NRC FORM 335 (2-89) NRCM 1102, 3201, 3202

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

(See instructions on the reverse)

1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, If any.)
NUREG/CR-5849
ORAU-92/C57

2. TITLE AND SUBTITLE

Manual for Conducting Radiological Surveys in Support of License Termination

Draft Report for Comment

3. DATE REPORT PUBLISHED

MONTH	YEAR
June	1992

4. FIN OR GRANT NUMBER
L1569

5. AUTHOR(S)

J.D. Berger

6. TYPE OF REPORT

7. PERIOD COVERED (Inclusive Dates)
N/A

8. PERFORMING ORGANIZATION – NAME AND ADDRESS (If NRC, provide Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)

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

9. SPONSORING ORGANIZATION – NAME AND ADDRESS (If NRC, type "Same as above"; if contractor, provide NRC Division, Office or Region, U.S. Nuclear Regulatory Commission, and mailing address.)

Division of Regulatory Applications
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555

10. SUPPLEMENTARY NOTES

11. ABSTRACT (200 words or less)

This document describes a process for conducting radiological surveys during decommissioning, to demonstrate that residual radioactive material satisfies criteria established by the U.S. Nuclear Regulatory Commission (NRC) for termination of a license. The manual describes procedures for design and conduct of surveys in a manner which will provide a high degree of assurance that NRC guidelines and conditions have been satisfied. The manual also describes methods for documenting the survey findings in a final report to the NRC. This manual updates information contained in NUREG/CR-2082, *Monitoring for Compliance With Decommissioning Termination Survey Criteria*, (ORNL 1981). It incorporates statistical approaches to survey design and data interpretation used by the Environmental Protection Agency for evaluation of hazardous materials sites under Superfund (CERCLA). Quality assurance is emphasized throughout.

12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.)

Decommissioning
Radiological Survey
License Termination

13. AVAILABILITY STATEMENT
Unlimited

14. SECURITY CLASSIFICATION
(This Page)
Unclassified
(This Report)
Unclassified

15. NUMBER OF PAGES

16. PRICE

NRC FORM 335 (2-89)

THIS DOCUMENT WAS PRINTED USING RECYCLED PAPER

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

AVAILABILITY NOTICE

Availability of Reference Materials Cited in NRC Publications

Most documents cited in NRC publications will be available from one of the following sources:

1. The NRC Public Document Room, 2120 L Street, NW., Lower Level, Washington, DC 20555
2. The Superintendent of Documents, U.S. Government Printing Office, P.O. Box 37082, Washington, DC 20013-7082
3. The National Technical Information Service, Springfield, VA 22161

Although the listing that follows represents the majority of documents cited in NRC publications, it is not intended to be exhaustive.

Referenced documents available for inspection and copying for a fee from the NRC Public Document Room include NRC correspondence and internal NRC memoranda; NRC bulletins, circulars, information notices, inspection and investigation notices; licensee event reports; vendor reports and correspondence; Commission papers; and applicant and licensee documents and correspondence.

The following documents in the NUREG series are available for purchase from the GPO Sales Program: formal NRC staff and contractor reports, NRC-sponsored conference proceedings, international agreement reports, grant publications, and NRC booklets and brochures. Also available are regulatory guides, NRC regulations in the *Code of Federal Regulations*, and *Nuclear Regulatory Commission Issuances*.

Documents available from the National Technical Information Service include NUREG-series reports and technical reports prepared by other Federal agencies and reports prepared by the Atomic Energy Commission, forerunner agency to the Nuclear Regulatory Commission.

Documents available from public and special technical libraries include all open literature items, such as books, journal articles, and transactions. *Federal Register* notices, Federal and State legislation, and congressional reports can usually be obtained from these libraries.

Documents such as theses, dissertations, foreign reports and translations, and non-NRC conference proceedings are available for purchase from the organization sponsoring the publication cited.

Single copies of NRC draft reports are available free, to the extent of supply, upon written request to the Office of Administration, Distribution and Mail Services Section, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

Copies of industry codes and standards used in a substantive manner in the NRC regulatory process are maintained at the NRC Library, 7920 Norfolk Avenue, Bethesda, Maryland, for use by the public. Codes and standards are usually copyrighted and may be purchased from the originating organization or, if they are American National Standards, from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

DISCLAIMER NOTICE

NUREG/CR–5849
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

ABSTRACT

This document describes a process for conducting radiological surveys during decommissioning, to demonstrate that residual radioactive material satisfies criteria established by the U.S. Nuclear Regulatory Commission (NRC) for termination of a license. The Manual describes procedures for design and conduct of surveys in a manner which will provide a high degree of assurance that NRC guidelines and conditions have been satisfied. The manual also describes methods for documenting the survey findings in a final report to the NRC. This Manual updates information contained in NUREG/CR-2082, *Monitoring for Compliance With Decommissioning Termination Survey Criteria*, (ORNL 1981). It incorporates statistical approaches to survey design and data interpretation used by the Environmental Protection Agency for evaluation of hazardous materials sites under Superfund (CERCLA). Quality assurance is emphasized throughout.

Contents

Page

Page

List Of Figures

List Of Tables

ACKNOWLEDGEMENTS

This Manual was a collaborative effort by the staff of the Environmental Survey and Site Assessment Program (ESSAP) of Oak Ridge Associated Universities. In addition to writing certain sections, James Berger and Laurence Friedman were responsible for the overall planning, technical review, and management of this project. Other technical contributors include Wade Adams, Dale Condra, Phyllis Cotten, Michele Landis, Ann Payne, Betty Smith, Clayton Weaver, and George Foltz of the ESSAP staff. Charles Comiskey was consulted to provide expertise in statistical concepts associated with the sampling plan design. Gail Lee joined the ESSAP staff as the technical writer for this project. Anna Robinson, Jody Shumpert, Tammy Claiborne, and Elaine Waters provided most of the word processing support.

Special thanks to Jim Malaro who served as the NRC Technical Monitor for this project, and to Christine Daily, David Fauver, Edward Shum, and Lee Abramson, and other members of the NRC staff, who provided support and guidance in critical areas throughout the planning phases and actual writing of this Manual.

1.0 INTRODUCTION

Sites that use radioactive material for any activity — manufacturing, research and development, education and training, or power production — all face the same eventuality:

- That activity will one day be concluded, and
- Precautions must be taken to ensure that future occupants and the environment are not subjected to unacceptable risks from residual radioactivity.

Many operations which have the potential to pose radiological risks are licensed by the U.S. Nuclear Regulatory Commission (NRC). As part of its regulatory responsibilities, the NRC has also established requirements for ceasing operations, removing residual radioactivity, and terminating the license. This process is known as **decommissioning**. Generally, in order for a license to be terminated the residual radioactivity must satisfy criteria which the NRC has determined to be environmentally acceptable. These criteria, known as **release criteria**, include numerical guideline levels for direct radiation radioactivity in soil and on surfaces and a set of conditions for applicaton of the guidelines. If the residual activity concentrations and amounts are below the release criteria, a site is considered acceptable for **unrestricted use**, i.e. without need for future radiological controls. The release criteria NRC has been using for license termination include those found in the following:

- Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors* (NRC 1974),
- *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Materials* (NRC 1987), Office of Nuclear Material Safety and Safeguards (NMSS), and
- *Branch Technical Position for Disposal or Onsite Storage of Thorium or Uranium Water from Past Operations* (46 FR 52061, October 23, 1981).

A site or facility is considered to be **contaminated**, when the radioactivity levels exceed the established release criteria. Usually, a site ceasing licensed operations can be adequately **decontaminated**, or **remediated**, i.e. the residual contamination reduced to acceptable levels for unrestricted release. However, some situations are encountered where decontamination to release criteria is not practical (for example, where the quantity of contaminated material is extremely large). In these cases, an alternative method of closure will be developed. An example of such a case is the cleanup of uranium mill tailings by stabilizing them in an engineered containment cell.

Over the years, many licensed sites used as facilities have been decommissioned. Occasionally, however, follow-up surveys have revealed residual radioactive contamination at levels exceeding the release criteria. This condition was usually attributed to an inadequate final radiological survey; problems primarily resulted because:

- Contaminated portions of the site were not all adequately surveyed, and/or
- Survey equipment and techniques were either inappropriate or were not sufficiently sensitive to measure specific potential contaminants at the levels established for release.

In addition, documentation was often incomplete, preventing independent assessment of conditions. The need for more detailed instructions for both performing and documenting a final survey in support of license termination became apparent.

1.1 Purpose

This Manual, contains procedures for conducting radiological surveys during decommissioning, to demonstrate that residual radioactive material satisfies release criteria. The purpose of this Manual is to assist the licensee in:

- Designing and conducting radiological surveys in a manner which will provide a high degree of assurance that NRC criteria have been satisfied, and
- Documenting the survey findings in a final survey report to NRC.

This Manual updates information contained in NUREG/CR-2082, *Monitoring for Compliance With Decommissioning Termination Survey Criteria*, (ORNL 1981). It incorporates statistical approaches to survey design and data interpretation, used by the Environmental Protection Agency for evaluation of hazardous materials sites under Superfund (CERCLA). Quality assurance is emphasized throughout. Survey methodologies described in the Manual utilize state-of-the-art, commercially available

instrumentation and procedures for conducting radiological surveys for decommissioning purposes.

Although this Manual is written primarily to assist the licensee in conducting radiological surveys for decommissioning purposes, its principles and methodologies will be useful for conducting other types of radiological surveys performed by licensees, NRC inspectors, and their contractors. It may also be useful for advanced planning by current nuclear facility operators or by those in the process of bringing a new facility on line. Surveys for certain purposes, however, such as providing radiological control in an operating facility; determining suitability for release or recycle of contaminated material; and designing decontamination or remedial actions plans, are outside the scope of this document.

1.2 Using This Manual

This Manual is intended to provide instructions for performing survey procedures that will generate sound data to support a facility's license termination application. It has been assumed that the user possesses a basic knowledge of radiation terms and fundamentals because, without such a background, authorization to possess and use radioactive material would not have been granted by the NRC. The Manual could not presume to anticipate all the possible combinations of operational, geological, financial, and personnel constraints that may affect each site's decommissioning process. Nevertheless, the basic steps that are required for decommissioning, regardless of the complexity of the facility, are outlined in the Manual (Section 2.0), and survey activities related to those various decommissioning steps are described.

The sections in the Manual are modular, and each module contains information related to a particular aspect of the surveys in support of the license termination process. While this modular approach creates some redundancy in information, it should allow each reader to concentrate only on those portions of the Manual that apply to his or her responsibilities. In addition, since the procedures within each module are listed in order of performance, options are provided to guide the user past portions of the Manual that may not be specifically applicable to his/her particular situation. Where appropriate, checklists, which condense and summarize each major point in the procedure, are provided. These checklists may be used to verify that all suggested procedures were followed or used to flag a condition where documentation would be required to explain why that step was unnecessary.

Examples of calculations are included to assist the user in application of the various mathematical formulae. A glossary of terms used in this Manual is provided in Section 12.0. Finally, a sample survey plan and a sample final survey report for a hypothetical reference uranium fuel fabrication facility, based on the methodologies and procedures presented in this Manual, are provided as Appendices C and D, respectively.

Throughout the manual, specific parameter values (e.g. grid sizes) are specified for use when conducting and documenting surveys. This is done to encourage standardization to the extent practicable and to facilitate evaluation of survey results. Where the parameter used is critical to the quality of the survey or is specified to ensure a minimum level of statistical accuracy, this is so stated. However, in many cases parameter values were selected either because they have become standard practice over the years and there appears to be no compelling reason to change them, or because the authors have found them to be practical, based on extensive field experience in conducting and documenting these types of surveys. Users are encouraged to comment on the usefulness of parameter values in this draft manual and to suggest alternatives.