FROM

DL-072996_05

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W., SUITE 2900
ATLANTA, GEORGIA 30323-0199

July 29, 1996

United States Department of Interior
U.S. Geological Survey (USGS)
ATTN: Mr. Gregory Alan Wandless,
Radiation Safety Officer (RSO)
12201 Sunrise Valley Drive
Reston, VA 22092

SUBJECT: TRANSMITTAL AND EXPLANATION OF A MATERIALS LICENSE AMENDMENT (REFERENCE: 257104; DOCKET NO. 030-10034)

Dear Mr. Wandless:

Enclosed is Amendment No. 28 to License No. 45-15923-01 issued in response to your letter dated June 14, 1996. This amendment authorizes the relocation of research activities conducted by Drs. Charles and Nancy Naeser to Room 3C232 of the J. W. Powell Building.

However, prior to decommissioning their former laboratory in Room 3D231, please provide the additional information specified in Mr. Jay Henson's letter of July 9, 1996 (copy enclosed). Please do not release Room 3D231 for non-radiological use until you have received written NRC authorization.

Also, I have reviewed your letter dated May 29, 1996 concerning the down-sizing of your program for use of licensed material. Outlined below are my comments.

1. Information referenced in Items 2, 3, and 4 of your letter has been reviewed by Mr. Jay Henson. His comments are contained in his letter to you dated July 9, 1996 (copy enclosed).

2. Concerning the other items in your letter:

   A. Item 1: Be sure that the documentation you provide to me for licensed material transferred includes the isotope, activity and the Item number on your NRC license that authorizes the isotope (for example, 6.A. Hydrogen 3, 6.B. Cobalt 60, ...).

   B. Item 5 and 6: Specify the anticipated date the information will be provided to the NRC.

   C. Item 7: Upon satisfactory completion of Dr. Naeser's training program for RSO, provide me with a letter attesting to his competency to independently perform the RSO duties.

   Even though the USGS program is being down-sized, I am not sure that 24 hours of on-the-job training in radiation safety, as you proposed, would be adequate for naming Dr. Naeser as sole Radiation Safety Officer (RSO).

   Accordingly, I have revised Condition No. 11 of License No. 45-15923-01 to continue to name Gregory Wandless as RSO and to identify Dr. Charles Naeser as "RSO in training"

When Dr. Naeser satisfactorily completes the 24-hour classroom training given by Mr. Michael Terpilak and at least three months (no specified clock hours) of on-the-job training in radiation safety under the supervision of Mr. Gregory Wandless, please provide me with a letter specifying inclusive dates of training and attesting to Dr. Naeser's competency to independently perform the RSO duties. This letter should be signed by the persons giving the training.

D. Item 8: No further information is required.

Please provide two copies of your response and refer to Mail Control No. 256959.

Thank you for your cooperation in this matter. If you have questions about this letter or your license, please call me at 404/331-5617 (FAX: 404/331-7437).

Sincerely,

Earl G. Wright

Earl G. Wright
Senior License Reviewer
Division of Nuclear Materials Safet

Enclosure:

I. Letter dated July 9, 1996

CC:
Mr. Gordon Eaton, Director USGS
Mr. Michael Terpilak, Consultant to USGS
bcc: Mr. Jay Henson MLIB 2, DNMS, RII

FROM

NRC FORM 374
(7-94)

U.S. NUCLEAR REGULATORY COMMISSION

MATERIALS LICENSE

Amendment No. 28

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974 (Public Law 93-438), and Title 10, Code of Federal Regulations, Chapter I, Parts 30, 31, 32, 33, 34, 35, 36, 39, 40, and 70, and in reliance on statements and representations heretofore made by the licensee, a license is hereby issued authorizing the licensee to receive, acquire, possess, and transfer byproduct, source, and special nuclear material designated below; to use such material for the purpose(s) and at the place(s) designated below; to deliver or transfer such material to persons authorized to receive it in accordance with the regulations of the applicable Part(s). This license shall be deemed to contain the conditions specified in Section 183 of the Atomic Energy Act of 1954, as amended, and is subject to all applicable rules, regulations, and orders of the Nuclear Regulatory Commission now or hereafter in effect and to any conditions specified below.

Licensee

1. U.S. Department of the Interior
Geological Survey
National Center
2. M.S. 927
12201 Sunrise Valley Drive
Reston, Virginia 22092

In accordance with the letter dated June 14, 1996

3. License Number 45-15923-01

is amended in its entirety to read as follows:

4. Expiration Date November 30, 2000 (extended)

5. Docket or Reference No. 030-10034

6. Byproduct, Source, and/or Special Nuclear Material	7. Chemical and/or Physical Form	8. Maximum Amount that Licensee May Possess at Any One Time Under This License
A. Hydrogen 3	A. Any	A. 2 millicuries (74 MBq) total
B. Carbon 14	B. Any	B. 8 millicuries (296 MBq) total
C. Phosphorus 32	C. Any	C. 2 millicuries (74 MBq) total
D. Phosphorus 33	D. Any	D. 2 millicuries (74 MBq) total
E. Sulphur 35	E. Any	E. 4 millicuries (148 MBq) total
F. Chlorine 36	F. Liquid	F. 50 microcuries (1.85 MBq)
G. Cobalt 60	G. Sealed sources	G. 3 sources, not to exceed 16 microcuries (592 kBq) total
H. Cobalt 60	H. Any	H. 500 microcuries (18.5 MBq) total
I. Nickel 63	I. Foils in Shimadzu Model EDC-M2 detector cells	I. Not to exceed 15 millicuries (555 MBq) per foil
J. Nickel 63	J. Sealed or plated sources	J. Not to exceed 15 millicuries (555 MBq) per sealed or plated source
K. Iron 55	K. Any	K. 10 millicuries (370 MBq)
L. Zinc 65	L. Any	L. 200 microcuries (7.4 MBq)
M. Strontium 89	M. Any	M. 10 microcuries (370 kBq)
N. Strontium 90	N. Any	N. 10 microcuries (370 kBq)
O. Tin 113	O. Any	O. 10 microcuries (370 kBq)

FROM

NRC FORM 374A (7-94)

U.S. NUCLEAR REGULATORY COMMISSION

License Number 45-15923-01

MATERIALS LICENSE SUPPLEMENTARY SHEET

Docket or Reference No. 030-10034

Amendment No. 28

Continued -

6. Byproduct, source, and/or special nuclear material	7. Chemical and/or physical form	8. Maximum amount that licensee may possess at any one time under this license
P. Antimony 125	P. Any	P. 100 microcuries (3.7 MBq)
Q. Barium 133	Q. Any	Q. 500 microcuries (18.5 MBq) total
R. Cesium 137	R. Sealed sources	R. 3 sources, not to exceed 20 microcuries (740 kBq) total
S. Ces 137	S. Any	S. 10 millicuries (370 MBq)
T. Prc nium 147	T. Sealed sources	T. 2 millicuries (74 MBq)
U. Protactinium 231	U. Any	U. 10 microcuries (370 kBq) total
V. Neptunium 237	V. Any	V. 10 microcuries (370 kBq) total
W. Americium 241	W. Any	W. 500 microcuries (18.5 MBq) total
X. Americium 241	X. Sealed sources (custom made)	X. 20 sources, not to exceed 40 millicuries (1.48 GBq) total
Y. Any byproduct material	Y. Activated samples	Y. 530 millicuries (19.65 GBq) total
Z. Technetium 99	Z. Liquid	Z. 1 millicurie (37 MBq)

9. Authorized Use:

A. through E.
For use in laboratory tracer studies and molecular biology procedures

F. For use in molecular bi y procedures

G. For use in the testing, evaluation, and calibration of detectors

H. For use in laboratory tracer studies

I. For use in Shimadzu Mini-2E gas chromatographs for sample analysis

J. For use in gas chromatographs for sample analysis

K. through O.
For use in laboratory tracer studies

R. For use in testing, evaluation, and calibration of detectors

NRC FORM 374A
(7-94)

U.S. NUCLEAR REGULATORY COMMISSION

License Number 45-15923-02

Docket or Reference No. 030-10034

Amendment No. 28

MATERIALS LICENSE
SUPPLEMENTARY SHEET

9. Authorized Use (Continued)

S. through W.
For use in laboratory tracer studies

X. For use in X-ray fluorescence studies

Y. For possession incident to neutron activations and radioactive dating studies

Z. For use in laboratory studies

CONDITIONS

10. Licensed material may be used at:

A. Geological Survey Physics Building, Lot "O" off South Lakes Drive, and the National Center (John Wesley Powell Federal Building), 12201 Sunrise Valley Drive, Reston Virginia.

B. Room 519, U.S. Geological Survey, Stephenson Center, Suite 129, 720 Gracern Road, Columbia, South Carolina.

11. The Radiation Safety Officer (RSO) for this license is Gregory A. Wandless. The Radiation Safety Officer in-training is Charles W. Naeser, Ph.D.

12. Authorized users:

A.	Allan B. Tanner	For materials listed in Subitems 6.A. through Z.
B.	Eurybiades Busenberg	For material listed in Subitem 6.I.
C.	Nancy D. Naeser	For materials listed in Subitem 6.Y.
D.	Philip A. Baedecker	For materials listed in Subitems 6.F, H, L through O, S, U through W and Y.
E.	Jeffrey N. Grossman	For materials listed in Subitems 6.F, H, L through O, S, U through W, and Y.
F.	Michael J. Kunk	For materials listed in Subitem 6.Y.
G.	Edward R. Landa	For material listed in Subitem Z.
H.	Derek R. Lovley	For materials listed in Subitems 6.A through C, D, J and Z.
I.	John W. Morgan	For materials listed in Subitems 6.F, H, J through O, S, U through W, and Y.
J.	Curtis A. Palmer	For materials listed in Subitems 6.F, H, J through O, S, U through W, and Y.
K.	Elizabeth J. Jones	For materials listed in Subitems 6.A through C, E and J.
L.	Michael J. Pickering	For materials listed in Subitems 6.G, R, and Y.

FROM

NRC FORM 374A
(7-84)

U.S. NUCLEAR REGULATORY COMMISSION

License Number 45-15923-01

Docket or Reference Number 030-10034

Amendment No. 28

MATERIALS LICENSE
SUPPLEMENTARY SHEET

CONDITIONS

Continued-

12. Authorized Users: (Continued)

M.	John F. Sutter	For materials listed in Subitem 6.Y.
N.	Gregory A. Wandless	For materials listed in Subitems 6.F, H, L through Q, S, V through Y.
O.	Joan Woodward	For materials listed in Subitems 6.A through E, and J.
P.	Francis H. Chapelle	For materials listed in Subitems 6.B, C and J.
Q.	Paul M. Bradley	For materials listed in Subitems 6.C, D and J.
R.	James E. Landmeyer	For materials listed in Subitems 6.C, D and J.
S.	Debra J. Lonergan	For materials listed in Subitems 6.C, D and F.
T.	Peggy K. Widman	For materials listed in Subitems 6.A through E, and J.
U.	Charles W. Naeser	For materials listed in Subitems 6.Y.

13. A.(1) The sealed source(s) specified in Item 7, shall be tested for leakage and/or contamination at intervals not to exceed 6 months. Any sealed source received from another person which is not accompanied by a certificate indicating that a test was performed within 6 months before the transfer shall not be put into use until tested.

(2) Notwithstanding the periodic leak test required by this condition, any licensed sealed source is exempt from such leak tests when the source contains 100 microcuries or less of beta and/or gamma emitting material or 10 microcuries or less of alpha emitting material.

B. Any source in storage and not being used need not be tested. When the source is removed from storage for use or transfer to another person, it shall be tested before use or transfer.

C. The test shall be capable of detecting the presence of 0.005 microcurie of radioactive material on the test sample. If the test reveals the presence of 0.005 microcurie or more of removable contamination, the source shall be removed from service and decontaminated, repaired, or disposed of in accordance with Commission regulations. A report shall be filed within 5 days of the date the leak test result is known with the U. S. Nuclear Regulatory Commission, Region II, Division of Nuclear Materials Safety, Nuclear Materials Licensing Inspection Branch, 101 Marietta Street, Suite 2900, Atlanta, Georgia 30323. The report shall specify the source involved, the test results, and corrective action taken. Records of leak test results shall be kept in units of microcuries and shall be maintained for inspection by the Commission. Records may be disposed of following Commission inspection.

D. Tests for leakage and/or contamination shall be performed by the licensee or by other persons specifically licensed by the Commission or an Agreement State to perform such services.

14. Sealed sources containing licensed material shall not be opened by the licensee.

License Number 45-15923-01

MATERIALS LICENSE
SUPPLEMENTARY SHEET

Docket or Reference Number 030-10034

Amendment No. 28

CONDITIONS

Continued-

15. Detector cells containing licensed material shall not be opened or the sources removed from the detector cell by the licensee.

16. The licensee shall conduct a physical inventory every 6 months to account for all sources and/or devices received and possessed under this license.

17. Licensed material shall not be used in or on human beings or in products distributed to the public.

18. The licensee shall maintain records of information important to safe and effective decommissioning at the U.S. Department of the Interior, Geological Survey, National Center, 12201 Sunrise Valley Drive, Reston, Virginia, pursuant to the provisions of 10 CFR 30.35(g) until this license is terminated by the Commission.

19. In addition to the possession limits in item 8, the licensee shall further restrict the possession of licensed material as follows:

    A. For unsealed sources to quantities less than 10^5 times the applicable limits in Appendix B, 10 CFR 30 as specified in 10 CFR 30.35(d) and

    B. For sealed sources, to quantities less than 10^{10} times the applicable limits in Appendix B, 10 CFR 30 as specified in 10 CFR 30.35(d).

20. The licensee may transport licensed material in accordance with the provisions of 10 CFR Part 71, "Packaging and Transportation of Radioactive Material."

FROM

NRC FORM 374A (7-94)

U S NUCLEAR REGULATORY COMMISSION

License Number 45-15923-01

MATERIALS LICENSE
SUPPLEMENTARY SHEET

Docket or Reference Number 030-10031

Amendment No. 28

CONDITIONS

Continued-

21. Except as specificall provided otherwise in this license, the licensee shall conduct its program in accordance with the statements, representations, and procedures contained in the documents including any enclosures, listed below. The Nuclear Regulatory Commission's regulations shall govern unless the statements, representations and procedures in the licensee's application and correspondence are more restrictive than the regulations.

A. Application dated June 26, 1990

B. Letters dated:

(1) October 4, 1990	
(2) August 29, 1991	
(3) December 10, 1991	
(4) January 14, 1993	[Add Columbia SC and authorized users there]
(5) January 14, 1993	[Add P-32, Ms. Lonergan as user, reinstate Cl-36 use]
(6) November 23, 1993	[Add P-33 w/Ms. Lonergan as user, deletes Yuri Gorby and Steven Mee as authorized users]
(7) July 1, 1994	[Change user names, add authorized user, delete departed users, change rooms]
(8) August 22, 1994	[Change Radiation Safety Officer]
(9) January 30, 1995	[Add authorized users]
(10) February 22, 1995	[Increase C-14 limit to 8 mCi]
(11) March 1, 1996	[NRC letter extends expiration date per 10 CFR 30.36]
(12) June 14, 1996	[New laboratory location, Room 3C232 of J. W. Powell Building]

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

EARL G. WRIGHT

DATE JUL 29 1996

BY Earl G Wright

Region II Division of Nuclear Materials Safety
101 Marietta Street, N.W., Suite 2900
Atlanta, GA 30323-0199

NMLICENSE 45-15923-01

APPENDIX B

UNITED STATES

NUCLEAR REGULATORY COMMISSION

NUREG/CR - 5489

MANUAL FOR CONDUCTING

RADIOLOGICAL SURVEYS IN SUPPORT OF

LICENSE TERMINATION

JUNE, 1992

NUREG/CR-5849
ORAU-92/C57

Manual for Conducting Radiological Surveys in Support of License Termination

Draft Report for Comment

Prepared by
J. D. Berger

Oak Ridge Associated Universities

Prepared for
U.S. Nuclear Regulatory Commission

Reprinted February 1993

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ORAU-92/C57

Manual for Conducting Radiological Surveys in Support of License Termination

Draft Report for Comment

Manuscript Completed May 1992
Date Published June 1992

Prepared by
J. D. Berger

Environmental Survey and Site Assessment Program
Energy/Environmental Systems Division
Oak Ridge Associated Universities
Oak Ridge, TN 37831-0117

Prepared for
Division of Regulatory Applications
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555
NRC FIN L1569

4.0 Planning and Designing the Final Status Survey

The purpose of the final status survey is to demonstrate that the release criteria established by the NRC have been met. Demonstrating that this has been achieved requires collection of data for determining surface activity levels, direct exposure rates, and radionuclide concentrations in soil. In addition, supplemental information, such as radionuclide concentrations in ground water and total site inventory of radioactive material, may be required by the NRC. The data should be accurate and reliable and should be adequate to satisfy other conditions and considerations which the NRC may impose. A well-documented, statistically based survey plan will be the basis for meeting these objectives.

The survey plan should describe the survey design in detail. The plan should include:

- A list of the types, numbers, and locations of measurements and samples to be obtained;
- Information on the equipment and techniques to be used for measuring, sampling, and analyzing data;
- The methods to be used to interpret and evaluate the survey data; and,
- Quality control procedures for ensuring the validity of the data.

This section discusses considerations for developing such a plan, including quality control procedures, and site information required to plan and design the survey. This section also describes how to select measurement/sampling locations and to determine the sampling frequency that will be required to assure the statistical significance of the data. A general flow chart for a radiological survey supporting license termination is provided in Figure 4-6; detailed flow charts for various activities related to the survey process are provided in Section 6.0. Appendix B provides a sample survey plan for a hypothetical reference fuel fabrication facility.

4.1 General Considerations for Survey Planning

4.1.1 Quality Assurance

Because the purpose of the final status survey is to demonstrate that a facility meets the established release criteria, the survey should be performed in a manner that assures the results are accurate and that uncertainties have been adequately considered. An effective QA program will define the data quality objectives of the survey and thereby determine, to a significant extent, the survey design. This program will operate in all stages of the survey through final validation of the data and the interpretation of the results.

The consensus nuclear industry standard for quality assurance is ANSI/ASME NQA-1, Quality Assurance Program Requirements for Nuclear Facilities (ANSI 1989). The NRC has also issued guidance for an acceptable QA program in Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Program — Effluent Streams and the Environment (NRC 1979). A quality assurance program, consistent with the information contained in these documents, should be developed.

Surveys should be performed by trained individuals who are following standard, written procedures, and are using properly calibrated instruments which are sensitive to the suspected contaminant. The custody of samples should be tracked from collection to analysis. Data should be recorded in an orderly and verifiable way and reviewed for accuracy and consistency. Every step of the decommissioning process, from training personnel to calculating and interpreting the data, should be documented in a way that lends itself to audit. These requirements are achieved through a formal program of quality assurance. Failure to follow such requirements may limit the usefulness of portions of the survey data.

<u>QA Plans</u>

The decommissioning plan should include a written QA plan that describes the organizational structure under which the decommissioning efforts — and particularly the final status survey — will be conducted. Functional and administrative responsibilities and interfaces of key individuals should be clearly delineated. Education, experience, and any other requirements for each key position should be specified. The size and complexity of the organizational structure will be determined by the magnitude of the decommissioning action.

QA Coordination

One individual should be designated as the QA officer or QA coordinator. This individual should not be involved in survey activities that generate data and should report directly to the project manager. The QA officer/coordinator should be responsible for ensuring that all QA objectives of the survey are met, should review selected field and analytical data to ensure adherence to procedures, and should approve the quality of data before it us used to test hypotheses regarding attainment of cleanup standards. Specifically, this individual:

- Serves as the focal point for survey QA activities and ensures that they are conducted in accordance with established policies and procedures

- Oversees survey activities by conducting internal audits and/or surveillance.

Documentation Requirements

All aspects of the survey should be documented in detail. For certain field or laboratory activities, consensus or industry-wide procedures, such as those developed by the Environmental Protection Agency (EPA), American Society of Testing and Materials (ASTM), DOE's Environmental Measurements Laboratory (EML), or other such organizations may be either adopted in whole or adapted to meet the requirements of the specific decommissioning action. These procedures become part of the administrative record of the survey. The procedures should be approved by the individual responsible for the decommissioning project and the effective date of the procedure should be indicated. Changes or exceptions to established procedures are likely to be required; and these also should be properly documented, signed, and dated.

Training/Certification of Survey Staff

All personnel conducting the surveys should receive training to qualify in the procedures being performed. The extent of training and qualifications should be commensurate with the education, experience, and proficiency of the individual and the scope, complexity, and nature of the activity. Training should be designed to achieve initial proficiency and to maintain that proficiency at least over the course of the decommissioning process. Records of training, including testing to demonstrate qualification, should be maintained.

Equipment Maintenance and Calibration

Measuring equipment should be maintained, calibrated, and tested to assure the validity of the survey data. Further, the procedures, responsibilities, and schedules for calibrating and testing equipment should be documented.

Proper maintenance of equipment varies, but maintenance information and use limitations should be provided in the vendor documentation. All measurement and analytical equipment should be tested and calibrated before initial use and should be recalibrated if maintenance or modifications could invalidate earlier calibrations. Field and laboratory equipment should be calibrated based on standards traceable to the National Institute of Standards and Technology (NIST). In those cases where NIST-traceable standards are not available, standards of an industry-recognized organization (for example, the New Brunswick Laboratory for various uranium standards) may be used. Minimum frequencies for calibrating equipment should be established and documented.

Measuring equipment should be tested at least once each day the equipment is used. Test results should be recorded in tabular or graphic form and compared to predetermined, acceptable performance ranges. Equipment that does not conform to the performance criteria should be immediately removed from service until the deficiencies can be resolved.

Data Management

A consistent method of data generation, handling, computations, evaluation, and reporting should be developed and documented as part of the survey plan. In general, information and data should be recorded in bound logs or on standardized field and laboratory record forms. Analytical data should not be obliterated by erasing or the use of whiteout. Incorrect entries should be corrected by striking a single line across the entry and entering new data. The correction or change should be initialed and dated by the person making the entry.

A system of data review and validation is important to ensure consistency, thoroughness, and acceptability. This begins with regular (daily or weekly) reviews of calculations based on field data; and reviews of final reports by survey and laboratory supervisors, QA officials, and project managers. All reviews should be signed and dated. Any questionable or invalid data should be identified in project records and in the survey report. Active records should remain under direct control of a designated individual during report preparation; inactive records should be protected from loss or destruction by storage in access-controlled areas or files and in facilities with fire protection. It is also recommended that copies (microfilm, computer disc, photostats, etc.) of critical data be produced and stored at a separate location.

Sample Chain-of-Custody

One of the most important aspects of sample management is to ensure that the integrity of the sample is maintained; that is, that there is an accurate record of sample collection, transport, analysis, and disposal. This ensures that samples are neither lost nor tampered with and that the sample analyzed in the laboratory is actually and verifiably the sample taken from a specific location in the field.

Sample custody should be assigned to one individual at a time. This will prevent confusion of responsibility. Custody is maintained when (1) the sample is under direct surveillance by the assigned individual, (2) the sample is maintained in a tamper-free container, or (3) the sample is within a controlled-access facility.

A chain-of-custody record (a standard form) should be initiated by the individual collecting or overseeing the collection of samples. A copy of this form should accompany the samples throughout transportation and analyses; and any break in custody or evidence of tampering should be documented.

Audits

Periodic audits should be performed to verify that survey activities comply with established procedures and other aspects of the QA plan and to evaluate the overall effectiveness of the QA program. The audits should be conducted in accordance with written guidelines or checklists, and should be performed by individuals not actively participating in the activities being audited. Audit results are reported to responsible management in writing, and actions to resolve identified deficiencies should be tracked and appropriately documented.

4.1.2 Health and Safety

Consistent with the approach for any operation, decommissioning activities should be planned and monitored to assure the health and safety of the worker and other personnel, both on- and off-site, are adequately protected.

Contamination control and radiation control support surveys are conducted for protection of personnel performing decontamination activities. These surveys are operational in nature, as opposed to determining the radiological status of a facility, and are typically conducted as part of a licensee's ongoing radiation protection program. However, at the stage of determining the final status of the site, residual radioactivity is expected to be below the guideline values for unrestricted release; therefore, the final status survey should not require radiation protection controls.

The primary health and safety concerns during a final survey are the common potential industrial hazards typically found at a construction site. These include exposed electrical circuitry, excavations, enclosed work spaces, sharp objects or surfaces, falling objects, tripping hazards, and working at heights. The survey plan should incorporate requirements and procedures for eliminating, avoiding, or minimizing these potential safety hazards.

4.1.3 Physical Characteristics of Site

The physical characteristics of the site will have a significant impact on the complexity, schedule, and cost of a survey. These characteristics include the number and size of buildings, type of building construction, building condition, total area of grounds, topography, and ground cover.

<u>Building Interiors</u>

Building design and condition will have a marked influence on the survey efforts. The time required to conduct a survey of building interior surface is essentially directly proportional to the total surface area. For this reason the degree of survey coverage is decreased as the potential for residual activity decreases.

Building construction features such as ceiling height and incorporation of ducts, piping, and certain other services into the construction will determine the ease of accessibility of various surfaces. Scaffolding, cranes, manlifts, or ladders may be necessary to reach some surfaces. Accessing some locations may actually require dismantling portions of the building. If the building is constructed of porous materials, such as wood or concrete, and the surface was not sealed, contamination may have found its way into the walls, floors, and other surfaces. It may be necessary to obtain cores for laboratory analysis. Another common difficulty is the presence of contamination beneath tile or other floor coverings. This occurs because the covering placed over contaminated surfaces or the joints in tile were not sealed to prevent penetration. It has been the practice in some facilities to "fix" contamination (particularly alpha emitters) by painting over the surface of the contaminated area. All this should be addressed in surveys.

The condition of surfaces after decontamination may affect the survey process. Removing contamination that has penetrated a surface usually involves removing the surface as well. As a result, the floors and walls of decontaminated facilities are frequently badly scarred or broken up and are often very uneven. Such surfaces are more difficult to survey, because it is not possible to maintain a fixed distance between the detector and the surface and pitted or porous surfaces may significantly attenuate radiations — particularly alpha and low-energy beta particles. Use of monitoring equipment on wheels is precluded by rough surfaces, and such surfaces also pose an increased risk of damage to fragile detector probe faces.

The presence of furnishings and equipment will restrict access to building surfaces and add additional items which the survey should address. Equipment that was used directly for processes or activities involving radioactive materials will likely have been removed; however, in cases where such equipment remains, relatively inaccessible surfaces may require evaluation. It may also become necessary to remove or relocate certain furnishings such as lab benches and hoods, to obtain access to potentially contaminated floors and walls.

Piping, drains, sewers, sumps, tanks and other components of liquid handling systems present special difficulties because of the inaccessibility of interior surfaces. Process information, operating history, and preliminary monitoring at available access points will assist in evaluating the extent of sampling and measurements that will be required. Evaluation of inaccessible surfaces is addressed in Sections 6.4.3 - 6.4.5

Expansion joints, stress cracks, and penetrations into floors and walls for piping, conduit, anchor bolts, etc. are potential sites for accumulation of contamination and pathways for migration into subfloor soil and hollow wall spaces. Wall/floor interfaces are also likely locations for residual contamination. Coring, drilling, or other such methods may be necessary to gain access for survey.

Building Exteriors

Exterior building surfaces will typically have a low potential for residual contamination; however, there are several locations which should be surveyed. If there were roof exhausts or the facility is in proximity to the air effluent discharge points, the possibility of roof contamination should be considered. Because roofs are periodically resurfaced, contaminants may have been trapped in roofing material, and samples of this material may have to be obtained. Wall penetrations for process equipment, piping, and exhaust ventilation are potential locations for exterior contamination. Roof drainage points such as driplines along overhangs, downspouts, and gutters are also important survey locations. Window ledges and outside exits (doors, doorways, landings, stairways, etc.) from former contamination control areas are also building exterior surfaces which should be addressed.

Grounds

Depending upon site processes and operating history, the radiological survey may include varying portions of the land areas. At a minimum, those areas immediately adjacent to facilities where radioactive materials were handled should be surveyed. Other potentially contaminated open land or paved areas to be considered include equipment, product, waste, and raw material storage areas; liquid waste collection lagoons; areas downwind (based on predominant wind directions on an average annual basis, if possible) of stack release points; surface drainage pathways; and roadways that may have been used for transport of radioactive or contaminated materials.

Buried piping and underground tanks, spills, and septic leach fields which may have received contaminated liquids are locations of possible contamination that will require sampling of subsurface soil. Information regarding soil type (e.g. clay, sand, etc.) may provide insight into the retention or migration characteristics of specific radionuclides. The need for special sampling by coring or split-spoon equipment, usually by a commercial firm, should be anticipated.

Disposition of on-site, low-level waste burials, authorized under AEC/NRC regulations, will require a decision by the NRC following review of the licensee's decommissioning plan. If radioactive waste has been removed, surveys of excavations will be necessary before backfilling. If such material is to be left in place, the NRC may request subsurface sampling around the burial site perimeter to assess the potential for future migration.

If ground cover should be removed or if there are other obstacles that limit access by either survey personnel or by any needed special equipment (electromagnetic scanners and subsurface sampling rigs) the time and expense of making land areas accessible should be considered. In addition, precautionary procedures should be developed to prevent spreading surface contamination during ground cover removal and/or the use of heavy equipment.

4.2 Designing the Survey

4.2.1 Classification of Areas by Contamination Potential

All areas of the site will not have the same potential for residual contamination and therefore do not require the same level of survey coverage to achieve an acceptable level of confidence that the site satisfies the established release criteria. By designing the survey such that areas with higher potential for contamination receive a higher degree of survey effort, the process will be both effective and efficient.

Two classifications of areas are used in this Manual; these are termed **affected** and **unaffected** areas. These classifications are defined as follows:

- **affected areas**: Areas that have potential radioactive contamination (based on plant operating history) or known radioactive contamination (based on past or preliminary radiological surveillance). This would normally include areas where radioactive materials were used and stored, where records indicate spills or other unusual occurrences that could have resulted in spread of contamination, and where radioactive materials were buried. Areas immediately surrounding or adjacent to locations where radioactive materials were used or stored, spilled, or buried are included in this classification because of the potential for inadvertent spread of contamination.

- **unaffected areas**: All areas not classified as affected. These areas are not expected to contain residual radioactivity, based on a knowledge of site history and previous survey information.

Segregation of the site into these two classifications should be justified by the licensee in the decommissioning plan (in those cases where a decommissioning plan is required to be submitted) and in the final survey report. It should be emphasized that review and concurrence by the NRC of the classification of areas is to the advantage of the licensee at the early stages of planning the final survey. It should also be recognized that as the final survey progresses, an area's classification may require changing, based on accumulated survey data.

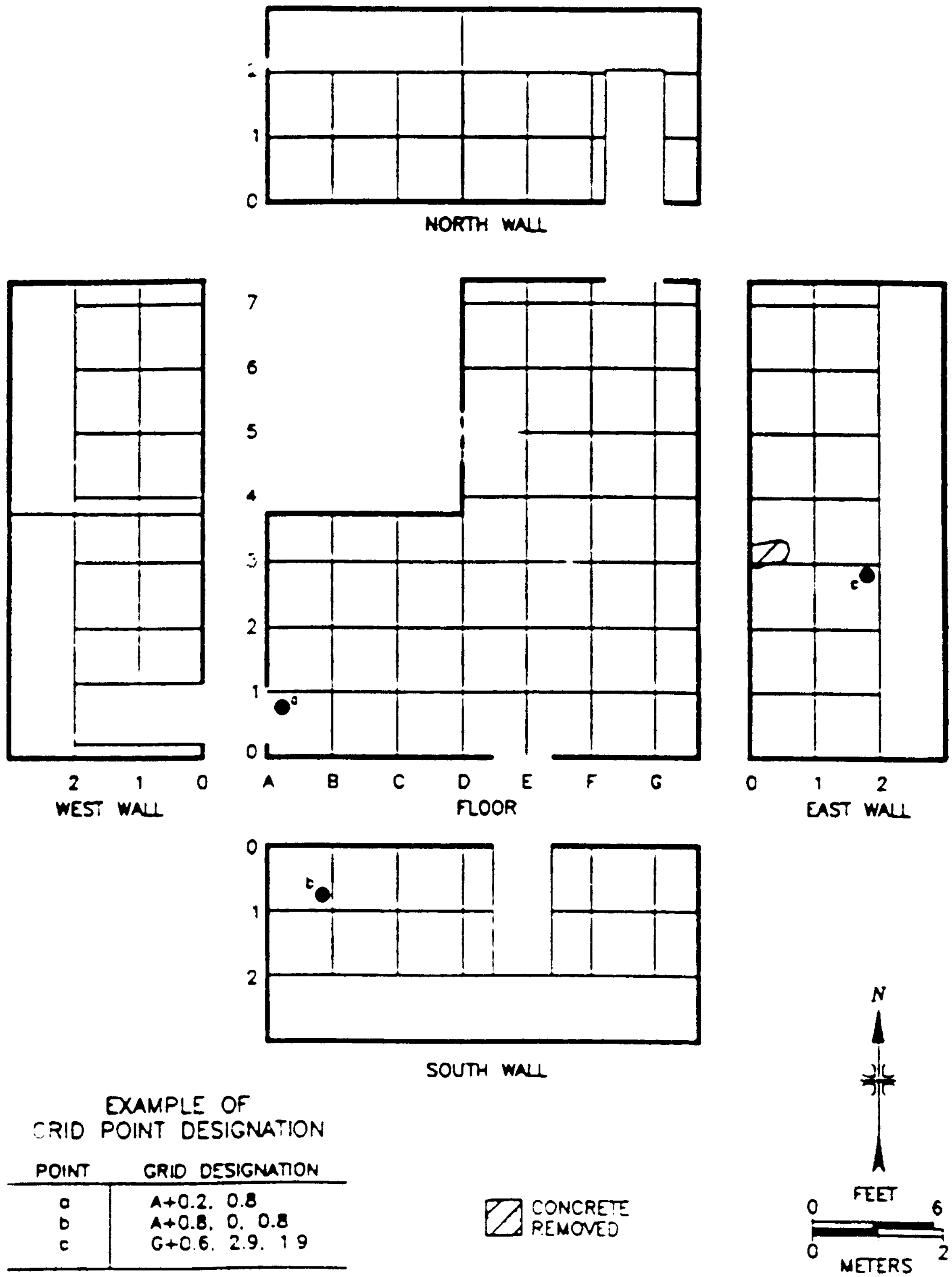
4.2.2 Establishing Reference Grid Systems

Grid systems are established at the site 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.

A **grid** consists of a system of intersecting lines, referenced to a fixed site location or bench mark. Typically, the grid lines are arranged in a perpendicular pattern, dividing the survey location into squares or blocks of equal area; however, other types of patterns (triangular, rectangular, hexagonal) have been used for survey reference purposes.

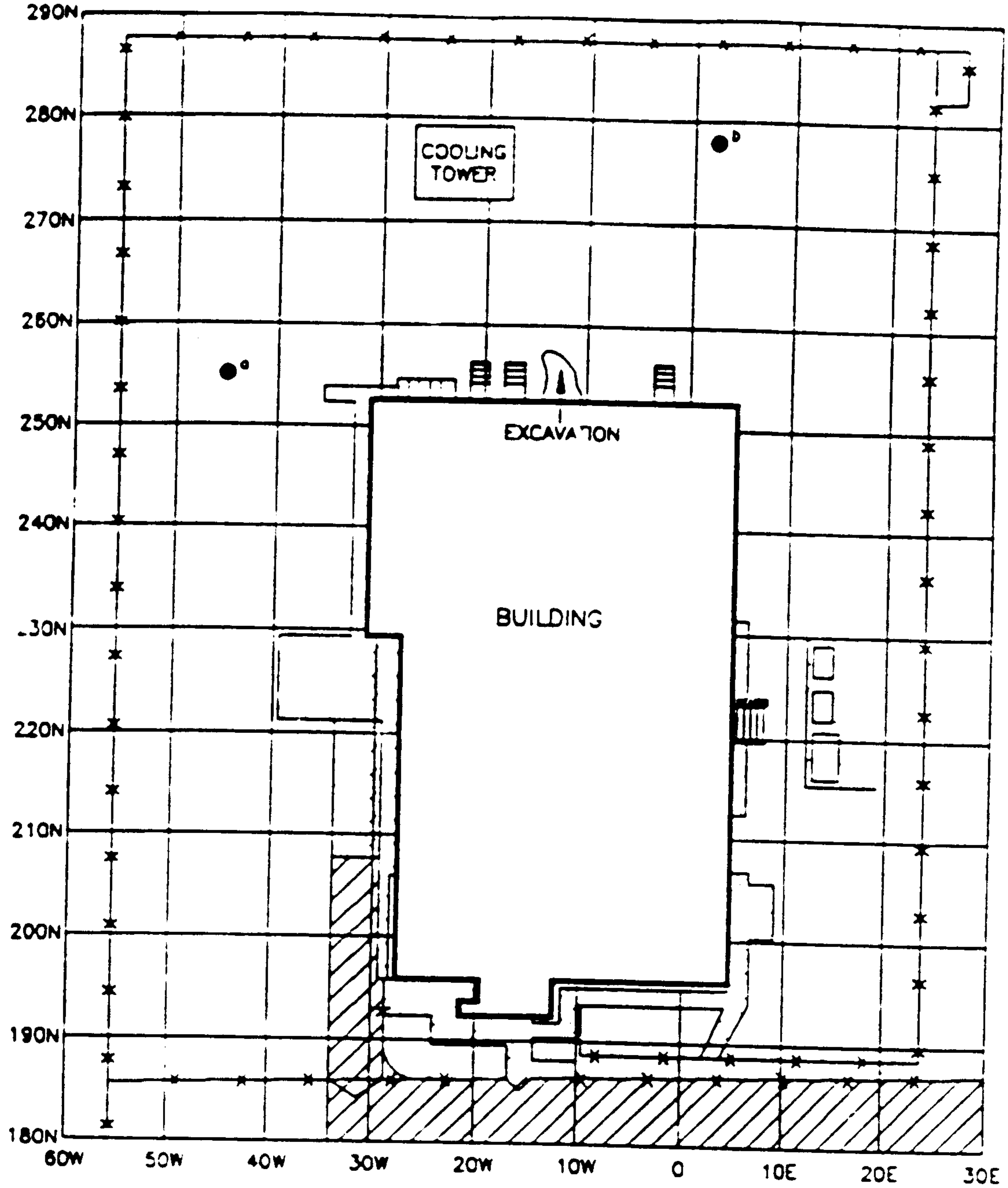
Grid patterns on horizontal surfaces are usually identified numerically on one axis and alphabetically on the other axis or in distances in different compass directions from the grid origin. Examples of building interior and land area grids are shown in Figures 4-1 and 4-2, respectively. Grids on vertical surfaces include a third designator, indicating position relative to floor or ground level. Figure 4-1 provides examples of designating grid locations in three dimensions.

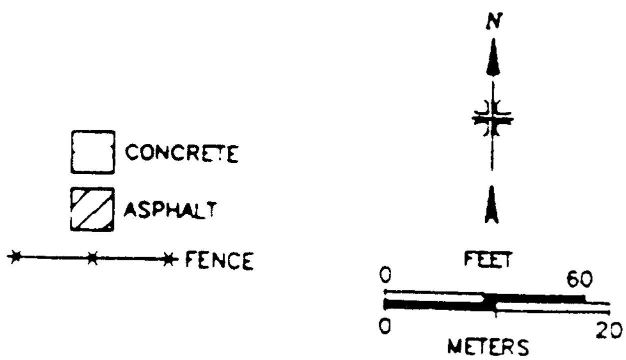


EXAMPLE OF
GRID POINT DESIGNATION

POINT	GRID DESIGNATION
a	A+0.2, 0.8
b	A+0.8, 0, 0.8
c	G+0.6, 2.9, 1.9

FIGURE 4-1: Example of a Grid System Used for Building Interior Survey





EXAMPLE OF GRID POINT DESIGNATION

POINT	GRID DESIGNATION
a	255N, 45W
b	278N, 2E

FIGURE 4-2: Example of Grid System for Survey of Site Grounds

For surveys of structures the basic grid system for affected areas is 1 m. Gridding may be limited to the floor and lower (up to 2 m height) walls, unless there is also a potential for upper wall and ceiling area contamination. Survey locations are referenced to the grid system; surveys of ungridded surfaces are referenced to the floor grid (if one exists) or to prominent building features.

Grounds and open land areas classified as affected areas are gridded at 10 meter intervals.

Unaffected areas do not require gridding for the purposes of establishing measurement or sampling locations; however, grids systems of large spacing, e.g. 5 to 10 m for large structural surfaces and 20 to 50 m for land areas, may be helpful to the licensee by facilitating the referencing of survey locations in those areas to a common site reference system.

The grids described above are intended primarily for reference purposes and do not necessarily dictate the spacing of survey measurements or sampling. Closer spaced survey locations may be required to demonstrate that average and *elevated area* guideline values are met to the required level of confidence. Larger spacing may be acceptable, based on the capabilities of survey techniques. Considerations for determining measurement/sampling spacing are provided in Sections 4.2.3 and 8.5.

To facilitate survey design and assure that the number of survey data points from an area is sufficient to enable statistical evaluation, the area may be divided into survey "units" which have common history or other characteristics or are naturally distinguishable from other portions of the site. Such survey units may combine contiguous rooms or land areas having the same potential contamination classification. The size of a survey unit should be chosen to assure that the total number of data points and/or the spacing (frequency) of measurement/sampling satisfy the requirements of Section 4.2.3. The maximum survey unit size for building surface areas classified as affected, limited to 100 m^2. A survey unit cannot include both affected and unaffected areas.

4.2.3 Selecting Measurement/Sampling Locations

It is not possible to perform measurements or conduct sampling at the theoretically infinite number of locations on a site. Instead, a survey should have as its objective the collection of quality radiological data from sufficient representative site locations, such that a statistically sound conclusion regarding the radiological status of the entire site can be developed. Meeting this objective requires a statistically based plan for selecting measurement and sampling locations.

Experience has indicated that residual contamination on a former radioactive material site is typically concentrated in a relatively small portion of the site. The pattern is asymmetrical, with much of the activity often located in small isolated hot-spots. If the licensee's cleanup efforts have been effective, however, essentially all locations will have residual activity below the guideline levels, and many areas will contain levels in the range of natural background and/or below the measurement sensitivities of the survey and analytical procedures. After cleanup, the pattern of residual activity will therefore likely approximate a normal distribution; the approach to survey design described below assumes such a distribution. If, based on site operating history or the results of preliminary surveys, there is reason to believe there may be unusual localized contamination patterns, the licensee should supplement the survey with samples from randomly selected points in the area of suspect localized contamination.

Structure Surveys

Affected Areas

At a minimum, the floors and lower walls of affected areas should receive 100% coverage during the final status survey. The coverage provided for upper walls and ceilings will be dependent upon the contamination potential for these surfaces. The survey measurements for surface activity will consist of a combination of surface scans, direct measurements, and measurements of removable activity. Procedures for performing these measurements are described in Section 6.4

Scans of 100% of affected area floor and lower wall surfaces are performed for all radiations which may be emitted from the radionuclides of interest. Locations of areas of elevated activity are identified and direct measurements are performed to define their extent and activity levels. Residual activity which exceeds 3 times the guideline value results in external radiation in excess of 2 times the guideline value above background at 1 m from the surface, or results in an average activity above the guideline value in any contiguous 1 m^2 area (refer to Section 8.5.2 for averaging procedures) should be remediated until these conditions are satisfied.

Once all identified elevated areas are evaluated and cleaned up as necessary, systematic measurements of surface activity are performed. If the scanning technique has been demonstrated to have a detection sensitivity for the radionuclide or radiations of interest at ≤ 25% of the guideline level, systematic measurements are performed at a spacing of 2 m or less to provide at least 30 data point locations. A recommended approach is to obtain data from grid line intersections (see Figure 4-3) or grid block centers. If the detection sensitivity of the scanning technique is not ≤ 25% of the guideline value, systematic measurements are performed at 1 m intervals.

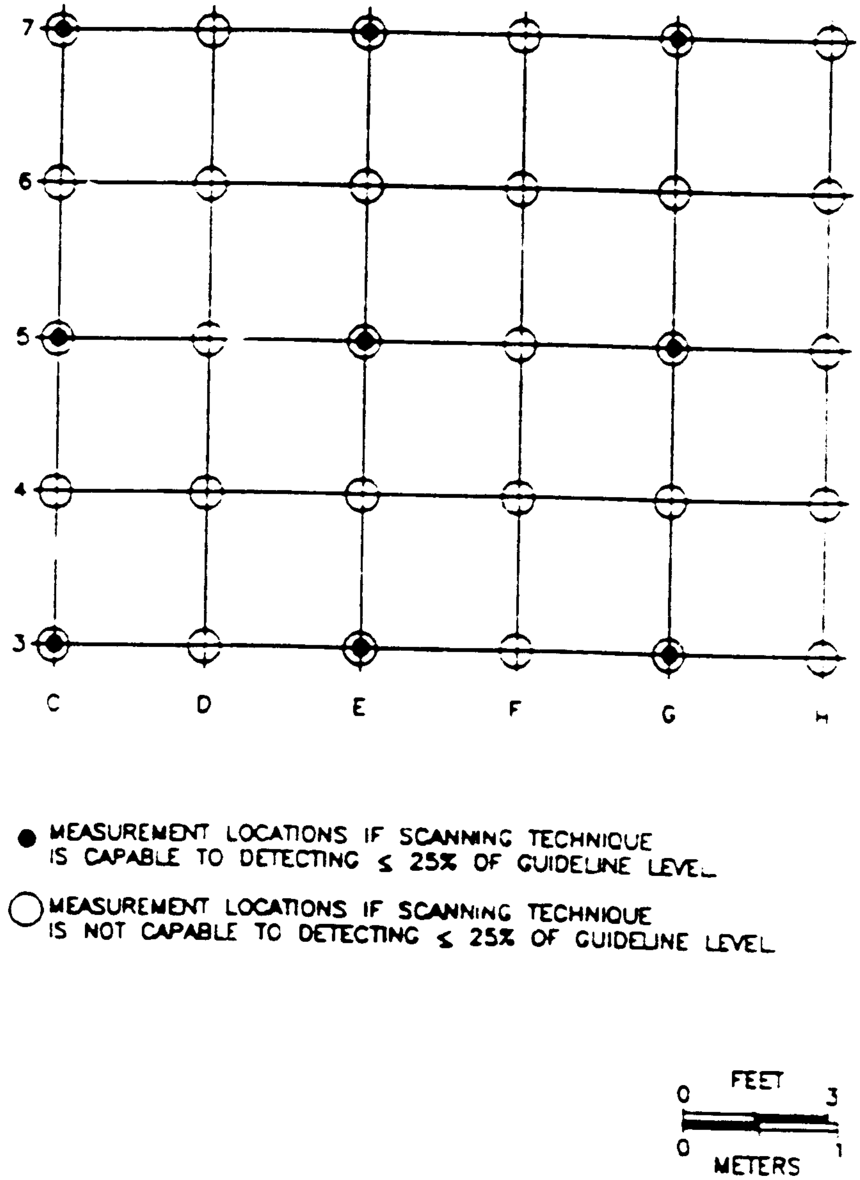


FIGURE 4-3: Standard Measurement/Sampling Pattern For Systematic Grid Survey of Structure Surfaces

The number of data points required to demonstrate that the confidence level of the survey satisfies the 95% objective for a survey unit, is a function of the average and variance of the data. Following the procedures in Sections 8.5 and 8.6, the need for any additional measurements is determined; if additional measurements are required, they should be obtained at approximately evenly-spaced intervals throughout the survey unit.

Upper walls, ceilings, and other overhead surfaces which are suspected of having residual activity at greater than 25% of the guideline value, based on operating history and previous surveys, are surveyed in the same manner as floors and lower walls. If there is no reason to suspect residual activity exceeding 25% of the guideline value on these surfaces, a minimum of 30 measurement locations each, on vertical and horizontal surfaces where radioactive material would likely accumulate, (air exhaust vents and horizontal surfaces where dust would settle) is selected. To assure a reasonable coverage of these surfaces, an average of at least 1 measurement location per 20 m^2 of surface area should be selected. At each location a scan of the immediate area is performed to identify the presence of any elevated activity levels, followed by the measurement. If scans or measurements indicate residual activity exceeding 25% of the guideline, the area is considered potentially contaminated and the surface exhibiting such levels should be surveyed in the same manner as floors and lower walls of affected areas.

If gamma emitting radionuclides are among the potential contaminants, exposure rate measurements at 1 m from floor and lower wall surfaces are performed at a frequency of 1 systemati easurement per every 4 m^2. If potential contaminants did not include gamma emitters, exposure rate measurements should be performed at a minimum spacing of 1 measurement per 10 m^2.

Unaffected Areas

Scans of unaffected surfaces should cover a minimum of 10% of the floor and lower wall surface area. At least 30 randomly selected measurement locations or an average measurement of 1 per 50 m^2 of building surface area, whichever is greater, for total and removable activity, should be performed for each survey unit. These locations should include all building surfaces. Identification of activity levels in excess of 25% of the guideline, either by scans or measurements, will require reclassification of the area to the "affected" category. Testing of the data relative to the confidence level objective is performed in the same manner as for affected areas and any additional measurement locations required should be selected randomly. Exposure rate measurements at 1 m from the floor are performed at each location of surface activity measurement.

Open Land Surveys

Affected Areas

As with structure surfaces, 100% coverage of affected open land areas (paved surfaces and soil) is necessary. Scanning is performed to identify locations of elevated activity levels. Areas of suspected elevated activity, identified in this manner, are evaluated by sampling and analyses to determine their activity level and area l extent, and results are compared with criteria (see Sections 2.2 and 8.5); cleanup is performed, as required, and scanning repeated. After scanning has indicated the guidelines and conditions have been satisfied, systematic soil sampling of each affected area grid block is performed at locations equidistant between the center and each of the four grid block corners (see Figure 4-4). If scanning is not capable of detecting surface areas with activity levels ≤ 75% of the guideline values for the radionuclides of interest, additional sampling will be required to provide an acceptable level of confidence that locations of elevated activity have been identified. An EPA procedure (EPA 1989) recommends a triangular grid with a sampling interval of 5 m on a side (enclosed area of approximately 10.8 m^2) for a 95% assurance that elevated areas in excess of 10 m^2 surface area are identified. By beginning with the standard systematic pattern and including additional sampling points, located along the 10 m grid lines, at block corners and centers, and midway between grid block corners (Figure 4-5), a triangular sampling pattern with spacing of 5 m or less (enclosed area of approximately 6.3 m^2) is obtained.

Paved surfaces are surveyed in the same manner as described above for structure surfaces.

For both soil sampling and paved surface measurements, a minimum of 30 data locations should be used. Data for each of these surface types are tested relative to the guideline value and the confidence level objective, and additional systematic sampling/measurement locations that may be required are obtained at approximately uniformly spaced intervals throughout the survey unit.

Exposure rates are measured at 1 m above the surface on the pattern shown in Figure 4-4.

Unaffected Areas

Unaffected open land area should be uniformly scanned for radiations from the radionuclides of interest. Spacing intervals between scanning paths should be such that a minimum of 10% of the surface is scanned. Soil sampling is performed at a minimum of 30 randomly selected locations. Surface activity measurements on paved areas are also performed at 30 randomly selected locations. Identification of hot-spots or individual locations with activity levels

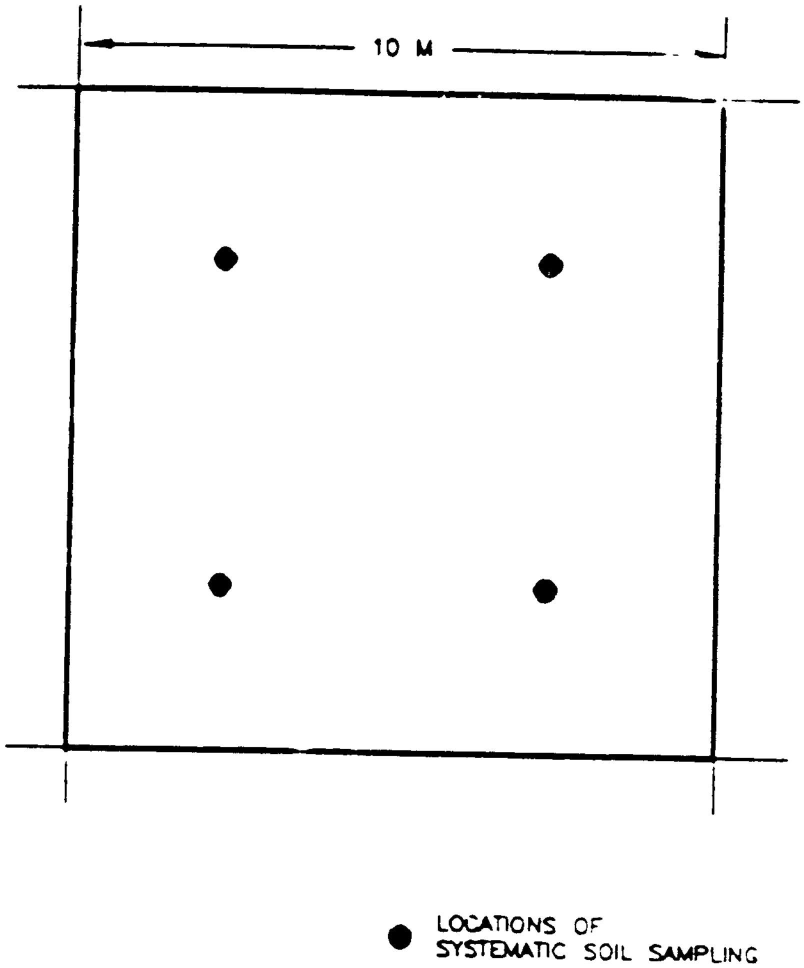


FIGURE 4-4: Standard Sampling Pattern for Systematic Grid Survey of Soil

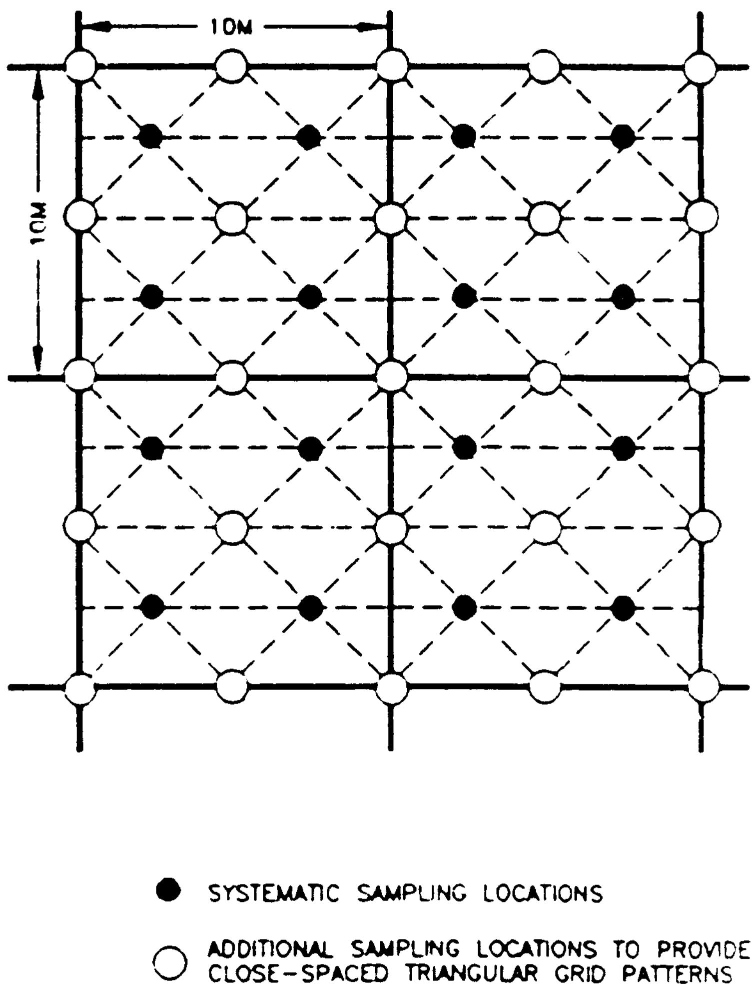


FIGURE 4-5: Sampling Pattern to Identify Soil Areas of Elevated Activity

in excess of 75% of the guideline value requires reclassification of the area as "affected".

Testing of results, relative to guidelines and confidence level objectives is performed according to Section 8.6 and any additional samples/measurements required are obtained at randomly selected locations in the survey unit.

<u>Other Measurement/Sampling Locations</u>

In addition to the building and land surface areas described above, there are numerous other locations where measurements and/or sampling should be performed. Examples include items of equipment and furnishings, building fixtures, drains, ducts, and piping. Many of these items or locations have both internal and external surfaces, requiring evaluation.

Each such location classified as affected should be scanned and individual measurements and/or samples obtained at representative points. Unaffected locations can, as with the building and land surfaces in such areas, be surveyed at lower frequencies, consistent with the contamination potential, the capability of scanning techniques to identify activity levels at or above guidelines, and findings as the survey progresses. Surveys of these types of locations are discussed in more detail in Section 6.0.

4.2.4 Subsurface Sampling

At the stage where the final status survey is being conducted, contaminated subsurface soil should already have been identified, characterized, and remediated, if necessary. Subsurface activity data may be required for determination of residual site inventory. In addition, if there is potential for residual activity below the surface layer, the survey plan should include subsurface sampling. The number and locations of samples should follow the same pattern as described above in section 4.2.3 sampling depth of surface soil. As an initial evaluation, samples may be collected at 1 m intervals, starting at the surface and continuing to at least 1 m below the suspected or potential region of activity. Shallow sampling may be conducted using manual equipment (post-hole diggers, small-diameter split barrel or Shelby tube samplers, and portable hand-operated or motorized augers). For depths below several meters, heavier equipment, such as a drill rig with an auger and/or a core sampler will be required. Use of electromagnetic sensing techniques, such as ground penetrating radar and magnetometry will assist in locating potential sampling areas and also should be a safety consideration if buried utilities or containers of potentially hazardous material (radiological or chemical) may be present. Use of a subsurface sampling technique which results in a borehole or soil face, accessible with a gamma sensitive detector, also enables scanning of the exposed soil surface to identify the presence and distribution of subsurface activity.

If a potential exists for activity to enter subsurface water, samples of water should be collected (if available) from the same locations as the subsurface soil samples. Knowledge of expected constituents is necessary when collecting subsurface water to determine whether special precautions for sample handling and collection are required to ensure representative samples. Expertise of hydrology specialists and those knowledgeable in subsurface water sampling technique should be sought, when such conditions are anticipated.

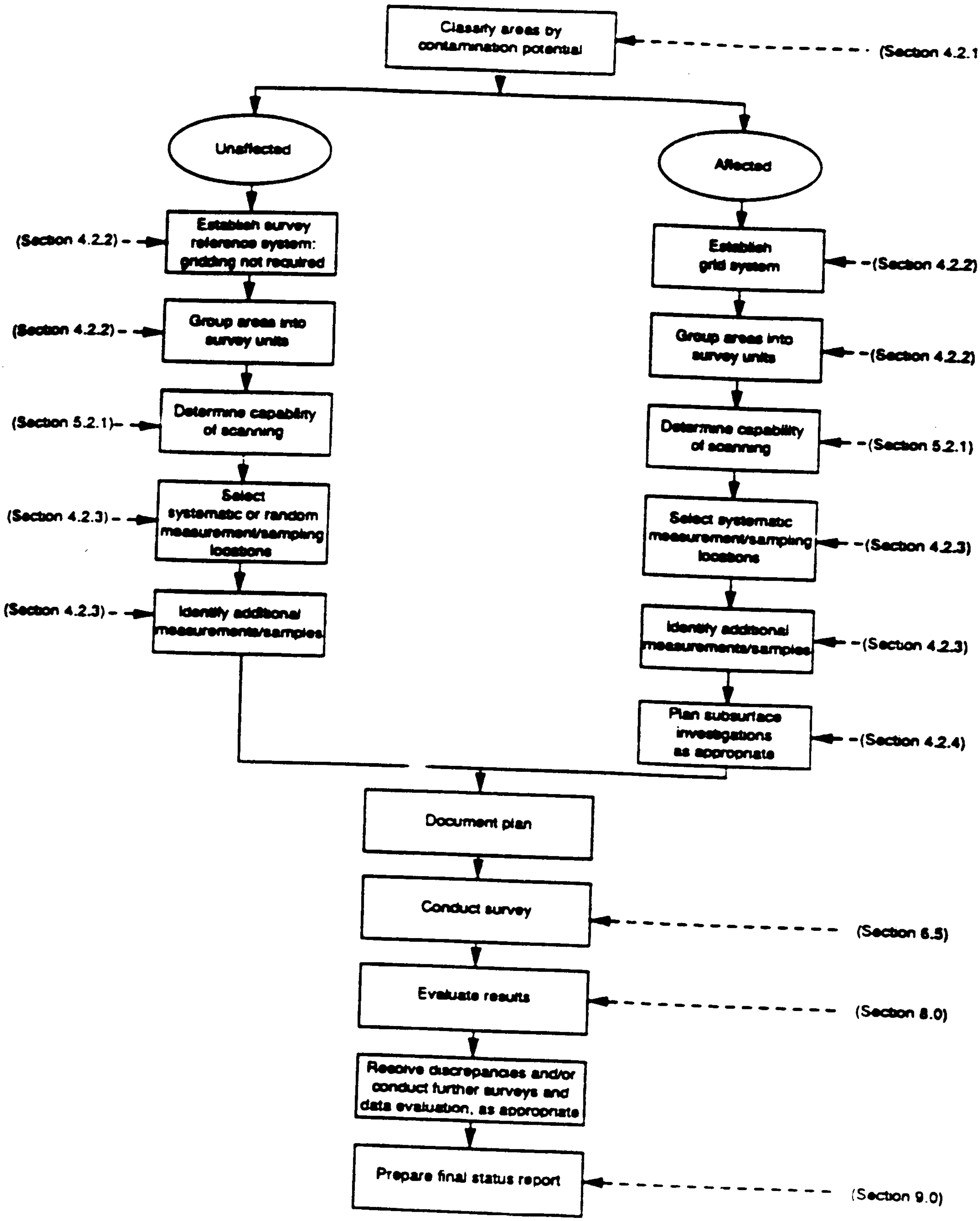


FIGURE 4.6: Flow Diagram for Planning Final Status Surveys

APPENDIX C

RADIOLOGICAL ASSESSMENT

RADIATION DETECTION

INSTRUMENT SURVEY

The following instrument surveys were taken in these designated laboratories located in John Wesley Powell Building

- Laboratory 3D231
- Laboratory 3D239

LABORATORY 3D231*
JOHN WESLEY BUILDING
NATIONAL CENTER
RESTON VIRGINIA

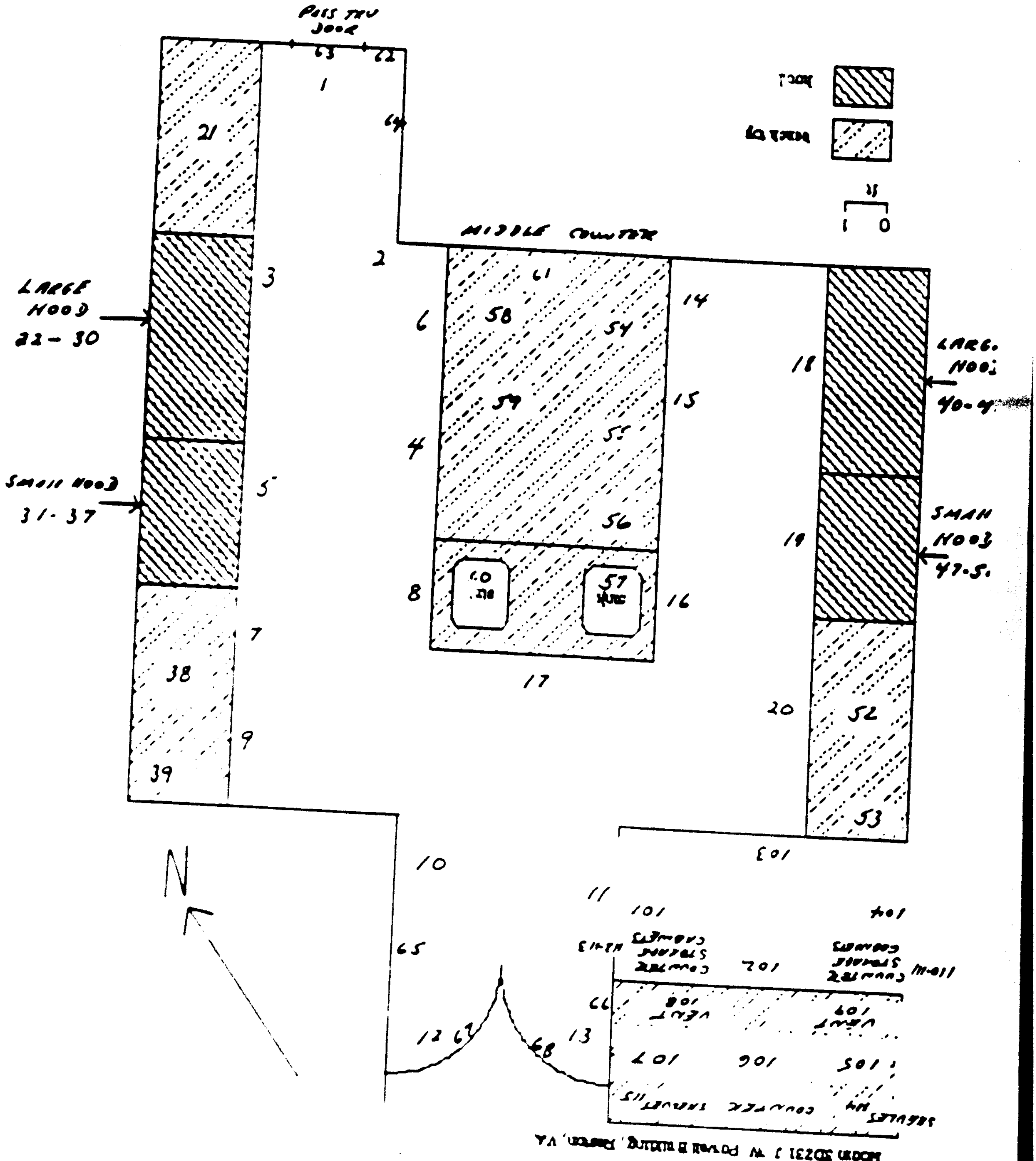
Swipe	Area		Location	Radiation Reading mR/hr at 1 cm	Radiation Reading µR/hr at 1 meter
1	west side of lab	floor	below door	0.020	15.0
2	west side of lab	floor	adjacent to counter	0.020	15.0
3	west side of lab	floor	adjacent to large hood	0.020	15.0
4	west side of lab	floor	adjacent to small hood	0.020	15.0
5	west side of lab	floor	adjacent to counter	0.020	15.0
6	west side of lab	floor	adjacent to middle counter	0.020	15.0
7	west side of lab	floor	adjacent to counter	0.020	15.0
8	west side of lab	floor	adjacent to sink	0.020	15.0
9	west side of lab	floor	adjacent to count.	0.020	15.0
10	west side of lab	floor	adjacent to wall	0.020	15.0
11	east side of lab	floor	entrance to small room	0.020	15.0
12	west side of lab	floor	entrance to lab	0.020	15.0
13	east side of lab	floor	entrance to lab	0.020	15.0
14	middle counter	floor	adjacent to counter	0.020	15.0
15	middle counter	floor	adjacent to counter	0.020	15.0
16	middle counter	floor	adjacent to sink	0.020	15.0
17	middle counter	floor	front of sinks	0.020	15.0
18	middle counter	floor	adjacent to large hood	0.020	15.0
19	middle counter	floor	adjacent to small hood	0.020	15.0
20	middle counter	floor	adjacent to counter	0.020	15.0
21	west side of lab	counter	middle	0.020	15.0
22	west side of lab	large hood	middle (bottom)	0.020	15.0
23	west side of lab	large hood	right side	0.020	15.0
24	west side of lab	large hood	left side	0.020	15.0
25	west side of lab	large hood	back portion	0.020	15.0
26	west side of lab	large hood	front glass	0.020	15.0
27	west side of lab	large hood	front grill	0.020	15.0
28	west side of lab	large hood	trap (inside hood)	0.020	15.0

Swipe	Area		Location	Radiation Reading mR/hr at 1 cm	Radiation Reading μR/hr at 1 meter
29	west side of lab	large hood	trap (counter)	0.020	15.0
30	west side of lab	large hood	sill front of hood	0.020	15.0
31	west side of lab	small hood	middle (bottom)	0.020	15.0
32	west side of lab	small hood	right side	0.020	15.0
33	west side of lab	small hood	left side	0.020	15.0
34	west side of lab	small hood	back portion	0.020	15.0
35	west side of lab	small hood	front glass	0.020	15.0
36	west side of lab	small hood	front grill	0.020	15.0
37	west side of lab	small hood	sill front of hood	0.020	15.0
38	west side of lab	counter	middle	0.020	15.0
39	west side of lab	counter	inside trap	0.020	15.0
40	west side of lab	large hood	middle-bottom	0.020	15.0
41	east side of lab	large hood	right side	0.020	15.0
42	east side of lab	large hood	left side	0.020	15.0
43	east side of lab	large hood	back portion	0.020	15.0
44	east side of lab	large hood	front glass	0.020	15.0
45	east side of lab	large hood	front grill	0.020	15.0
46	east side of lab	large hood	sill front of hood	0.020	15.0
47	east side of lab	small hood	middle (bottom)	0.020	15.0
48	east side of lab	small hood	right side	0.020	15.0
49	east side of lab	small hood	left side	0.020	15.0
50	east side of lab	small hood	back side	0.020	15.0
51	east side of lab	small hood	sill front of hood	0.020	15.0
52	east side of lab	counter	middle	0.020	15.0
53	east side of lab	counter	inside trap	0.020	15.0
54	middle counter	counter	middle	0.020	15.0
55	middle counter	counter	middle	0.020	15.0
56	middle counter	counter	near sink	0.020	15.0

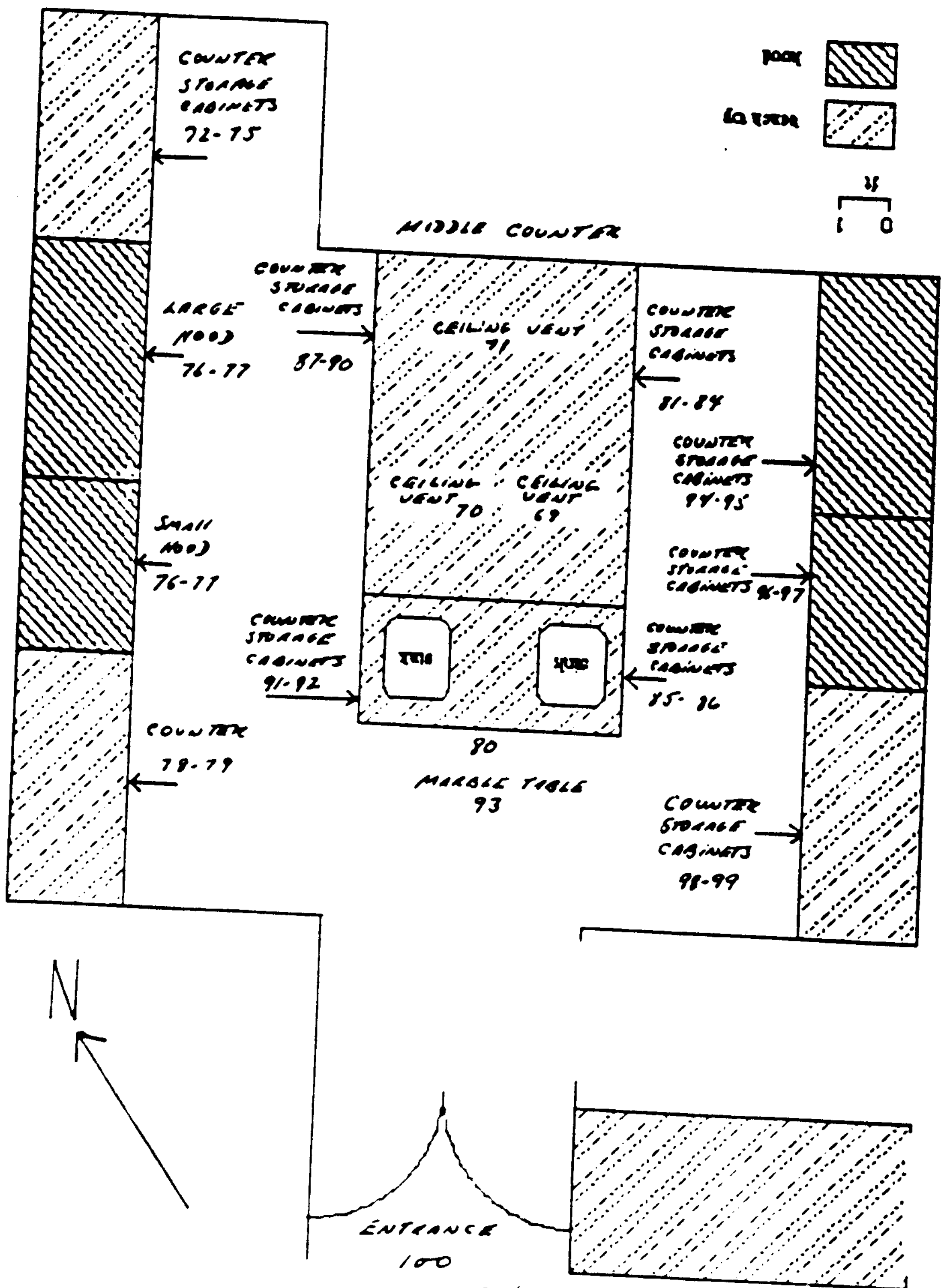
Swipe	Area		Location	Radiation Reading mR/hr at 1 cm	Radiation Reading μR/hr at 1 meter
57	middle counter	sink	inside and drain	0.020	15.0
58	middle counter	counter	middle	0.020	15.0
59	middle counter	counter	middle	0.020	15.0
60	middle counter	sink	inside and drain	0.020	15.0
61	middle counter	counter	inside trap	0.020	15.0
62	west side of lab	wall	3 feet up wall	0.020	15.0
63	west side of lab	pass through door	3 feet up wall	0.020	15.0
64	west side of lab	wall	2 feet up wall	0.020	15.0
65	west side of lab	wall near door entrance	3 feet up wall	0.020	15.0
66	east side of lab	wall near door entrance	3 feet up wall	0.020	15.0
67	west side of lab	door inside	2 feet up wall	0.020	15.0
68	east side of lab	door inside	2 feet up wall	0.020	15.0
69	east side of lab	ceiling vents	front - eastside	0.020	15.0
70	west side of lab	ceiling vents	front - westside	0.020	15.0
71	rear side of lab	ceiling vents	rear of lab	0.020	15.0
72	west side of lab	counter storage	inside drawers	0.020	15.0
73	west side of lab	counter storage	outside drawers	0.020	15.0
74	west side of lab	counter storage	inside drawers	0.020	15.0
75	west side of lab	counter storage	outside drawers	0.020	15.0
76	west side of lab	large & small hood storage	inside storage area	0.020	15.0
					15.0
77	west side of lab	large & small hood storage	outside storage area	0.020	15.0
					15.0
78	west side of lab	counter storage	inside drawers	0.020	15.0
79	west side of lab	counter storage	outside drawers	0.020	15.0
80	middle counter	middle counter storage	outside	0.020	15.0
					15.0
81	middle counter	middle counter	inside drawers	0.020	15.0
82	middle counter	counter east side	outside drawers	0.020	15.0
83	middle counter	counter east side	inside drawers	0.020	15.0
84	middle counter	counter east side	outside drawers	0.020	15.0

Swipe	Area		Location	Radiation Reading mR/hr at 1 cm	Radiation Reading µR/hr at 1 meter
85	middle counter	middle counter storage sink	inside drawers	0.020	15.0
86	middle counter	middle counter	outside drawers	0.020	15.0
87	middle counter	middle counter storage	inside drawers	0.020	15.0
88	middle counter	middle counter west side	outside drawers	0.020	15.0
89	middle counter	middle counter west side	inside drawers	0.020	15.0
90	middle counter	middle counter west side	outside drawers	0.020	15.0
91	middle counter	middle counter west side	inside drawers	0.020	15.0
92	middle counter	middle counter west side	outside drawers	0.020	15.0
93	middle counter	marble table	middle drawers	0.020	15.0
94	east side of lab	counter storage	inside drawers	0.020	15.0
95	east side of lab	counter storage	outsider drawers	0.020	15.0
96	east side of lab	counter storage	insider drawers	0.020	15.0
97	east side of lab	counter storage	outsider drawers	0.020	15.0
98	east side of lab	counter storage	insider drawers	0.020	15.0
99	east side of lab	counter storage	outsider drawers	0.020	15.0
100	east side of lab	entrance to lab	front of doors	0.020	15.0
101	east side of lab	small room storage	floor. entrance	0.020	15.0
102	east side of lab	small room storage	floor. front of cabinets	0.020	15.0
103	east side of lab	small room storage	floor. front of wall	0.020	15.0
104	east side of lab	small room storage	floor. rear wall	0.020	15.0
105	east side of lab	small room storage	counter top middle	0.020	15.0
106	east side of lab	small room storage	counter top middle	0.020	15.0
107	east side of lab	small room storage	counter top middle	0.020	15.0
108	east side of lab	small room storage	vent front of room	0.020	15.0
109	east side of lab	small room storage	vent rear of room	0.020	15.0
110	east side of lab	small room storage	storage cabinets (inside)	0.020	15.0
111	east side of lab	small room storage	storage cabinets (outside)	0.020	15.0
112	east side of lab	small room storage	storage cabinets (inside)	0.020	15.0
113	east side of lab	small room storage	storage cabinets (outside)	0.020	15.0
114	east side of lab	small room storage	storage shelves. back	0.020	15.0
115	east side of lab	small room storage	storage shelves. front	0.020	15.0

- In accordance with section 4.2.2 Establishing Reference Grid Systems. since unaffected areas do not require gridding for the purpose of establishing measurement or sampling locations. the specific laboratory survey locations (instrument and smear) were marked. identified by white adhesive tabs and the laboratories were locked and secured to deny and prohibit areas pending the NRC review of this Radiological Safety Assessment report.



PASS THRU DOOR
MIDDLE COUNTER
LARGE HOOD
22-30
SMALL HOOD
31-37
N



Room 3D231 J. W. Powell Building, Reston, VA

LABORATORY 3D239
JOHN WESLEY BUILDING
NATIONAL CENTER
RESTON VIRGINIA

Swipe	Area		Location	Radiation Reading mR/hr at 1 cm	Radiation Reading µR/hr at 1 meter
1	west side of lab	floor	below door	0.020	15.0
2	west side of lab	floor	adjacent to counter/hood	0.020	15.0
3	west side of lab	floor	adjacent to hood	0.020	15.0
4	west side of lab	floor	between 2 hoods	0.020	15.0
5	west side of lab	floor	adjacent to hood	0.020	15.0
6	west side of lab	floor	adjacent to middle counter	0.020	15.0
7	west side of lab	floor	adjacent to middle counter	0.020	15.0
8	west side of lab	floor	corner of middle counter	0.020	15.0
9	west side of lab	floor	entrance to small room	0.020	15.0
10	west side of lab	floor	entrance to small room	0.020	15.0
11	west side of lab	floor	middle of floor	0.020	15.0
12	east side of lab	floor	adjacent to middle counter	0.020	15.0
13	east side of lab	floor	adjacent to counter and hood	0.020	15.0
14	east side of lab	floor	adjacent to middle counter	0.020	15.0
15	east side of lab	floor	adjacent to middle counter	0.020	15.0
16	east side of lab	floor	middle of floor	0.020	15.0
17	east side of lab	floor	corner of middle counter	0.020	15.0
18	east side of lab	floor	adjacent to middle counter	0.020	15.0
19	east side of lab	floor	adjacent to hood	0.020	15.0
20	east side of lab	floor	adjacent to hood	0.020	15.0
21	west side of lab	room	middle of marble table	0.020	15.0
22	west side of lab	room	middle of floor	0.020	15.0
23	west side of lab	room	middle of wood table	0.020	15.0
24	west side of lab	room	desk, middle	0.020	15.0
25	west side of lab	room	wall, 3 feet up	0.020	15.0
26	east side of lab	room	middle of floor	0.020	15.0
27	east side of lab	room	middle of floor	0.020	15.0
28	east side of lab	room	middle of floor	0.020	15.0

Swipe	Area		Location	Radiation Reading mR/hr at 1 cm	Radiation Reading µR/hr at 1 meter
29	east side of lab	room	wall. 3 feet up	0.020	15.0
30	east side of lab	room	wall. 3 feet up	0.020	15.0
31	east side of lab	counter	middle	0.020	15.0
32	east side of lab	counter	middle	0.020	15.0
33	east side of lab	counter	middle	0.020	15.0
34	east side of lab	counter	inside trap	0.020	15.0
35	east side of lab	canopy hood	inside	0.020	15.0
36	east side of lab	canopy hood	outside	0.020	15.0
37	east side of lab	shelving	inside	0.020	15.0
38	east side of lab	shelving	outside	0.020	15.0
39	east side of lab	shelving	inside	0.020	15.0
40	east side of lab	shelving	outside	0.020	15.0
41	east side of lab	vent	front of room	0.020	15.0
42	east side of lab	vent	rear or room	0.020	15.0
43	east side of lab	storage areas	inside	0.020	15.0
44	east side of lab	storage areas	outside	0.020	15.0
45	east side of lab	storage areas	inside	0.020	15.0
46	east side of lab	storage areas	outside	0.020	15.0
47	west side of lab	wall	rear. 3 feet up	0.020	15.0
48	east side of lab	wall	rear. 3 feet up	0.020	15.0
49	east side of lab	wall	front. 3 feet up	0.020	15.0
50	east side of lab	wall	front. 3 feet up	0.020	15.0
51	west side of lab	counter	middle	0.020	15.0
52	west side of lab	counter	middle	0.020	15.0
53	west side of lab	counter	inside trap	0.020	15.0
54	west side of lab	equipment	on counter	0.020	15.0
55	west side of lab	counter storage area	inside	0.020	15.0
56	west side of lab	counter storage area	outside	0.020	15.0

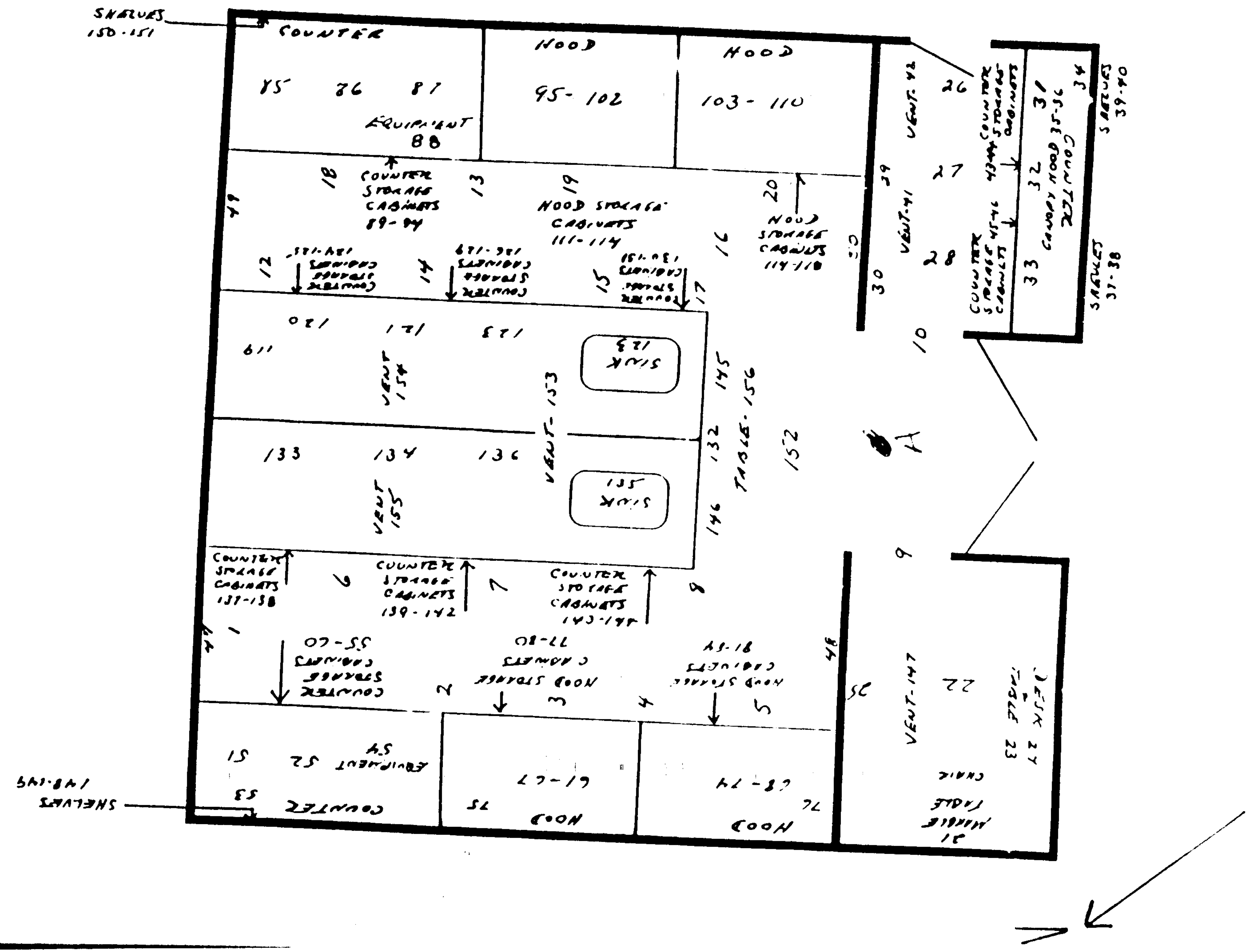
Swipe	Area		Location	Radiation Reading mR/hr at 1 cm	Radiation Reading µR/hr at 1 meter
57	west side of lab	counter storage area	inside	0.020 0.020	15.0 15.0
58	west side of lab	counter storage area	outside	0.020 0.020	15.0 15.0
59	west side of lab	counter storage area	inside	0.020 0.020	15.0 15.0
60	west side of lab	counter storage area	outside	0.020 0.020	15.0 15.0
61	west side of lab	counter. hood	middle. bottom	0.020	15.0
62	west side of lab	counter. hood	right side		
63	west side of lab	counter. hood	left side	0.020	15.0
64	west side of lab	counter. hood	back portion		
65	west side of lab	counter. hood	front glass	0.020	15.0
66	west side of lab	counter. hood	front grill	0.020	15.0
67	west side of lab	counter. hood	sill front of hood	0.020	15.0
68	west side of lab	counter. hood	middle. bottom	0.020	15.0
69	west side of lab	counter. hood	right side	0.020	15.0
70	west side of lab	counter. hood	left side	0.020	15.0
71	west side of lab	counter. hood	back portion	0.020	15.0
72	west side of lab	counter. hood	front glass	0.020	15.0
73	west side of lab	counter. hood	front grill	0.020	15.0
74	west side of lab	counter. hood	sill front of hood	0.020	15.0
75	west side of lab	counter. hood	inside trap	0.020	15.0
76	west side of lab	counter. hood	inside trap	0.020	15.0

Swipe	Area		Location	Radiation Reading mR/hr at 1 cm	Radiation Reading µR/hr at 1 meter
77	west side of lab	storage areas (hood)	inside	0.020	1a5.0
78	west side of lab	storage areas (hood)	outside	0.020	15.0
79	west side of lab	storage areas (hood)	inside	0.020	15.0
80	west side of lab	storage areas (hood)	outside	0.020	15.0
81	west side of lab	storage areas (hood)	inside	0.020	15.0
82	west side of lab	storage areas (hood)	outside	0.020	15.0
83	west side of lab	storage areas (hood)	inside	0.020	15.0
84	west side of lab	storage areas (hood)	outside	0.020	15.0
85	east side of lab	counter	middle	0.020	15.0
86	east side of lab	counter	middle		
87	east side of lab	counter	middle	0.020	15.0
88	east side of lab	counter	equipment	0.020	15.0
89	east side of lab	storage areas	inside	0.020	15.0
		(counter)		0.020	15.0
90	east side of lab	storage areas	outside	0.020	15.0
		(counter		0.020	15.0
91	east side of lab	storage areas	inside	0.020	15.0
		(counter)		0.020	15.0
92	east side of lab	storage areas	outside	0.020	15.0
		(counter)		0.020	15.0
93	east side of lab	storage areas	inside	0.020	15.0
		(counter)		0.020	15.0
94	east side of lab	storage areas	outside	0.020	15.0
		(counter)		0.020	15.0
95	east side of lab	hood	middle bottom	0.020	15.0
96	east side of lab	hood	right side	0.020	15.0
97	east side of lab	hood	left side	0.020	15.0
98	east side of lab	hood	back portion	0.020	15.0
99	east side of lab	hood	front glass	0.020	15.0
				0.020	15.0

Swipe	Area		Location	Radiation Reading mR/hr at 1 cm	Radiation Reading µR/hr at 1 meter
100	east side of lab	hood	front grill	0.020	1a5.0
101	east side of lab	hood	sill, front of hood		
102	east side of lab	hood	trap - insi le	0.020	15.0
103	east side of lab	hood	middle bottom	0.020	15.0
104	east side of lab	hood	right side		
105	east side of lab	hood	left side	0.020	15.0
106	east side of lab	hood	back portion		
107	east side of lab	hood	front glass	0.020	15.0
108	east side of lab	hood	front grill		
109	east side of lab	hood	sill, front of hooc	0.020	15.0
110	east side of lab	hood	trap - inside		
111	east side of lab	storage areas, hood	inside drawers	0.020	15.0
112	east side of lab	storage areas, hood	outside drawers	0.020	15.0
113	east side of lab	storage areas, hood	insider drawers	0.020	15.0
114	east side of lab	storage areas, hood	outside drawers	0.020	15.0
115	east side of lab	storage areas, hood	inside drawers	0.020	15.0
116	east side of lab	storage areas, hood	outside drawers	0.020	15.0
117	east side of lab	storage areas, hood	inside drawers	0.020	15.0
118	east side of lab	storage areas, hood	outside drawers	0.020	15.0
119	east side of lab	middle counter	inside trap	0.020	15.0
120	east side of lab	middle counter, hood	middle		15.0
121	east side of lab	middle counter, hood	middle	0.020	15.0
122	east side of lab	middle counter, hood	middle	0.02	15.0

Swipe	Area		Location	Radiation Reading mR/hr at 1 cm	Radiation Reading µR/hr at 1 meter
123	east side of lab	middle count sink	inside drains and sink	0.020	15.0
124	east side of lab	middle counter storage	inside drawers	0.020	15.0
125	east side of lab	middle counter storage	outside drawers	0.020	15.0
126	east side of lab	middle counter storage	inside drawers	0.020	15.0
	east side of lab	middle counter storage	outside drawers	0.020	15.0
128	east side of lab	middle counter storage	inside drawers	0.020	15.0
129	east side of lab	middle counter storage	outside drawers	0.020	15.0
130	east side of lab	middle counter storage	inside drawers	0.020	15.0
131	east side of lab	middle counter storage	outside drawers	0.020	15.0
132	east side of lab	middle counter	front. 3 feet up	0.020	15.0
133	west side of lab	counter	middle	0.020	15.0
134	west side of lab	counter	middle	0.020	15.0
135	west side of lab	counter	middle	0.020	15.0
136	west side of lab	sink	inside sink and drains	0.020	15.0
137	west side of lab	counter storage area	inside drawers	0.020	15.0
138	west side of lab	counter storage area	outside drawers	0.020	15.0
139	west side of lab	counter storage area	inside drawers	0.020	15.0
140	west side of lab	counter storage area	outside drawers	0.020	15.0
141	west side of lab	counter storage area	inside drawers	0.020	15.0
142	west side of lab	counter storage area	outside drawers	0.020	15.0
143	west side of lab	counter storage area	inside drawers	0.020	15.0

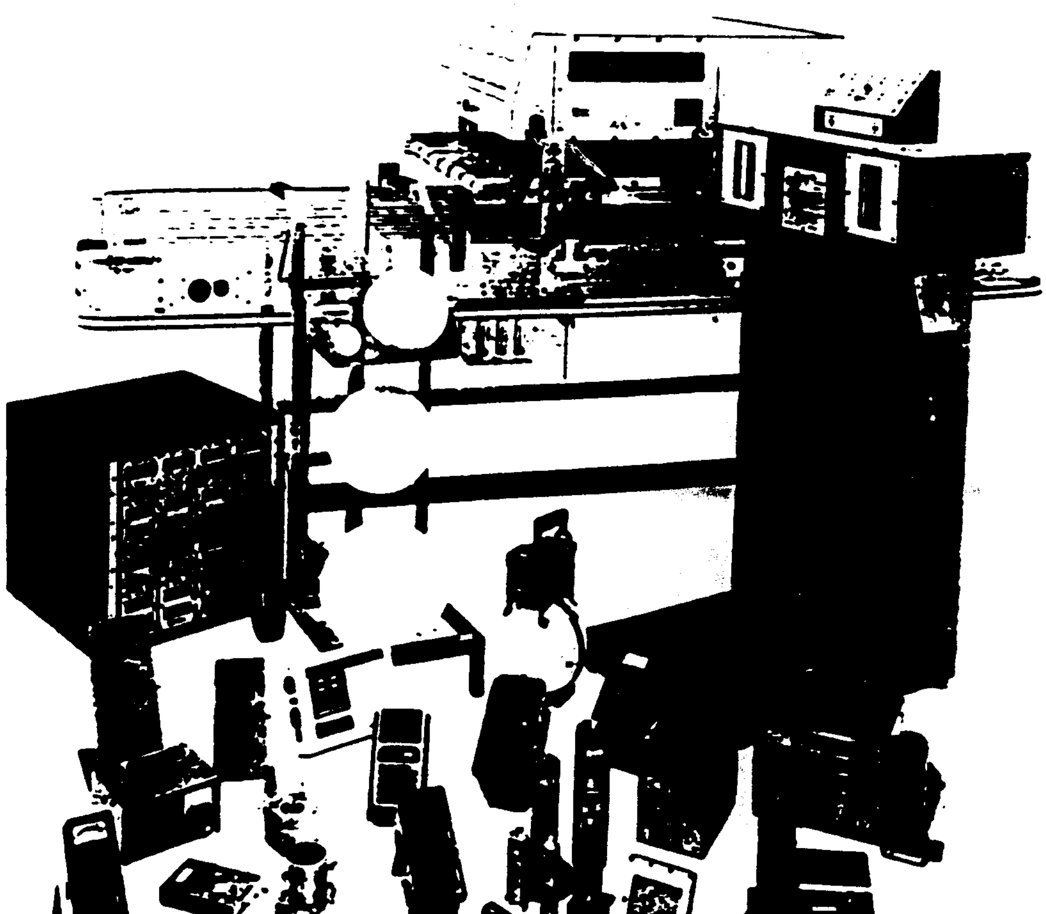
Swipe	Area		Location	Radiation Reading mR/hr at 1 cm	Radiation Reading µR/hr at 1 meter
144	west side of lab	counter storage area	outside drawers	0.020	15.0
145	east side of lab	counter storage area	front	0.020	15.0
146	west side of lab	counter storage area	front	0.020	15.0
147	west side of lab	vent (inside)	room. inside	0.020	15.0
148	west side of lab	shelves	inside		
149	west side of lab	shelves	outside	0.020	15.0
150	east side of lab	shelves	inside	0.020	15.0
151	east side of lab	shelves	outside	0.020	15.0
152	middle of lab	front of sink	floor	0.020	15.0
153	middle of lab	middle counter	front vent	0.020	15.0
154	east side of lab	lab	vent	0.020	15.0
155	west side of lab	lab	vent	0.020	15.0
156	middle of lab entrance	table	front of middle counter	0.020	15.0



SHELVES 150-151
COUNTER
85 86 87
EQUIPMENT 88
HOOD 95-102
HOOD 103-110
COUNTER STORAGE CABINETS 89-94
HOOD STORAGE CABINETS 111-114
HOOD STORAGE CABINETS 115-118
VENT-42
VENT-41
COUNTER STORAGE CABINETS 43-44
COUNTER STORAGE CABINETS 45-46
CANOPY HOOD 35-36
COUNTER
SHELVES 39-40
SHELVES 37-38
VENT 154
VENT-153
VENT 155
SINK 123
SINK 135
TABLE-156
152
A
COUNTER STORAGE CABINETS 137-138
COUNTER STORAGE CABINETS 139-142
COUNTER STORAGE CABINETS 143-144
VENT-147
DESK 27
TABLE 23
SHELVES 148-149

APPENDIX D

PORTABLE RADIATION SURVEY INSTRUMENTS UTILIZED IN SCANNING SURVEY



LUDLUM MEASUREMENTS, INC.

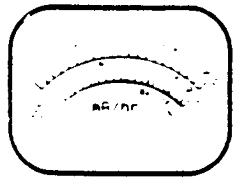
P.O. Box 810 • 501 Oak • Sweetwater, Texas 79556
915-235-5494 • Fax 915-235-4672 • 800-622-0828(USA)

GENERAL PURPOSE PORTABLE SURVEY METERS

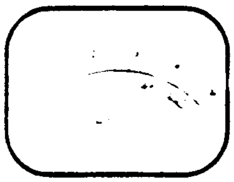
METER DIALS

202-2 for Models 2.3
with any detector
0 - 5k cpm

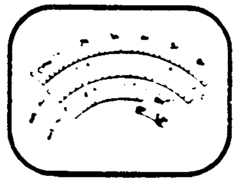
202-627 for Models 3, 14C
with 44-9
0 - 2 mR/hr



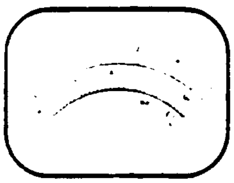
202-666 for Model 3
with 44-[illegible]
0 - 50 uR/hr



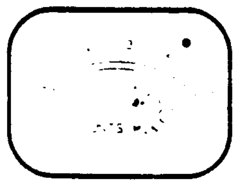
202-608 for Models 3, 14C
with 44-9
Dual Scale
0 - 2 mR/hr
0 - 6.6k cpm



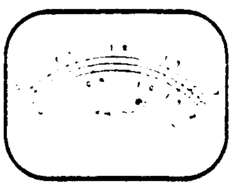
202-654 for Model 3
with 44-[illegible]
Dual Scale
0 - 50 uR/hr
0 - 6.4k cpm



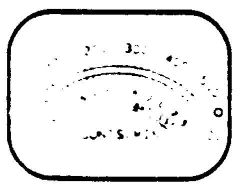
202-558 for Models 4
with any detector
0 - 500 cpm
0 - 2.5 kv
OR (overrange)



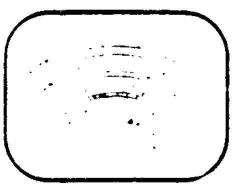
202-084 for Models 3, 14C
with 44-6, 44-38
0 - 2 mR/hr



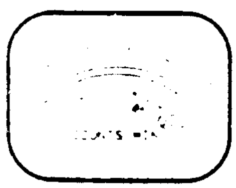
202-643 for Model 16
with any detector
0 - 500 cpm
0 - 2.5 kV
OL (overload)



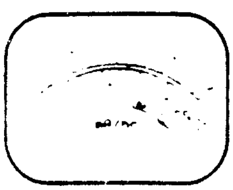
202-241 for Models 3, 14C
with 44-6, 44-38
Dual Scale
0 - 2 mR/hr
0 - 2.4k cpm



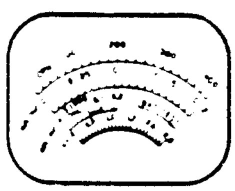
202-356 for Models 12, 18
with any detector
0 - 500 cpm
0 - 2.5 kV



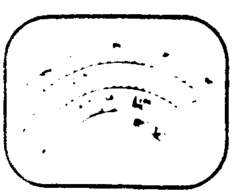
202-085 for Models 3, 14C
with 44-[illegible]
0 - 2 mR/hr



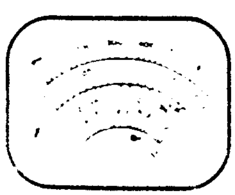
202-365 for Models 12, 18
with 44-7
Dual Scale
0 - 0.2 mR/hr
0 - 420 cpm
0 - 2.5 kV



202-330 for Models 3, 14C
with 44-7
Dual Scale
0 - 2 mR/hr
0 - 4.2k cpm



202-618 for Models 12, 18
with 44-9
Dual Scale
0 - 0.2 mR/hr
0 - 660 cpm
0 - 2.5 kV



ABOVE METER DIALS ARE MOST COMMON; OTHERS ARE AVAILABLE ON REQUEST

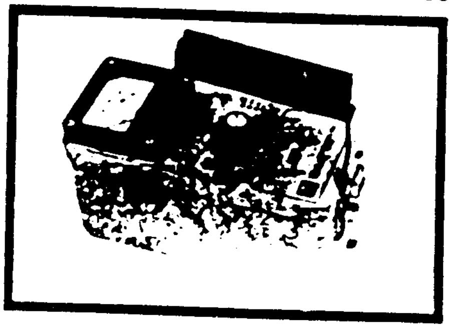
1 GENERAL PURPOSE PORTABLE SURVEY METERS

COMMON SPECIFICATIONS

CONNECTOR: Series "C" (*others available*)
AUDIO: Built in unimorph speaker with ON OFF switch (*greater than 60 dB at 2 feet*)
LINEARITY: Reading within ±10% of true value with detector connected
CALIBRATION CONTROLS: Accessible from front of instrument (*protective cover provided*)
RESPONSE: Toggle switch for FAST (4 seconds) or SLOW (22 seconds) from 10% to 90% of final reading
RESET: Pushbutton to zero meter
POWER: 2 each "D" cell batteries
(*housed in sealed compartment that is externally accessible*)
BATTERY LIFE: Typically 600 hours with alkaline batteries
(*battery condition can be checked on meter*)
BATTERY DEPENDANCE: Less than 3% change in readings to battery endpoint
METER: 2.5" (6.4cm) arc, 1 mA analog type
CONSTRUCTION: Cast and drawn aluminum with beige polyurethane enamel paint
TEMPERATURE RANGE: 5°F (-15°C) to 122°F (50°C)
May be certified for operation from -40°F (-40°C) to 150°F (65°C)
SIZE: 6.5" (16.5cm) H X 3.5" (8.9cm) W X 8.5" (21.6cm) L including handle
WEIGHT: 3.5 lbs (1.6kg) including batteries

MODEL 3 Survey Meter

4 Range General Purpose Survey Meter
(typical range 0 - 200 mR/hr or 0 - 500,000 cpm)



COMPATIBLE DETECTORS: G-M, scintillation
METER DIAL: 0 - 2 mR/hr or 0 - 5k cpm, BAT TEST
(*others available*)
MULTIPLIERS: X0.1, X1, X10, X100
HIGH VOLTAGE: Adjustable from 200 - 1500 volts
THRESHOLD: 30 mV ± 10 mV

NOTE: The 3 range version of the Model 3 is the Model 2 Survey Meter

ALPHA BETA-GAMMA G-M DETECTORS

MODEL 44-7
End Window G-M Detector

MODEL 44-9
Pancake G-M Detector

MODEL 44-7

INDICATED USE: Alpha, beta-gamma survey and sample counting
DETECTOR: End window halogen quenched G-M
WINDOW: 1.7 ± 0.3 mg/cm² mica
WINDOW AREA:
Active - 6 cm²
Open - 5 cm²
EFFICIENCY(2pi geometry): 5% [illegible] C, 20% [illegible] Sr/Y, 15% [illegible] Pu
SENSITIVITY: Typically 2100 cpm/mR/hr [illegible] Cs gamma
ENERGY RESPONSE: Energy dependant
DEAD TIME: Typically 160 us
COMPATIBLE INSTRUMENTS: General purpose survey meters, ratemeters, and scalers
OPERATING VOLTAGE: 900 volts
CONNECTOR: Series "C" (*others available*)
CONSTRUCTION: Anodized Aluminum housing with stainless steel protective screen (*79% open*)
TEMPERATURE RANGE: 5°F (-15°C) to 122°F (50°C)
May be certified to operate from -40°F (-40°C) to 150°F (65°C)
SIZE: 1.8" (4.6cm) diameter X 5.8" [illegible] cm L
WEIGHT: 1 lb (0.5kg)

MODEL 44-9

INDICATED USE: Alpha, beta-gamma survey, frisking
DETECTOR: Pancake type halogen quenched G-M
WINDOW: 1.7 ± 0.3 mg/cm² mica
WINDOW AREA:
Active - 15 cm²
Open - 12 cm²
EFFICIENCY(2pi geometry): Typically [illegible]% [illegible] C, 45% [illegible] Sr/⁹⁰Y, 38% ⁹⁹Tc, 65% ³²P, 30% [illegible]
SENSITIVITY: Typically 3300 cpm/mR/hr [illegible] Cs *gamma*
ENERGY RESPONSE: Energy dependant
DEAD TIME: Typically 80 us
COMPATIBLE INSTRUMENTS: General purpose survey meters, ratemeters, and scalers
OPERATING VOLTAGE: 900 volts
CONNECTOR: Series "C" (*others available*)
CONSTRUCTION: Aluminum body with beige polyurethane enamel paint, and stainless steel protective screen (*79% open*)
TEMPERATURE RANGE: 5°F (-15°C) to 122°F (50°C).
May be certified to operate from -40°F (-40°C) to 150°F (65°C)
SIZE: 1.8" (4.6cm) H X 2.7" (6.9cm) W X [illegible] (27.2cm) L
WEIGHT: 1 lb (0.5kg)

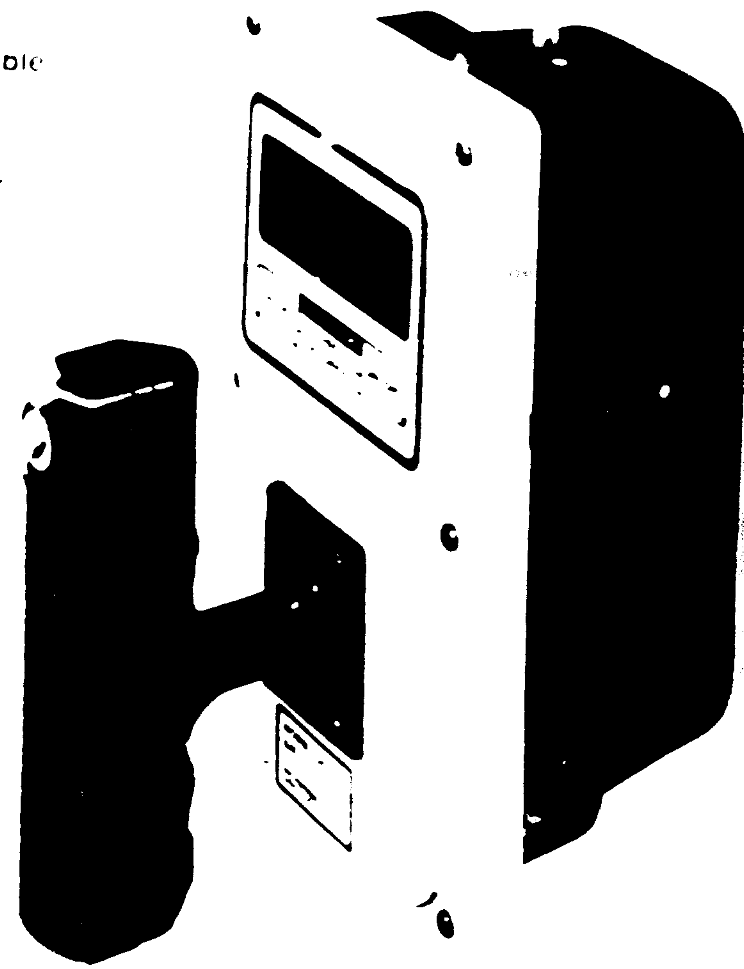
NOTE: [illegible]

VICTOREEN

VICTOREEN, INC.
(216) 248-9300
FAX (216) 248-9301

Pressurized Ion Chamber Survey Meter
Model 450P

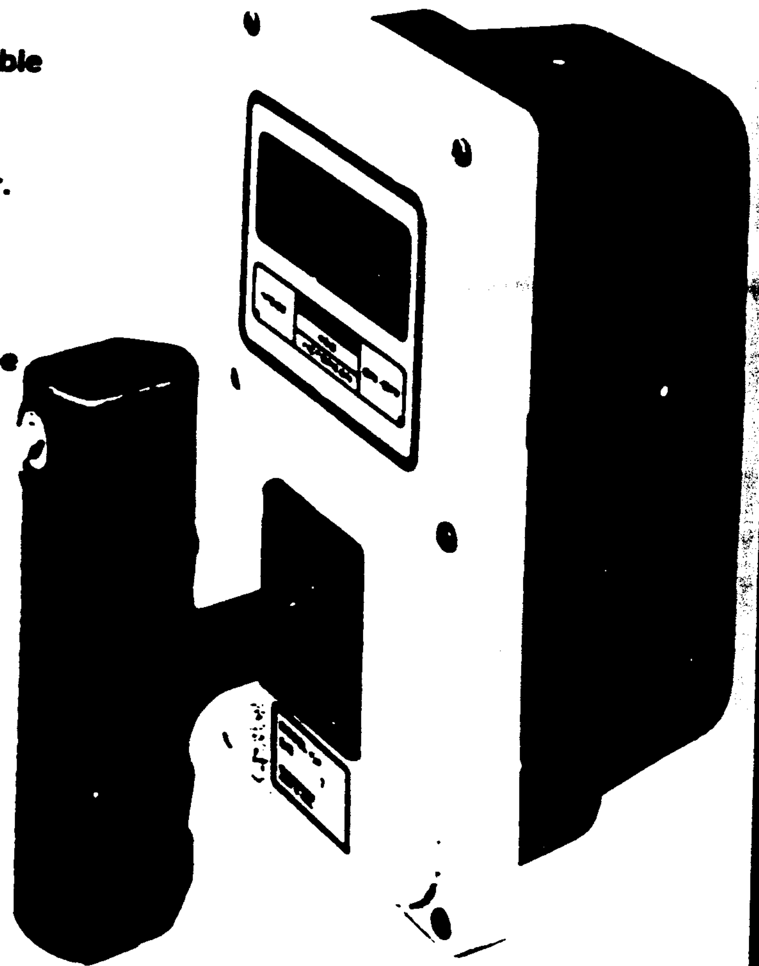
- **Extremely Fast Response** to measure radiation from leakage, scatter, beams, and pin holes
- **High Sensitivity** Micro-R measurements of exposures and exposure rates
- **Display Flash Alarm Feature** programmable on any range
- **Unique Method of Communication** for calibration and use as a remote detector
- **Serves Wide Range of Applications** for NDT, x-ray, accelerator, environmental and others
- **Illuminated Analog Digital Display** can be used in the dark
- **Available** with a Dose Equivalent Energy Response and [illegible]



VICTOREEN

Pressurized Ion Chamber Survey Meter
Model 450P

- **Extremely Fast Response to measure radiation from leakage, scatter, beams, and pin holes.**
- **High Sensitivity Micro-R measurements of exposures and exposure rates.**
- **Display Flash Alarm Feature programmable on any range.**
- **Unique Method of Communication for calibration and use as a remote detector.**
- **Serves Wide Range of Applications for NDT, x-ray, accelerator, environmental and others.**
- **Illuminated Analog/Digital Display can be used in the dark.**
- **Available with a Dose Equivalent Energy Response and SI units.***



The Model 450P is a light-weight portable survey meter consisting of a pressurized ionization chamber, microprocessor-based with a combined analog/digital liquid crystal display. The 450P has the extremely fast response required to measure ionizing radiation from leakage, scatter, beams and pinholes. The 450P has an illuminated analog/digital LCD display. The instrument utilizes an infrared communicator for calibration and allows the instrument to be used as a remote detector. The Model 450P has a programmable "flash alarm" which causes the display to pulsate at a rate of once per second when the measured dose rate exceeds a preset limit (set via a terminal). The ionization chamber is filled to a pressure of 6 atmospheres to enhance sensitivity and energy independence.

The 450P measures exposure, exposure rate, and can be used to "freeze" the maximum exposure rate encountered. The user can configure either integrate or freeze mode.

*Model 450P-DE-SI.

(continued on reverse side)

6000 COCHRAN ROAD, CLEVELAND, OHIO 44139 U.S.A.

Detector: 300 cc volume air ionization chamber pressurized to 6 atmospheres

Controls: Two push button switches are provided on the front surface of the instrument "ON/OFF" and "MODE"

Automatic Features:
Auto-ranging and auto-zeroing

Response Time: Analog response time from 10% to 90% of reading for a full scale step increase is dependent on operating range

Response time for a step increase in radiation exposure rate from background

Step increase, background to:	Time to reach 90% of final value (seconds)
400 uR/h	4.2
4 mR/h	3.3
10 mR/h	4.3
40 mR/h	4.5
100 mR/h	2.7
1 R/h	2.0
4 R/h	2.7

The following table shows time measured from 10% to 90% of final value for a step increase or decrease in exposure rate such that a range change does not occur. These values are the response times for the various ranges

Range	10%-90% Response (sec.)
0-500 uR/h (5 uSv/h)	5
0-5 mR/h (50 uSv/h)	2
0-50 mR/h (500 uSv/h)	1.8
0-500 mR/h (5 mSv/h)	1.8
0-5 R/h (50 mSv/h)	1.8

Options: Model 450-1A Communicator: Consists of RS-232 serial port with 1200 baud operation.

The Model 450-1A Communicator, connected to the survey meter and a dumb terminal or a computer with a terminal program, provides the following functions

Read stored calibration coefficients and other data from the internal EEPROM device. Recall current factors and data. Modify current calibration coefficients. Enter test mode. Change function: FREEZE or integrate, or Read internal integrate value when in FREEZE. Change units: Conventional or SI. Baud rate: 1200. Exit and store current calibration coefficients, display units and user notes. Quit and do not modify any calibration coefficients or user notes

Display: A liquid crystal Analog/Digital display is provided

Analog display:

100 element bar graph 2.5 inches (6.4cm) long. Bar graph is divided into 5 major segments, each labeled with the appropriate value for the range of the instrument.

Digital display:

2 1/2 digit display is followed by a significant zero digit depending on the operating range of the instrument. The units of measurement are indicated on the display at all times. Digits are 1/4 inch (6.4mm) high. "Low Battery" and "Freeze" messages, indicating the operating condition of the instrument, are also provided on the display.

Batteries: Two 9 volt transistor batteries

Battery Life: 200 hours continuously on new batteries. To continue integration, batteries may be changed one at a time permitting the instrument to remain operational.

Warm-Up Time:

Less than two minutes for initial operation when the instrument is in equilibrium with ambient temperature

Environmental Effects

Temp. range: -20°C to +50°C

Humidity range:

0 to 100%, instrument is designed to be moisture-proof

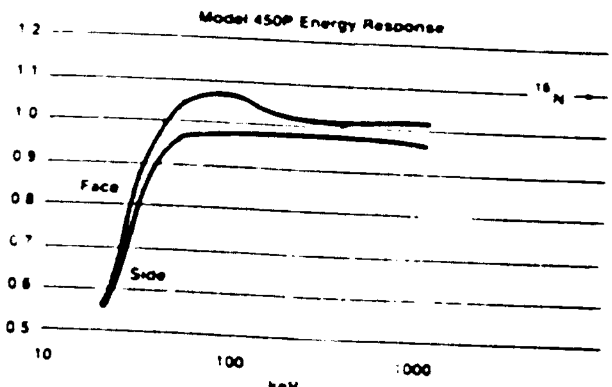
Geotropism: negligible

Dimensions: 4 inches (10cm) wide, 8 inches (20cm) long, 6 inches (15cm) high

Weight: 2 lb 6 oz (1.07 kg)

Energy Response:

^{16}Nitrogen gamma rays are 110% to 120% of indicated readings as determined at the University of Lowell



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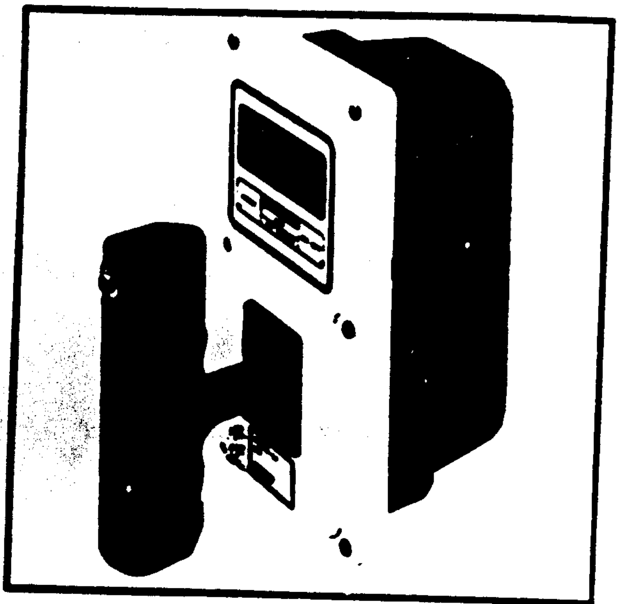
Model 450P Pressurized Ion Chamber Survey Meter

VICTOREEN



- **Extremely fast response to measure radiation from leakage, scatter beams, and pinholes**
- **High sensitivity micro-R measurements of exposures and exposure rates**
- **Display flash alarm, programmable on any range**
- **Unique method of communication for calibration and use as a remote detector**
- **Serves wide range of applications for NDT, X-ray, accelerator, environmental and others**
- **Illuminated display can be used in the dark**
- **Available with a dose equivalent energy response and SI units ***

Introduction:

The Model 450P is an innovative radiation survey instrument. It is based on the proven characteristics of the ion chamber radiation detector married to the latest CMOS microprocessor technology and liquid crystal displays.

The only controls present on the basic instrument are an ON-OFF button and a MODE button. No other controls are necessary because the instrument is both auto-ranging and auto-zeroing.

The display is unique, offering both a 100 element analog bargraph that is fully labelled with scale digits and a 2 1/2 digit digital display that also provides the proper units of measurement. The bar graph is provided with a faster time constant than the digital display making the instrument ideal for surveys.

* **Model 450P-DE-SI**

The top surface of the instrument has an overlay which covers both of the display switches, completely sealing this surface. The instrument is fully gasketed to make it moisture proof. The gasket also serves to shock-mount the printed circuit boards, liquid crystal display, and ion chamber assembly. The instrument will remain operational after a drop from a height of 3 ft. onto a concrete floor.

The variables FREEZE, INTEGRATE, R or Sv are factory set when the Model 450P is purchased without a communicator. The customer can choose settings.

The FREEZE button is a special feature that permits the instrument to remember and indicate the highest dose rate from the time the instrument is placed in the freeze mode. This feature permits placing an instrument in a potentially high radiation area and determining the maximum value the instrument sees.

The Integrate Mode operates continuously 30 seconds after the instrument has been turned on. Integration is performed even if the instrument is displaying in mR/h or R/h.

The Model 450P has a programmable "flash" alarm which causes the display to pulsate at a rate of once per second when the measured dose rate exceeds a preset limit (set via a terminal). The ionization chamber is filled to a pressure of 6 atmospheres to enhance sensitivity and energy independence.

Calibration is accomplished by an infra-red two-way communication, Model 450-1A. The communicator uses a RS-232 port. The two-way communicator can be used to interrogate the instrument for calibration information, perform a calibration of the instrument, change between the integrate display mode or the FREEZE display mode, or change units (English-SI).

The IR Communicator also allows the use of the Model 450P as a remote detector.

To guard against battery-related instrument failure, a "Low Battery" condition is indicated continuously on the face of the display when a battery change is required.

Specifications

Radiation Detected:

Beta above 1 MeV, gamma and X-rays above 25 keV

Operating Ranges:

0-500 μR/h or 0-5 μSv/h
0-5 mR/h or 0-50 μSv/h
0-50 mR/h or 0-500 μSv/h
0-500 mR/h or 0-5 mSv/h
0-5 R/h or 0-50 mSv/h

Accuracy: Within 10% of reading between 10% and 100% of full scale indication on any range exclusive of energy response. Calibration source is ^{137}Cs.

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SPECIFICATIONS:

Radiation Types Detected: Beta above 1 MeV, gamma and X-rays above 25 keV.

Operating Ranges:

0-500 µR/h or 0-5 µSv/h
0-5 mR/h or 0-50 µSv/h
0-50 mR/h or 0-500 µSv/h
0-500 mR/h or 0-5 mSv/h
0-5 R/h or 0-50 mSv/h

Accuracy: Within 10% of reading between 10% and 100% of full scale, indication on any range, exclusive of energy response. Calibration source is ^{137}Cs.

Detector: 300 cc volume air ionization chamber pressurized to 6 atmospheres.

Warm-Up Time: Less than 2 minutes for initial operation when the instrument is in equilibrium with ambient temperature.

Energy Response: See curve. ^{16}N data taken at the University of Lowell.

Angular Response: At ^{137}Cs and 38 keV - within 10% through 180°.

Response Time: Analog response time from 10% to 90% of reading for a full scale step increase is dependent on operating range.

Response time for a step increase in radiation exposure rate from background:

Step increase, background to:	*Time to reach 90% of final value (seconds)*
400 µR/h	4.8
4 mR/h	3.3
10 mR/h	4.3
40 mR/h	4.5
100 mR/h	1.8
400 mR/h	2.7
1 R/h	2.0
4 R/h	2.7

The following table shows time measured from 10% to 90% of final value for a step increase or decrease in exposure rate such that a range change does not occur. These values are the response times for the various ranges.

Range

Range	*10%-90% Response (sec.)*
0-500 µR/h (5 µSv/h)	5
0-5 mR/h (50 µSv/h)	2
0-50 mR/h (500 µSv/h)	1.8
0-500 mR/h (5 mSv/h)	1.8
0-5 R/h (50 mSv/h)	1.8

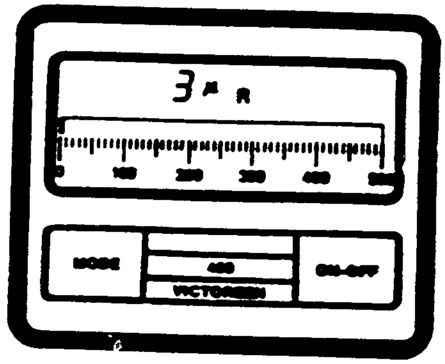
Dimensions: 4" (10 cm) wide x 8" (20 cm) long x 6" (15 cm) high

Weight: 1 lbx. 14 oz. (0.85 kg)

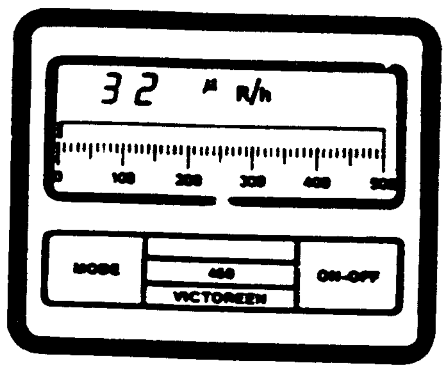
Option: Model 450-1A Communicator: Consists of RS232 serial port 1200 baud operation. The Model 450-1A Communicator, connected to the survey meter and a dumb terminal or computer with terminal emulation program, provides the following functions:

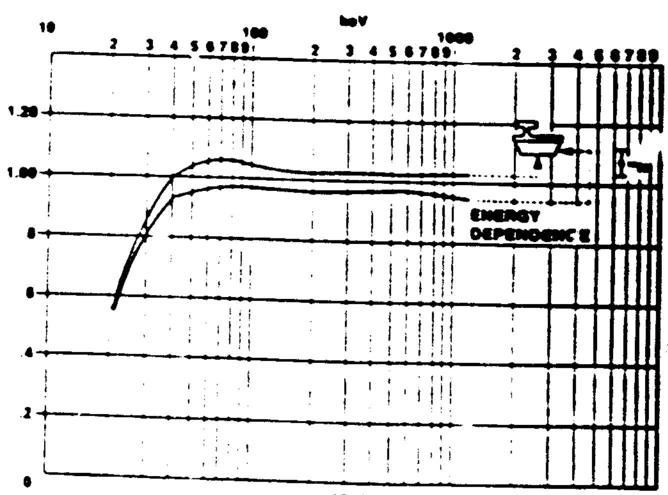
Read stored calibration coefficients and other data from the internal EEPROM device;
Recall current factors and data;
Modify current calibration coefficients;
Enter test mode;
Change function: FREEZE, Integrate, or Read internal integrate value when in FREEZE.
Change units: Conventional or SI;
Baud rate: 1200;
Exit and store current calibration coefficients, display units, and user notes;
Quit, and do not modify any calibration coefficients, or user notes.

Integrated Exposure: *<0.1 second to hours exposure time.*



Exposure Rate: *<5 second response 0-500 µR/h, upper ranges even faster.*





APPENDIX E

RADIOLOGICAL ASSESSMENT

SWIPE SAMPLE ANALYSIS

The following instrument surveys were taken in these designated laboratories located in John Wesley Powell Building:

- Laboratory 3D231
- Laboratory 3D239

REPORT OF SAMPLE ANALYSIS

Rev 1.0

For: Ray Safe Associates

Job: Wipe Samples(H.P. Survey)

Sample Type: Gross Gamma

Date: August 21, 1996

By: 8/16/96

Equipment Description:

Counter	Detector
Packard Prias 1	NaI

Sample Date: July 28, 1995

Counting Parameters:

Gross Gamma

Input Background Data:

Background Cts	Ct Time (m)	Background CPM	% Error
456.00	5.00	91.20	9.18%

Input Efficiency Data:

Isotope	Gross Counts	Time (m)	DPM	Efficiency (4 Pi)	% Error
I-129	18482	1	31080	59.17%	10.00%

MDA Calculation:

MDA (CPM)	MDA (DPM)	MDA (uCi)
20.50	35	1.56E-05

Sample Data: Note: A zero reading for DPM or uCi values indicates only that the sample activity was less than the MDA

Sequence Number	Sample ID	Gross Counts	Ct Time (m)	*DPM*	*uCi*	% Error at 95% C.L.
1	Lab 3D231 1-5	443	5	0	0.00E+00	0
2	6-10	443	5	0	0.00E+00	0
3	11-12	450	5	0	0.00E+00	0
4	13-17	475	5	0	0.00E+00	0
5	18-23	461	5	0	0.00E+00	0
6	24-30	448	5	0	0.00E+00	0
7	31-36	466		0	0.00E+00	0
8	37-41	442	5	0	0.00E+00	0
9	42-44	462	5	0	0.00E+00	0
10	45-49	457	5	0	0.00E+00	0
11	50-54	442	5	0	0.00E+00	0
12	55-61	446	5	0	0.00E+00	0
13	62-66	458	5	0	0.00E+00	0
14	67-69	432	5	0	0.00E+00	0
15	70-74	457	5	0	0.00E+00	0
16	75-79	474	5	0	0.00E+00	0
17	80-84	454	5	0	0.00E+00	0
18	85-89	457	5	0	0.00E+00	0
19	90-92	451	5	0	0.00E+00	0
20	93-97	442	5	0	0.00E+00	0
21	98-101	450	5	0	0.00E+00	0
22	102-107	442	5	0	0.00E+00	0
23	108-112	463	5	0	0.00E+00	0
24	113-115	453	5	0	0.00E+00	0

LS Counter Data Reduction Program - ESI (LS 1701)

Report Date: 8/21/96
Sample Date: 8/16/96

Instrument Data: *Beckman LS-1701*

Window: Wide Window (User No [illegible] 1)

Background Data:

Bkg CPM	Count Time (min)	% Error (95% C.L.)
23	1	40.87%

MDA Data:

MDA (CPM): 25   MDA (DPM): 42

Sample Data: Note: A zero reading for DPM values indicates only that the sample activity was less than the MDA.

Seq No	Sample ID	Count Time (min)	SCR	CPM	Efficiency	CF	DPM	Error (95% C.L.)
1	Ray Sate Assoc. Lab 3D321	1	0.194	36	58.703%	1.00	0	0.00%
2	2	1	0.200	30	58.260%	1.00	0	0.00%
3	3	1	0.207	29	57.743%	1.00	0	0.00%
4	4	1	0.087	23	66.605%	1.00	0	0.00%
5	5	1	0.182	33	59.589%	1.00	0	0.00%
6	6	1	0.105	38	65.276%	1.00	0	0.00%
7	7	1	0.304	23	59.580%	1.00	0	0.00%
8	8	1	0.136	22	62.986%	1.00	0	0.00%
9	9	1	0.138	29	62.839%	1.00	0	0.00%
10	10	1	0.167	30	60.697%	1.00	0	0.00%
11	11	1	0.226	31	56.340%	1.00	0	0.00%
12	12	1	0.292	24	51.466%	1.00	0	0.00%
13	13	1	0.200	25	58.260%	1.00	0	0.00%
14	14	1	0.143	28	62.469%	1.00	0	0.00%
15	15	1	0.194	31	58.703%	1.00	0	0.00%
16	16	1	0.241	29	55.232%	1.00	0	0.00%
17	17	1	0.174	23	60.180%	1.00	0	0.00%
18	18	1	0.214	28	57.226%	1.00	0	0.00%
19	19	1	0.103	29	65.423%	1.00	0	0.00%
20	20	1	0.200	25	58.260%	1.00	0	0.00%
21	21	1	0.114	35	64.611%	1.00	0	0.00%
22	22	1	0.100	30	65.645%	1.00	0	0.00%
23	23	1	0.050	20	69.338%	1.00	0	0.00%
24	24	1	0.043	23	69.854%	1.00	0	0.00%
25	25	1	0.172	29	60.328%	1.00	0	0.00%
26	26	1	0.107	28	65.128%	1.00	0	0.00%
27	27	1	0.100	20	65.645%	1.00	0	0.00%
28	28	1	0.192	26	58.851%	1.00	0	0.00%
29	29	1	0.261	23	53.755%	1.00	0	0.00%
30	30	1	0.143	35	62.469%	1.00	0	0.00%
31	31	1	0.167	30	60.697%	1.00	0	0.00%
32	32	1	0.172	29	60.328%	1.00	0	0.00%
33	33	1	0.130	23	63.430%	1.00	0	0.00%
34	34	1	0.037	27	70.298%	1.00	0	0.00%
35	35	1	0.069	29	67.934%	1.00	0	0.00%
36	36	1	0.108	37	65.054%	1.00	0	0.00%
37	37	1	0.219	32	56.857%	1.00	0	0.00%
38	38	1	0.083	36	66.900%	1.00	0	0.00%
39	39	1	0.120	25	64.168%	1.00	0	0.00%
40	40	1	0.182	22	59.589%	1.00	0	0.00%
41	41	1	0.045	22	69.707%	1.00	0	0.00%
42	42	1	0.250	40	54.567%	1.00	0	0.00%
43	43	1	0.375	32	45.336%	1.00	0	0.00%
44	44	1	0.194	36	58.703%	1.00	0	0.00%
45	45	1	0.125	32	63.799%	1.00	0	0.00%
46	46	1	0.222	27	56.635%	1.00	0	0.00%
47	47	1	0.143	42	62.469%	1.00	0	0.00%
48	48	1	0.097	31	65.8[illegible]%	1.00	0	0.00%
49	49	1	0.172	29	[illegible].328%	1.00	0	0.00%
50	50	1	0.185	27	59.368%	1.00	0	0.00%

LS Counter Data Reduction Program - ESI (LS 1701)

Report Date: 8/21/96
Sample Date: 8/16/96

Instrument Data: *Beckman LS 1701*

Window: Wide Window (User No. 1)

Background Data:

Bkg CPM	Count Time (min)	% Error (95% C.L.)
23	1	40.87%

MDA Data:

MDA (CPM): 25   MDA (DPM): 42

Sample Data: Note: A zero reading for DPM values indicates only that the sample activity was less than the MDA.

Seq No.	Sample ID	Count Time (min)	SCR	CPM	Efficiency	CF	DPM	Error (95% C.L.)
1	Ray Safe Assoc. Lab 3D321	1	0.160	25	61.214%	1.00	0	0.00%
2	52	1	0.200	30	58.260%	1.00	0	0.00%
3	53	1	0.038	26	70.224%	1.00	0	0.00%
4	54	1	0.269	26	53.164%	1.00	0	0.00%
5	55	1	0.156	32	61.509%	1.00	0	0.00%
6	56	1	0.167	30	60.697%	1.00	0	0.00%
7	57	1	0.182	33	59.589%	1.00	0	0.00%
8	58	1	0.211	38	57.448%	1.00	0	0.00%
9	59	1	0.174	23	60.180%	1.00	0	0.00%
10	60	1	0.091	33	66.310%	1.00	0	0.00%
11	61	1	0.107	28	65.128%	1.00	0	0.00%
12	62	1	0.222	36	56.635%	1.00	0	0.00%
13	63	1	0.292	24	51.466%	1.00	0	0.00%
14	64	1	0.200	35	58.260%	1.00	0	0.00%
15	65	1	0.143	28	62.469%	1.00	0	0.00%
16	66	1	0.174	23	60.180%	1.00	0	0.00%
17	67	1	0.194	36	58.703%	1.00	0	0.00%
18	68	1	0.087	23	66.605%	1.00	0	0.00%
19	69	1	0.143	35	62.469%	1.00	0	0.00%
20	70	1	0.122	41	64.020%	1.00	0	0.00%
21	71	1	0.200	30	58.260%	1.00	0	0.00%
22	72	1	0.375	24	45.336%	1.00	0	0.00%
23	73	1	0.161	31	61.140%	1.00	0	0.00%
24	74	1	0.172	29	60.328%	1.00	0	0.00%
25	75	1	0.222	36	56.635%	1.00	0	0.00%
26	76	1	0.050	20	69.338%	1.00	0	0.00%
27	77	1	0.139	36	62.765%	1.00	0	0.00%
28	78	1	0.028	36	70.962%	1.00	0	0.00%
29	79	1	0.088	34	66.531%	1.00	0	0.00%
30	80	1	0.182	33	59.589%	1.00	0	0.00%
31	81	1	0.179	28	59.811%	1.00	0	0.00%
32	82	1	0.176	34	60.032%	1.00	0	0.00%
33	83	1	0.061	33	68.525%	1.00	0	0.00%
34	84	1	0.135	37	63.060%	1.00	0	0.00%
35	85	1	0.171	35	60.402%	1.00	0	0.00%
36	86	1	0.094	32	66.088%	1.00	0	0.00%
37	87	1	0.111	27	64.833%	1.00	0	0.00%
38	88	1	0.265	34	53.460%	1.00	0	0.00%
39	89	1	0.217	23	57.005%	1.00	0	0.00%
40	90	1	0.107	28	65.128%	1.00	0	0.00%
41	91	1	0.107	28	65.128%	1.00	0	0.00%
42	92	1	0.139	36	62.765%	1.00	0	0.00%
43	93	1	0.080	25	67.122%	1.00	0	0.00%
44	94	1	0.176	34	60.032%	1.00	0	0.00%
45	95	1	0.172	29	60.328%	1.00	0	0.00%
46	96	1	0.194	36	58.703%	1.00	0	0.00%
47	97	1	0.219	32	56.857%	1.00	0	0.00%
48	98	1	0.097	31	65.867%	1.00	0	0.00%
49	99	1	0.200	30	58.260%	1.00	0	0.00%
50	100	1	0.219	32	56.857%	1.00	0	0.00%

LS Counter Data Reduction Program - ESI (LS 1701)

Report Date: 8/21/96
Sample Date: 8/16/96

Instrument Data: *Beckman LS-1701*

Window: Wide Window (User No. 1)

Background Data:

Bkg CPM	Count Time (min)	% Error (95% C.L.)
23	1	40.87%

MDA Data:

MDA (CPM): 25

MDA (DPM): 41

Sample Data: Note: A zero reading for DPM values indicates only that the sample activity was less than the MDA.

Seq No	Sample ID	Count Time (min)	SCR	CPM	Efficiency	CF	DPM	Error (95% C.L.)
1	Ray Safe Assoc. Lab 3D321	1	0.175	40	60.106%	1.00	0	0.00%
2	102	1	0.103	29	65.423%	1.00	0	0.00%
3	103	1	0.114	35	64.611%	1.00	0	0.00%
4	104	1	0.128	39	63.577%	1.00	0	0.00%
5	105	1	0.200	25	58.260%	1.00	0	0.00%
6	106	1	0.065	31	68.230%	1.00	0	0.00%
7	107	1	0.212	33	57.374%	1.00	0	0.00%
8	108	1	0.107	28	65.128%	1.00	0	0.00%
9	109	1	0.233	30	55.823%	1.00	0	0.00%
10	110	1	0.118	34	64.316%	1.00	0	0.00%
11	111	1	0.125	40	63.799%	1.00	0	0.00%
12	112	1	0.194	36	58.703%	1.00	0	0.00%
13	113	1	0.050	20	69.338%	1.00	0	0.00%
14	114	1	0.094	32	66.088%	1.00	0	0.00%
15	115	1	0.346	26	47.478%	1.00	0	0.00%

REPORT OF SAMPLE ANALYSIS
Rev 1 0

...ent: Ray Safe Associates
...ob: Wipe Samples(H P Survey)
...mple Type: Gross Gamma

Date: August 21, 1996
By: ELW

Sample Date: August 16, 1996

...quipment Description:

Counter	Detector
Packard Prias 1	NaI

Counting Parameters:
Gross Gamma

...put Background Data:

Background Cts	Ct Time (m)	Background CPM	% Error
456.00	5 00	91 20	9.18%

...put Efficiency Data:

Isotope	Gross Counts	Time (m)	DPM	Efficiency (4 Pi)	% Error
I-129	18482	1	31080	59.17%	10.00%

...DA Calculation:

MDA (CPM)	MDA (DPM)	MDA (uCi)
20 50	35	1.56E-05

...ple Data: Note: A zero reading for DPM or uCi values indicates only that the sample activity was less than the MDA

Sequence Number	Sample ID	Gross Counts	Ct Time (m)	*DPM*	*uCi*	% Error at 95% C.L.
1	Lab3D239 1-6	467	5	0	0.00E+00	0
2	7-13	457	5	0	0.00E+00	0
3	14-20	446	5	0	0.00E+00	0
4	21-25	440	5	0	0.00E+00	0
5	26-30	443	5	0	0.00E+00	0
6	31-35	467	5	0	0.00E+00	0
7	36-39	454	5	0	0.00E+00	0
8	40-44	460	5	0	0.00E+00	0
9	45-49	459	5	0	0.00E+00	0
10	50-53	458	5	0	0.00E+00	0
11	54-58	458	5	0	0.00E+00	0
12	59-61	450	5	0	0.00E+00	0
13	62-68	466	5	0	0.00E+00	0
14	69-71	451	5	0	0.00E+00	0
15	72-76	464	5	0	0.00E+00	0
16	77-79	475	5	0	0.00E+00	0
17	80-84	445	5	0	0.00E+00	0
18	85-89	455	5	0	0.00E+00	0
19	90-93	437	5	0	0.00E+00	0
20	94-98	460	5	0	0.00E+00	0
21	99-100	463	5	0	0.00E+00	0
22	101-105	447	5	0	0.00E+00	0
23	106-111	448	5	0	0.00E+00	0
24	112-116	463	5	0	0.00E+00	0
25	117-121	438	5	0	0.00E+00	0

REPORT OF SAMPLE ANALYSIS
Rev 1 0

…er: Ray Safe Associates
…ob: Wipe Samples(H.P. Survey)
…mple Type: Gross Gamma

Date: August 21, 1996
By: ELW

Sample Date: August 16, 1996

…quipment Description:

Counter	Detector
Packard Prias I	NaI

Counting Parameters: Gross Gamma

…put Background Data:

Background Cts	Ct Time (m)	Background CPM	% Error
456.00	5 00	91 20	9.18%

…put Efficiency Data:

Isotope	Gross Counts	Time (m)	DPM	Efficiency (4 Pi)	% Error
I-129	18482	1	31080	59 17%	10 00%

…DA Calculation:

MDA (CPM)	MDA (DPM)	MDA (uCi)
20 50	35	1 56E-05

…mple Data: Note: A zero reading for DPM or uCi values indicates only that the sample activity was less than the MDA

Sequence Number	Sample ID	Gross Counts	Ct Time (m)	*DPM*	*uCi*	% Error at 95% C L
1	Lab 3D239 122-127	461	5	0	0 00E+00	0
2	128-132	461	5	0	0 00E+00	0
3	133-136	461	5	0	0 00E+00	0
4	137-141	452	5	0	0 00E+00	0
5	142-146	459	5	0	0.00E+00	0
6	147-151	443	5	0	0 00E+00	0
7	152-156	440	5	0	0 00E+00	0

LS Counter Data Reduction Program - ESI (LS 1701)

Report Date: 8/21/96
Sample Date: 8/16/96

Instrument Data: *Beckman LS-1701*

Window: Wide Window (User No. 1)

Background Data:

Bkg CPM	Count Time (min)	% Error (95% C.L.)
23	1	40.87%

MDA Data:

MDA (CPM): 25 MDA (DPM): 41

Sample Data: Note: A zero reading for DPM values indicates only that the sample activity was less than the MDA.

Seq No.	Sample ID	Count Time (min)	SCR	CPM	Efficiency	CF	DPM	Error (95% C.L.)
1	Ray Safe Assoc.LabJD239	1	0.067	30	68.082%	1.00	0	0.00%
2	2	1	0.172	29	60.328%	1.00	0	0.00%
3	3	1	0.095	21	66.014%	1.00	0	0.00%
4	4	1	0.111	36	64.833%	1.00	0	0.00%
5	5	1	0.240	25	55.306%	1.00	0	0.00%
6	6	1	0.143	35	62.469%	1.00	0	0.00%
7	7	1	0.185	27	59.368%	1.00	0	0.00%
8	8	1	0.083	24	66.900%	1.00	0	0.00%
9	9	1	0.256	43	54.124%	1.00	0	0.00%
10	10	1	0.200	35	58.260%	1.00	0	0.00%
11	11	1	0.250	24	54.567%	1.00	0	0.00%
12	12	1	0.217	23	57.005%	1.00	0	0.00%
13	13	1	0.233	43	55.823%	1.00	0	0.00%
14	14	1	0.138	29	62.839%	1.00	0	0.00%
15	15	1	0.172	29	60.328%	1.00	0	0.00%
16	16	1	0.179	28	59.811%	1.00	0	0.00%
17	17	1	0.125	24	63.799%	1.00	0	0.00%
18	18	1	0.143	28	62.469%	1.00	0	0.00%
19	19	1	0.148	27	62.100%	1.00	0	0.00%
20	20	1	0.206	34	57.817%	1.00	0	0.00%
21	21	1	0.308	26	50.284%	1.00	0	0.00%
22	22	1	0.154	39	61.657%	1.00	0	0.00%
23	23	1	0.292	24	51.466%	1.00	0	0.00%
24	24	1	0.194	31	58.703%	1.00	0	0.00%
25	25	1	0.138	29	62.839%	1.00	0	0.00%
26	26	1	0.138	29	62.839%	1.00	0	0.00%
27	27	1	0.129	31	63.503%	1.00	0	0.00%
28	28	1	0.167	24	60.697%	1.00	0	0.00%
29	29	1	0.200	25	58.260%	1.00	0	0.00%
30	30	1	0.148	27	62.100%	1.00	0	0.00%
31	31	1	0.143	28	62.469%	1.00	0	0.00%
32	32	1	0.324	37	49.103%	1.00	0	0.00%
33	33	1	0.273	22	52.869%	1.00	0	0.00%
34	34	1	0.097	31	65.867%	1.00	0	0.00%
35	35	1	0.125	32	63.799%	1.00	0	0.00%
36	36	1	0.162	37	61.066%	1.00	0	0.00%
37	37	1	0.207	29	57.743%	1.00	0	0.00%
38	38	1	0.167	30	60.697%	1.00	0	0.00%
39	39	1	0.175	40	60.106%	1.00	0	0.00%
40	40	1	0.290	31	51.614%	1.00	0	0.00%
41	41	1	0.042	24	69.928%	1.00	0	0.00%
42	42	1	0.160	25	61.214%	1.00	0	0.00%
43	43	1	0.125	32	63.799%	1.00	0	0.00%
44	44	1	0.161	31	61.140%	1.00	0	0.00%
45	45	1	0.111	36	64.833%	1.00	0	0.00%
46	46	1	0.188	32	59.146%	1.00	0	0.00%
47	47	1	0.143	35	62.469%	1.00	0	0.00%
48	48	1	0.148	27	62.100%	1.00	0	0.00%
49	49	1	0.161	31	61.140%	1.00	0	0.00%
50	50	1	0.258	31	53.977%	1.00	0	0.00%

LS Counter Data Reduction Program - ESI (LS 1701)

Report Date: 8/21/96
Sample Date: 8/16/96

Instrument Data: *Beckman LS-1701*

Window: Wide Window (User No. 1)

Background Data:

Bkg CPM	Count Time (min)	% Error (95% C.L.)
23	1	40.87%

MDA Data:

MDA (CPM): 25

MDA (DPM): 42

Sample Data: Note: A zero reading for DPM values indicates only that the sample activity was less than the MDA.

Seq No.	Sample ID	Count Time (min)	SCR	CPM	Efficiency	CF	DPM	Error (95% C.L.)
1	51	1	0.107	28	65.128%	1.00	0	0.00%
2	52	1	0.156	32	61.509%	1.00	0	0.00%
3	53	1	0.231	26	55.971%	1.00	0	0.00%
4	54	1	0.235	34	55.675%	1.00	0	0.00%
5	55		0.167	30	60.697%	1.00	0	0.00%
6	56		0.182	22	59.589%	1.00	0	0.00%
7	57	1	0.240	25	55.306%	1.00	0	0.00%
8	58	1	0.171	35	60.402%	1.00	0	0.00%
9	59	1	0.088	34	66.531%	1.00	0	0.00%
10	60	1	0.152	23	61.805%	1.00	0	0.00%
11	61	1	0.097	31	65.867%	1.00	0	0.00%
12	62	1	0.083	24	66.900%	1.00	0	0.00%
13	63	1	0.065	31	68.230%	1.00	0	0.00%
14	64	1	0.176	34	60.032%	1.00	0	0.00%
15	65	1	0.154	39	61.657%	1.00	0	0.00%
16	66	1	0.162	37	61.066%	1.00	0	0.00%
17	67	1	0.138	29	62.839%	1.00	0	0.00%
18	68	1	0.136	22	62.986%	1.00	0	0.00%
19	69	1	0.172	29	60.328%	1.00	0	0.00%
20	70	1	0.250	24	54.567%	1.00	0	0.00%
21	71	1	0.178	24	59.885%	1.00	0	0.00%
22	72	1	0.121	33	64.094%	1.00	0	0.00%
23	73	1	0.115	26	64.537%	1.00	0	0.00%
24	74	1	0.147	34	62.174%	1.00	0	0.00%
25	75	1	0.152	33	61.805%	1.00	0	0.00%
26	76	1	0.114	35	64.611%	1.00	0	0.00%
27	77	1	0.167	36	60.697%	1.00	0	0.00%
28	78	1	0.161	31	61.140%	1.00	0	0.00%
29	79	1	0.200	30	58.260%	1.00	0	0.00%
30	80	1	0.139	36	62.765%	1.00	0	0.00%
31	81	1	0.321	28	49.324%	1.00	0	0.00%
32	82	1	0.250	44	54.567%	1.00	0	0.00%
33	83	1	0.136	22	62.986%	1.00	0	0.00%
34	84	1	0.154	26	61.657%	1.00	0	0.00%
35	85	1	0.088	34	66.531%	1.00	0	0.00%
36	86	1	0.167	30	60.697%	1.00	0	0.00%
37	87	1	0.176	34	60.032%	1.00	0	0.00%
38	88	1	0.219	32	56.857%	1.00	0	0.00%
39	89	1	0.171	35	60.402%	1.00	0	0.00%
40	90	1	0.091	22	66.310%	1.00	0	0.00%
41	91	1	0.097	31	65.867%	1.00	0	0.00%
42	92	1	0.157	31	61.436%	1.00	0	0.00%
43	93	1	0.074	24	67.565%	1.00	0	0.00%
44	94	1	0.281	27	52.278%	1.00	0	0.00%
45	95	1	0.176	32	60.032%	1.00	0	0.00%
46	96	1	0.296	34	51.170%	1.00	0	0.00%
47	97	1	0.333	27	48.438%	1.00	0	0.00%
48	98	1	0.143	30	62.469%	1.00	0	0.00%
49	99	1	0.139	28	62.765%	1.00	0	0.00%
50	100	1	0.161	36	61.140%	1.00	0	0.00%

LS Counter Data Reduction Program - ESI (LS 1701)

Report Date: 8/21/96
Sample Date: 8/16/96

Instrument Data: *Beckman LS 1701*

Window: Wide Window (User No 1)

Background Data:

Bkg CPM	Count Time (min)	% Error (95% C.L.)
23	1	40.87%

MDA Data:

MDA (CPM): 25   MDA (DPM): 42

Sample Data: Note: A zero reading for DPM values indicates only that the sample activity was less than the MDA.

Seq No.	Sample ID	Count Time (min)	SCR	CPM	Efficiency	CF	DPM	Error (95% C.L.)
1	Ray Safe Assoc. 101	1	0.161	31	61.140%	1.00	0	0.00%
2	102	1	0.158	19	61.362%	1.00	0	0.00%
3	103	1	0.321	28	49.324%	1.00	0	0.00%
4	104	1	0.136	22	62.986%	1.00	0	0.00%
5	105	1	0.188	32	59.146%	1.00	0	0.00%
6	106	1	0.222	27	56.635%	1.00	0	0.00%
7	107	1	0.129	31	63.503%	1.00	0	0.00%
8	108	1	0.038	26	70.224%	1.00	0	0.00%
9	109	1	0.132	38	63.282%	1.00	0	0.00%
10	110	1	0.138	29	62.839%	1.00	0	0.00%
11	111	1	0.120	25	64.168%	1.00	0	0.00%
12	112	1	0.115	26	64.537%	1.00	0	0.00%
13	113	1	0.108	37	65.054%	1.00	0	0.00%
14	114	1	0.132	38	63.282%	1.00	0	0.00%
15	115	1	0.115	26	64.537%	1.00	0	0.00%
16	116	1	0.121	33	64.094%	1.00	0	0.00%
17	117	1	0.121	33	64.094%	1.00	0	0.00%
18	118	1	0.100	30	65.645%	1.00	0	0.00%
19	119	1	0.160	25	61.214%	1.00	0	0.00%
20	120	1	0.178	45	59.885%	1.00	0	0.00%
21	121	1	0.100	30	65.645%	1.00	0	0.00%
22	122	1	0.136	22	62.986%	1.00	0	0.00%
23	123	1	0.357	28	46.666%	1.00	0	0.00%
24	124	1	0.152	33	61.805%	1.00	0	0.00%
25	125	1	0.219	32	56.857%	1.00	0	0.00%
26	126	1	0.080	25	67.122%	1.00	0	0.00%
27	127	1	0.161	31	61.140%	1.00	0	0.00%
28	128	1	0.103	29	65.423%	1.00	0	0.00%
29	129	1	0.192	26	58.851%	1.00	0	0.00%
30	130	1	0.091	22	66.310%	1.00	0	0.00%
31	131	1	0.074	27	67.565%	1.00	0	0.00%
32	132	1	0.098	20	65.793%	1.00	0	0.00%
33	133	1	0.194	31	58.703%	1.00	0	0.00%
34	134	1	0.138	29	62.839%	1.00	0	0.00%
35	135	1	0.120	25	64.168%	1.00	0	0.00%
36	136	1	0.147	34	62.174%	1.00	0	0.00%
37	137	1	0.133	30	63.208%	1.00	0	0.00%
38	138	1	0.143	28	62.469%	1.00	0	0.00%
39	139	1	0.273	22	52.869%	1.00	0	0.00%
40	140	1	0.200	30	58.260%	1.00	0	0.00%
41	141	1	0.067	30	68.082%	1.00	0	0.00%
42	142	1	0.167	36	60.697%	1.00	0	0.00%
43	143	1	0.125	32	63.799%	1.00	0	0.00%
44	144	1	0.125	32	63.799%	1.00	0	0.00%
45	145	1	0.190	21	58.999%	1.00	0	0.00%
46	146	1	0.139	36	62.765%	1.00	0	0.00%
47	147	1	0.190	21	58.999%	1.00	0	0.00%
48	148	1	0 83	36	66.900%	1.00	0	0.00%
49	149	1	0.111	27	64.833%	1.00	0	0.00%
50	150	1	0.194	36	58.703%	1.00	0	0.00%

LS Counter Data Reduction Program - ESI (LS 1701)

Report Date: 8/21/96
Sample Date: 8/16/96

Instrument Data: *Beckman LS-1701*

Window: Wide Window (User No. 1)

Background Data:

Bkg CPM	Count Time (min)	% Error (95% C.L.)
23	1	40.87%

MDA Data:

MDA (CPM): 25 MDA (DPM): 37

Sample Data: Note: A zero reading for DPM values indicates only that the sample activity was less than the MDA.

Seq No.	Sample ID	Count Time (min)	SCR	CPM	Efficiency	CP	DPM	Error (95% C.L.)
1	Ray Safe Assoc. 151	1	0.042	24	69.928%	1.00	0	0.00%
2	152	1	0.111	27	64.833%	1.00	0	0.00%
3	153	1	0.033	30	70.593%	1.00	0	0.00%
4	154	1	0.097	31	65.867%	1.00	0	0.00%
5	155	1	0.094	32	66.088%	1.00	0	0.00%
6	156	1	0.027	37	71.036%	1.00	0	0.00%

APPENDIX F

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

U.S. Nuclear Regulatory Commission
Division of Fuel Cycle, Medical, Academic,
and Commercial Use Safety
Washington, DC 20555

April 1993

The instructions in this guide, in conjunction with Table 1, specify the radionuclides and radiation exposure rate limits which should be used in decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table 1 do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control is considered on a case-by-case basis.

1. The licensee shall make a reasonable effort to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table 1 prior to the application of the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces of premises, equipment, or scrap which are likely to be contaminated but are of such size, construction, or location as to make the surface inaccessible for purposes of measurement shall be presumed to be contaminated in excess of the limits.

4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to, special circumstances such as razing of buildings, transfer of premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

   a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent and degree of residual surface contamination.

   b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment, or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table 1. A copy of the survey report shall be filed with the Division of Fuel Cycle Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, and also the Administrator of the NRC Regional Office having jurisdiction. The reports should be filed at least 30 days prior to the planned date of abandonment. The survey report shall:

   a. Identify the premises.

   b. Show that reasonable effort has been made to eliminate residual contamination.

   c. Describe the scope of the survey and general procedures followed.

   d. State the findings of the survey in units specified in the instructions.

Following review of the report, the NRC will consider visiting the facilities to confirm the survey.

TABLE I

ACCEPTABLE SURFACE CONTAMINATION LEVELS

NUCLIDES[a]	AVERAGE[b,c,f]	MAXIMUM[b,d,f]	REMOVABLE[b,e,f]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/[illegible]

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

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

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

[d] The maximum contamination level applies to an area of not more than 100 cm^2.

[e] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

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

APPENDIX G

CALIBRATION CERTIFICATES

FOR

RADIATION SURVEY INSTRUMENTS

UTILIZED IN

SCANNING SURVEY

ECOLOGY SERVICES, INC

10220 Old Columbia Road
Columbia, Maryland 21046
(410) 381-2600
1-800-932-7299
Fax (410) 381-2602

Certificate of Calibration

Calibrated on: 08.12.96 **Calibration Due:** 02.12.97

Job # 60589

Issued To:
Ray-Safe Associates
1916 Grayslake Drive
Silver Spring, Maryland 20906
Mike Terpilak
(301)598-5633

Instrument Identification:
Instrument Ludlum Model 2 SN 22331
Detectors
1 Ludlum Model 44-7 S/N PR05338

Calibration Data: mR/hr
Equipment J L Shepherd Model 28-5A
(SN 10245, 137Cs, 51 mRHM)

Scale/Range	Actual	As Found	Indicated	Correction
X 0 1	0 100	0 100	0 100	1 00
	0 400	0 400	0 400	1 00
X 1	1 00	1 00	1 00	1 00
	4 00	3 80	3 80	1 05
X 10	10 0	7 5	10 0	1 00
	40 0	31 0	40 0	1 00

Precalibration Checks:

Battery Reading	Bat Test
Detector Shield	Open
Condition Received	Good
Contamination Levels	[X] < 100 DPM
	[ ] > 100 DPM
Input Sensitivity	31 2 mV
High Voltage	880 V
Audio Response	Sat
Meter deflection/response	Sat
Zero adj	Zeroed
Reset Sw	Sat
Other	

Environmental Conditions:

Temperature (C)	22 03
Pressure (mmHg)	754 6
Relative Humidity (%)	58 64

Detector Response:

Detector Orientation	Perpendicular
Nuclide	NA
Nuclide S/N	NA
Efficiency	NA
Uncertainty	NA
Correction Factors	
a) Temp/Pressure	1 000
b) Branching Ratio	1 000
c) Geometry	1 000
d) Total	1 000

Check Source:

Nuclide	Unknown
Scale/Range	X 1
Indication	0.9 mR/hr

Serviced By [signature]

Reviewed By ESI Q.C. 1

Comments:

Ecology Services, Inc , certifies that the above instrument has been calibrated by standards traceable to the NIST, have been derived from accepted values of natural physical constants or have been derived by the ratio type of calibration technique The calibration system conforms to the requirements of MIL-STD-45662A, ANSI N323-1978, NCRP Report No 112, NRC Reg Guide 10 8 Rev 2, 1987 and 10 CFR Part 35

HPSI Corp and Affiliated Companies

1350 Piccard Dr, Suite 121, Rockville, MD 20850

(301) 670-1818
(800) 969-HPSI

CALIBRATION CERTIFICATE

cility U.S. Department of the Interior Date 4-5-96
Due 4-97

rvey Meter:
nufacturer Ludlum Model: 3 Serial #: 88228

obe:
nufacturer: Ludlum Model: 44-9 Serial #: 010560

librated [x] Cs-137 [ ] Electronic

ter zeroed [x] Operators check [x] Battery check [x] Internal Adjustment [ ]

Scale	Calculated Exposure Rate	Meter Reading	Correction Factor (C.F.)
X100	100 / 20	100 / 20	1.0
X10	10 / 2	10 / 2	1.0
x1	10 / 2	10 / 2	1.0
x.1	.10 / .02	.10 / .02	.1.0

Efficiencies

Isotope — % Efficiency —
Isotope ______ % Efficiency ______
Isotope ______ % Efficiency ______

ector center axis [ ] parallel [ ] perpendicular [x] to radiation field Beta shield: [ ] Open [ ] Close

rument check source: Scale: ______ Reading ______ HV applied to detector: ______

s instrument has been calibrated using procedures recommended by the U.S.N.R.C. and was ctioning correctly at the time of calibration with the following exceptions:

None

brated By Scott Benjamin (Md License No 31 035 01)

Victoreen, Inc.

VICTOREEN

[illegible] 161?

CALIBRATION DATA

RATE

	Range mR/h	Rate mR	Reading mR/h	% Error	Comments
Background	0 – [illegible]	[illegible]	0.011	N/A	
	0 – [illegible]	[illegible]	[illegible]	1.0?	Cal Point
	[illegible]	[illegible]		[illegible]	
	0 – [illegible]	[illegible]	[illegible]	0.[illegible]	Cal Point
	0 – [illegible]	[illegible]	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]	[illegible]	Cal Point
	[illegible]	[illegible]	[illegible]	[illegible]	

[illegible]	[illegible]	[illegible]		
0 – [illegible]	[illegible]	[illegible]	-1.8?	Cal Point
0 – 50	[illegible]	40.7	-0.9?	Cal Point

INTEGRATED

Range mR	Exposure mR	Reading mR		
[illegible]	[illegible]	[illegible]	[illegible]	Cal Point

[illegible] ______________________ [illegible]

[illegible] ______________________ [illegible]

[illegible]

Temperature [illegible]

Humidity [illegible]