	14	8	4
4	8	2	11	2
5	12	4	5	17
6	3	5	11	2
7	0	17	6	17
8	8	7	21	14
9	3	10	8	9
10	13	7	8	14
11	16	14	0	15
12	9	4	7	31
13	7	9	7	4
14	6	12	3	5
15	29	5	6	17
16	0	19		
17	3	10		
18	15	14		
19	10	2		
20	2	10		
21	31	8		
Average DPM	10	9	8	12
Standard Deviation, DPM	8	5	5	8
Maximum DPM	31	19	21	31
Action Limit, DPM	700	700	700	700

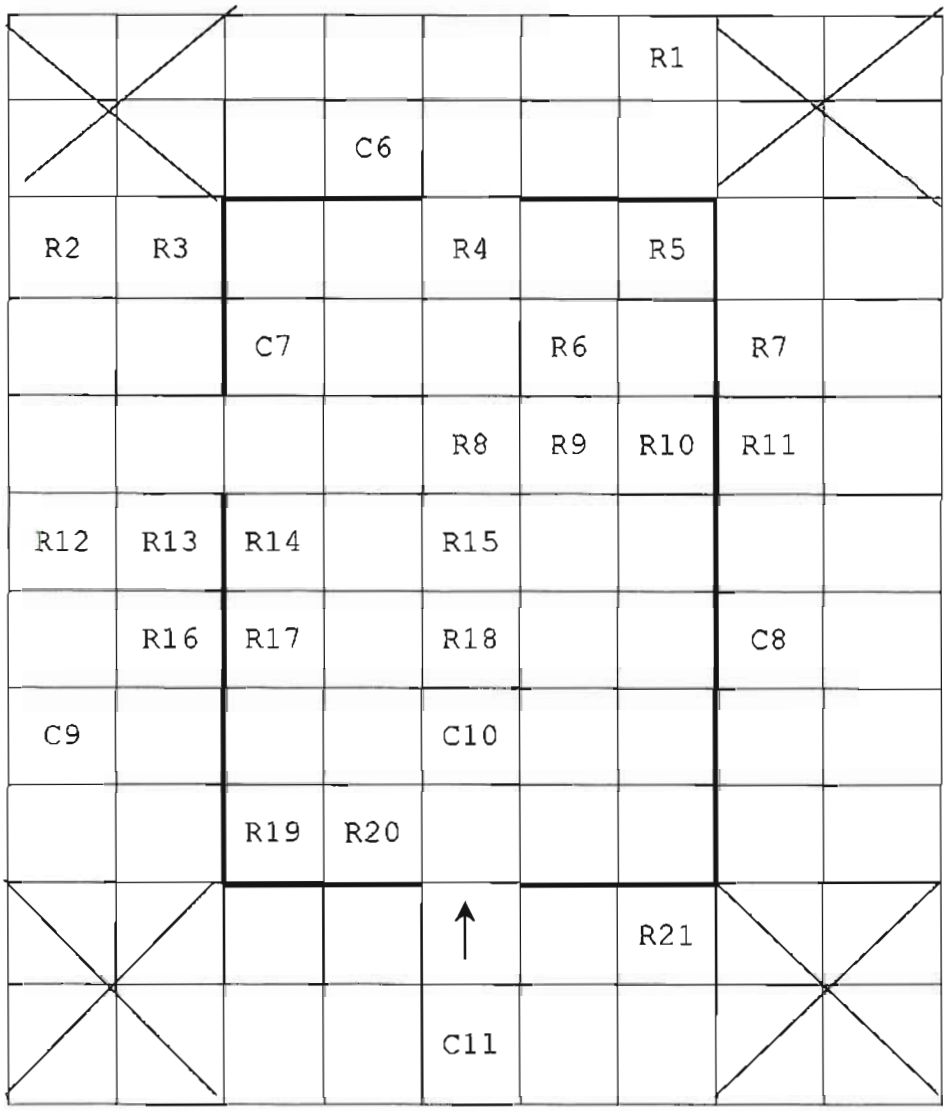


Figure 12-3-9. Grid Map for Building 53, Room 118

Legend:
→ = Main entrance
C12 = Left Counter
C13 = Right Counter
C14 = Left Sink
C15 = Right Sink

Table 12-3-23. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053				
C. Survey Unit or Room Number: 119				
Survey Date: 06/09/00			Count Times: 1 minute	
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	4	5	16	6
2	20	1	26	3
3	2	10	8	7
4	1	17	0	10
5	0	3	10	14
6	2	12	7	9
7	4	5	9	4
8	28	1	14	21
9	14	2	9	19
10	7	9	11	125
11	2	12	4	5
12	6	14	15	2
13	8	7	8	7
14	19	4	0	0
15	19	6	8	2
16	7	12	13	7
17	6	14	11	11
18	6	14	1	12
19	0	10	0	20
20	0	7	11	21
21	24	8	8	7
Average DPM	9	8	9	15
Standard Deviation, DPM	9	5	6	26
Maximum DPM	28	17	26	125
Action Limit, DPM	700	700	700	700

Table 12-3-24. Final Status Survey Summary for CONTROL STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053				
D. Survey Unit or Room Number: 119				
Survey Date: 06/09/00			Count Times: 1 minute	
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	4	5	29	8
2	20	1	25	11
3	2	10	2	10
4	1	17	11	11
5	0	3	5	17
6	2	12	24	18
7	4	5	10	4
8	28	1	29	6
9	14	2	14	6
10	7	9	31	1
11	2	12	31	10
12	6	14	19	1
13	8	7	29	13
14	19	4	32	8
15	19	6	18	6
16	7	12	14	0
17	6	14	8	4
18	6	14	52	11
19	0	10	21	13
20	0	7		
21	24	8		
Average DPM	9	8	21	8
Standard Deviation, DPM	9	5	12	5
Maximum DPM	28	17	52	18
Action Limit, DPM	700	700	700	700

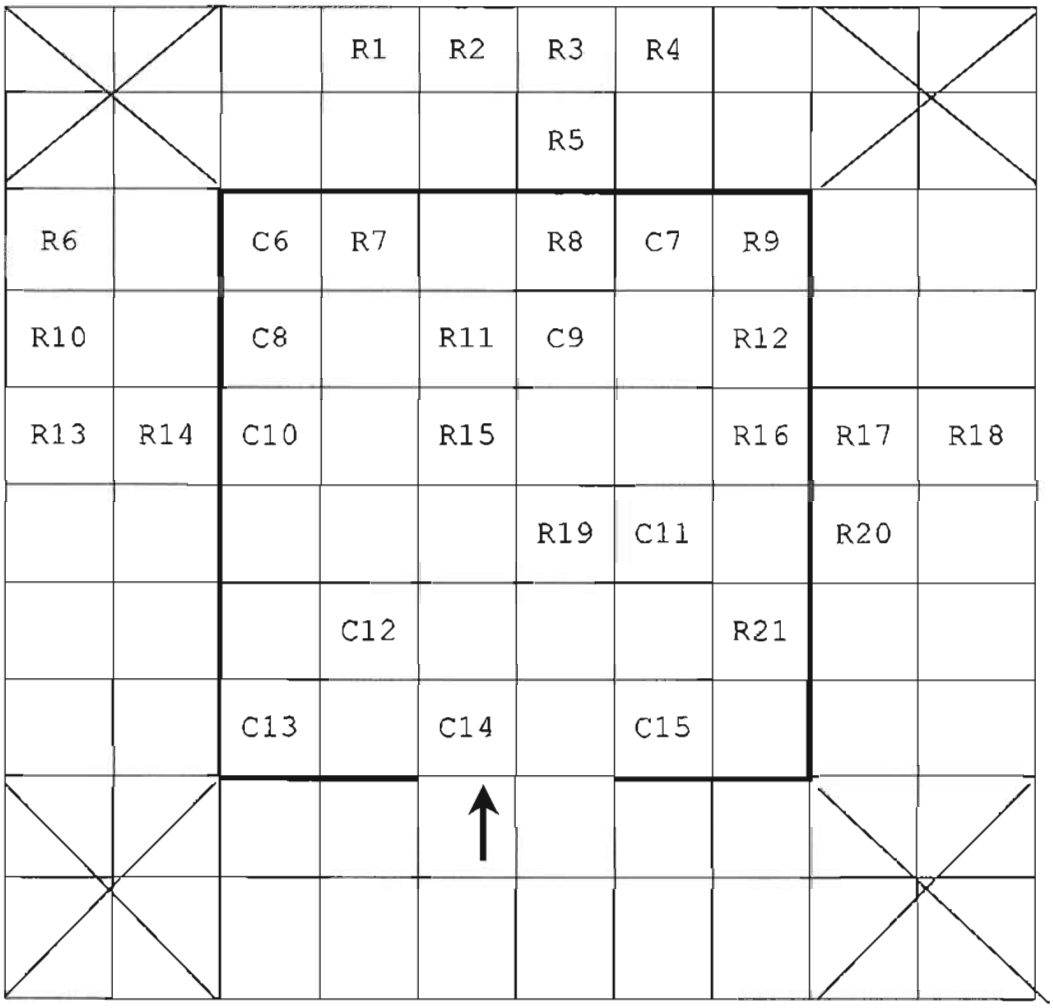


Figure 12-3-10. Grid Map for Building 53, Room 119

Legend:

→ = Main Entrance ; C16 = Sink; C17 = Hood; C18 = Center Counter; C19 Middle Counter

Table 12-3-25. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053				
E. Survey Unit or Room Number: 120				
Survey Date: 06/09/00			Count Times: 1 minute	
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	4	5	3	7
2	20	1	8	7
3	2	10	33	5
4	1	17	1	15
5	0	3	4	5
6	2	12	2	10
7	4	5	0	7
8	28	1	13	9
9	14	2	0	10
10	7	9	9	4
11	2	12	0	7
12	6	14	7	12
13	8	7	0	17
14	19	4	14	2
15	19	6	12	7
16	7	12	5	19
17	6	14	24	8
18	6	14	4	2
19	0	10	3	7
20	0	7	9	7
21	24	8	21	9
Average DPM	9	8	8	8
Standard Deviation, DPM	9	5	9	4
Maximum DPM	28	17	33	19
Action Limit, DPM	700	700	700	700

Table 12-3-26a. Final Status Survey Summary for CONTROL STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053				
Survey Unit or Room Number: 120				
Survey Date: 06/09/00			Count Times: 1 minute	
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	4	5	13	7
2	20	1	0	18
3	2	10	15	4
4	1	17	7	9
5	0	3	0	5
6	2	12	16	11
7	4	5	6	17
8	28	1	0	7
9	14	2	3	10
10	7	9		
11	2	12		
12	6	14		
13	8	7		
14	19	4		
15	19	6		
16	7	12		
17	6	14		
18	6	14		
19	0	10		
20	0	7		
21	24	8		
Average DPM	9	8	7	10
Standard Deviation, DPM	9	5	7	5
Maximum DPM	28	17	16	18
Action Limit, DPM	700	700	700	700

Table 12-3-26b. Final Status Survey Summary for CONTROL STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053				
Survey Unit or Room Number: 120D				
Survey Date: 06/09/00			Count Times: 1 minute	
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	4	5	3	7
2	20	1	3	7
3	2	10	2	12
4	1	17	3	7
5	0	3	0	10
6	2	12	12	9
7	4	5	6	14
8	28	1	1	14
9	14	2	10	19
10	7	9	17	9
11	2	12	22	6
12	6	14	13	4
13	8	7	13	9
14	19	4	13	4
15	19	6	0	10
16	7	12	21	4
17	6	14	25	6
18	6	14	14	16
19	0	10	11	11
20	0	7	4	5
21	24	8	0	15
22			18	4
23			9	2
24			18	4
25			2	12
26			0	12
27			9	4
28			18	6
29			17	14
30			13	7
31			0	15
Average DPM	9	8	10	9
Standard Deviation, DPM	9	5	8	4

Maximum DPM	28	17	25	19
Action Limit, DPM	700	700	700	700

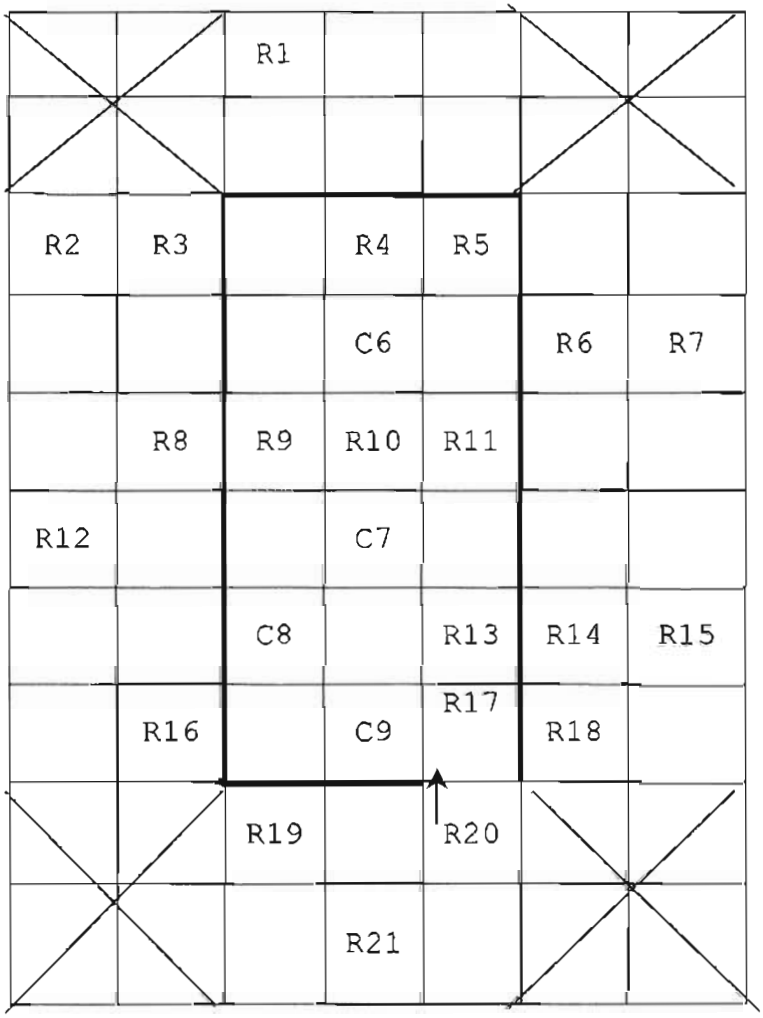


Figure 12-3-11. Grid Map for Building 53, Room 120
Legend:

→ = Main Entrance

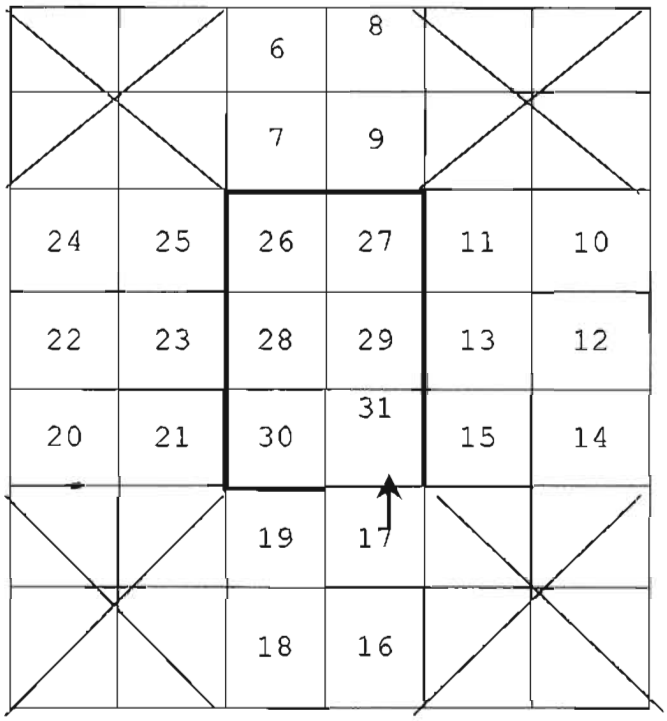


Figure 12-3-12. Grid Map for Building 53, Room 120D

Legend:
→ = Main Entrance

Table 12-3-27. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 121		
Survey Date: 04/21/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	19	6	76	0
2	12	7	16	9
3	16	9	3	7
4	13	7	8	4
5	17	9	12	11
6	2	10	37	0
7	23	6	3	10
8	7	9	26	11
9	12	11	7	14
10	13	9	3	10
11	3	7	3	10
12	23	1	2	10
13	12	7	22	4
14	18	9	21	8
15	2	10	0	7
16	0	7	15	14
17	12	11	16	9
18	7	12	0	10
19	3	7	8	4
20	22	6	5	5
21	12	16	20	4
Average DPM	12	8	14	8
Standard Deviation, DPM	7	3	17	4
Maximum DPM	23	16	76	14
Action Limit, DPM	700	700	700	700

Table 12-3-28. Final Status Survey Summary for CONTROL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053	Survey Unit or Room Number: 121			
Survey Date: 04/21/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	19	6	9	7
2	12	7	11	14
3	16	9	31	3
4	13	7	5	0
5	17	9	25	8
6	2	10	7	20
7	23	6	17	1
8	7	9	3	7
9	12	11	4	5
10	13	9	14	4
11	3	7	25	1
12	23	1	7	12
13	12	7	11	11
14	18	9	7	14
15	2	10	0	7
16	0	7	25	13
17	12	11	17	4
18	7	12	0	10
19	3	7	19	4
20	22	6	3	7
21	12	16	12	9
22			8	4
23			0	12
24			3	7
25			17	6
26			6	17
27			2	10
28			26	11
29			16	6
Average DPM	12	8	11	8
Standard Deviation, DPM	7	3	9	5
Maximum DPM	23	16	31	20
Action Limit, DPM	700	700	700	700

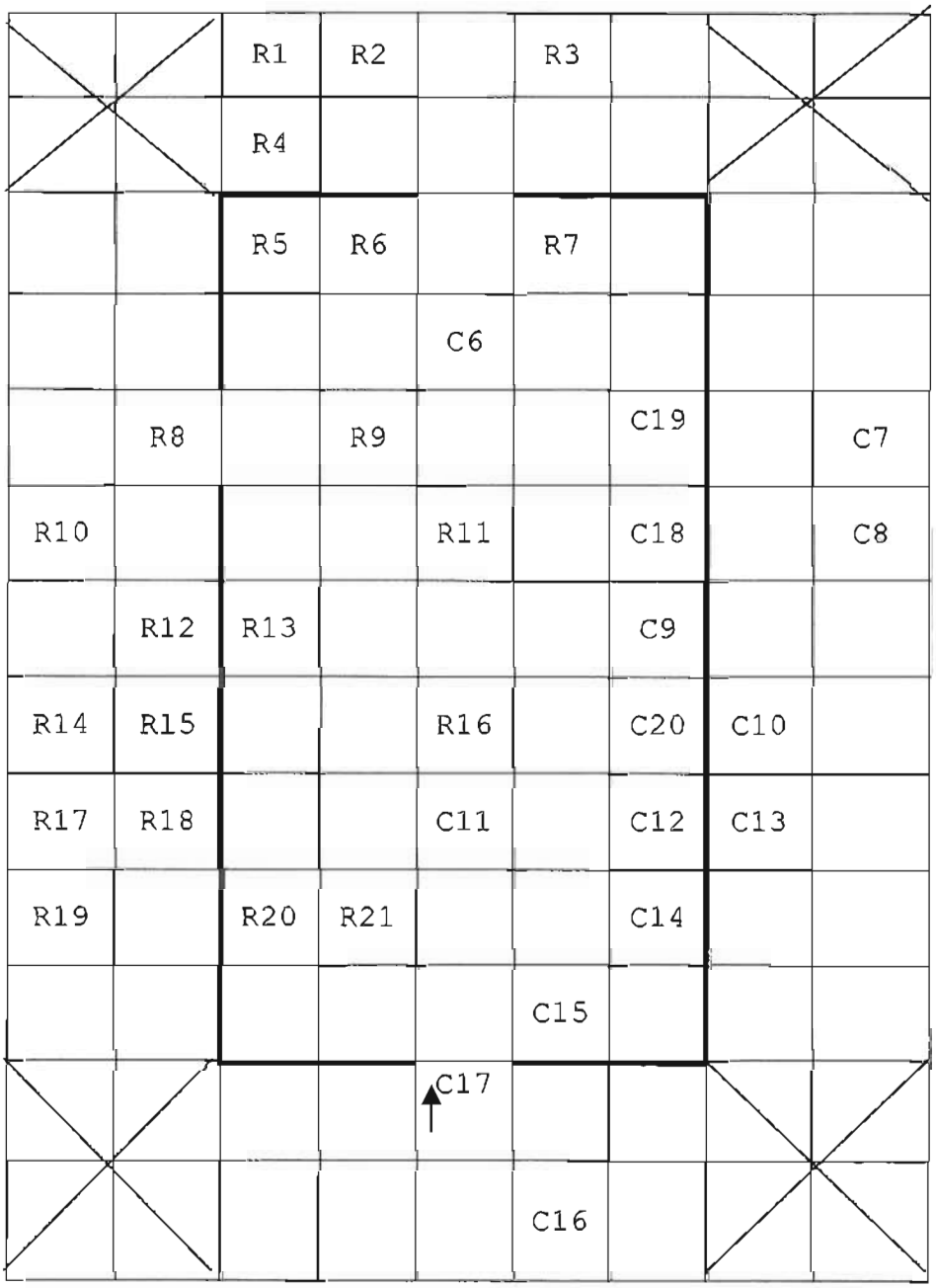


Figure 12-3-13. Grid Map for Building 53, Room 121

Legend:
→ = Main entrance; C18= LEFT (L) COUNTER; C19= L COUNTER, FRONT; C20=FRONT COUNTER; C21=RIGHT (R) COUNTER; C22=L SMALL SINK; C23=L LARGE SINK; C24=L SMALL SINK; C25=L FRONT SINK; C26=R SINK; C27=HOOD; C28= HOOD; C29= BIOHOOD

Table 12-3-29. Final Status Survey Summary for RANDOM STATISTICAL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053		Survey Unit or Room Number: 122		
Survey Date: 04/21/00		Count Times: 1 minute		
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	19	6	18	6
2	12	7	7	12
3	16	9	9	4
4	13	7	0	3
5	17	9	0	5
6	2	10	0	15
7	23	6	13	4
8	7	9	10	12
9	12	11	8	4
10	13	9	8	9
11	3	7	0	13
12	23	1	12	2
13	12	7	21	6
14	18	9	11	9
15	2	10	16	6
16	0	7	14	2
17	12	11	4	5
18	7	12	6	12
19	3	7	11	9
20	22	6	21	6
21	12	16	1	17
Average DPM	12	8	9	8
Standard Deviation, DPM	7	3	7	4
Maximum DPM	23	16	21	17
Action Limit, DPM	700	700	700	700

Table 12-3-30. Final Status Survey Summary for CONTROL SAMPLES FOR IMPACTED SURVEY UNIT				
Building: 053	Survey Unit or Room Number: 122			
Survey Date: 04/21/00	Count Times: 1 minute			
Liquid Scintillation Swipe Results for Background, H-3 and C-14 Analyses for Residual Contamination				
Sample Number	DPM, Background		DPM, H-3	DPM, C-14
	H-3	C-14		
1	19	6	15	9
2	12	7	10	2
3	16	9	21	6
4	13	7	17	4
5	17	9	10	11
6	2	10	18	1
7	23	6	9	14
8	7	9	17	6
9	12	11	13	2
10	13	9	0	10
11	3	7	11	4
12	23	1	12	7
13	12	7	13	11
14	18	9	10	9
15	2	10	16	11
16	0	7	4	10
17	12	11	14	2
18	7	12	14	0
19	3	7	9	7
20	22	6	19	6
21	12	16	10	2
22			14	9
23			9	7
24			15	16
25			17	6
26			2	10
27			1	12
28			20	8
29			12	9
30			11	9
31			0	2
32			2	10
33			1	15
34			13	4

35			0	17
Average DPM	12	8	11	8
Standard Deviation, DPM	7	3	6	4
Maximum DPM	23	16	21	17
Action Limit, DPM	700	700	700	700

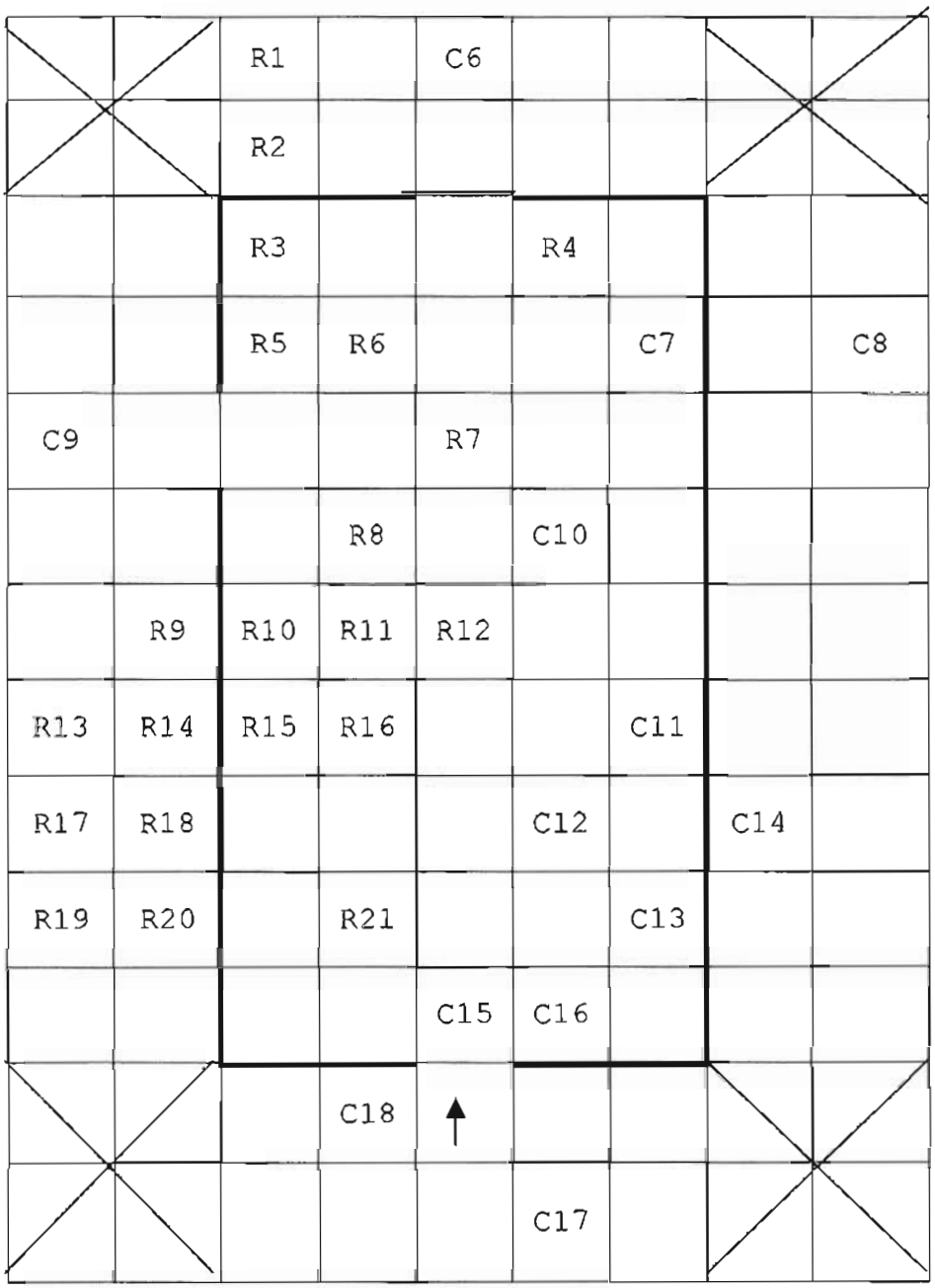


Figure 12-3-14. Grid Map for Building 53, Room 122

Legend:
→ = Main entrance; C19=R FRONT COUNTER; C20=R REAR COUNTER; C21=BACK COUNTER; C22=L REAR COUNTER; C23=L FRONT COUNTER; C24=L FRONT SINK; C25=L REAR SINK #1; C26=L REAR SINK #2; C27=REAR SINK; C28=R REAR SINK #1; C29=R REAR SINK #2; C30=R FRONT SINK#1; C31=R FRONT SINK#2; C32=R FRONT SINK#3; C33=EYEWASH SINK; C34=ISLAND COUNTER; C35=HOOD